LNICST

Weina Fu
Shuai Liu
Jianhua Dai (Eds.)

390

LNICST

e-Learning, e-Education, and Online Training

7th EAI International Conference, eLEOT 2021
Xinxiang, China, June 20–21, 2021
Proceedings Part II

Part 2

EAI

Springer

Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering 390

More information about this series at http://www.springer.com/series/8197

Weina Fu · Shuai Liu · Jianhua Dai (Eds.)

e-Learning, e-Education, and Online Training

7th EAI International Conference, eLEOT 2021
Xinxiang, China, June 20–21, 2021
Proceedings Part II

Springer

Editors
Weina Fu
Hunan Normal University
Changsha, China

Shuai Liu
Hunan Normal University
Changsha, China

Jianhua Dai
Hunan Normal University
Changsha, China

ISSN 1867-8211 ISSN 1867-822X (electronic)
Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering
ISBN 978-3-030-84385-4 ISBN 978-3-030-84386-1 (eBook)
https://doi.org/10.1007/978-3-030-84386-1

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

We are delighted to introduce the proceedings of the Third European Alliance for Innovation (EAI) International Conference on e-Learning, e-Education, and Online Training (eLEOT 2021). This conference brought together researchers, developers, and practitioners from around the world who are leveraging and developing e-educational technologies as well as related learning, training, and practice methods. The theme of eLEOT 2021 was “The Educational Revolution: Opportunities and Challenges Brought by COVID-19”.

The technical program of eLEOT 2021 consisted of 104 full papers, including 2 invited papers, in oral presentation sessions at the main conference tracks: Track 1 – New Trends of Teaching: Evaluation, Reform, and Practice and Track 2 – Intelligent Learning and Education. The technical program also featured two keynote speeches. “Artificial Intelligence Computing Solutions and Applications”, given by Xiaochun Cheng from Middlesex University, UK, reviewed the rational, the potential, and the limitations of relevant AI computing solutions and AI applications, and discussed how new and better AI applications could be developed in the future by integrating diverse AI computing solutions.

“Blockchain-based Secure Data Sharing Platform in IoT”, given by Jin Li from Guangzhou University, China, looked at a data incentive mechanism to provide data privacy and fairness measures for users in IoT, providing two different constructions of the proposed mechanism, and analyzing their performances on privacy protection and transaction efficiency.

Coordination with the steering chairs, Imrich Chlamtac, Bruno Kesler, and Giovanni Vincenti, was essential for the success of the conference. We sincerely appreciate their constant support and guidance. It was also a great pleasure to work with such an excellent organizing committee team for their hard work in organizing and supporting the conference. In particular, we are grateful to the Technical Program Committee (TPC), led by our TPC chair, Guanglu Sun, who completed the peer-review process for the technical papers and put together a high-quality technical program. We are also grateful to the conference manager, Elena Davydova, for her support and to all the authors who submitted their papers to the eLEOT 2021 conference.

We strongly believe that the eLEOT conference provides a good forum for all researchers, developers, and practitioners to discuss all science and technology aspects that are relevant to e-learning and e-education. We also expect that the future editions of the conference will be as successful and stimulating as eLEOT 2021, as indicated by the contributions presented in this volume.

July 2021

Weina Fu
Shuai Liu
Jianhua Dai

Organization

Steering Committee

Chair

Imrich Chlamtac	University of Trento, Italy

Co-chairs

Bruno Kesler	University of Trento, Italy
Giovanni Vincenti	University of Baltimore, USA

Organizing Committee

General Chair

Shuai Liu	Hunan Normal University, China

Technical Program Committee Chair

Guanglu Sun	Harbin Univerity of Science and Technology, China

Special Issue Chair

Gautam Srivastava	Brandon University, Canada

Panel Chair

Arun Kumar Sangaiah	Vellore Institute of Technology, India

Session Chair

Zeguang Lu	National Academy of Guo Ding Institute of Data Sciences, China

Publications Chair

Khan Muhammad	Sejong University, South Korea

Tutorials Chair

Tao Li	Hunan Normal University, China

Web Chair

Weina Fu	Hunan Normal University, China

Publicity and Social Media Chair

Lei Chen	Georgia Southern University, USA

Local Chair

Junna Zhang	Henan Normal University, China

Technical Program Committee

Shui-Hua Wang	Loughborough University, UK
Amin Taheri-Garavand	Lorestan University, Iran
Khan Muhammad	Sejong University, South Korea
Gautam Srivastava	Brandon University, Canada
Dang Thanh	Hue Industrial College, Vietnam
Thippa Reddy Gadekallu	Vellore Institute of Technology, India
Uttam Ghosh	Vanderbilt University, USA
Norbert Herencsar	Brno University of Technology, Czech Republic
Hari Mohan Pandey	Edge Hill University, UK
Jerry Chun-Wei Lin	Western Norway University of Applied Sciences, Norway
Ashutosh Dhar Dwivedi	Technical University of Denmark, Denmark
Adam Zielonka	Silesian University of Technology, Poland
Marcin Woźniak	Silesian University of Technology, Poland
Arun Kumar Sangaiah	Vellore Institute of Technology, India
Ping Yu	Jilin University, China
Mu-Yen Chen	National Cheng Kung University, Taiwan
Xiaochun Cheng	Middlesex University, UK
Fida Hussain Memon	Jeju National University, South Korea
Wu-xue Jiang	The Education University of Hong Kong, Hong Kong
Dan Zhang	Xinyang Vocational and Technical College, China
Dongye Liu	Inner Mongolia University, China
Fanyi Meng	Harbin Institute of Technology, China
Feng Chen	Xizang Minzu University, China
Fu Guang Guo	Henan Vocational College of Industry and Information Technology, China
Guanglu Sun	Harbin University of Science and Technology, China
Tenghui He	Hunan Normal University, China
Heng Li	Henan Finance University, China
Jian Feng Cui	Xiamen University of Technology, China
Keming Mao	Northeastern University, China
Lei Ma	Beijing Polytechnic, China
Shuai Wang	Hunan Normal University, China
Xiaogang Zhu	Nanchang University, China
Xin Chun Zhou	Baoji University of Arts and Sciences, China

Xinyu Liu	Hunan Normal University, China
Xuan Yue Tong	Nanyang Institute of Technology, China
Yan Ning Zhang	Beijing Polytechnic, China
Yong Jun Qin	Guilin Normal College, China

Contents – Part II

Internet of Things and Collaborative Computing

Contents – Part I

Design and Development of Online Education System

Design of Online Multimodule Educational Administration System Based on Time Difference Database Technology

Jun-mei Li[1](✉) and Yong-lan Yan[2]

[1] School of Computer Engineering, Jingchu University of Technology, Jingmen 448000, China
[2] Guangzhou College of Technology and Business, Guangzhou 510850, China

Abstract. At present, the online multi-module educational administration system is poorly targeted, resulting in low retrieval accuracy. In order to solve the above problems, a new online multi-module educational administration system is designed, and the hardware and software of the system are designed. The hardware of the system consists of a computer carrier and its supporting peripherals, an information collector, a central data processor and communication equipment. The internal storage recording instrument of the hardware is equipped with an FTP server, and the network can view, download and delete data at any time. The remote control can also control the operation status of the collection and storage tasks. Mainly through Tomcat 7.0 server, using the Java language to compile software program code, build a hierarchical framework system to achieve software work. The experimental results show that the designed online multi-module educational administration system has stronger information retrieval ability and higher retrieval precision.

Keywords: Time difference database · Online educational administration · Multi-module educational administration · Educational administration system

1 Introduction

The rapid development of computer and network technology has triggered the global digital frenzy, which has played a huge role in promoting the development of social economy. What followed was a fundamental change in the way people access, communicate, and process information. While the society changes at full speed, it also brings new opportunities and challenges to the educational administration management in colleges and universities. To realize the networking of university campus, network construction is the basic and various management information system construction is the core. How to make use of the existing educational resources to quicken the pace of networked university construction, make the campus network keep up with the pace of school reform, and do a better job in basic services for students and teachers is the core task of digital campus construction [1, 2].

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 3–15, 2021.
https://doi.org/10.1007/978-3-030-84386-1_1

The object of educational administration management is the basic information of every student and teacher and the related information of daily educational administration. These messages are in constant flux. Therefore, the educational administration management information system should be able to provide the sufficient information, the quick inquiry method and the on-line processing educational administration function for the user. At the same time, the Academic Affairs Office should provide accurate statistical data for the superior departments. Due to the large number of staff, complex data sources and difficult statistical management work, in the past, each work needs to spend a lot of energy and time, the statistical data is often not accurate [3, 4]. Therefore, the informationization of educational administration is to focus on solving these problems.

To sum up, this paper introduces TDOA database technology to design a new online multi-module educational system, and designs the hardware and software of the system, and validates the effectiveness of the system.By building collectors, the storage has strong compatibility and storage space; Through the hierarchical design of the retrieval process, the retrieval accuracy is higher; Xgboost algorithm is introduced, and the second-order Taylor function is added to the gradient lifting iterative decision tree algorithm to improve the speed and accuracy of xgbost algorithm for data file classification.Compared with the traditional method, it has faster information retrieval speed and higher retrieval accuracy, saving a lot of manpower and material resources.

2 Hardware Design of Online Multimodule Educational Administration System Based on Time Difference Database Technology

The design of online multi-module educational administration system based on TDOA database technology mainly uses Tomcat 7.0 server to compile the software code by using Java language, and constructs the hierarchical framework of the system. The hierarchy structure is shown in Fig. 1:

According to Fig. 1, the design of online multi-module educational administration system based on TDBMS is mainly divided into three layers: the first layer is the information display layer. Mainly responsible for the customer and the operator to the art course assistant system access, as well as page information browsing and related task operation, is the client main contact application system level, the second layer is the network processing layer. Through the use of the server network supported by the principal computer to analyze the information needs of customers and operators, and transmit the analysis results to the third layer for logical examination and correlation analysis, the requirements that meet the requirements of network rules can be obtained through examination and retrieval of the relevant data to meet the customer needs; the third layer is the data application layer, which is the highest and most core level of the whole system structure. Mainly responsible for receiving the relevant requirements information transmitted to the second layer, carrying out logical operation and relevant content analysis, and managing the data of the whole system, including data analysis, classification, inspection, storage and other tasks, and also responsible for the detection of system problems, maintenance and system update [5].

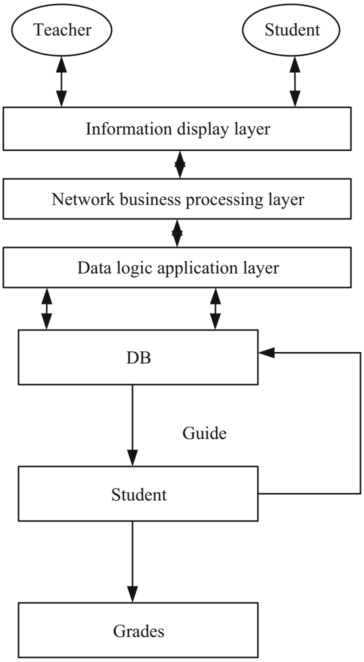


Fig. 1. Hierarchical framework of online multimodule educational administration system based on TDBMS

The hardware part of online multi-module educational administration system based on TDOA database technology is mainly computer carrier and its peripherals, information collector, central data processor and communication equipment. The hardware

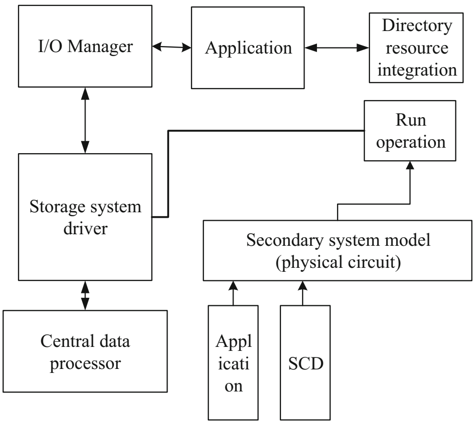


Fig. 2. Hardware structure of online multimodule educational administration system based on time difference database

structure of online multi-module educational administration system based on TDOA database technology is shown in Fig. 2:

According to Fig. 2, the basic computer equipment is Windows 10 processing system, Tomcat 7.0 server, Oracle 10 database, 360 GB disk memory, 4 GB running memory, supporting mobile network, wireless network and broadband, supporting TCP/IP network communication protocol computer server. Infrastructure based on this computer configuration and designed for the system, communication links with external information collectors and communication devices through LAN or mobile networks, supported by network protocol rules [6, 7].

Hardware peripherals are mainly composed of information collector and communication devices. Because of the complexity, large scale and various sources of the information database of fine arts courses, it is necessary to enrich and arrange the database of fine arts courses information retrieval system by information collector, which is mainly responsible for extracting and saving the information related to fine arts from a large number of web sites or related platforms to the structured information database. Therefore, the collector needs to be strong enough in compatibility and adaptability, as well as large enough information storage space. The collector structure is shown in Fig. 3:

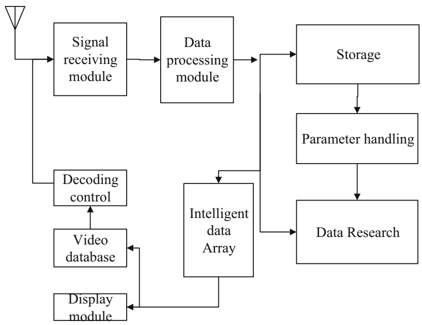


Fig. 3. Collector structure

This article selects the multifunctional data acquisition instrument, each way of independent amplification 1–1000 times; can choose the corresponding operation mode according to the software characteristic (DC/AC voltage/ICP adaptable with constant current source), strong adaptability; can support GPS synchronization, support mobile network and wireless network communication, can access all the website information allowed by the Internet under the communication protocol support; 12/16/24 bit models are complete, can measure UV signal; each way can set gain, can measure IEPE input, can measure rotate speed, can increase D/A, arbitrary signal generator, DDS frequency synthesizer [8]. The multifunctional harvester is shown in Fig. 4 below:

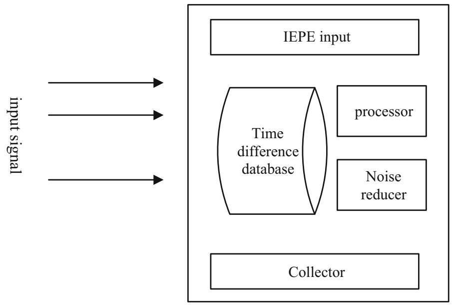


Fig. 4. Structure of multifunctional acquisition instrument

In addition, in order to ensure the normal operation of data acquisition and storage, a large capacity data acquisition recorder is configured, which can be used for offline independent acquisition and storage, as well as real-time acquisition and transmission. The internal storage capacity is up to 512 gb. The memory chip adopts the storage medium with small volume and large space (which can be expanded to 1 TB) and occupies almost no space, reducing the waste of space volume [9]. The circuit diagram of the acquisition instrument is shown in Fig. 5.

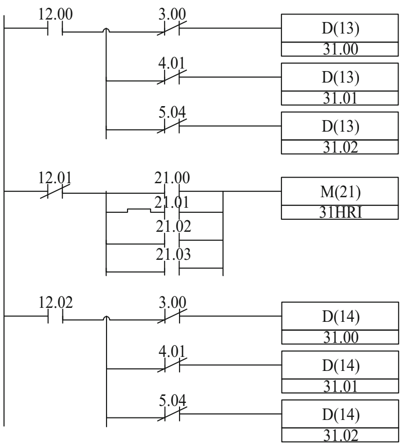


Fig. 5. Circuit diagram of acquisition instrument

The three core components of a computer server are the CPU central data processor, internal memory, and input/output devices. The main function of the central processing unit is to interpret the computer instructions and process the data in the computer software, read the instructions, decode and execute the instructions, control and allocate all the hardware resources of the computer (such as memory, input and output units), and perform general operations. The computer server circuit diagram is shown in Fig. 6:

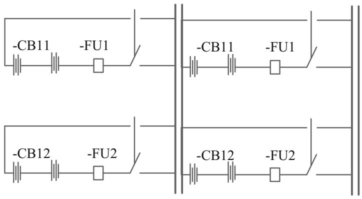


Fig. 6. Computer server circuit diagram

The central processing unit consists of two main parts: the controller and the arithmetic unit. It also includes the cache memory and the data and bus to realize the connection between them. In general, the central data processor is primarily responsible for processing instructions, executing operations, controlling time, and processing data for the information retrieval system [10]. The central processing unit controls other parts of the computer through the control circuit. The data information collected by the information collector is transmitted to the central processing unit of the computer server through the communication device for data processing. The data is transmitted orderly through the input unit, and the analyzed and processed data is transmitted outwards through the output unit or is transmitted to the memory for data backup and storage. The output information or instruction is then transmitted to the corresponding peripheral terminal through the communication device to execute the instruction task.

3 Software Design of Online Multimodule Educational Administration System Based on Time Difference Database Technology

After completing the hardware design of the system, the work flow of the online multimodule educational administration system is shown in Fig. 7 according to the system hardware and software flow.

According to the above data retrieval flow, the software retrieval is completed by information analysis, keyword data analysis, data retrieval, judging whether the retrieval results are appropriate and data input. Specific retrieval steps as follows.

Step 1: Course Management. Curriculum management is mainly responsible for the management of online art courses, and arranging the time of online courses by integrating the relevant information of teachers and students [11]. Because the system curriculum content is rich and diverse, the curriculum change will cause the bigger influence, therefore, the curriculum content and the time arrangement must be rigorous and reasonable, avoids many time changes. Confirm the course information input system course management interface, facilitate the relevant personnel inquiry understanding. At the same time, the corresponding course editing function should be designed so that the staff or clients can customize some information of the course, which is conducive to the development of the system. Also equipped with the corresponding notification function, users can get timely information on the course to inform, so that users can better respond to course adjustments, updates and so on.

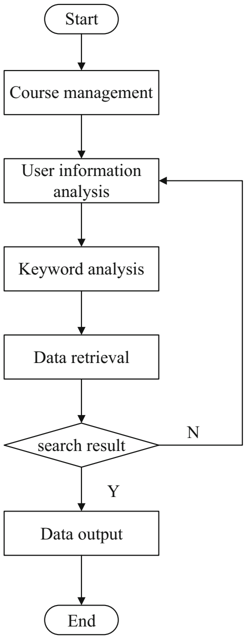


Fig. 7. Workflow of multimodule educational administration system

Step 2: Information Retrieval. Information retrieval is the most important function of the online art course assistant system [12], which is mainly responsible for analyzing the information needs of users, and then retrieving the related contents according to the analysis results. Firstly, the system searches the information in its own database. The information that can not be found is searched through the network communication to the Internet website and platform, and the information is obtained if the access authority permits, and saved in its own database to improve the system's data information resources. The acquired information resource is transmitted to the user's terminal interface through the information transmission line, and then the user can operate the information resource within the scope of authority. The information retrieval operation is shown in Fig. 8:

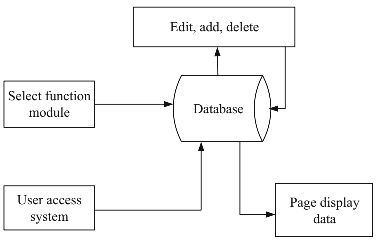


Fig. 8. Information retrieval operation process diagram

Part III: User information analysis. User information analysis is mainly responsible for system user login and information management. Users use the system, first of all to register the login account applied to the system, and set the password and related security issues, to strengthen the confidentiality of the account [13]. Then need to carry on the real name authentication, facilitates the curriculum study and the user management, prevents the appearance to defraud the account to cause the threat to other users. After registration, users have their own user center to edit and manage the information, which can record the user's learning, interest, style and other related information, enhance the system's personalized characteristics, and facilitate the system to supervise and manage the user's operation to some extent, and standardize the system's application order. At the same time, according to the user's identity there are different permissions, administrators than ordinary users for more administrative permissions, such as part of the information management, local interface access and curriculum information modification.

Step 4: System management. System management module is responsible for the information management of the whole system, including user operation, data processing, access to other platforms and so on [14]. Its core is the computer central processing procedure, carries on the total control to system each aspect content. Its control operation part mainly compiles through the Java code.

Step 5: Data storage. The data storage takes the computer disk as the main carrier and is connected with the information retrieval function module. Users through the login account, to access the database, according to the user's corresponding authority to find or edit data resources and other operations.

Web browsers in the software area are encrypted by special codes to ensure the security of the data stored in the management and control system. The login page of the system software part is registered by the user's registered mobile phone number, and the student enters the system browser visible to the student, and the student enters the teacher's login browser through the same login page. Through the mutual adjustment between the database of software system and each module of hardware area, the operation of browsers is maintained, and the stable operation of system and the safety of file data are guaranteed.

The ultimate goal of designing the hardware area of educational administration system is to ensure the system security and improve the system efficiency. Therefore, in order to achieve the design goal [15], this paper presents the XGBoost algorithm to assist the system management and control function. The XGBoost algorithm is an optimized distributed gradient computation integration algorithm. The idea of the algorithm is derived from the gradient lift iterative decision tree. The second order Taylor function is added to the gradient lift iterative decision tree algorithm to improve the speed and accuracy of XGBoost algorithm in classifying data files. The algorithm is specifically completed by using the following formula:

$$y_i = \theta(x_i) = \sum_{k=1}^{k} f_k(x_i) \tag{1}$$

Among them, k is the total number of data in XGBoost submodel, y_i is the predictive value of uankong data sample, x_i is the characteristic value of input file data, f_k is the controlled regression value of the algorithm's kth period.

In order to calculate the weights of each file data, [16] we use the Taylor function to normalize the initial input data and avoid the confusion of the data.

$$0 = 1(y, y_i) + \sum_{k=1}^{k} \beta(f_k) \tag{2}$$

In the standard model, $1(y, y_i)$, 0 represents the difference between the predicted value of the previous formula and the recorded value of the actual data, the normalized processing coefficient and the positive value after calculating the weights of the data, so as to prevent confusion among the data [17]. The final simplified formula of the XGBoost algorithm is shown as follows: through the superposition calculation of multiple data, the formula 1 and formula 2 are fused, the predicted values of the iterative samples of the data are brought into the loss function [18–20], and the results are multiplied by the normalization coefficient:

$$\mathrm{o}^{\mathrm{t}} = \sum_{\mathrm{i}=1}^{\mathrm{N}} 1\left(\mathrm{y_i}, \mathrm{y}^{\mathrm{t}-1} + \mathrm{g_i f_i(x_i)} + \frac{1}{2}\mathrm{h_i y_i(x_i)}\right) + \beta(\mathrm{f_i}) \tag{3}$$

Based on Formula 1, the input data is compared with the data in the system database, and if the same type of medical record information is retrieved, it is stored in the same storage space to facilitate the operation of information call. According to Formula 2, the redundant data of decision tree are integrated and classified. Finally, the final management classification of data is accomplished by Formula 3.

4 Experimental Research

In order to verify the effectiveness of the online multi-module educational administration system based on TDOA database proposed in this paper, experimental comparison is made with the traditional system.

The experimental parameters are set as Table 1:

Table 1. Experimental parameters

Project	Parameter
The server	Nginx1.0.15 server
data type	Static data/dynamic data
Operating system	Lniux operating system
Interaction mode	Web database interaction
Response mechanism	Pageinit response mechanism

According to the above experimental parameters, the system in this paper is compared with the traditional system. The experimental results are shown in Fig. 9.

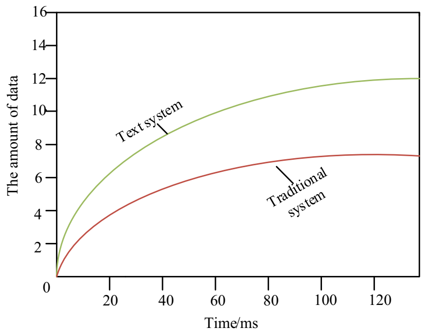


Fig. 9. Experimental results of retrieval capability

According to Fig. 9, the retrieval ability of online multi-module educational administration system based on TDBMS is better than that of traditional system, and the ability of grasping keywords is better. The retrieval system in this paper introduces Oracle 10 database and expands the scope of the database. Oracle 10 database has the ability of data analysis, can record the data and integrate all the data words into the database for the convenience of the users. In the process of retrieval, the system can quickly analyze the keywords, and search in the database, through the search of data information and feedback information, generate effective independent data, all independent data at the same time in the same time, in a way of feedback to a number of principles, according to their own specific content to choose each other, so as to achieve a diversified information retrieval. The server document designed in this paper also has the function of data extraction. XML documents inside the system can feed back information to users in real time to help users better analyze data.

The results of the precision experiments are shown in Table 2:

Table 2. Accuracy test results

System	Number of search terms	Number of related entries
The paper system	1589	1572
Based on data mining system	1241	1109
Based on data analysis system	1025	822

Compared with the experimental results in Table 2, the data retrieval ability of the system proposed in this paper is stronger, and the system proposed in this paper is better than the traditional system in terms of the amount of retrieval data and retrieval accuracy. When searching for the same keywords, the system proposed in this paper has the largest number of retrieval terms and keywords, of which the relevance between the retrieved terms and keywords is as high as 98.93%, the data relevance of the traditional data mining system is 89.36%, and the data relevance of the traditional data analysis system is 80.19%.

At the same time, the file transmission task is assigned at this time, and the files are transmitted centrally according to different transmission directions. The security degree of the transferred files is compared, and the control security rate comparison table is constructed as follows (Tables 3 and 4):

Table 3. Result table of system design control safety rate

Control time/s	Control safety rate
20	88%
40	94%
60	97%
80	99%

Table 4. Results of traditional system design control safety rate

Control time/s	Control safety rate
20	67%
40	78%
60	82%
80	86%

To sum up, the online multi-module educational administration system based on TDOA database proposed in this paper has strong file management and control performance, can process complicated file information to a certain extent, and can continuously provide file inspection service by querying accurate separate files in the complex information flow, and can provide a solid data operation basis for subsequent research operations.This is because the design of the system through the application of xgbost algorithm for distributed gradient calculation, improve the speed and accuracy of data file classification, avoid data confusion.

5 Concluding Remarks

Based on the analysis of the characteristics of the current online system application and users' use, this paper designs the online multi-module educational administration system based on TDB, introduces the basic hardware facilities of the system, and compiles the main software programs in Java language, and reasonably designs the application modules of the system, which is beneficial to the intelligent and personalized development of the information automatic retrieval system and the development and progress of the field of information education technology in our country.

References

1. Qingjia, M., Chenhui, W., Wei, G.: Design of the landslide multi-factor monitoring system based on the GNSS technology. In: MATEC Web of Conferences, vol. 306, no. 1, p. 03003 (2020)
2. Zhang, Q., Kong, X.: Design of automatic lung nodule detection system based on multi-scene deep learning framework. IEEE Access **8**(7), 90380–90389 (2020)
3. Asuncion-Astronomo, A., Hila, F.C., Dingle, C.A.M., et al.: Design of a multi-shell portable neutron spectrometry system based on indium foil detectors. Radiat. Meas. **132**(9), 106248 (2020)
4. Zhang, P., Wang, D., Zhang, J.: Construction of a cloud-based mold manufacturing system based on JAFMAS. J. Phys.: Conf. Ser. **1699**(1), 012021 (2020). (9pp)
5. Cui, T., Zhao, W., Wang, C.: Design optimization of vehicle EHPS system based on multi-objective genetic algorithm. Energy **179**(JUL.15), 100–110 (2019)
6. Jianqiu, L.: Construction of real-time interactive mode-based online course live broadcast teaching platform for physical training. Int. J. Emerg.Technol. Learn. (iJET) **13**(06), 73 (2018)
7. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
8. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
9. Gang, W., Zhikai, Z., Yongjie, N.: Design of compressed sensing algorithm for coal mine IoT moving measurement data based on a multi-hop network and total variation. Sensors **18**(6), 1732 (2018)
10. Rodriguez-Alabanda, O., Guerrero-Vaca, G., Romero, P.E., et al.: Educational software tool based on the analytical methodology for design and technological analysis of multi-step drawing processes. Comput. Appl. Eng. Educ. **27**(1), 38–48 (2019)
11. Liu, Z.H., Peng, Q.L., Li, X., et al.: Acoustic emission source localization with generalized regression neural network based on time difference mapping method. Exp. Mech. **60**(2), 979–694 (2020)
12. Liu, Z., Peng, et al.: Time difference mapping method for locating the acoustic emission source in a composite plate. Chin. J. Acoust. **38**(04), 124–137 (2019)
13. Xue, N., Yang, J., Shen, D., et al.: The location of partial discharge sources inside power transformers based on TDOA database with UHF sensors. IEEE Access **PP**(99), 1 (2019)
14. Nabil, A., Abdelfatah, M.A., Mousa, A., et al.: Tropospheric mapping function model for Egypt, as derived from precise tropospheric delay database (2019)
15. Bellinaso, M.D., Soares, F., Rocha, R.: Do bulk-fill resins decrease the restorative time in posterior teeth? A systematic review and meta-analysis of in vitro studies. J. Invest. Clin. Dentistry **10**, e12463 (2019)
16. Guglin, M., Omar, H.R.: Right atrial pressure predicts mortality among LVAD recipients: analysis of the INTERMACS database. Heart Lung Circ. (2020)
17. Emami, N., Heinonen, J., et al.: A life cycle assessment of two residential buildings using two different LCA database-software combinations: recognizing uniformities and inconsistencies. Buildings **9**, 20 (2019)
18. Suchman, K.I., Poeran, J., Huang, H.H., et al.: Are histological examinations of arthroplasty specimens performed consistently across the country? A large database study. Clin. Orthop. Relat. Res. **2019**, 477 (1815)

19. Ogino, Y., Schmidt, A.J.: Impact of class-level labelling change on prescriptions of antidepressants for adolescents: an interrupted time-series study using a health insurance claims database in Japan, 2005–2013. PLOS One **15**, e0243424 (2020)
20. Abraham, H.G., Xia, Y., Mukherjee, B., et al.: Incidence and survival of inflammatory breast cancer between 1973 and 2015 in the SEER database. Breast Cancer Res. Treat. **185**(12) (2021)

Chemical Structure Data Retrieval Algorithm for Chemistry Online Teaching

Guang-min Jiang[1](✉), Xin Dai[2], and Wei Hou[2]

[1] Teng Zhou Vocational Education Centre, Teng Zhou 277500, China
[2] Zaozhuang Vocational College of Science and Technology, Zaozhuang 277500, China

Abstract. In the process of chemical network education, there are some problems in chemical molecular structure retrieval, such as low retrieval efficiency and slow retrieval speed, which can not meet the needs of teaching. Therefore, a large-scale chemical structure data retrieval algorithm is proposed for chemistry online teaching. Through the analysis of the chemical data, the chemical structure of the molecule was obtained. Using JSP technology and driver, the retrieval speed is improved. In the process of chemistry online teaching, large-scale chemical structure data can be retrieved. Through the comparative experiment, the retrieval speed and efficiency are taken as the experimental indexes. The retrieval speed ratio of this method is more than 2.3, and the retrieval time is about 100 s.

Keywords: Online teaching · Chemical structure · Data retrieva · Molecular structure

1 Introduction

Under the current novel coronavirus pneumonia, many schools are facing the reform of offline education mode. Online education has become the main trend of teaching nowadays. Among them, organic chemistry is an important branch of chemistry, which plays a very important role in the process of undergraduate talent training. Learning this course well is of great significance for the future study, work and scientific research of science and engineering students [1]. In the process of chemistry learning, the mastery of chemical molecular structure is an important link in the process of learning. In order to make online chemistry learning more vivid, it is necessary to search large-scale chemical structures for chemistry teaching. Therefore, it is urgent to develop a more efficient chemical structure data retrieval method.

With the sustainable development and progress of national economy, more and more researches are focused on the field of chemical structure data. JSP technology is a text-based, display centered development technology, which combines XML conversion format with database, and provides a separation mode of dynamic and static combination for the system [2]. In a typical database, the application of JSP program to the website can provide dynamic content for the system, and complete the tasks of database connection by using network template. Traditional methods for large-scale chemical

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 16–24, 2021.
https://doi.org/10.1007/978-3-030-84386-1_2

structure retrieval have some disadvantages [3], in reference [4], nine undergraduate chemistry students were investigated, and the challenges of online learning chemistry were described, including their omission of laboratory. Such as low efficiency and slow speed of data detection, which can not meet the needs of users.

In view of the above problems, a large-scale chemical structure data retrieval algorithm based on JSP technology is proposed. In order to shorten the waiting time of users, it is necessary to improve the speed of data retrieval. JSP technology is usually used to achieve large-scale data retrieval. Aiming at the problem of rapid growth of chemical structure data, the molecular structure processing mode is established. The experimental results show that the algorithm has fast retrieval speed and high efficiency, and can meet the needs of users.

2 Method

2.1 Data Analysis of Chemical Molecular Structure

The representation of molecular structure information is usually displayed in computer system by graphic representation, linear coding and structure coding. Due to the large space occupied by molecules in chemical structure, it is not suitable for large-scale chemical structure data retrieval [4, 5]. For the retrieval of chemical structure data, we need to use SDF format file to store the molecular form of chemical structure. Because SDF file storage format is connected by two-dimensional structure, it is usually suitable for molecular data storage and calculation in computer [6]. The information about molecular molar data in chemical structure mainly includes two parts: structure data information and physicochemical data information.

Due to the large amount of data contained in the molecular structure data information, it is more complex to retrieve the structure data. Therefore, it is necessary to search a large number of atoms and bonds in molecules. According to the historical records of physical and chemical properties in different databases, information such as ID, molecular formula, alias and water solubility can be retrieved. Taking the chemical molecular structure of dichloroacetic acid as an example, the molecular structure is shown in Fig. 1.

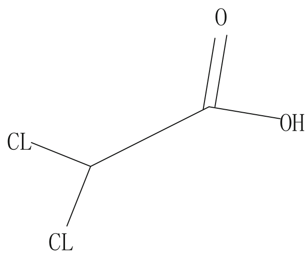


Fig.1. Chemical molecular structure of chloroacetic acid (two chloroacetic acid)

The structure of dichloroacetic acid is used as the basis for file storage, and the specific description information is shown in Table 1.

Table 1. Two chloroacetic acid format file

Molar data structure	Mrv0541	02241214202D				
	6	5	0	0	0	0.0000
	0.8225	1.4289	0.0000			
	0	0	0	0	0	
	1.2375	0.6542	0.0000			
	0	0	0	0	0	
	0.8113	0.0000	0.0000			
	0	0	0	0	0	
	1	2	1	0	0	0
	2	3	2	0	0	0
Physical and chemical data	><DRUGBANK_ID> DB08808 ><GENERIC_NAME> Dichloroacetic acid					

The end symbol of chemical structure data is “END”, and the end symbol of physical and chemical data is “$$$$”.

Before searching chemical molecular structure in chemistry online teaching, it is necessary to normalize the structure data [7–9]. In the process of structure matching, we need to use graph isomorphism algorithm, so sometimes we will encounter the problem of inconsistent retrieval structure: for example, when the user enters the question structure shown in Fig. 2, this problem will occur. From a chemical point of view, formula (1) and formula (2) in Fig. 2 express the same molecule. But from a graph point of view, they are two different graphs. In this way, if users submit queries with different structure diagrams, they will get different results, which should be avoided in chemical structure queries. Therefore, the data of chemical structure were normalized as follows.

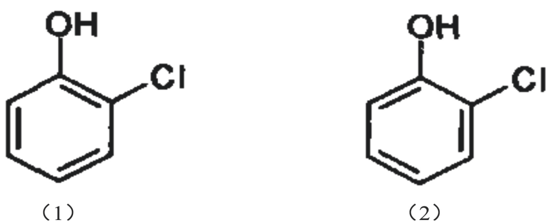


Fig. 2. Different drawing methods of the same molecular structure

Before loading data to database, use structure conversion function to structures.sdf The structure data in the file is converted one by one. The method is as follows: first, read the 2D structure data of a compound from the structures [10–13]. SDF file, and construct the corresponding molecule object with the smile string. Then the member function of the Molecule. object is called aromatize (true) to detect the aromaticity of the Molecule structure and handle it accordingly. Finally, the other member function toformat () of the molecule object is used to convert the molecule into a mol format string and a smiles string, respectively. The normalized structure data of the compounds were encoded to form the values of each field in the data table molecue, which were imported into the database.

2.2 Molecular Data Retrieval Based on JSP Technology

The molecular structure of a compound is a two-dimensional undirected connected graph. The molecular structure retrieval is realized by transforming the molecular structure retrieval into the graph isomorphism problem [14, 15]. Substructure matching has been proved to be NP complete problem, that is, the time consumption of the algorithm increases exponentially with the number of nodes (atoms). In the process of searching chemical teaching resources, when JSP technology is used for database operation, it usually has the following operation steps: connection, query, output and result display [16–18]. The interface of connection class is usually used to connect database in JSP, and it is implemented by various drivers. Generally, the Prepared Statement is used to query the database and save the query results to the system. The main feature of this method is that there is no preprocessing stage. The sliding window is always moved back one bit. The comparison order of characters in the pattern is not limited. It can be from front to back or from back to front.

The driver provided by Microsoft is used to hold the query and update of data, and the type information of Prepared Statementcan be viewed from the code. According to the programming model, for large-scale data parallel computing, the main task is decomposition and result merging [9, 10]. First, the information in the function is assigned to the key and value to form the corresponding key value list as the input stage. In each input phase, any frame belongs to the value combined by the same key. Then the value is assigned to each node, waiting for the next task. Because the running function needs to be processed, therefore, in the last node, the generated results should be merged to complete the result set [19, 20].

Based on JSP technology, the efficient retrieval ability mainly depends on the allocation stage. Suppose that the total number of parallel issues in the processing stage of Map task and Reduce task is M and R respectively. Suppose there are s calculation nodes A1, A2, A3…, As-1, As. The specific calculation formulas (1) and (2) are shown below.

$$M = \sum_{i=1}^{s} M_i \tag{1}$$

$$\mathrm{R} = \sum_{i=1}^{s} R_i \tag{2}$$

From formula (1) and formula (2), it can be seen that M_i and R_i are values on different nodes, and distributed processing can promote the matching of chemical structure data with high speed.

3 Simulation Experiment and Analysis

3.1 Data Source

In this experiment, the molfile of MDL company is used as the question map, and the SDF file is used as the collection of the target map. It is widely used, and its experimental data can be obtained free of charge on the NCI open chemical database website.

3.2 Experimental Environment

The experimental distributed environment needs four hosts, whose frequency size is 2.00 GHz and memory size is 3 GB. The simulation software is matlab (2019 a). The configuration information of each node in the computer is shown in Table 2.

Table 2. Node information configuration

Number	IP	Role	Software environment
1	218.195.2555.44	NameNode: JobTracker	Ubuntu11.05, JRE1.5, Hadoop0.10
2	218.195.2555.45	DataNode: TaskTracker	
3	218.195.2555.46		
4	218.195.2555.47		

In order to verify the rationality of the large-scale chemical structure data retrieval algorithm based on JSP technology, the following experiments are carried out using retrieval speed and retrieval efficiency as experimental indicators.

3.3 Experimental Results and Analysis

Retrieval Speed Verification

The target set of the experiment is to compare the retrieval rate of the traditional algorithm (reference [3] method) and the proposed algorithm in the system for large-scale chemical structure data retrieval under the condition of consistent data, combined with the retrieval algorithm. In the experiment, the selected data size is 100 M, with the size of 10 atoms as a molecular data structure, increasing from 0 M to 6 M of N atoms. The experimental comparison results are shown in Fig. 3.

When a heteroatom is added to large-scale chemical structure data, the time of data retrieval can be reduced. With the increase of the number of heteroatoms in chemical structure, the time of data retrieval for chemical structure tends to be stable. As can be seen from Fig. 3, the time spent on data retrieval using traditional algorithms fluctuates back and forth in 200–250 s with the increase of the number of atoms. However, with the increase of the number of atoms, the retrieval time of this algorithm is gradually reduced, and finally stabilized at about 100 s.

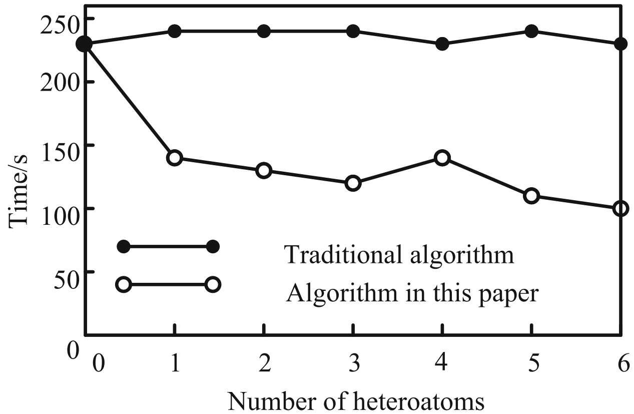


Fig. 3. Search rate comparison results of two algorithms

Retrieval Efficiency Verification

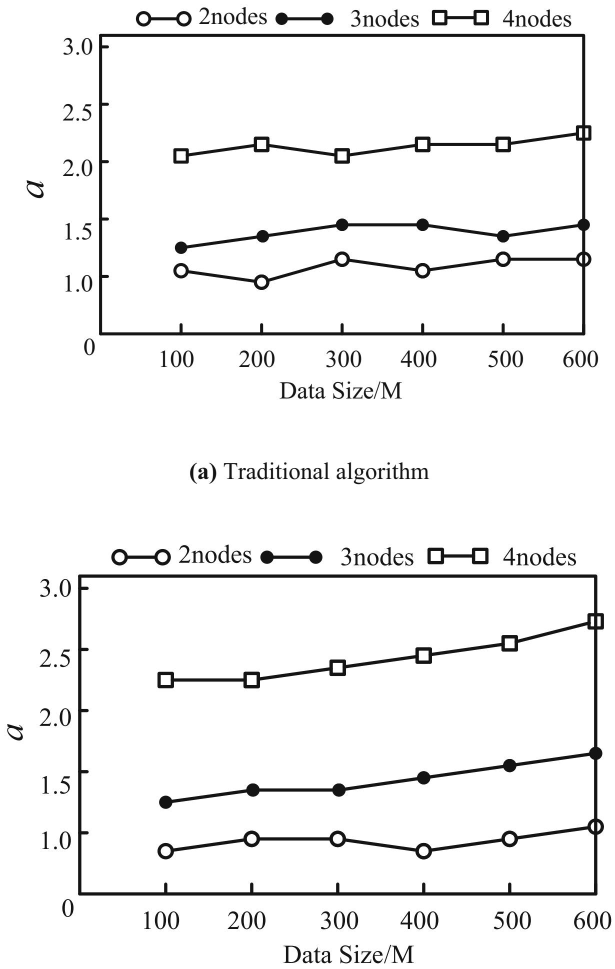
To ensure the same amount of data, the traditional algorithm and the algorithm in this paper are used to retrieve the large-scale chemical structure data in the distributed mode. The experimental data set is A = {100, 200, 300, 400, 500, 600}, typical chemical structures were selected for experimental verification. With the increase of the amount of data, the retrieval speed of distributed compound matching is greatly improved. The search speed based on distributed can reflect the advantage of great difference, and the definition of speedup is shown in formula (1).

$$a = \frac{T_S}{T_P} \tag{3}$$

According to the Formula (3), T_S is the time spent by the program executing the retrieval on the system, T_P is the time spent by the program executing the retrieval in parallel on the distributed cluster, and a is the speedup ratio. As the amount of data continues to grow, the time of chemical structure data matching increases linearly. The traditional algorithm and the algorithm in this paper are used for data retrieval of large-scale chemical structures in this trend, and the acceleration is shown in Fig. 4.

It can be seen from Fig. 4 that with the increase of the number of nodes, the speedup ratio of chemical structure data retrieval increases in a certain proportion. When the number of nodes is 2, the speedup ratio of traditional retrieval algorithm is 1.15, and that of this algorithm is 1.25. When the number of nodes is 3, the speedup ratio of traditional retrieval algorithm is 1.49, and that of this algorithm is 1.65. When the number of nodes is 4, the speedup ratio of traditional retrieval algorithm is 2.35, and that of this algorithm is 2.85.

After the above experimental contents, the following experimental conclusions can be drawn. With the increase of the number of atoms, the time of data retrieval using traditional algorithms fluctuates back and forth in 200–250 s. However, with the increase of the number of atoms, the retrieval time of this algorithm is gradually reduced, and finally stabilized at about 100s. When the number of nodes is 2, the speedup ratio



(a) Traditional algorithm

(b) Algorithm in this paper

Fig. 4. Acceleration ratio

of traditional retrieval algorithm is 1.15, and that of this algorithm is 1.25. When the number of nodes is 3, the speedup ratio of traditional retrieval algorithm is 1.49, and that of this algorithm is 1.65. When the number of nodes is 4, the speedup ratio of traditional retrieval algorithm is 2.35, and that of this algorithm is 2.85. It can be seen that the large-scale chemical structure data retrieval algorithm based on JSP technology has stable scalability, can meet the requirements of large-scale data retrieval, and the retrieval speed is fast.

4 Conclusion

In the case of chemistry online teaching, aiming at the problem of low efficiency of chemical structure data retrieval, a large-scale chemical structure data retrieval algorithm based on JSP technology is proposed. Using JSP technology, large-scale chemical structure data retrieval can be realized through the network. Experimental results show that the algorithm has fast retrieval speed, high efficiency and strong scalability. It can be better applied in chemistry online teaching, which is conducive to improving the teaching effect.

References

1. Liu, D., Wang, J.: Design of Internet online auxiliary teaching system based on Web. Mod. Electron. Tech. **40**(20), 28–30 (2017)
2. Guo, H., Li, Y., An, H.: A Parallel communication algorithm in supersonic COIL's calculations using multiblock mesh. J. Comput. Res. Dev. **53**(5), 1166–1172 (2016)
3. Lee, M.W.: Online teaching of chemistry during the period of COVID-19: experience at a national university in Korea. J. Chem. Educ. **97**(9), 2834–2838 (2020)
4. Jeffery, K.A., Bauer, C.F.: Students' responses to emergency remote online teaching reveal critical factors for all teaching. J. Chem. Educ. **97**(9), 2472–2485 (2020)
5. Xing, C., Xiong, Z., Li, Y., et al.: Construction algorithm of geometric invariant based on area ratio. Appl. Res. Comput. **34**(6), 1900–1904 (2017)
6. Lin, Z., Shuai, J.: Multi-crossover strategy of multi-objective cellular genetic algorithm research on flexible job-shop scheduling problem. Sci. Technol. Eng. **17**(7), 69–76 (2017)
7. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training, pp. 1–374. Springer, Heidelberg (2018)
8. Harshman, J., Yezierski, E.: Assessment data-driven inquiry: a review of how to use assessment results to inform chemistry teaching. Sci. Educ. **25**(2), 97–107 (2017)
9. Penny, M.R., Cao, Z.J., Patel, B., et al.: Three-dimensional printing of a scalable molecular model and orbital kit for organic chemistry teaching and learning. J. Chem. Educ. **94**(9), 1265–1271 (2017)
10. Peng, Z., Jimenez, J.L.: KinSim: a research-grade, user-friendly, visual kinetics simulator for chemical-kinetics and environmental-chemistry teaching. **96**(4), 806–811 (2019)
11. Liu, S., Lu, M., Li, H., et al.: Prediction of gene expression patterns with generalized linear regression model. Front. Genet. **10**, 120 (2019)
12. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
13. Guo, Y., Gao, N.: Rational synthetic parameter analysis of open-framework AlPOs Based on Data Mining Method. Chin. J. Inorgan. Chem. **32**(3), 457–463 (2016)
14. Cooper, M.M., Stowe, R.L.: Chemistry education research—from personal empiricism to evidence, theory, and informed practice. Chem. Rev. **118**(12), 6053–6087 (2018)
15. Shapiro, H.B., Lee, C.H., Roth, N.E.W., et al.: Understanding the massive open online course (MOOC) student experience: an examination of attitudes, motivations, and barriers. Comput. Educ. **110**, 35–50 (2017)
16. Zancanaro, A., Nunes, C.S., de Souza, D.M.J.C.: Evaluation of free platforms for delivery of Massive Open Online Courses (MOOCs). Turk. Online J. Dist. Educ. **18**(1), 166–181 (2017)
17. Pölloth, B., Teikmane, I., Schwarzer, S., et al.: Development of a modular online video library for the introductory organic chemistry laboratory. J. Chem. Educ. **97**(2), 338–343 (2019)

18. Crimmins, M.T., Midkiff, B.: High structure active learning pedagogy for the teaching of organic chemistry: assessing the impact on academic outcomes. J. Chem. Educ. **94**(4), 429–438 (2017)
19. Krijtenburg-Lewerissa, K., Pol, H.J., Brinkman, A., et al.: Insights into teaching quantum mechanics in secondary and lower undergraduate education. Phys. Rev. Phys. Educ. Res. **13**(1), 010109 (2017)
20. Gadaleta, D., Lombardo, A., Toma, C., Benfenati, E.: A new semi-automated workflow for chemical data retrieval and quality checking for modeling applications. J. Cheminf. **10**(1), 1–13 (2018). https://doi.org/10.1186/s13321-018-0315-6

Multi Mode Interactive Information Processing Method in Online Education System of Ideological and Political Course

Hong-gang Wang(✉) and Li-tang Xu

School of Marxism, Fuyang Normal University, Fuyang 236037, China

Abstract. In order to optimize the traditional online teaching mode, taking the basic course of Ideological and political online teaching design as an example, this paper proposes a multi-mode interactive information processing method in the online education system of Ideological and political courses. Through live broadcast and interactive communication, we organize and carry out online distance courses, and actively explore and practice online live broadcast, online question answering, group discussion, bullet screen communication, real-time interaction and other teaching forms, so as to obtain real-time and efficient teaching effect. It also provides new ideas for the new teaching mode of Internet plus teaching. Meanwhile, the transformation of teaching mode has set up a new concept for forming diversified and multi type teaching contents and curriculum system.

Keywords: Ideological and political course · Online education · Interactive information · Classroom interaction

1 Introduction

With the application of information technology in Ideological and political classroom teaching, the interaction behavior of Ideological and political classroom teaching is more diverse. The interaction of Ideological and political classroom teaching is no longer just the interaction between people, but supplemented by the interaction between people and technology [1, 2]. In recent years, with the new education mode online education (e-learning) and MOOC (massive openonline courses), the large-scale open online courses are proposed and gradually popularized, which makes more learners have the opportunity to study on the online platform. Accordingly, the platform has accumulated a large amount of teaching behavior data and knowledge resources, which provides a good foundation for the platform to update and improve itself [3, 4]. Under this background, this paper explores the characteristics, performance and rules of the interaction of Ideological and political classroom teaching under the application of information technology supported teaching media, and puts forward the multi-mode interactive information processing method in the online education system of Ideological and political courses. Aiming at the particularity of learning structure and learning situation of local colleges

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 25–38, 2021.
https://doi.org/10.1007/978-3-030-84386-1_3

and universities, according to the teaching object and course nature, we actively explore and design the online teaching mode and teaching organization strategy in line with our students' learning rules, so as to ensure the teaching effect and quality.

2 Multi Mode Interactive Information Processing in Online Education of Ideological and Political Courses

2.1 Multi Mode Interactive Structure of Online Education of Ideological and Political Courses

Compared with the traditional ideological and political classroom mode, the synchronous interactive elements of Ideological and political classroom in the online education system of Ideological and political courses are more complex, which mainly consists of five elements: the lecturer, the assistant teacher, the local students, the online students and the interactive teaching terminal. Among them, the lecturer is the core of synchronous ideological and political classroom teaching, undertaking the task of Ideological and political classroom teaching. Online synchronous ideological and political classroom is a kind of distance education in terms of teaching nature. The essence of Ideological and political distance education is a cross school, cross regional education system and teaching mode. Its characteristics are: students and teachers separated from each other, using a specific transmission system and media for teaching, teaching interactive information in the process of communication is two-way, dynamic. In the online synchronous ideological and political classroom, the lecturer and online students are separated from each other in space. They teach through Internet technology, and the video transmission process is bidirectional and real-time. As a result, online synchronous ideological and political classroom is different from traditional ideological and political classroom in teaching interaction. In the traditional ideological and political classroom teaching process, teachers and students are in the same space, teaching interaction is face-to-face, a teacher only teaches one class of students [5]. In the online synchronous ideological and political classroom, teachers and students are separated in space, which leads to teachers' inability to manage online students effectively. Therefore, teachers need to assist teachers to organize and manage online students in the teaching process. Figure 1 shows the structure of the interaction relationship between online synchronous ideological and political classroom based on information interaction.

In the online synchronous ideological and political classroom, the interaction between the lecturer and the local students is face-to-face, and the interaction between the lecturer and the online students is realized through Internet technology. The online synchronous ideological and political classroom completes the video collection of local and online ideological and political classroom through multimedia devices such as cameras and pickups, and completes the teaching work of Ideological and political classroom through video interaction [6]. The main feature of online synchronous ideological and political classroom teaching is the combination of interactive mode.

The types of interaction can be divided into three categories, namely, the interaction between students and teachers, the interaction between students and learning content and the interaction between students and other students. The subjects of Ideological and

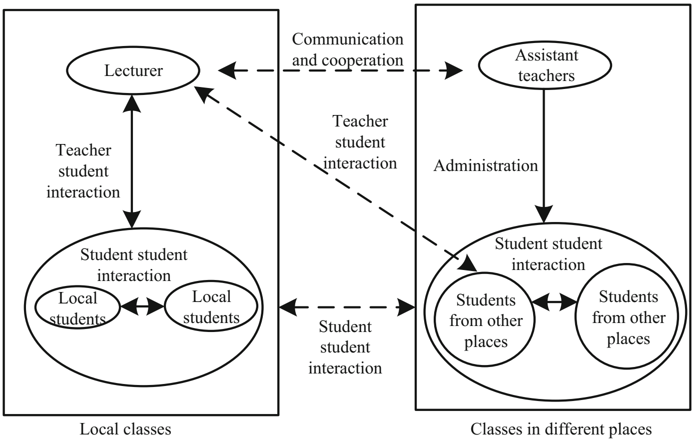


Fig. 1. Interaction structure of online synchronous ideological and political classroom

political classroom interaction are mainly teachers, students and student groups. Five types of interaction can be obtained by combining the three subjects [7]. The five types of interaction are summarized as shown in Table 1.

Table 1. Interaction behavior of Online Ideological and political classroom based on teaching subject

Interaction type	Interactive behavior
Individual teacher and individual student	Organizing teaching; classroom narration; classroom questioning; classroom practice; classroom evaluation
Individual teachers and student groups	Questions and answers; requirements and responses; evaluation and feedback; individual counseling; direct contact
Individual student and individual student	Communication and discussion among students in the process of classroom teaching, class practice and class discussion
Individual student and student group	Group discussion: discussion, communication and opinion evaluation between middle school students and the whole group of students
Student group and student group	Discussion and interaction between individual students and the whole class when demonstrating or expressing opinions

In the process of online teaching, ideological and political classroom teaching interaction is not only the original single interpersonal interaction, but also the human-computer interaction between teachers and students and information technology. The use of subject tools in Ideological and political classroom teaching can improve students' initiative, teaching interactivity and generativity [8]. Based on this, this paper further studies the interactive content of Ideological and political classroom teaching in the information technology environment, further improves the teacher language and student language, and adds the category of technology on the basis of Table 1. The details are shown in Table 2.

Table 2. Interactive content of online teaching in Ideological and political class

Classification	Code		Formulation	Content
Teacher's speech	Indirect impact	1	Teachers accept emotion	Accept and clarify students' attitude or emotional tone in a non threatening way
		2	Teachers encourage praise	Praise or encourage the action or behavior of a student
		3	Adoption of opinions	Recognize the student's statement; modify or restate the student's statement; apply it to solve the problem; summarize what the student said
		4	Ask open questions	Based on Teachers' opinions or ideas, ask students questions and look forward to their answers
		5	Asking closed questions	
	Direct influence	6	Teach	Provide facts or opinions on the content or steps; express the teacher's own opinion, put forward the teacher's own explanation, or quote the opinion of an authority (not the student)
		7	Instructions	Instructing or ordering students to do something has the function of expecting students to obey

(*continued*)

Table 2. (*continued*)

Classification	Code	Formulation	Content
	8	Criticism	The content of the statement is to attempt to change the behavior of students, from unacceptable to acceptable; to scold students; to explain why teachers take such behavior; and to refer to themselves extremely
Speech students	9	Response (passive response)	Students respond to what the teacher says. Teachers make students answer questions, or lead students to speak, or construct dialogue situation. Students are limited to express their ideas freely
	10	Response (active response)	Students' answers go beyond the answers to the questions, express their own ideas, initiate new topics, and freely express their opinions and ideas, such as raising thinking questions and open structure
	11	Ask questions on your own initiative	Ask questions and express your opinions freely
	12	Discuss with peers	Discussion and exchange of views
Quiet	13	It is not conducive to the confusion of teaching	A brief pause, quiet, or confusion. So that the observer can not understand the communication between teachers and students
	14	Ponder a problem	Students think about problems

(*continued*)

Table 2. (*continued*)

Classification	Code	Formulation	Content
	15	Do exercises	Students do classroom exercises
Technology	16	Teachers' operation technology	Teachers use technology to present teaching content and explain opinions
	17	Student operation technology	To make use of the teaching content
	18	The role of technology in students	Students observe media presentation

Based on Table 2, the MySQL service module is added to the system. Provide a master and slave database cluster mode. When the system enters the title and submits the data to the master database, the master database sends the transaction to each slave database and waits for the response from the slave database. When the slave database is ready, it sends a confirmation message to the master database. When all the slave databases send a confirmation message to the master database, the master database will send a commit transaction message to all the slave databases. At this time, the title will be entered into the master-slave database to complete a data writing process [9]. Compared with a single MySQL server, the database cluster will be slightly slower in data update. However, when the interactive teaching system reads more data than it writes, the sacrifice is acceptable. By describing the average load of teaching information, we can see the difference between single database and database cluster. The formula of the average load of the system can be described as.

$$\text{AverageLoad} = (\Sigma\ \text{WriteData} + \Sigma\ \text{ReadData})/\,\Sigma\ \text{Capacity} \tag{1}$$

In formula (1), Average Load is the average load of the system, Write Data is the load of writing data, Read Data is the load of reading data, and Capacity is the total transaction volume of the system. Through different database forms, we can see the average load of the system, assuming that the number of transactions per second of each database is 20000, the number of read data transactions is 16000, and the number of write data transactions is 4000. Since synchronous replication is also required from the database, the number of write data transactions is multiplied by the number of database clusters.

2.2 Interactive Processing Function of Online Teaching Information in Ideological and Political Classroom

According to the dissemination mode of information in the teaching process, this paper analyzes the process of students' knowledge self construction, and optimizes the interactive function of teaching information. In the learning process, students can not only acquire knowledge through the learning tasks issued by teachers, they can choose the form of e-learning materials for auxiliary learning, and these learning materials are large in quantity and variety, so the function of interactive information management module is to centralize the management of these teaching interactive information [10]. According to the analysis of the functional requirements of the interactive teaching system, the interactive teaching system is divided into five functional modules: question bank management, homework management, interactive information management, online chat and system management [11–13]. Next, five functional modules will be designed in detail. Figure 2 shows the functional tree diagram of information processing of interactive teaching system.

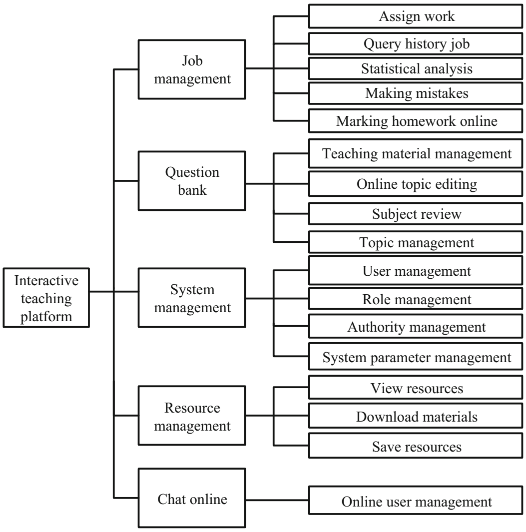


Fig. 2. Information processing function of Ideological and political education interactive system

Aiming at the problem of scattered teaching interactive information, this paper attempts to establish an interactive information sharing system with the help of SAE cloud storage service. Through the research of the current teaching interactive information system, this paper summarizes two schemes of the current interactive information sharing [14]. The first is to share interactive information by uploading interactive information. The operation mode of this kind of interactive information system is: each interactive information corresponds to a score. When users download interactive information, they have to deduct the corresponding interactive information score, while the user's score comes from uploading interactive information. Through this mode to achieve a virtuous circle of interactive information. The second is that administrators upload interactive information, and users download interactive information directly. There is no user interaction in this form. Users only need to find the interactive information they want.

In the first method, interactive information is stored in the cloud for centralized management of interactive information. If users are allowed to upload interactive information freely, the quality of interactive information will not be guaranteed, and the centralization of high-quality interactive information will be meaningless [15]. Therefore, the second solution is more suitable for the cloud. Aiming at the problem of insufficient user interaction in the second scheme, the interactive information sharing scheme is improved. Due to the huge amount of interactive information in the cloud, users need a certain amount of energy to find the appropriate interactive information. Therefore, a module is added to realize the sharing of interactive information among users and help other users find the appropriate interactive information faster. At the same time, the system provides users with personal interactive information space to save users' interactive information.

At the beginning of the design, we need to consider whether we can open up a file domain name in SAE storage space to store user interaction information. After analysis, it is considered that using data table to link interactive information can save more space. For users, the content of interactive information is the same, but the interactive information cannot be managed. If there are no special needs, users are not required to manage the interactive information. In addition, although the cloud storage space is large, but beyond a certain limit, it will also increase the deployment cost of interactive teaching system.

Through the above analysis, combined with the characteristics of cloud storage, the interactive information sharing system of Ideological and political online teaching system is proposed, as shown in Fig. 3. The interactive information of teaching interactive system is divided into two parts: private interactive information and open interactive information. The privacy interaction information is used to store the privacy interaction information of the system itself, which is controlled by the cloud administrator. Open interactive information, as a centralized system of interactive information, provides users with interactive teaching information. Interactive information is stored persistently through SAE's cloud storage service, and users' sharing and personalized interactive information space design are realized in the form of interactive information URL.

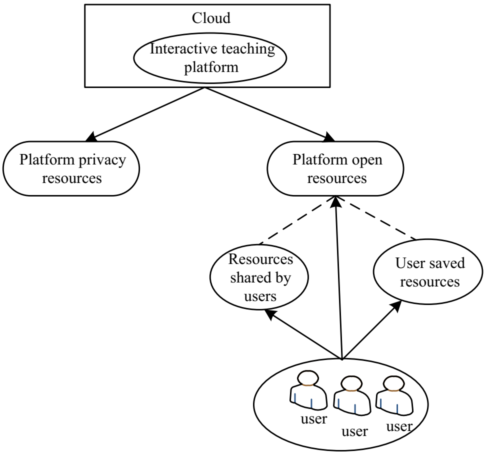


Fig. 3. Interactive information sharing platform of Ideological and political online teaching system

According to the interactive information sharing system of teaching interactive system, the system is mainly divided into two sub modules: view/download interactive information and user interactive information. And the interactive information sharing resource processing process is optimized, the specific steps are shown in Fig. 4.

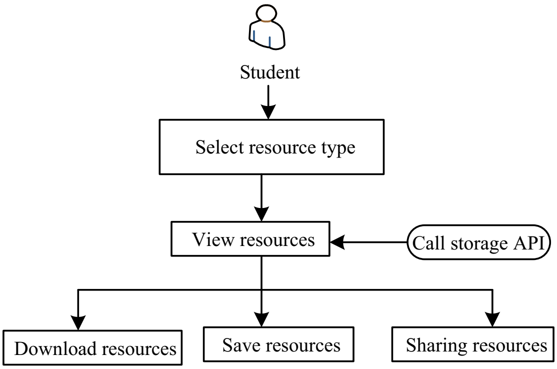


Fig. 4. Interactive information sharing resource processing flow

Furthermore, NVivo 8.0 developed by QSR International company is used as the video analysis system of Ideological and political classroom to process and analyze the ideological and political classroom teaching video under the background of deep integration of information technology and teaching. Using NVivo 8.0 software to analyze different types of data, such as text, pictures, audio and video, has great advantages in processing teaching information analysis. When observing the interactive files of teaching letters, you can change the playback speed, cycle a part continuously, rewind or skip a part. You can create your own script for the video file, or create a script or other comments for a part of the video. You can view the relevant video parts by clicking the script. NvivoB. 0 can also create and export professional models or graphs based on project information, such as bar chart, column chart and pie chart, and use charts to view data from a new perspective. In order to achieve the effective processing of multi-mode interactive information in the ideological and political online education system and improve the speed of information processing.

2.3 Realization of Multi Mode Interactive Information Processing

According to the textbook knowledge points and curriculum design plan, the knowledge is made into various courseware and sent to the teaching system. students can learn online according to their personal needs. This is a one-way process, teachers are not in the process of information processing, need to understand the learning situation of students and the use of interactive information. Students can quickly obtain these interactive information, effectively break the separation of regional interactive information, so that more learners have the opportunity to obtain better interactive information, and promote education equity. In order to better realize the processing of interactive information, the static learning and dynamic learning mode are further optimized, as shown in Fig. 5.

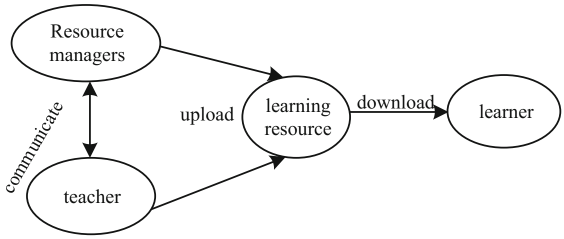


Fig. 5. Interactive information processing principle under static learning mode

With the development of more and more teaching systems, how to make better interaction between learners and learners, learners and teachers, learners and learning information has become a new research field. Based on the problem of insufficient interaction of static learning application mode, dynamic interactive application mode began to appear. The specific principle is shown in Fig. 6.

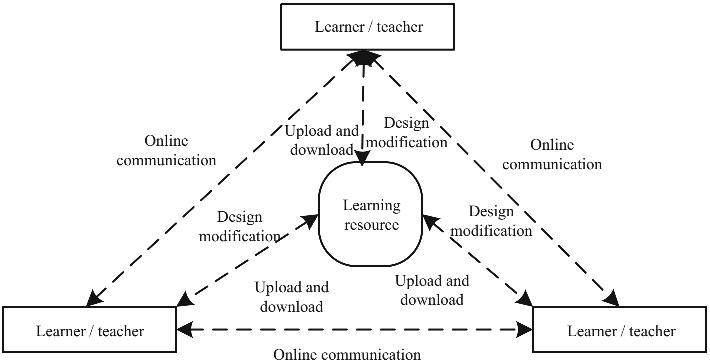


Fig. 6. Interactive information processing principle under dynamic learning mode

The question bank system of interactive teaching system, like other systems, has much more query operations on the database than update and add operations. For example, the administrator can input most of the test questions at one time through batch import and other tools, and then the maintenance of the question bank is reduced, only a small number of test questions are input, while the operating system is constantly reading the data from the database. The openness of the system will allow many users to access at the same time, which puts forward certain requirements for the performance of the database. Through the way of database cluster to achieve query load, it can effectively deal with the performance bottleneck of database. Through the systematic analysis of different disciplines to determine the breadth of students' knowledge and the breadth of interactive information involved, and each discipline is subdivided into different knowledge points a, further refining the scope of students' knowledge and the scope of interactive information. Therefore, a vector matching model of students' interactive information knowledge breadth is proposed.

$$\mathrm{ka} = \{\mathrm{a}_0, \mathrm{a}_1, \mathrm{a}_2, \mathrm{a}_3, \mathrm{a}_4, \mathrm{a}_5\} \tag{2}$$

This paper calculates the degree of problem and interactive information knowledge model of students and interactive information from two levels of breadth and depth. In this paper, the angle cosine formula is used to calculate the similarity between the two vectors. $\mathrm{X} = (\mathrm{X}_1, \mathrm{X}_2, \mathrm{X}_3 \ldots\ldots, \mathrm{X}_\mathrm{n})$ and $\mathrm{Y} = (\mathrm{Y}_1, \mathrm{Y}_2, \mathrm{Y}_3 \ldots\ldots, \mathrm{Y}_\mathrm{n})$ represent the knowledge breadth vector and depth vector of data source respectively.

$$\cos\theta = \frac{X \cdot \mathrm{Y}}{\mathrm{ka} + |X| + |Y|} \tag{3}$$

When the angle is larger and the cosine value is smaller, the matching degree between students and interactive information is lower. Combined with Gaussian distribution probability density function, the knowledge depth model matching between students and interactive information is quantified.

$$\mathrm{F(M, N)} = \frac{1}{\sqrt{2\pi}\cos\theta}\exp\left(-\frac{(X - Y)^2}{2\cos\theta}\right) \tag{4}$$

Interactive teaching system provides two learning mechanisms, one is “I want to learn”, the other is “I want to learn”. The operation mode provided by the interactive teaching system provides an asynchronous interactive learning mechanism for students and teachers. The interaction level is mainly between teachers and students, and the whole learning effect is two-way docking with teachers and students. The interactive information mode of learning attachment provided by the interactive teaching system provides an asynchronous interactive “I want to learn” learning mechanism between students. The instructional designer uploads the interactive information of learning attachment to the system. Students actively search for interactive information for learning, students can share interactive information to other students, help other students find interactive information, form a benign flow of interactive information between students, online chat system, provide synchronous communication between students and teachers, students and students. Teachers can answer questions for students in time and help them solve problems in the process of learning. Students use the power of group wisdom to exchange learning experience and solve practical problems. Sina cloud system SAE is selected as the deployment environment of the interactive teaching system, and the interactive information of the question bank is stored in the cloud database by using the distributed database Mysql service. Using the persistent file storage service, the interactive information of learning attachment is stored in the cloud storage, and the learning interactive information of the teaching interactive system is built in the cloud for management. It saves the cost of infrastructure purchase and abandons the disadvantages of repeated construction of interactive information. SAE provides a dynamic scaling mechanism of multiple virtual machines, which can calculate according to the visits of teachers and students, increase the flexibility of interactive information, and enhance the interaction of teaching interactive system. SAE has the heterogeneous characteristics of cloud computing, students can use mobile devices in their spare time to complete homework and check wrong questions, which improves students’ learning efficiency.

3 Experimental Results and Analysis

In order to verify the feasibility of the multi-mode interactive information processing method in the online education system of Ideological and political courses proposed in this paper, questionnaires were distributed in the pilot schools and data were collected. The survey of students' use mainly starts from the following aspects: whether the system operation is simple, whether it needs open analysis after the homework is completed, whether it can effectively complete the homework, and whether it can understand the mastery of knowledge through the homework. The results are shown in Fig. 7.

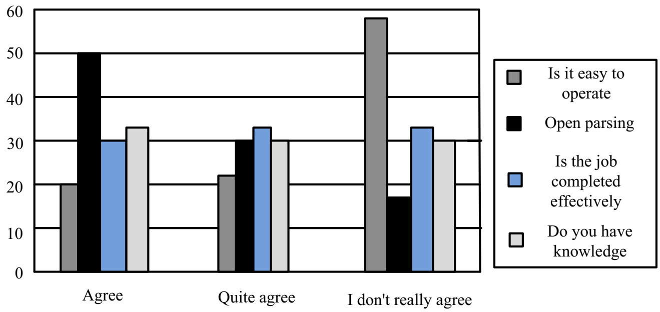


Fig. 7. Survey of students' satisfaction with using

As can be seen from Fig. 7, students are not very satisfied with the operation, but basically agree with the open analytic answers. At the same time, most of the students agree whether they can complete the homework effectively, only a few students think that they can not complete the homework better in the system. Most of the students think that they can understand the mastery of knowledge through homework.

The survey of teachers' use is mainly carried out from the following aspects: whether it is in line with teaching habits, whether the function setting is reasonable, whether it can cover the knowledge points of teaching materials, and whether it is difficult to choose topics. The results are shown in Fig. 8.

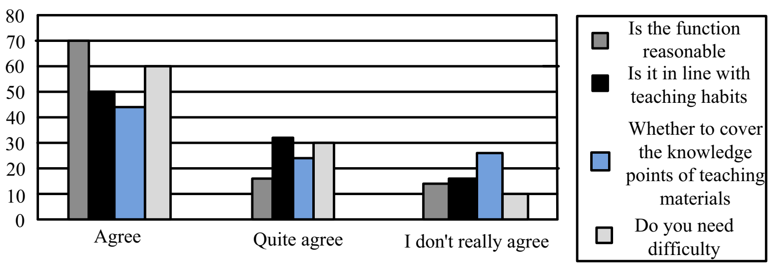


Fig. 8. Survey of teachers' satisfaction

It can be seen from Fig. 8 that teachers are quite satisfied with the system functions. Basically covers the teaching methods of teachers, but also basically in line with the teaching habits. The textbook is divided into chapters, which basically covers the knowledge points of the textbook. At the same time, the difficulty of the topic is distinguished, which helps teachers to achieve multi effect homework design. Teachers are quite satisfied with this. In general, the proposed interactive system of Ideological and political education is safer, more stable, more reliable and more efficient than the traditional teaching application.

In order to further verify the information processing performance of this method in online teaching of Ideological and political course, the online learning duration of 30 students in a high school was tested under the same experimental environment. The reference [3] and reference [4] methods were used as the control group to test the total daily online learning time of the three methods. The higher the online time, the better the students' evaluation of the model. The specific experimental results are shown in Fig. 9.

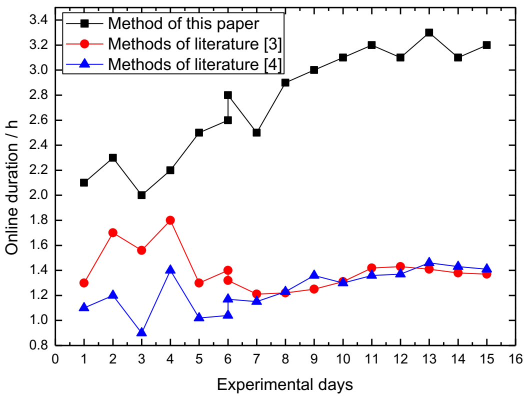


Fig. 9. Comparison of online learning duration

According to the analysis of Fig. 9, the online learning time of students using this method is generally on the rise, and the maximum learning time is up to 3.3 h, which is far higher than that of the two comparative methods. It shows that this method has advantages in online learning of Ideological and political courses.

4 Conclusion

Through the effective management and transmission of massive teaching information, the online teaching effect of Ideological and political education can be better improved and the teaching interaction can be better carried out. Including interactive information sharing, learning exchange, interactive chat, so that any student and teacher can enjoy the latest interactive information and services, break the barriers of uneven distribution of interactive information, promote education equity, and lead the continuous innovation of teaching technology. The future research on this topic can be carried out from the following methods. Improve the definition and practical application of learner centered education model, because the starting point of this model is to improve the problems existing in the current online education platform. Therefore, its definition and application scenarios are still incomplete, and it needs to be improved in the future to improve its use value.

Fund Project. Fuyang Normal University 2019 School-level Undergraduate Teaching Project: "MOOC + Flipped Classroom Hybrid Teaching Model Design" Number: (2019JYXM35);2019 Provincial College Student Innovation and Entrepreneurship Project: "Research on the Innovation and Development of Red Tourism in Anhui Province Based on SWOT Analysis" Number: (S201910371062).

References

1. Pertuze, J.A., et al.: Political uncertainty and innovation: the relative effects of national leaders' education levels and regime systems on firm-level patent applications. Res. Policy **48**(9), 103808 (2019)
2. Pertuze, J.A., Reyes, T., Vassolo, R.S., et al.: Political uncertainty and innovation: the relative effects of national leaders' education levels and regime systems on firm-level patent applications. Res. Policy **48**(9), 103808 (2019)
3. Yin, Y.: Research on ideological and political evaluation model of university students based on data mining artificial intelligence technology. J. Intell. Fuzzy Syst. **33**(6), 1–10 (2020)
4. Haiying, Y.: Study on the development of multi dimension political education for university students based on computer system and internet platform. Int. J. Eng. Model. **31**(1), 316–322 (2018)
5. Svrd, P.: Using african truth and reconciliation commission documentation for truth telling and reconciliation. Educ. Inf. **25**(6), 1–8 (2020)
6. Chen, J., Liu, C., Chang, R., et al.: From traditional to vr-based online education platforms: a model of the mechanism influencing user migration. Inf. (Switzerland) **11**(9), 423 (2020)
7. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training. Springer, Heidelberg (2018)
8. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
9. Makki, R., Carvalho, E., Soto, A.J., et al.: ATR-vis: visual and interactive information retrieval for parliamentary discussions in Twitter. ACM Trans. Knowl. Discov. Data **12**(1), 1–33 (2018)
10. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
11. Mao, C.L., Zou, S.L., Yin, J.H.: Educational evaluation based on Apriori-Gen algorithm. Eur. J. Math. Sci. Technol. Educ. **13**(10), 6555–6564 (2017)
12. Wang, Y.: Analysis on the construction of ideological and political education system for college students based on mobile artificial intelligence terminal. Soft. Comput. **24**(11), 8365–8375 (2020). https://doi.org/10.1007/s00500-020-04932-6
13. Yunfang, Z., Yuexi, W.: Interactive teaching path analysis of higher vocational ideological and political courses based on artificial intelligence algorithms. In: 2019 11th International Conference on Measuring Technology and Mechatronics Automation (ICMTMA), pp. 458–461. IEEE (2019)
14. Yanchun, K.: Research on reform intelligent effect evaluation system (RIEES) of teaching methods of ideological and political theory course in colleges and universities. In: 2018 International Conference on Smart Grid and Electrical Automation (ICSGEA), pp. 287–290. IEEE (2018)
15. Xia, Y.: Big data based research on the management system framework of ideological and political education in colleges and universities. J. Intell. Fuzzy Syst. (Preprint), 1–10

Design of Online Training System for Innovative and Entrepreneurial Talents Based on Interdisciplinary Integration

Yu-feng Men[1(✉)] and Hong Cai[2]

[1] Dalian University of Science and Technology, Dalian 116052, China
[2] Weifang Engineering Vocational College, Weifang 262500, China

Abstract. Since the current online talent training system only focuses on talent training resources in a certain discipline, the number and types of resources shared within the system are relatively small, so it is necessary to design a multi-disciplinary cross-integrated innovative and entrepreneurial talent online training system to expand the amount of data resource sharing. The system is designed from both hardware and software aspects. In the hardware design, related parameters such as servers and storage devices are designed, and the overall system architecture is designed; in the software design, the resource information processing in the system is first completed, and the system resources The video is encoded and decoded, and the server and client are separately maintained through Socket to realize the accurate identification and communication of resource information; then the system database ER diagram and database table are designed. In the performance simulation test of the system, the experimental results show that the maximum number of shared resources of the designed system is 1 million, which is a significant increase in the number of shared resources of the original system, which verifies the effectiveness of the designed system.

Keywords: Interdisciplinary integration · Innovative and entrepreneurial talents · Online training · System design

1 Introduction

In the era of knowledge economy, innovation and entrepreneurship has become an important theme of world economic development. Countries all over the world attach great importance to the important role of innovation in promoting social progress and economic development, and have issued various policies to promote and promote innovation and entrepreneurship. With China's sustained and rapid economic growth, the rapid development of industry, agriculture and service industry has given birth to a large number of talent demand. In 2001, China joined the WTO, the domestic competition became international, and the competition for innovative talents became increasingly fierce [1, 2]. At present, the main contradiction between supply and demand of talents in China is the contradiction between the growing demand for innovative talents and the traditional

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 39–49, 2021.
https://doi.org/10.1007/978-3-030-84386-1_4

mode of talent training. This leads to a significant dissimultaneous interpreting between talent training and talent demand in the universities. On the one hand, the demand for high-quality innovative talents is far from being met, and on the other hand, a large number of graduates are hard to obtain employment. This contradiction seriously restricts the healthy and sustainable development of China's economy and higher education. Therefore, to adapt to the needs of the development of the times and industry, to reform the talent training mode in Colleges and universities and to improve the training level of application-oriented innovative talents is an important issue to be solved in China's higher education.

The traditional talent training system has been unable to meet the higher needs of society, so the talent training mode of interdisciplinary integration arises at the historic moment. Interdisciplinary is to integrate two or more disciplines, master more than two disciplines knowledge, have more than two disciplines skills, and learn to integrate knowledge and skills. The cultivation of innovative and entrepreneurial talents by interdisciplinary integration is to integrate two or more disciplines in the process of talent cultivation, so as to cultivate college students' innovative and entrepreneurial ability and improve their comprehensive quality. To this end, this article proposes a multidisciplinary cross-integration of innovative and entrepreneurial talent online training system design. Servers and storage devices constitute the hardware part of the system. Use video encoding and decoding and frame rate calculation to improve video fluency. Paradigm theory is used in database design. This completes the software design part of the system.

2 Multi-disciplinary Cross-Integration of Innovative and Entrepreneurial Talent Online Training System Design

2.1 Hardware Design

The users of this system are divided into teachers, students and administrators. Each type of user has its own corresponding authority and corresponding functions. Generally speaking, it is composed of home page, daily summary, weekly report, project information, personal files and resource sharing modules, covering all aspects of online communication between students and teachers during school. Development tools are an important means to build a hybrid architecture of resource sharing system. Development tools mainly include servers, storage devices, operating systems and functional software.As the operation core of the whole system, the server selects the Dell (TM) upgraded PowerEdge r740 dedicated server, built-in Xeon SP scalable series processor, equipped with inter c621 series chipset, supports DDR4 2666 (24 slots), with 8 3.5-disk hard disk facilities, em 64t, 800 MHz front-end bus, with up to 8 pcle3.0 slots, h330, h730 and h740 array cards, Broadcom gigabit network card (four ports) is provided, which can play the role of central node of hybrid architecture, provide large capacity data interaction for the whole system, and expand the number of data sharing of the system; the storage device adopts the way of connecting disk array and database server It can save the historical data and forecast data of database system and application system, which is convenient to call and share [3, 4]. As a resource sharing system, business data will grow greatly over time, and data records will become increasingly large, so there is a higher requirement for the scalability of database driver interface. Operating system is the basis of system operation. For small and medium-sized enterprises, the operating system of enterprise network generally adopts Linux, which has low requirements for server hardware, and can meet the server configuration of PC server of small and medium-sized enterprises to the greatest extent, and has good stability in daily operation. It integrates windows pages, which is easy to operate, powerful and widely used for users. Under this design concept, the system design architecture is as follows (Fig. 1):

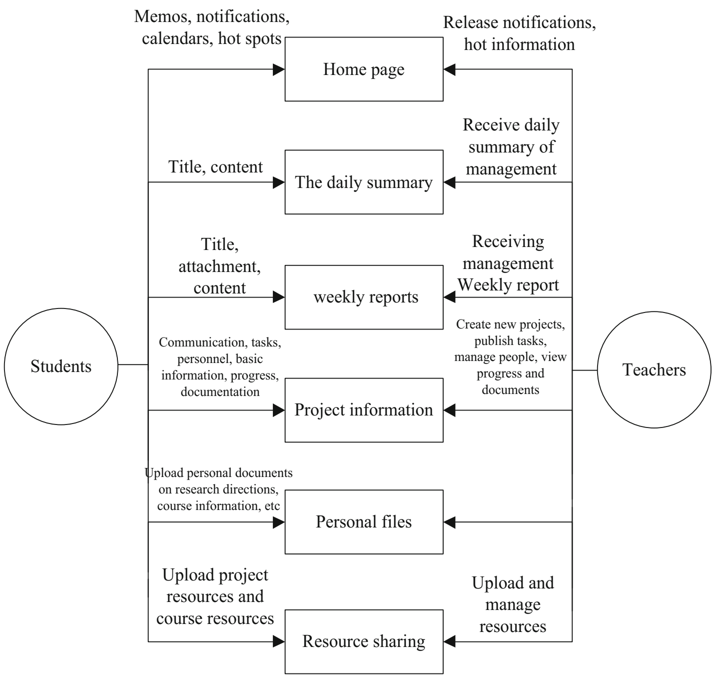


Fig. 1. System design architecture

For the successful construction and continuous application of the system, the development process needs to follow the unified design principles of the system. When designing the system, System structure should be comprehensively planned, especially the system construction structure and database structure. The overall situation needs to be considered. Seeing the problem requires the principle of advanced nature. In system construction, the trend of maturity, advancement and internationalization should be adopted. In the process of construction, The relevant standards should be fully followed. Mature and stable mainstream website architecture should be used for reference. and ensure the scalability and sustainable use ability of the system; in the principle of scalability, the construction of information system must take into account the changing development needs, and in the design, The relationship between modules should be fully considered, so as to reduce the cost Block coupling.

2.2 Resource Information Processing in the System

In the online training system of innovative and entrepreneurial talents designed in this paper, the most important teaching resource information is video resources. In fact, video playback is to quickly switch multiple images with subtle differences in the same position. For human vision, it is like the image in "motion". This sense of image motion gives people the experience of video. When playing the video, when the frame rate reaches 16–24 fps, for the naked eye, what you see is smooth video [5, 6]. In general, the video files used in the online training system are avi, MKV and other formats, which are the packaging format of the original video after the algorithm compression. The capacity calculation formula of the original video can be expressed as follows:

$$F_C = F_W \times F_H \times \frac{F_{bit}}{F_B} \times FPS \times \frac{60}{F_{MB}} \tag{1}$$

In the above formula, F_C represents the capacity required for playback of the original video, F_W and F_H represent the width and height of the video respectively, and the units are calculated in pixels. $\frac{F_{bit}}{F_B}$ represents the conversion between the number of bits and bytes of the video color, and FPS Represents the number of frames, and $\frac{60}{F_{MB}}$ represents the conversion between bytes and megabytes.If calculated according to the above formula, a 45-min MOOC requires more than 375G of capacity. In actual use, the transmission speed and playback quality of the video cannot be guaranteed, especially the network video. Therefore, it is necessary to compress the original teaching multiple information, and the process is shown in the following Fig. 2:

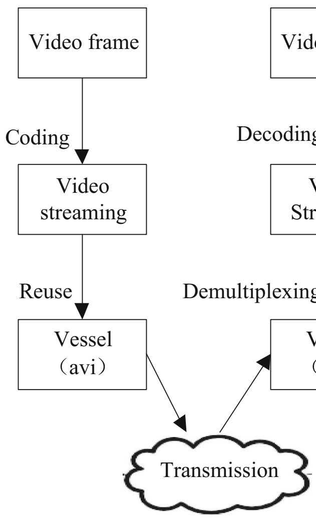


Fig. 2. Schematic diagram of video encoding and decoding

As shown in the figure above, the container refers to the format of the video itself, such as MP4 and other audio and video tracks that have different characteristics, and the audio and video streams are stored on the track. The stream is generated when the video is encoded by the encoder, so during the playback process, different tracks will be played back synchronously. Therefore, different compression algorithms determine the format of video encoding. This article chooses AAC advanced audio coding. This coding method has more sampling rate and bit rate support, and is more efficient in the decoding process. It can effectively compress audio and video. The difference between lossless compression and lossless compression at a bit rate of 448kbps is very small. It is the best lossy compression format currently in use. In the system designed in this paper, the transport layer is an important layer of interactive communication in the entire system. In the general interactive communication layer, there are generally two important underlying protocols, namely TCP and UDP protocols [7, 8]. This article adopts the Socket API based on C language, this abstraction layer can facilitate users to directly use TCP and UDP protocols. Socket can realize the mode that the server and the client maintain separately, and establish a link to complete the opening, reading and writing, and closing of the file. The process is as follows (Fig. 3):

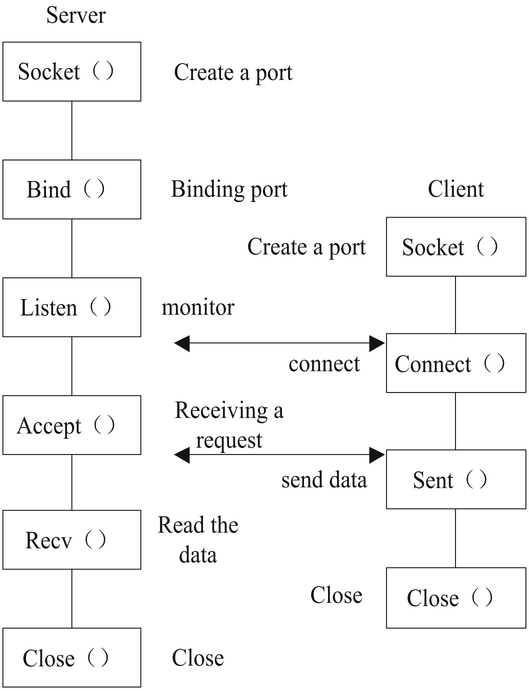


Fig. 3. Socket connection interaction process

In the process of communication, the connection is established and opened, you can write certain content to your own file and save it for the other party to read or read the content of the other party. After the communication ends, the file can be closed.

In the actual interaction process of the system, due to problems such as light in the classroom, it is difficult to identify and communicate during the interaction. Therefore, it is necessary to improve the system's tracking and identification algorithm. Make the difference between the pixel value of the pixel point corresponding to the current frame image and the previous frame image, and determine the magnitude of the difference and the threshold:

$$d = |I_L(x, y, i) - I_L(x, y, i-1)|$$
$$ID_L(x, y, i) = \begin{cases} 1, d \geq T \\ 0, d < T \end{cases} \tag{2}$$

In the above formula, $ID_L(x, y, i)$ represents the detection result of the corresponding pixel in the image of two adjacent frames, 1 represents the pixel of the moving target, 0 represents the background pixel, which is the threshold. The threshold setting will be based on the actual situation of the system and the past Operating experience, this article is set to 50. After the binary image is obtained under the above operation, after denoising, the accurate identification and communication of resource information in the system's interaction process can be realized.

2.3 Database Design

Database design is a very important step in system development and the starting point of software design. The quality of database design is related to the logic and stability of the system, so in the development of software system, the theory of database paradigm is put on the focus. In order to realize the efficient organization, storage and management of data, database design must follow the necessary principles to reduce redundancy and ensure the integrity and correctness of data. The database is the direct response and data performance of the requirements, so the design must meet the user's needs, repeatedly corresponding to the relevant data, and timely adjust and modify when there are changes [9, 10]. Conceptual structure design is the process of transforming user requirements into conceptual model. Conceptual structure design can fully display the actual relationship,

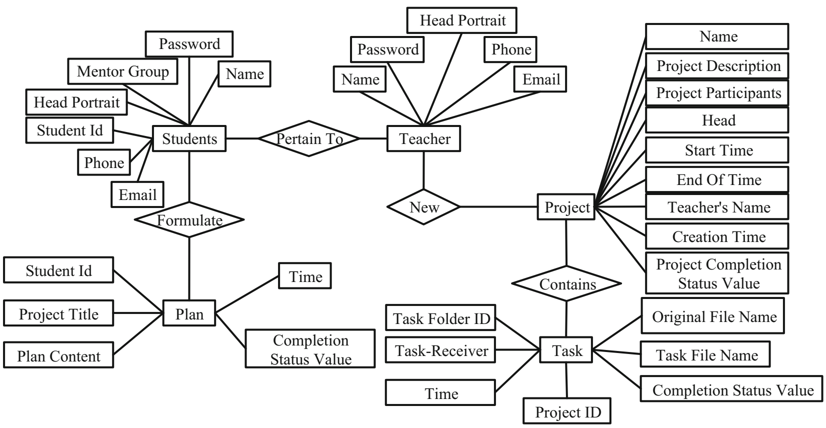


Fig. 4. Entity relationship diagram

easy to understand, easy to change, easy to transform to the relationship, network, hierarchy and other data models [11, 12]. Conceptual structure design uses entity relationship diagram to describe the relationship between entities. Part of the entity relationship diagram of the process management of innovative and entrepreneurial talents cultivation with interdisciplinary integration is shown in the following Fig. 4:

It is mainly composed of students, tutors, plans, projects, tasks and other entities. This system uses MySQL database to ensure the portability of the code, which is suitable for this system. In the database design, the main task is to complete the design of data table structure. Through the design and implementation, it mainly includes the table structure design of six modules, including user management, memo, daily and weekly reports, project information, personal files and resource sharing [13]. In the database, the database tables need to be divided according to the functional design of the system. The division of these database tables t is usually represented by the function matrix, as shown in the following formula:

$$T = \begin{bmatrix} t_{11} & t_{12} & \cdots & t_{1m} \\ t_{21} & t_{22} & \cdots & t_{2m} \\ \cdots & & & \\ t_{n1} & t_{n2} & \cdots & t_{nm} \end{bmatrix} \tag{3}$$

In the formula, n field descriptions can be combined into set A, and m data table descriptions are recorded as set B. Formula (2) can be obtained:

$$A \cup B = W \tag{4}$$

Where, W is the set of subtables of the database, then the formula for the number of subtables divided by the database w can be obtained:

$$w = \sqrt{1.28mn + 4.32m + 4.46n + 0.36} \tag{5}$$

The sub tables of the database are mainly divided into student management database table, memo database table, daily summary database table, weekly report database table, new project information database table, personal task information database table and course resource information database table. The specific field description is shown in the following Table 1:

According to the analysis of users' requirements in the previous chapter, more specific system requirements are obtained. These requirements are designed into the specific functions of the system, and the overall framework of the system is given. On the basis of clarifying the logic of use, a more reasonable and specific data table is designed, and some data tables are given, such as student table, memo table, daily summary table, weekly report table, project table, task table, course resource table and shared resource table, which lays a solid foundation for the construction of the whole system.

Table 1. Database tables

Field name	Field type	Length of field	Illustration
Id	Int	10	–
Name	Varchar	20	Name
Student Id	Varchar	20	Number of students
Password	Varchar	20	Password
Group	Varchar	50	Panel
Phone	Varchar	11	Telephone
Email	Varchar	20	Mailbox
Img	Varchar	100	Head
Plan	Varchar	100	Project title
Time	Date	–	Year
Hours	Time	–	Hours
Status	Int	11	State value
Plan_ Details	Varchar	500	Details of the plan
Stu_ Id	Int	100	Id of student tables
Title	Varchar	100	Title
Content	Varchar	250	Daily Content
Weekly_File	Varchar	100	Annex Name
Weekly_Title	Varchar	100	Title
Weekly_Content	Varchar	3000	Weekly Content
Orig-Filename	Varchar	100	Original Annex Name
Week	Varchar	30	Week 1
Tern	Varchar	30	First semester

3 System Test

3.1 Build System Test System

After the completion of the system design, in order to find the defects in the system as soon as possible and ensure the reliability in practical application, The system needs to be tested and the results recorded, design comparative experiments to verify whether the number of data resource sharing has been increased compared with the traditional system. The design of the system server uses the parameter configuration in this paper, carries on the page setting and the student source information import in the system, imports the existing student source information to the university end, the information format imported is dBASE IV version of DBF file, if the information format is excel or other formats, the file needs to be re exported and converted. After making sure that the web server is set up successfully, you can upload and download the required information. First, deploy the architecture of the experimental cloud environment, as shown in the Fig. 5:

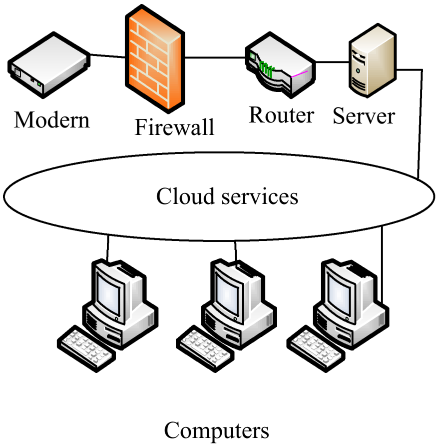


Fig. 5. Cloud environment architecture deployment

The stable operation of the system needs the support of software and hardware environment, and the system is based on J2EE platform. In order to ensure the normal operation of the system, the required software includes JDK compiler, Tomcat server and SQL Server 2005. The server memory needs to be more than 4G, and the hard disk is 512g. Because the system is designed and implemented based on cloud environment, the client needs to install browser. In order to verify that the designed system has a larger number of data resources to share, it is necessary to use KVM converter to control the user hosts in different areas. The KVM converter uses rekason sp1708-b, and its parameters are as follows (Table 2):

Table 2. KVM converter parameters

Order number	Relevant parameters	Specific indicators
1	Number of hosts connected	256
2	Scan interval	1–255 s
3	Input and output interfaces	USB interface conversion module
4	Power supply voltage	AC 100–240 V, 50–60 Hz, 1 A

Under the above experimental preparation, the traditional system and the designed system are tested for the number of data resource sharing.

3.2 Experimental Results and Analysis

In the above experimental environment, the KVM converter is used to control different user hosts. After successfully logging into the system, the user hosts are used to count the resource sharing data in the system. The results are as follows (Table 3):

Table 3. Comparison of experimental results

Number of experiments	Number of resources shared by traditional systems (10,000)	Number of system-sharing resources designed (10,000)	Expected number of shared resources (10,000)
1	1	1	1
2	5	5	5
3	9.7	9.86	10
4	10	49.9	50
5	10	97.8	100
6	10	100	500
7	10	100	1000

As can be seen from the above table, after the fourth experiment, the number of shared resources of the traditional system reached 100000. In the later experiment, the expected amount was continuously increased, and the number of shared resources of the traditional system did not exceed 100000, indicating that the maximum number of shared resources of the traditional system was 100000. After the sixth experiment, the number of shared resources of the designed system reached 1 million, In the seventh experiment, the expected amount is adjusted to 10 million, and the number of shared resources of the designed system remains at 1 million, which indicates that the maximum number of shared resources of the designed system is 1 million. To sum up, it can be seen that the number of shared resources of the designed system has increased significantly, which verifies the effectiveness of the designed system. This is mainly because the method in this paper uses the paradigm theory to design the database, so the capacity of the database is relatively large. At the same time, the system focuses on the research of multi-disciplinary teaching resources, and the type and number of resources are not restricted by disciplines.

4 Conclusion

The cultivation of innovative and entrepreneurial talents with interdisciplinary integration is a new journey of the reform of talent cultivation mode in Colleges and universities. The establishment of interdisciplinary innovative and entrepreneurial talent training objectives points out the direction of reform for talent training; scientific curriculum system is the main carrier of innovative and entrepreneurial talent training activities, and is the key step to achieve the goal of talent training; the construction of interdisciplinary innovative and entrepreneurial talent training platform is to find a specific practice path for talent training; the construction of interdisciplinary innovative and entrepreneurial talent training platform is to find a specific practice path for talent training; Teachers are the practitioners of talent training program, and building a reasonable teaching team can provide a strong guarantee for talent training. Only with these basic conditions can the cultivation of innovative and entrepreneurial talents with interdisciplinary integration become a reality, and it is possible to cultivate comprehensive innovative talents from all walks of life for the country. The main contribution of the method in this paper is to expand the number of original system resource sharing and increase the speed of calculation.

References

1. Chen, P., Tian, Y., Liu, W.: North star: global innovative talent development program with STEM education as the core: interpretation based on “charting a course for success:america’s strategy for STEM education” (2019–2023). J. Dist. Educ. **37**(02), 3–14 (2019)
2. Zeng, F., Lu, C.: Research on intelligent classroom teaching model based on vocational education cloud network platform: taking the course of automotive electrical appliances and auxiliary electronic systems as an example. Sci. Educ. Article Cult. (36), 140–141,163 (2019)
3. Chou, Y., Liu, J., Gu, Y.: An experimental teaching system of digital signal processing for applied talents cultivation. Res. Explor. Lab. **39**(08), 179–182+235 (2020)
4. Li, Y.: Online and offline mixed teaching practice based on smart vocational education—take “overhaul of automobile engine electronic control system” as an example. Auto Time (20), 66–67 (2020)
5. Lin, Y., Li, T., Pan, Y., et al.: Research on hybrid teaching of civil engineering specialty course integrating online and offline. J. Archit. Educ. Inst. High. Learn. **29**(01), 91–101 (2020)
6. Zhao, H., Gu, L., Liu, W.: Research on the construction of online excellent courses of core competence of vocational posts under the background of educational informatization. Theory Pract. Innov. Entrep. **3**(16), 64–65 (2020)
7. Sun, X., Li, J., Xie, J.: The application model research of blended learning in safety system engineering. Jiaoyu Jiaoxue Luntan (16), 264–267 (2020)
8. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
10. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training, pp. 1–374. Springer, Heidelberg (2018)
11. Jiang, X.: Exploration and practical research on the construction of benchmarking system project for party members in pri-vate colleges under the background of the new era. Sci. Educ. Article Cult. (11), 43–45 (2020)
12. Zhao, Z., Liu, L.: Study on teaching reform of the course of “motion control system” in application-oriented university. J. Cangzhou Teach. Coll. **35**(01), 98–101 (2019)
13. Wang, F., Liu, X., Ma, Y.: Research on the teaching reform of laboratory animal science course to strengthen on-line teaching and scientific innovation ability. Res. Explor. Lab. **38**(10), 195–197 (2019)

Diversified Design of Distance Teaching Platform for Pathogenic Microorganism and Immunology

Dan Wang, Lian-shi Dong(✉), and Ying Wang

Medical and Nursing Branch, Panjin Vocational and Technical College, Panjin 124000, China

Abstract. In the current distance teaching platform, when carrying out diversified teaching, it is difficult to carry out diversified teaching because of the poor bearing capacity of platform load. Therefore, the paper proposes the diversified design of distance teaching platform for pathogenic microorganism and immunology course. Firstly, the b/s framework is used to construct the platform structure. At the same time, the load balancing of platform server is balanced by using consistency hash algorithm. Access database is used as the database of teaching platform. The paper establishes the calculation method of teaching resource relevance and the teaching classification operation mode for students, and improves the function business of the platform, and completes the diversified design of the platform. In order to verify the feasibility of the design platform, the design experiment uses the teaching resources of pathogenic microorganism and immunology course in a university as the database resource, and carries out the platform test comparison experiment with the traditional method platform. The experimental results show that the design teaching platform has better performance than other flat platforms, and at the same time, it can still have better load capacity under different teaching modes, which can meet the original design intention.

Keywords: Diversified teaching · Hash algorithm · Balanced processing · B/S architecture

1 Introduction

With the promotion of campus culture and the deepening of educational informationization research, more and more informationization management systems have been designed and developed and successfully applied to all levels of college management departments [1–3]. With the development of diversified teaching modes, the era of simple teaching and chalk teaching is gradually replaced by multimedia teaching mode, LAN teaching mode and distance teaching mode. At present, the research on the teaching platform is relatively mature, and most of them use B/s and C/S structure to build the platform. In order to meet the needs of use, the current research direction begins to turn to improve the diversity of the platform. Most of the researches on teaching platform abroad focus on the function of Moodle, the application of Moodle in teaching and the function redevelopment of Moodle [4–6]. At the same time, on the basis of teaching

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 50–60, 2021.
https://doi.org/10.1007/978-3-030-84386-1_5

practice, the future development direction of Moodle is explored, and the function of Moodle is adjusted, improved and perfected. According to the characteristics of Moodle platform, domestic scholars use B/S structure to design the platform structure and improve the compatibility of the platform in the B/S structure to achieve diversity teaching. However, this type of load is often larger server-side pressure, the current lack of research on load distribution, there are limitations [7, 8].

2 Diversified Design of Distance Teaching Platform for Pathogenic Microbe and Immunology Course

2.1 B/S Structural Platform Architecture Design

This platform is developed using the B/S platform architecture, with the basic framework and physical framework defined and used as the basis for platform deployment, as shown in Fig. 1:

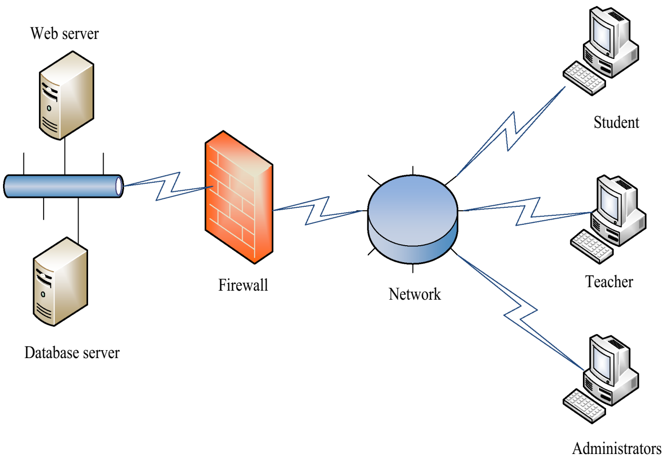


Fig. 1. Platform physical architecture diagram

The architecture of the platform is shown below. The physical architecture diagram details the various communication entities associated with the architecture of the system, including the Web server (apache server), the database server, the firewall, the Internet, and various user terminals. Among them, the apache server receives the request information from the client user and produces the dynamic web page according to the request information of the user, and processes various business logic in use of the system: including identifying the user's permission, judging the permission of database access, providing the user's demand and other logic rules, and separating the database server and the Web server in the physical structure in this platform, which is in the charge of special persons, so as to ensure the security of data, reduce the amount of data transmission, and provide the speed of data access. The user terminal uses the browser to make use of the system platform. The network architecture of the platform is shown in Fig. 2:

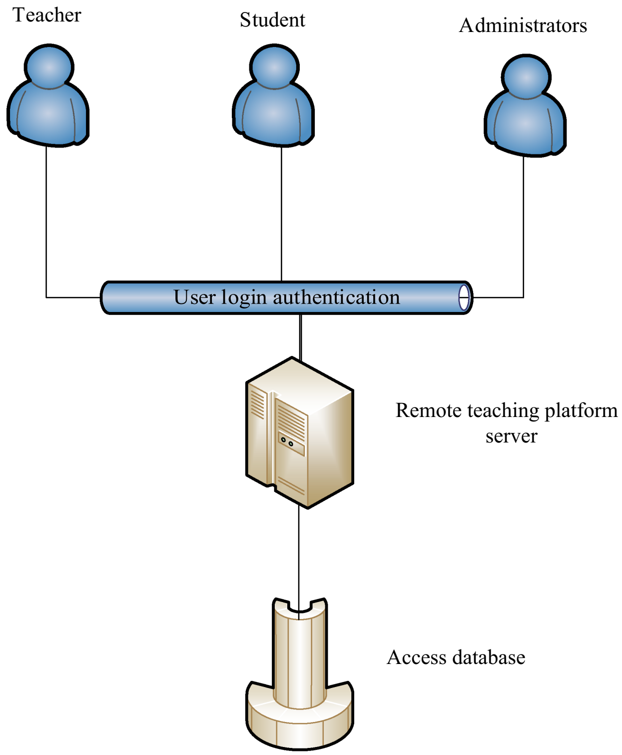


Fig. 2. Platform network architecture

In the distance teaching platform of this paper, the platform users are divided into three kinds of user identity: administrator, teacher and student. The platform puts the information setting of each college at the administrator level. The hospital administrator is responsible for checking and managing the teaching situation of all teachers in the hospital.

2.2 Platform Server Load Balancing Operation

Considering the load balance of teaching platform, this paper uses consistent hash algorithm to balance the load of platform server.

First, the media server node is mapped to a value range ring by hash function, then the real-time media streaming request is also mapped to the ring $\left[0, 2^{32} - 1\right]$, and the nearest media server node is searched clockwise to process the request. The load rate of media server node is obtained by the following formula:

$$LB_i = \varepsilon C_i + \eta M_i + \theta B_i + \varsigma L \tag{1}$$

In the formula (1), LB_i represents the load rate of the platform's first server node, C_i, M_i, B_i, L_i and represent the load balance index of the server, respectively representing CPU utilization, memory utilization, bandwidth utilization and connection ratio, and

$\varepsilon + \eta + \theta + \varsigma = 0$. The load server in the platform sends the relevant load, and uses the formula (1) to calculate the corresponding load rate LB_i. When the node of the platform server is $LB_i > LB_{Max}$, the nodes in the server are allocated to ensure the load balance of the platform server.

2.3 Multivariate Database Design for Teaching Platform

In this paper, ACCESS database is selected as the main database of the platform. The database has the advantages of simple installation, flexible operation, convenient transfer and simple operation environment [9]. ACCESS in this platform is mainly used in the following aspects: system database: that is, the entire system contains the database files, including pre-quality course name, course description, course website, TCP/IP filing number, traffic statistics, contact information and other settings. Administrator database: the management of the account, password and permissions set. Student user database: the student user's account number, password and information settings. The system platform module, the column sets the database: Mainly is carries on the rank to the high-quality goods curriculum's section content the column sets. Other column database: the column can be set by the high-quality curriculum builders, the platform developed in this study only preset the message board, contact us and other columns database settings. Platform access to the data in the database, the use of AD0 data access object technology, the application of platform database access. Enables clients to access and manipulate data in a database service system through any of the OLE DB providers. Combining ADO and ASP, we can establish the web page content provided by the database information, and then we can insert, query, update and delete the database. In ADO, we can use JavaScript, VBScript and other scripting languages to control access to the database and output query results, use RecordSet object to operate the database, use ODBC's system data source, ADO can also connect to many types of databases. In the ASP solution, ADO is the ability to provide users with the ability to develop fully functional database applications and connect to any database that is compatible with ODBC.

2.4 Correlation Operation of Diversified Teaching Resources

The data is stored in the database of this paper in a tree structure. In the ontology tree, nodes represent concepts, and edges connecting nodes represent relationships between concepts [10–12]. A node in the ontology tree is designated as the root node. Each node has at least one path to the root node, and the nodes on this path are the immediate ancestors of the node, the closest immediate ancestors being called parental nodes. For the two nodes in the ontology tree, they must share a common set of ancestor nodes.

The node representing the most specific concept is generally related to the nearest common ancestor of two nodes. Given two concepts $c1$ and $c2$, the most common method to calculate the similarity is to calculate the semantic distance of nodes according to their ontology levels: the closer the distance is, the higher the similarity is. When there are multiple paths in a node [13–15], the shortest path or average path of all paths is considered, and the corresponding common definitions are given, and the semantic similarity between the data of two nodes is calculated:

$$sim(c1, c2) = \frac{\alpha}{dist(c1, c2) + \alpha} \tag{2}$$

In formula (2), where $dist(c1, c2)$ represents the shortest path length from $c1$ to $c2$, and $dist(c1, c2) = \sum_{1}^{n} 1$ and α represent the adjustment factor. Considering the influence factors between nodes and the density of ontology tree [16–19], when the is-a relationship and part of relationship appear between nodes, the following formula is used to calculate the similarity:

$$\begin{aligned} sim(c1, c2) = {} & \alpha \times \frac{1}{\left(\sum_{i=1}^{n} wt(e_i)\right)^2 + 1} + \beta \times \frac{\deg ree(lso(c1, c2))}{\deg ree(Tree)} \\ & + \lambda \times \frac{depth(lso(c1, c2))}{depth(c1) + depth(c2) - depth(lso(c1, c2))} \end{aligned} \tag{3}$$

In formula (3), $lso(c1, c2)$ represents the common ancestor node of $c1$ and $c2$. $depth(ci)$ represents the path length from the root node to ci. The first term in the formula represents the distance between the upper and lower relationship edges in the short path from $c1$ to $c2$, e_i represents the i-th relationship connecting two nodes, and wt represents the weight value. The second term reflects the density of nodes, where $\deg ree(lso(c1, c2))$ represents the degree value of $lso(c1, c2)$ and $\deg ree(Tree)$ represents the degree value of ontology tree [20]. The third term reflects the depth of nodes, in which α, β, λ represents adjustable parameters. According to the relevance of teaching resources, we classify them.

2.5 Platform Student User Classification

Cluster analysis can establish a macro concept, discover the distribution pattern of data, and the possible correlation between data. Its purpose is to provide targeted services to the learning group with a certain characteristic attribute. Clustering is to divide the whole data into different groups, and make the gap between groups as large as possible, and the difference within groups as small as possible. Different from classification, before clustering, users do not know how many groups to divide data into, nor do they know the specific criteria of grouping, while the characteristics of data set are unknown in clustering analysis. According to certain clustering rules, clustering can gather data with the same characteristics, which is also called unsupervised learning. Clustering can be carried out according to learners' educational level, age, hobbies, etc. The process of clustering can be carried out by different algorithms according to the needs, and the attribute information of students can be compared comprehensively. At the same time, K-means algorithm is used for clustering operation in this paper. Let C represent the collection of document information, and A and B are platform learning users:

$$\begin{aligned} & A, B \in C, A = (a_1, a_2, \ldots a_n) \\ & B = (b_1, b_2, \ldots, b_m) \end{aligned} \tag{4}$$

Then the dissimilarity d between two learning users can be expressed as:

$$d(A, B) = \sum f\left(a_i, b_j\right) \tag{5}$$

At the same time, the corresponding d value is calculated according to the dissimilarity matrix, as follows:

$$d = \begin{pmatrix} f(a_1, b_1)\, f(a_1, b_2) \cdots f(a_1, b_m) \\ f(a_2, b_1)\, f(a_2, b_2) \cdots f(a_2, b_m) \\ \vdots \quad\quad \vdots \quad \cdots \quad \vdots \\ f(a_n, b_1)\, f(a_n, b_2) \cdots f(a_n, b_m) \end{pmatrix} \tag{6}$$

In formula (6), when $a_i = b_j$ is $f\left(a_i, b_j\right) \neq 0$, and when $a_i \neq b_j$ is $f\left(a_i, b_j\right) = 0$. When $d(A, B)$ is close to 0, the greater the difference between the two learning users is, and vice versa. By setting a threshold value in the platform, when $d(A, B)$ reaches the threshold value, the two students will be added to the cluster and form a student category.

2.6 Implementation of Business Functions of Teaching Platform

The platform designed in this paper provides two login methods in user login, namely user password login and QR code scanning login. The operation process of platform login is shown in Fig. 3

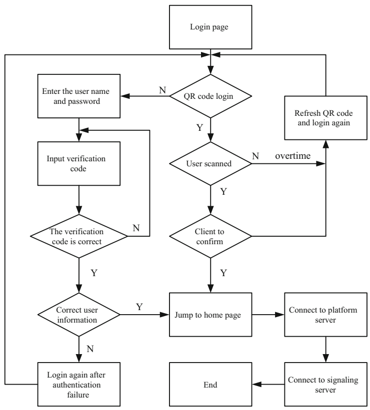


Fig. 3. Flow chart of user login

Log in with a user name and password. The user first enters the user name, password and verification code information. After that, the verification code entered by the user is verified. If the verification code is wrong, the user needs to re-enter the verification code. Only after the verification code is passed, the browser submits the login form containing the user name and password to the server for verification. If it fails, the login information entered by the user is cleared, and the user executes the login process again. In order to protect users' privacy, the system first uses HTTPS The protocol encrypts the login information and prevents man in the middle attack, and calculates the message digest of the password through MD5 algorithm, so as to prevent the background developers from misoperation, which leads to the direct disclosure of the user password in plaintext form; secondly, when the user logs in, it needs to input the verification code, which can prevent the script program from brutally cracking the user account to a certain extent; in addition, when the user registers, it is used for each user A unique random string (called salt) is generated, and the value stored in the database is the message digest calculated by MD5 algorithm after the hash value of user password and salt are spliced. Log in to the system by scanning the QR code. After the user enters the login page, between the browser and the server.

Maintain a long connection to view the status of user code scanning. When the user does not scan the QR code, confirm login or cancel login within the specified time, the login page will refresh the QR code and the user will execute the login process again. In the communication module of teaching platform, this platform uses mqtt protocol to realize the communication between platforms. First, the client subscribes to the related topic, and then when the topic has a message update, mqtt broker forwards the message to the client. At the same time, the corresponding instant messaging module is designed to realize. Some instant messaging topics are shown in Table 1.

Table 1. Theme design of instant messaging module

Theme	Subject category	Topic description
/e/eid/pres/uid	Status information	Used to notify users of status
/e/eid/im/u/uid	Instant messaging	For two person chat
/e/eid/im/g/gid	Instant messaging	For group chat
/e/eid/u/notice/uid	Notice	Personal notification message
/e/eid/g/notice/gid	Notice	Group notification message
/e/eid/gmanage/gid	Notice	For group management

In Table 1, eid, uid and gid represent course number, user number and group number respectively, and they are variable numbers.

3 Experimental Demonstration and Analysis

In order to verify the feasibility of the design platform, this paper uses the teaching resources of pathogenic microorganisms and immunology in a university as the platform data resources, and carries out comparative experiments with the platforms in literature [1], literature [2] and literature [4] to test the performance of the platform.

3.1 Platform Establishment Environment

The platform server environment is Dell PowerEdge r720 (Xeon e5–2609/2 GB/300 gb), CPU model: Xeon e5–2609 2.4G, memory capacity: 2 GB ECC DDR3, standard hard disk capacity: 1 TB, network controller: Intel four port Gigabit network, CPU frequency: 2.4 GHz. Client environment: Tsinghua Tongfang (u49f-i3314001) 200 desktop computers, screen size: 14 inch 1366x768, CPU model: Intel Core i5 3317u, CPU frequency: 1.7 GHz, memory capacity: 2 GB DDR3, hard disk capacity: 128 GB SSD, solid state disk, ie8.0. Integrated build Java language compiler environment, Tomcat server, access database.

3.2 Teaching Resource Data

The teaching resource data of pathogenic microorganism and immunology in a university was used as the experimental resource data.

Table 2. Data of experimental teaching resources

Resource type	Resource format	Number of resources	Resource size
video	.mp4	148↑	218 GB
Audio frequency	.mp3	Paragraph 98	12 GB
Written words	.txt	Chapter 45	86 MB
Picture	.png	278	1.78 GB

3.3 Classification Test of Teaching Resources

The teaching resources of pathogenic microorganism and Immunology selected in this experiment include multi chapter and multi type research direction teaching resources. Therefore, the platform is needed to classify these teaching resources. The experimental results are shown in Table 3.

Table 3. Experiment on classification ability of platform teaching resources

Platform number	Classification accuracy	Classification error rate	Number of classification types
Platform one	98.79%	1.04%	68
Platform 2	90.51%	4.65%	61
Platform 3	98.17%	0.98%	30
Platform 4	91.24%	4.33%	62

In Table 3, platform one is the distance teaching platform designed in this paper, platform two is the teaching platform in literature [1], platform three is the teaching platform in literature [2], and platform four is the teaching platform in literature [4].

It can be seen from Table 2 that the accuracy and error rate of the teaching platform designed in this paper are lower than those of other platforms, while the accuracy and error rate of the three classification of the platform are similar to those of this platform, but the number of types in the platform is less, and the classification is rough.

3.4 Teaching Resource Search Test

After classification, in order to verify the query ability of the platform to different teaching resources after classification, we use the experimental platform to query different table and graph resources in teaching resources, and verify the query ability of the platform. The test results are shown in Table 4.

Table 4. Platform teaching resources query test

Algorithm comparison		Linked list	Linear structure	Fork tree structure
Platform 1	Recall ratio	89.7%	91.4%	95.4%
	Precision ratio	91.2%	94.5%	91.7%
Platform 2	Recall ratio	82.1%	80.5%	81.2%
	Precision ratio	78.5%	77.6%	72.4%
Platform 3	Recall ratio	75.2%	77.5%	70.3%
	Precision ratio	80.2%	81.5%	83.5%
Platform 4	Recall ratio	72.5%	70.3%	70.2%
	Precision ratio	81.4%	83.5%	84.7%

In Table 4, it can be found that the recall and precision of the design platform are better than other platforms in the query of teaching resources, which proves that the platform has strong computing ability on the relevance of teaching resources.

3.5 Platform Diversified Use Load Test

In order to verify the load capacity of the platform under different use modes, 350 simulated users were established to simulate group chat interaction, video teaching and teaching test, and verify the load capacity of the test platform. The test results are shown in Table 5.

The results in Table 5 show that under the group chat interaction of 350 simulated users on the four platforms, the CPU and memory occupancy rates of the servers on the four platforms are less than 50%, and the load condition is good. The load test results of simulated user video teaching are shown in Table 6.

It can be found from the results in Table 6 that due to the large amount of data to be distributed and transmitted in video teaching, the platform load is required to be higher. Except for platform 1, the load of other platforms is higher than 50%, and the

Table 5. Load of group chat interactive teaching platform

Platform number	Server CPU usage%	Server memory usage%	Average data update delay
Platform one	16.7	18.5	78 ms
Platform 2	25.8	19.8	133 ms
Platform 3	31.1	23.4	147 ms
Platform 4	36.5	28.7	182 ms

Table 6. Load of video teaching platform

Platform number	Server CPU usage%	Server memory usage%	Average data update delay
Platform one	26.9	28.9	115 ms
Platform 2	54.6	49.8	386 ms
Platform 3	56.7	43.1	497 ms
Platform 4	65.3	61.4	487 ms

Table 7. Load of teaching test teaching platform

Platform number	Server CPU usage%	Server memory usage%	Average data update delay
Platform one	19.7	22.1	94 ms
Platform 2	43.5	48.2	216 ms
Platform 3	38.9	33.1	233 ms
Platform 4	39.2	40.5	287 ms

data update delay is higher than 200ms, which indicates that there is a certain pressure on the platform load. The load test results of simulated users are shown in Table 7.

In Table 7, it can be found that the load pressure on the platform is reduced in the teaching test operation of simulated users. But after three different platform operations, we can see that platform one is better than other platforms in carrying out diversified teaching.

4 Conclusion

In this paper, the B/S structure is used to build a diversified teaching platform, and the consistent hash algorithm is used to improve the server load distribution of the platform. It can meet the actual use of multiple teaching mode and improve the quality of teaching. However, most of the research of this platform focuses on the platform structure and platform load, and the user interface of the platform is lack of improvement and beautification, including page layout, font display and other issues, which still need to be further adjusted.

References

1. Yang, G.-H., Ying, C.-L., Zhao, D., et al.: Research and design of distance sports teaching platform based on cloud platform. Electron. Design Eng. **26**(10), 21–25 (2018)
2. Yang, G.-H., Hao, D., et al.: Development and design of distance PE teaching platform based on WEB. Electronic Design Eng. **26**(22), 10–13 (2018)
3. Li, C., Lu, Y., Lai, W., et al.: Experimental technology and management. **35**(2), 103–107 (2018)
4. Wang, L.-M., Deng, Q.-C., Feng, X.: Design and Implementation of Network Teaching Platform Based on Web. J. Hebei Inst. Archit. Eng. **36**(4), 122–125 (2018)
5. Shen, G., Cai, Q., Ding, X., et al.: Design of experimental platform for automobile intelligent anti-theft system based on internet of things. Exp. Technol. Manage. **35**(10), 133–135 (2018)
6. Heng, R.: Research on content construction of kindergarten teachers' distance training. J. Hubei Radio Telev. Univ. **38**(4), 14–18 (2018)
7. Guo, Y.: Design and implementation of cooperative learning platform based on network. Comput. Knowl. Technol. **14**(9), 68–69 (2018)
8. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
9. Breen, C., Zhu, T., Bond, R., et al.: The evaluation of an open source online training system for teaching 12 lead electrocardiographic interpretation. J. Electrocardiol. **02**(3), 454–461 (2016)
10. Jianqiu, L.: Construction of real-time interactive mode-based online course live broadcast teaching platform for physical training. Int. J. Emerg. Technol. Learn. (iJET) **13**(06), 73 (2018)
11. Li, Y., Huang, Q., Huang, X., et al.: Exploration of duifene platform-based flip class teaching mode at medical colleges in minority areas. Creat. Educ. **12**(01), 47–53 (2021)
12. Xu, D.: Research on internationalized teaching methods of civil engineering specialty in applied universities based on network cloud platform-taking the course of "engineering mechanics" as an example. J. Phys.: Conf. Ser. **1744**(3), 032055 (2021)
13. Yang, H.: Construction and application of smart education teaching platform. J. Phys.: Conf. Ser. **1744**(4), 042147 (2021)
14. Wang, X.: Application research on higher mathematics network teaching platform of higher vocational colleges combined with computer in cloud computing era. J. Phys.: Conf. Ser. **1744**(4), 042025 (2021)
15. Wang, L.: Construction of English network teaching platform relying on computer big data. J. Phys.: Conf. Ser. **1744**(3), 032142 (2021)
16. Chen, W., Chen, X., Peng, J., et al.: Landslide susceptibility modeling based on ANFIS with teaching-learning-based optimization and Satin bowerbird optimizer. Front. Geosci. **12**(1), 93–107 (2021)
17. Petrişor, R.-M., Petrişor, S.-M.: Digital permanences in the contemporary educational space. The moodle elearning platform. Land Forces Acad. Rev. **26**(1), 45–48 (2021)
18. Li, Y., Zhang, R., Yang, Y.: Practice of distance online teaching of automobile theory. Open Access Libr. J. **8**(01), 1–5 (2021)
19. Coovadia, H., Ackermann, C.: Integrating digital pedagogies into a typical student learning lifecycle and its effect on exam performance. Acc. Educ. **30**(1), 42–62 (2021)
20. Green, B.A., Lung, Y.S.M.: English language placement testing at BYU-Hawaii in the time of COVID-19. Lang. Assess. Q. **18**(1), 6–11 (2021)

Design of Sports Dance Online Interactive Teaching System Based on Intelligent Terminal

Jing Zhao[1](✉) and Ya-na Tang[2]

[1] Xi'an International Studies University, Xi'an 710128, China
[2] South China Institute of Software Engineering GU, Guangzhou 510990, China

Abstract. This research designs an online interactive teaching system of sports dance based on intelligent terminal. In the hardware part of the system, the processor, memory and storage circuit, wireless transceiver circuit, power circuit, liquid crystal display module and circuit module are designed; In the software part of the system, the data in the system are mainly processed, and the corresponding database is designed. The experimental results show that the sports dance online interactive teaching system based on intelligent terminal not only improves the storage capacity of the system, shortens the response time of the system, but also improves the maximum concurrent number of the system, which shows that it has high practical significance and can effectively realize the online teaching of sports dance.

Keywords: Intelligent terminal · Sports dance · Online interaction · Teaching system

1 Introduction

Sports dance is a dance of international social activities, which plays an important role in enriching human life and improving human self-cultivation. However, due to the limitation of time and space in traditional dance teaching, it is difficult for the majority of fans to arrange time to study reasonably [1].

With the continuous development and maturity of computer network technology and communication technology, online teaching has become a reality. The use of online video teaching can make up for the limitations of traditional sports dance teaching, so that people do not have to learn sports dance at a designated time and place, which can increase the interest of dance lovers and improve dance.

Generally speaking, the sports dance video teaching system uses the combination of sports dance and computer technology, uses the recorded dance teaching video to express the teaching content of the course in a digital form, and uses the establishment of a database to compare the various teaching resources in the teaching system and Student and teacher information is stored and managed. It can not only effectively manage teaching resources, but also provide learning opportunities for fans more clearly and conveniently through video teaching. At present, the commonly used teaching systems

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 61–74, 2021.
https://doi.org/10.1007/978-3-030-84386-1_6

mainly include online interactive teaching system of sports dance based on VEM framework and online interactive teaching system of sports dance based on VEM framework of Leap Motion Motion controller. However, it is found in practical application that the above-mentioned traditional system has some shortcomings such as poor storage capacity and long response time.

Smart terminals are also called mobile smart terminals, mainly including mobile phones, tablets, laptops, vehicle-mounted smart terminals, PDA smart terminals, wearable devices, etc. In our country, students, no matter in primary and secondary schools, generally have mobile phones. This creates conditions for the development of teaching based on intelligent terminals. Therefore, in view of the shortcomings of the traditional system, this research is based on the intelligent terminal to design the online interactive teaching system of sports dance.

2 Hardware Design of Sports Dance Online Interactive Teaching System

The hardware structure of Sports Dance online interactive teaching system is shown in Fig. 1.

In Fig. 1, the data layer mainly stores teaching data in the form of XML database. The data layer takes knowledge points as the core; the intermediate agent layer mainly interacts with the system after the learners log in to the system and returns to the information base according to the learners' learning results; the realization layer mainly accepts the user's request and returns the generated formatted data to the page.

2.1 Processor Design

ARM's Cortex-M3 processor is the latest generation of embedded ARM processors. It provides a low-cost platform, reduced pin count, reduced system power consumption, and excellent computing performance for the needs of MCU. And advanced interrupt system response. In addition, ARM's Cortex-M3 processor is a 32-bit RISC processor, which provides additional code efficiency and exerts the high performance of the ARM core in the storage space of the usual 8-bit and 16-bit systems [2, 3].

Stm32f103zet6 is a high-performance arm Cortex-M3 32-bit RISC microcontroller produced by stm32f103zet6. Therefore, it is compatible with all arm development tools and software. Stm32f103xx is a complete series, its members are completely foot to foot compatible, software and function are also compatible. In the reference manual, stm32f103x4 and stm32f103x6 are classified as small capacity products, stm32f103x8 and stm32f103x B are classified as medium capacity products, and stm32f103x C, stm32f103x D and stm32f103x e are classified as large capacity products. Small capacity products have smaller flash memory, RAM space and fewer timers and peripherals. The high-capacity products have larger flash memory, RAM space and more on-chip peripherals, such as SDIO, FSMC, I2S and DAC, while maintaining compatibility with other products of the same series.

STM32F103ZET6 is mainly equipped with 3 12-bit analog-to-digital converters, 1us conversion time, up to 21 input channels; 2-channel 12-bit digital-analog converter;

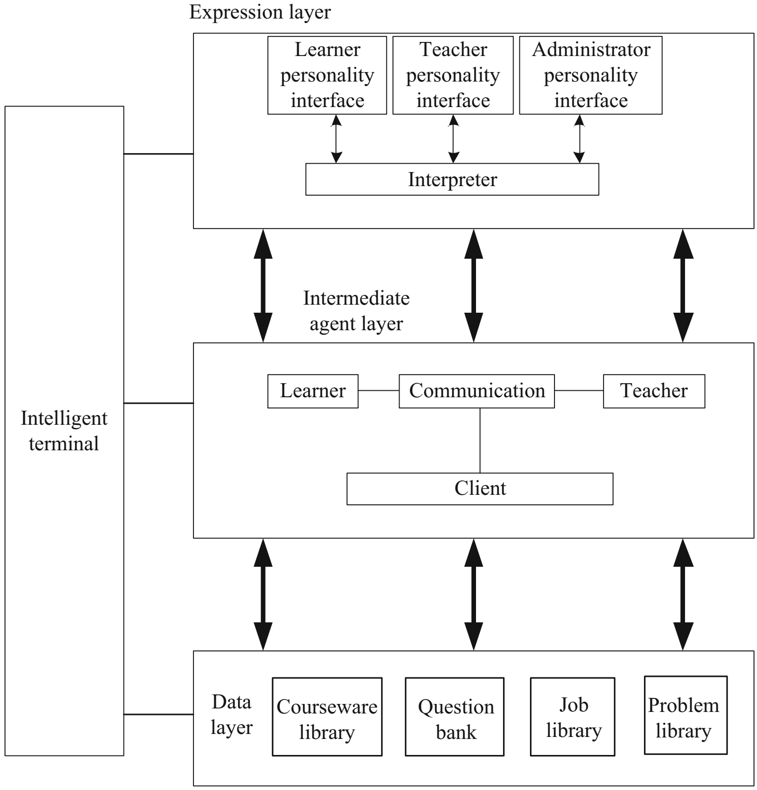


Fig. 1. Hardware structure of online interactive teaching system of sports dance

12-channel DMA controller; up to 11 timer, Are 4 16-bit timers, each timer has up to 4 channels for input capture, output comparison, PWM or pulse counting and incremental encoder input [4, 5]; 2 16-bits with dead zone Control and emergency braking, PWM advanced control timer for motor control; 2 watchdog timers (independent and window type); 2 16-bit basic timers for driving DAC; 1 system time timer: 24-bit self-decreasing counter; up to 13 communication interfaces, respectively 2 I2C interfaces; 5 USART interfaces; 3 SPI interfaces, 2 of which can be reused as I2S interfaces; Controller area network CAN interface (2.0B Active); USB 2.0 full-speed host/slave/OTG interface; up to 112 users can operate general-purpose I/O pins; debug mode has a serial single-wire JTAG debug port.

2.2 Design of Memory and Storage Circuit

SRAM is a kind of static random access memory. SRAM uses registers to store information, and it can save the internal data without refreshing the circuit. Therefore, SRAM has high performance, and the speed of SRAM is very fast, so it is the fastest read-write storage device at present [6–8]. SRAM needs four to six transistors and some other parts, while DRAM only needs one transistor and a small capacitor for the same memory cell.

Therefore, for SRAM and DRAM with the same capacity, the cost of SRAM is much more expensive than DRAM, and the chip area is also larger.

Therefore, this system chooses 256K × 16bit SRAM, the model is IS61WV25616BLL-10TLI, it is a high-speed asynchronous CMOS performance SRAM produced by ISSI company, the operating frequency can be up to 125 MHz, the operating voltage is 3.3 V, and the operating power consumption The maximum is 85 mW, the static power consumption is 7 mW, with three-state output, the data read and write control is divided into high byte and low byte, and the address line and data line operate independently [9].

In SRAM, the decoder and interface circuit with external signal are around the array of memory cells arranged in matrix form. Memory cells are usually in the form of square or matrix to reduce the area of the whole chip and facilitate data access. A0-a17 is the address input, I/o0-i/O15 is the data input and output, and /CE is the chip enabling end. The low level is effective. When the driving level is low, the device is enabled. /OE is the data output enable end, low level valid, / we is the write enable end, low level valid, /Ub and /lb are the high and low byte control end, low level valid respectively. SRAM operation is divided into read operation and write operation. When the address of MCU /lb /CE is low, the data can be read from MCU /lb /CE Write data. The function of high and low byte control terminals /Ub and /lb is to facilitate users to write or read only one byte of data at a time [10].

2.3 Wireless Transceiver Circuit Design

The RF wireless transceiver module is also the core module of the system. This research uses CC1101RF transceiver to design RF wireless transceiver module. The CC1101RF transceiver is a sub-1 GHz high-performance radio frequency transceiver launched by Texas Instruments. It is Chipcon's Smart RF 04 technology based on a 0.18 micron CMOS crystal and is designed for extremely low power RF applications. The CC1101RF transceiver integrates a highly configurable modem. This modem supports different modulation formats, and its data transfer rate can reach 500 kbps. By turning on the forward error correction option integrated on the modem, performance can be improved. In addition, the CC1101RF transceiver provides extensive hardware support for data packet processing, data buffering, burst data transmission, clear channel assessment, connection quality indication and electromagnetic wave excitation.

Cc1101rf transceiver can provide a wide range of hardware support for packet processing, data buffering, burst transmission, received signal strength indication (RSSI), idle channel assessment (CCA), link quality indication and wireless wake-up (wor). Cc1101rf transceiver is compatible with CC1100 in code, package and external pin. It can be used in the most commonly used open RF design with frequency lower than 1 GHz in the world. The main characteristics of cc1107 transceiver are as follows:

- Small size (QLP 4 × 4mm package, 20 pins);
- Real single chip UHF RF transceiver;
- Frequency bands: 300–348 MHz, 400–464 MHz and 800–928 MHz;
- High sensitivity (- 110D BM at 1.2 kbps, 1% packet error rate);
- The programmable data transmission rate can reach 500 kbps;

- Low current consumption (15.6 m a, 2.4 kbps, 433 MHz in Rx);
- The output power of programmable control can reach + 10d BM for all supporting frequencies;
- Need few external components: on chip frequency synthesizer, no external filter or RF conversion;
- The programmable baseband modem supports 2-fsk, GFSK, MSK and ook;
- Optional forward error correction with interleaving;
- Separate 64 byte RX and TX data FIFO;
- Efficient SPI interface: all registers can be controlled by a "burst" converter.

The working principle of CC1101RF transceiver is as follows: CC1101RF transceiver chip has multiple functional modules, mainly including low noise amplifier (LNA), power amplifier (PA), analog-to-digital converter (ADC), multiplier, 90-degree phase shifter, Baseband modem and frequency synthesizer, etc. When receiving data, the CC1101RF transceiver can be used as an IF (Intermediate Frequency) receiver. The received RF signal first passes through a low-noise amplifier (LNA) to amplify the useful signal and suppress noise, and then down-convert to an intermediate frequency (IF) through a mixer. At the intermediate frequency, two orthogonal components he signals I and Q are respectively converted into digital signals through two analog-to-digital converters (ADC) [11, 12]. After the two digital signals are controlled by forward error correction, they are packed and stored in the 64Byte receive buffer (RXFIFO). Wait for the microcontroller to read the data. The transmitted data of CC1101 is based on the direct synthesis of RF frequency. Its internal frequency synthesizer includes a complete LC voltage-controlled oscillator (VCO) and a 90-channel signal generated by the down-conversion mixer in the receiving mode. Degree phase shift network. The transmitted data is first stored in the 64Byte transmission buffer, and then the data is packaged and modulated. The modulated signal is directly generated by the frequency synthesizer and then passed through the phase shift network and power amplifier (PA), and finally transmitted through the antenna.

2.4 Design of Power Supply Circuit

The battery panel uses 36 ah, 12 V maintenance free lead-acid battery as the energy storage element, that is, the output voltage of the battery is 12 V. When selecting the power conversion chip for 5 V voltage conversion circuit, it is necessary to have an overall evaluation of the overall power consumption of the system. In order to make the power conversion chip meet the maximum load requirements of the system and leave a certain margin, at the same time, it is necessary to consider the efficiency of chip conversion. 5 V power supply is mainly for LED The display power consumption is relatively large, and the maximum power consumption can reach several watts. Considering the above factors, in this system, the 5 V voltage conversion chip selects the Synchronous Step-Down Switching Regulator lm2576-5.0v of national semiconductor company, which can provide various functions of the step-down switching regulator, and can drive 3 A at most It contains a frequency compensator and a fixed frequency oscillator of 52 kHz, which can reduce the number of external components to the minimum and make the designer more convenient.

2.5 LCD Module Design

Syg128641 LCD module is adopted, which is a 128 × 64 dot matrix LED backlight STN LCD with blue background and white characters. With negative pressure conversion function, its connection principle is shown in Fig. 2.

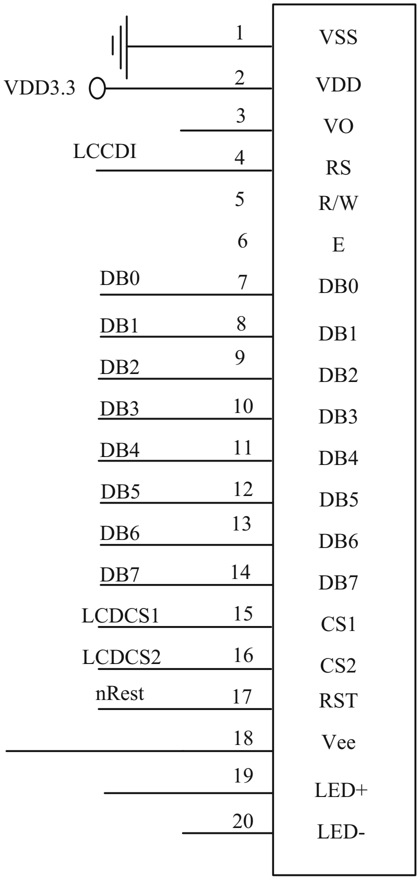


Fig. 2. Partial connection diagram of LCD module

In Fig. 2, DB0–DB7 represent data line 0~data line 7, VOUT represents voltage output, LEDA represents backlight input, RD represents read signal, CE represents chip select signal, and C/D represents command/data selection.

2.6 Liquid Crystal Display Module Circuit Design

The integrated LCD controller of OMAP-L138 includes two independent controllers, one raster controller and one LCD display interface display driver (Lido) controller. Each controller operates independently and only one controller can be effective at the same time. Grating controller is used to process synchronous LCD interface [13], which provides clock and data for continuous graphic refresh of passive display; Lido controller supports asynchronous LCD interface, which provides programmable control signal and output data. The maximum resolution supported by LCD controller is 1024 × 1024 pixels, and the maximum frame rate is determined by image size and clock frequency. LCD controller supports two kinds of LCD, STN (super twisted nematic) LCD and TFT (thin film transistor) LCD.

This research uses POWERTIP's TFT LCD PH320240T-005-IQ, which has a resolution of 320 × 240 pixels, supports 24bit RGB (red, green, and blue) color mode, uses 3.3 V power supply, and its operating current is generally 75 mA. The dot clock frequency is 6.4 MHz. The internal LCD controller of OMAP-L138 only provides 16 data lines, while the selected LCD screen PH320240T-005-I-Q has a total of 24 data lines. In this design, the excess 8 data lines are directly pulled up. The LCD_AC_ENB_CSn signal is used here as the LCD controller data output enable signal, that is, the DE signal. In order to ensure the high quality of the liquid crystal display, this design adds a resistance of 33 Ω to the data line, clock line and control line to do impedance matching processing to eliminate signal reflection and ensure signal integrity [14, 15].

3 Software Design of Online Interactive Teaching System for Sports Dance

3.1 Teaching Data Processing

Based on the hardware design of the above-mentioned sports dance online interactive teaching system, the software design of the sports dance online interactive teaching system. Under the intelligent terminal, the software development of the sports dance online interactive teaching system is mainly composed of teaching resources, bulletin boards, resource downloads, student communication and management systems, in order to meet the functions of downloading and sharing learning resources of students, and understanding the latest learning trends. Teachers can also use the software to publish news and carry out teaching to complete classroom teaching and experimental analysis.

The software designed this time mainly includes news updates, bulletin boards, download centers, communication areas, system management, course introduction, teaching methods, syllabus, teaching plans, bibliography, electronic courseware, stereo and answers, case addition and deletion functions. In order to avoid conflicts between various functions in the system, a resource database is constructed, and the port of the sports dance online classroom teaching system is connected to the database to ensure that the data transmission speed is increased when resources are requested to download. In addition, set the user authentication function in the system software, because there are more users using the software, if there are more users accessing a project at the same time, there will be a stuck phenomenon, so set the user authentication function. According to the different identities of teachers and students, access to different system resources. So as to improve the use of the online classroom teaching system. The user authentication link needs to mobilize the database to complete, so it is necessary to enter the relevant information of teachers and students in the online classroom teaching software to improve the response speed of the system. The implementation steps are as follows:

First, user requirements are abstracted as information structure, which is also the basis of database design;

Second, construct the result tree, add any structure through filtering and reordering, and judge the data attributes. The calculation formula is as follows:

$$|G| = \frac{v \in t}{\int V \times K_i} \tag{1}$$

In formula (1), $|G|$ is the data in the database, $\int V$ is the data attribute, K_i is the attribute determination factor, and $v \in t$ represents the attribute of the data v is t.

Third, the attributes of the data are obtained through the above calculations, and the result tree is constructed according to the attributes of the data;

Fourth, format the system data and use the following formula to achieve:

$$G\log = \sqrt{\frac{p_{bv}}{Z \times v}} \tag{2}$$

In formula (2), $G\log$ stands for formatting factor, Z stands for data entity attributes, v stands for configuration data, and p_{bv} stands for data hierarchy logic.

Fifth, the formatted vocabulary specified in the XML document is implemented to construct the result tree. Each type of data in the database corresponds to a formatted object class. Mapping process is shown in Fig. 3.

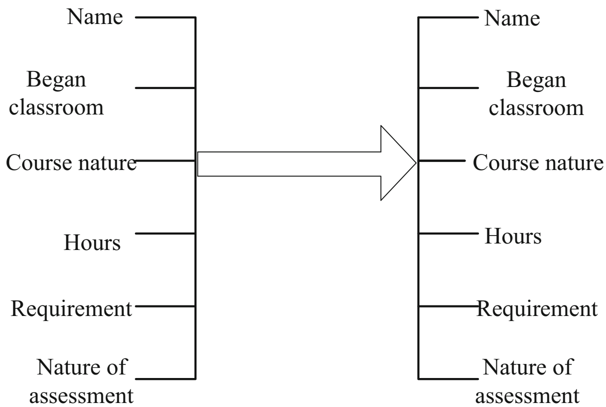


Fig. 3. Data mapping process

When an attribute of a data in the system database has the same attribute value in multiple object instances, all the system name information is stored in a single database table to avoid data redundancy;

Sixth, create a course group. In the process of creating, if the service nature of assessment encounters an access request, it first executes the data segment. Because the amount of data mapped to the library table is large, which affects the query efficiency, it creates a course group, stores the same kind of data information in the unified curriculum table, and then returns the execution result to the system together with the JSP file;

Seventh, test function, which is the core part of the distance teaching management system, separates the generation and display of the content in the system. According to the result of separation, the level of students is distinguished. The degree of discrimination of each test question in the system is determined in advance by an experienced teacher, and is continuously adjusted according to the test takers' scores. The mathematical expression of the overall degree of discrimination is:

$$Q_n = \left(\sum_{x} j \times W_j\right) / M \tag{3}$$

In formula (3), Q_n is the discrimination degree of question n, W_j is the full score of question j, $\sum_{x} j$ is the full score of the whole paper, and M is the test taker's score.

The calculation process and results are stored in the database, so that the system can continuously improve the database structure according to the level of students.

3.2 Database Design

The data after the above processing is stored, and the relevant information of the relationship table between the main entities in the database is shown in Table 1.

Table 1. The relationship table between the main entities in the database

Entity 1	Entity 2	Relationship type
Student	Class	an: 1
Class	Profession	an: 1
Forum message	Leave a feedback	1: an
Student	Forum message	1: an
Student	leave a feedback	1: an
Student	Q & A	1: an
System users	Operating	1: an
Test questions	Chapter	an: 1
Test questions	Error	1: 1

Based on the above analysis, the software flow is designed as follows:

1) Connect the system database with the system hardware;
2) Check whether the hardware connection is successful. If successful, access the relevant information. If unsuccessful, send an error report and return to the login page;

3) Through the output - Edit - Review - modify - delete and other steps to complete the software operation.

The structure of class table is shown in Table 2.

Table 2. Class table structure

Serial number	Field name	Types of	length	meaning
1	Classid	Integer	256	Welder id
2	Institutename	Character type	30	College name
3	Majorname	Character type	30	Professional title
4	Classcode	Character type	8	Class number
5	Classname	Character type	20	Class name

According to the above process, the data is stored to complete the research on the online interactive teaching system of sports dance based on the intelligent terminal.

4 Experimental Comparison

In order to verify the effectiveness of the design of Sports Dance online interactive teaching system based on intelligent terminal, experimental analysis is carried out, and in order to ensure the preciseness of the experiment, the performance of this research system is compared with the traditional system.

4.1 Comparison of System Storage Capacity

The storage capacity comparison between the online interactive teaching system of sports dance based on intelligent terminal and the traditional system is shown in Fig. 4.

Analyzing Fig. 4, we can see that in the first phase of testing, the data storage capacity of the research system is similar to that of the traditional system. The data storage capacity of the research system is on the rise throughout the entire time period, and the data storage capacity is relatively high. The overall data storage capacity is higher than that of the traditional system. It can be proved that this research can achieve the system design goal in data storage capacity, and there is no storage slack, and the storage capacity is superior.

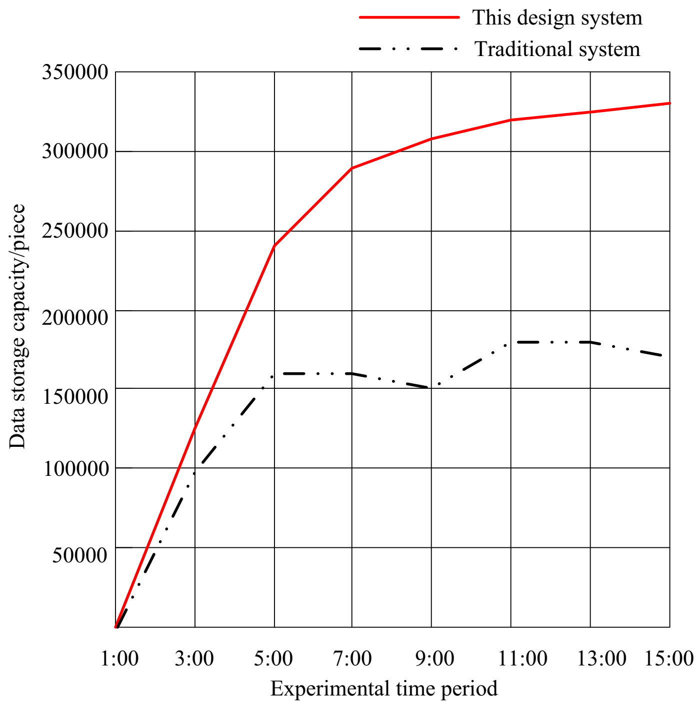


Fig. 4. System storage capacity comparison

4.2 Comparison of Response Time of Different Requests

Compare the response time of this research system and the traditional system under different requests. The main test contents include the response time of teacher assignment, user login operation, online classroom operation and homework operation. The comparison results are shown in Fig. 5.

Analyzing Fig. 5, we can see that the transmission rate of different systems is different under different user operations. By comparison, it can be seen that the response time of the four operations of this research system is relatively short, and it can respond to user operations in a short time. However, the traditional system has a longer response time in user login operation time response, online classroom operation time response, and homework exercise operation, and the response time is much longer than this research system.

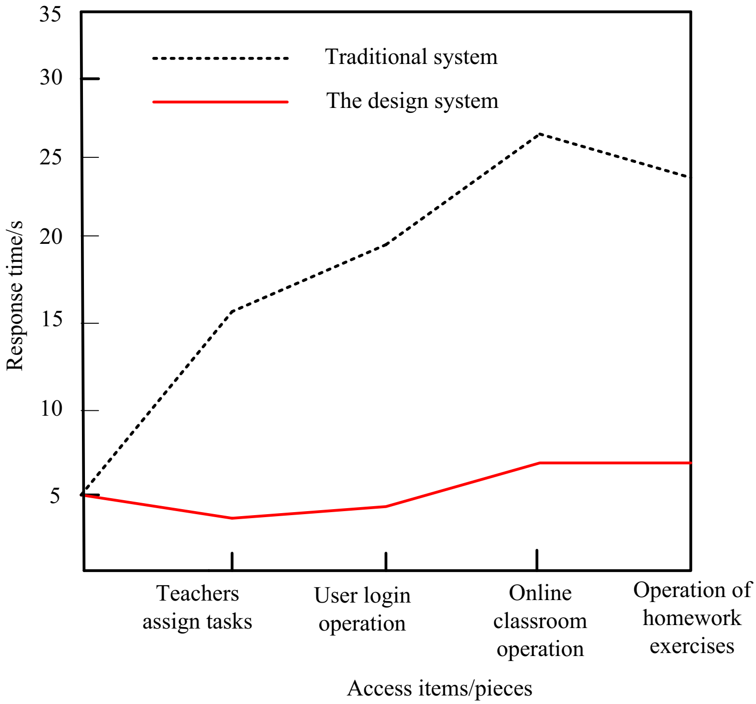


Fig. 5. Comparison of response time of different requests

4.3 Comparison of the Maximum Number of Concurrent Systems

Figure 6 shows the comparison result of the maximum concurrency between the research system and the traditional system.

Analyzing Fig. 6 we can see that when the number of concurrent data of the research system and the traditional system accomplish the same goal, the system time shows a gradual upward trend. Careful analysis shows that the research system takes less time than traditional systems to complete the maximum concurrency.

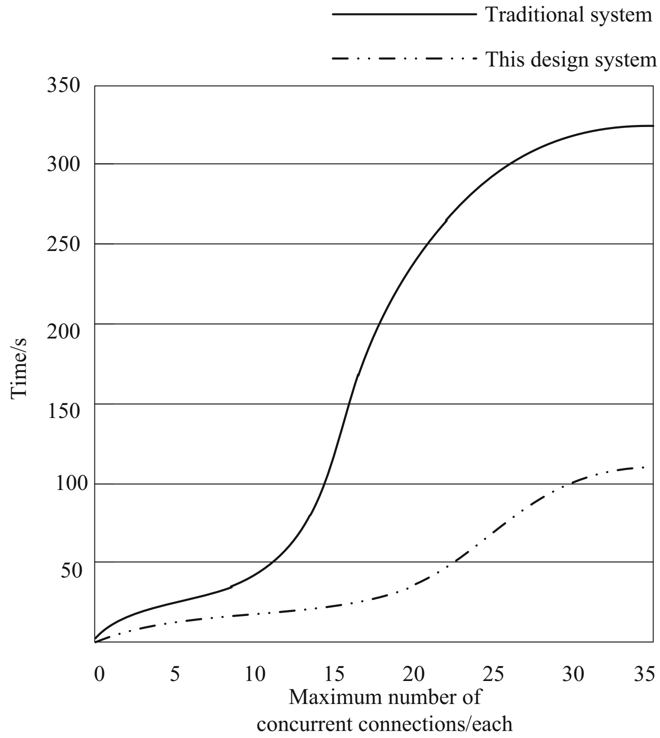


Fig. 6. Comparison of the maximum number of concurrent systems

5 Conclusion

This study designed an online interactive teaching system of sports dance based on intelligent terminal. The functions of the system include user login and authentication, information management, course management and database design. This system can not only realize the sharing of teaching resources, but also create network courses. The system reduces the limitation of communication between teachers and students, students can ask questions on the message board, teachers reply students can check, the design of other network classroom teaching software development system is also of reference significance. However, due to the limitation of research time, the system still has some deficiencies. In the following research, the system will be further optimized from the perspective of teaching resource oriented mining.

References

1. Li, Y., Zhang, D., Guo, H., Shen, J.: A novel virtual simulation teaching system for numerically controlled machining. Int. J. Mech. Eng. Educ. **46**(1), 64–82 (2018)
2. Feng, D., Liu, Y., Mazloomi, M.S., Limaye, A., Turner, M., Evans, P.D.: A virtual reality system to augment teaching of wood structure and protection. Int. Wood Prod. J. **11**(2), 46–56 (2020)

3. Hoad, K., Kunc, M.: Teaching system dynamics and discrete event simulation together: a case study. J. Oper. Res. Soc. **69**(4), 517–527 (2018)
4. Miller, R.E., Dunn, P.: Teaching case: mihotel: applicant processing system design case. J. Inf. Syst. Educ. **29**(1), 21–24 (2018)
5. Zheng, H., Perez, Z.: Design of multimedia engineering teaching system based on internet of things technology. Int. J. Continuing Eng. Educ. Life-Long Learn. **29**(4), 293–305 (2019)
6. Yanmei, T., Jie, A.: Research on teaching quality evaluation system based on the mathematical model of teaching efficiency. Int. J. Eng. Model. **31**(1), 236–243 (2018)
7. Zhe, L., Meng, C., Takanori, M., Juan, L.: Construction and application of korean-english-japanese multilingual teaching aid system based on knowledge map. Int. J. Dist. Educ. Technol. **16**(4), 1–14 (2018)
8. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
10. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): E-Learning, E-Education, and Online Training, pp. 1–374. Springer, Heidelberg (2018)
11. Luo, L.L.: Design of online and offline hybrid intelligent assistant teaching system. Microcomput. Appl. **35**(08), 105–108 (2019)
12. Chen, P.S., Dou, H.B.: Design and impementation of intelligent physical teaching system based on knowledge. Tech. Autom. Appl. **38**(12), 169–171 (2019)
13. Chen, J.Y., Wang, Z., Chen, J.Y., et al.: Design and research on intelligent teaching system based on deep learning. Comput. Sci. **46**(S1), 550–554+576 (2019)
14. Wang, X.M., Zhou, H.C., Zhou, X.: Design of flipped classroom assistant system. Comput. Technol. Dev. **29**(11), 133–138 (2019)
15. Ning, R., Xing, W.N.: The online course teaching system design of the university network based on the VEM framework. Tech. Autom. Appl. **39**(02), 48–51 (2020)

Construction of Online Distance Three Dimensional Teaching Platform for Industrial Design Major in Colleges and Universities

Ji-wei Liu[1(✉)] and Li-na Dong[2]

[1] College of Design and Art, Shenyang Aerospace University, Shenyang 110136, China
[2] School of the Arts, Tianjin University of Commerce, Tianjin 300134, China

Abstract. Aiming at the problems that the traditional classroom teaching method cannot update the database in real time, resulting in incomplete data transmission and low efficiency of tutoring, a remote online 3D teaching platform for industrial design major in colleges and universities is designed. According to the framework of online distance stereoscopic teaching platform, the infrastructure layer, database layer and application service layer are designed. The information is stored in the SQLite lightweight database of memory to provide students with the required course information of industrial design. From the exhibition three-dimensional teaching mode, competition three-dimensional teaching mode, training three-dimensional teaching mode and project driven three-dimensional teaching mode four methods, design online distance three-dimensional teaching platform mode. The experimental results show that all the black box test contents of the system are passed, and the highest counseling efficiency is 99%, which has a good counseling effect.

Keywords: Industrial design major in colleges and universities · Online distance · Three-dimensional teaching · Platform construction

1 Introduction

Distance education is a kind of education mode where the training courses are transmitted to distance (outside the campus) through audio, video (live or video) and computer technology including real-time and non real-time [1]. Its emergence has changed the traditional education space, time, work and family relations, economic constraints, which are the requirement of the development of the times, but also the social demand for a variety of forms of education [2]. It is a new component of the existing higher education system and a supplement [3]. Industrial design is a comprehensive design of the function, material, structure, shape, color, surface treatment, decoration and other elements of mass-produced industrial products from the perspectives of society, economy, technology and art, so as to create new products that can meet people's growing material needs [4].

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 75–89, 2021.
https://doi.org/10.1007/978-3-030-84386-1_7

At present, domestic colleges and universities attach great importance to the practical teaching of industrial design. The core of industrial design is product design. If it is separated from enterprises, design will become the water without a source. It is an indisputable fact that industrial design can develop only when it is combined with enterprises. Therefore, colleges and universities now choose to cooperate with enterprises to complete the practical teaching of students. There are professional practice teaching links in the training programs of various colleges and universities. Due to the accommodation of enterprises and the internship funds of schools, students generally choose to visit the enterprises for internship, or directly contact the internship site nearby by themselves, so as to guide students to understand the actual design process and practical teaching knowledge. This can play a certain role, but due to the short time and other reasons, students can not better integrate into the practical teaching link, and the pertinence is poor. In the traditional classroom and satellite TV teaching process, students' learning time and place are limited, and the course content presents a linear display mode, which can not be updated in real time. In the traditional classroom, when the server sends and returns files to the client, the data is centralized, but the file is large, which is easy to cause network congestion and data loss. However, the use of satellite TV teaching method is affected by the quality of the floppy disk, which is prone to the loss of course data.

For this reason, this paper puts forward the construction of online distance three-dimensional teaching platform for industrial design major in colleges and universities. Aiming at the problem that the traditional classroom teaching method can not update the database in real time, the infrastructure layer, database layer and application service layer are designed. The information is stored in SQLite lightweight memory database, which provides students with the required course information of industrial design. Starting from the four methods of display three-dimensional teaching mode, competition three-dimensional teaching mode, training three-dimensional teaching mode and project driven three-dimensional teaching mode, the online remote three-dimensional teaching platform mode is designed to optimize the teaching efficiency. Experimental results show that the proposed method has good application performance.

2 Industrial Design Major Framework Design of Online Distance Stereoscopic Teaching Platform

To establish an online distance three-dimensional teaching platform for industrial design major in colleges and universities, the construction of the platform needs to integrate and apply information technology in combination with new information technologies such as big data, cloud computing and mobile Internet, so as to meet the needs of all parties as much as possible [5]. Information collection is very important for the construction of the platform. By strictly controlling the collection mode, we can realize the strict control of the course teaching mode. On the basis of hierarchical structure design, the platform has certain expansibility and adaptability at all levels [3]. Figure 1 shows the framework of online distance stereoscopic teaching platform.

As can be seen from Fig. 1, the online distance stereoscopic teaching platform can be divided into three levels: Infrastructure layer, database layer and application service layer. The three do their best and each do their best to provide students with the necessary information on industrial design courses.

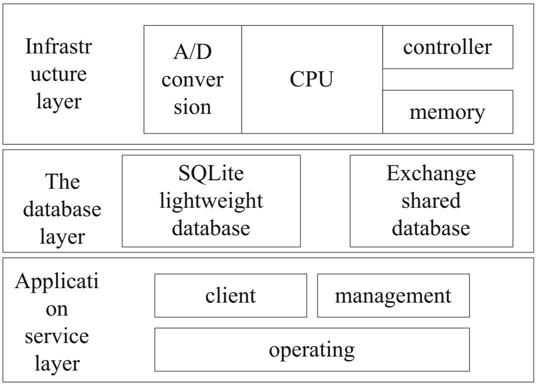


Fig. 1. Framework of online distance stereoscopic teaching platform

2.1 Infrastructure Layer

The digital sensor used in the infrastructure layer is to add or modify the A/D conversion module of traditional analog sensor to make its output signal digital (or digital coding). It mainly includes function realization, A/D conversion controller, single chip microcomputer (CPU), memory, communication interface, temperature detection circuit, etc.

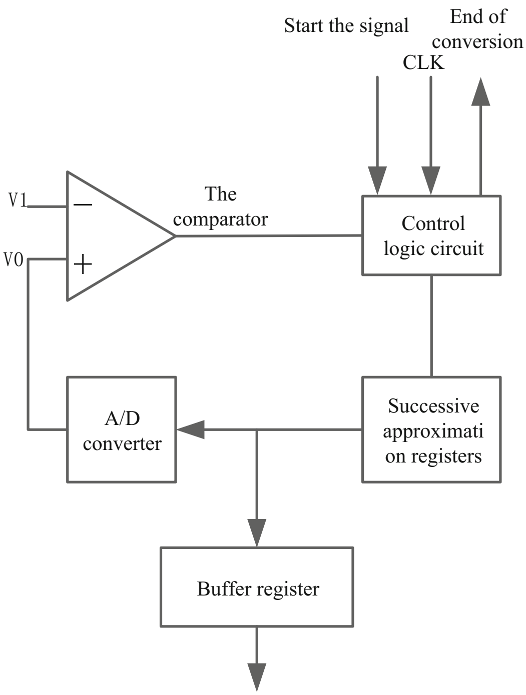


Fig. 2. A/D conversion structure

[6]. Through software design, comprehensive compensation is performed on the sensor's linearity, zero point, temperature drift, creep and other performance parameters, eliminating the influence of human factors and improving the accuracy and reliability of compensation [7]. The output compatibility error is more than 0.02%, the characteristic parameters are identical, and the interchangeability is good. The A/D converter with successive approximation method is composed of a comparator, D/A converter, buffer register and control logic circuit, as shown in Fig. 2.

Adopting A/D conversion is to convert analog signal into digital signal, and convert analog quantity into digital quantity through certain circuit. From the high position to the low position, the trial comparison is like using a balance to weigh the object, and the weight is gradually increased or decreased from heavier to lighter. [8]. The conversion process of successive approximation method is as follows: During initialization, all bits of successive approximation register are cleared; At the beginning of the conversion, the highest position 1 of the successive approximation register is sent to the D/A converter, and the analog quantity generated after the D/A conversion is sent to the comparator, which is called vo. Compared with the analog quantity VI to be converted, the optimal one is selected to complete the A/D conversion [9].

2.2 Database Layer

The collection of a large amount of industrial design professional course information needs to be classified reasonably and in accordance with the prescribed data format and technical specifications. The database layer can transmit, store, and divide the basic structure of data information processing and sharing into three levels, and examine the database from three different perspectives.

Using SQLite lightweight database, its internal structure is shown in Fig. 3.

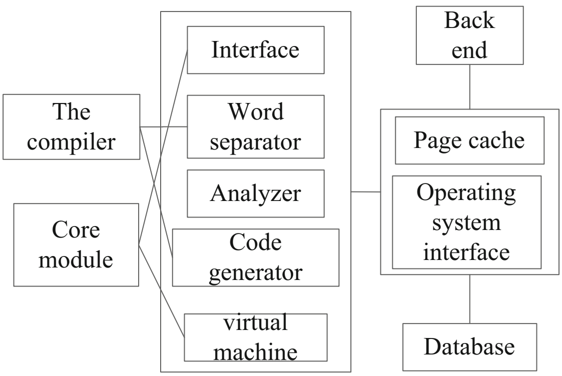


Fig. 3. Internal structure of SQLite database

As can be seen from Fig. 3, SQLite lightweight database adopts modular design, which is composed of eight independent modules. Each module divides the complex query process into several small tasks. This interface is composed of SQLite capi, which is used to interact with SQLite. Whether it is a program, script language or library file, it needs to compile the program to process the relevant code. The word segmentation program and the word segmenter cooperate to process structured query sentences in text form, analyze their grammatical validity, and convert them into hierarchical data structures that are easier to process at the underlying virtual machine. Virtual machine, also known as virtual database engine, is mainly used to interpret and execute byte code. SQLite is used to realize the version management of database in the system. In addition to software, users can create database table structure for application, add some initial records, and update the data table structure. The system also provides SQLiteDatabase class, which encapsulates some API interfaces to manipulate the database. This class can be used to add, query, update and delete data.

The database using internal model as framework is called physical database; the data using conceptual model is called conceptual database, and the database using external model is called user database.

(1) Physical data layer
The innermost layer of the database is the data collection actually stored on the physical storage device. The data is the original data and objects processed by the user, including bit strings, fields and fields, which are used to process the commands described in the internal mode.
(2) Conceptual data layer
Conceptual data layer is the central layer of database, which is mainly represented by logical attributes. Each data type has a logical relationship, that is, a group of data record relationships. In different data levels, all the logical relationships are not physical states. For database managers, it is a platform to store all the data.

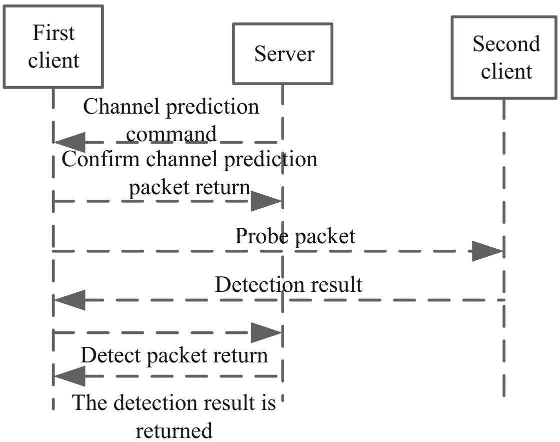


Fig. 4. Client design

2.3 Application Service Layer

The user data layer is the data layer for the convenience of users to view, which represents different data sets. With the help of the logical relationship of the concept data layer, the data mapping is transformed into different databases for hierarchical connection. The client design of this level is shown in Fig. 4.

The client module can accurately reflect the students' learning ability and skill level, and provide the basis for the online remote three-dimensional automatic tutoring of the system. The module is composed of collaborative teaching agent and other agents. Each teaching subject has the necessary knowledge to solve the problem independently. As an independent individual, artificial intelligence is mainly responsible for displaying specific teaching materials, solving problems and guiding students' views. It combines the knowledge of curriculum structure, answers students' questions and supervises students' learning behavior. It is a specific measure to realize students' personalized interactive learning. In the teaching process, teachers can collect students' feedback information through the network to improve the teaching strategy library, and use their own reasoning mechanism to solve the problems encountered in the teaching process. The interaction between teachers and students can supplement students' knowledge at any time in the classroom. The personalized data collection method is adopted to add the interactive information of teachers and students to the basic content of the basic courseware displayed by teachers, which can be stored in the database after being supplemented by students themselves.

3 Mode Design of Online Distance Stereoscopic Teaching Platform

In daily teaching, design practice teaching is an important way to cultivate the practical design ability of industrial design students. Whether the design practice teaching mode and scheme design are reasonable or not is the key to whether the design practice teaching can achieve the expected teaching objectives. In order to achieve the expected effect of practical teaching of industrial design major, and ultimately meet the requirements of the outline of the design personnel training requirements, and meet the needs of enterprises and society, the online remote three-dimensional teaching mode of industrial design major in colleges and universities is proposed. The three-dimensional practice teaching mode in the research mainly includes the design practice mode based on exhibition, the design practice mode based on design competition, the design practice mode based on internal and external training base, and the design studio practice mode based on project driving, as shown in Fig. 5.

3.1 Three-Dimensional Teaching Model of Exhibition

The basic goal of the design practice teaching ability of the exhibition is to cultivate the user research ability of industrial design students. The basic process of this mode is described as follows: First, according to the requirements of the course, the teacher assigned the students specific design practice theme; Second, after understanding and understanding the theme tasks of design practice, students will find out the theme and

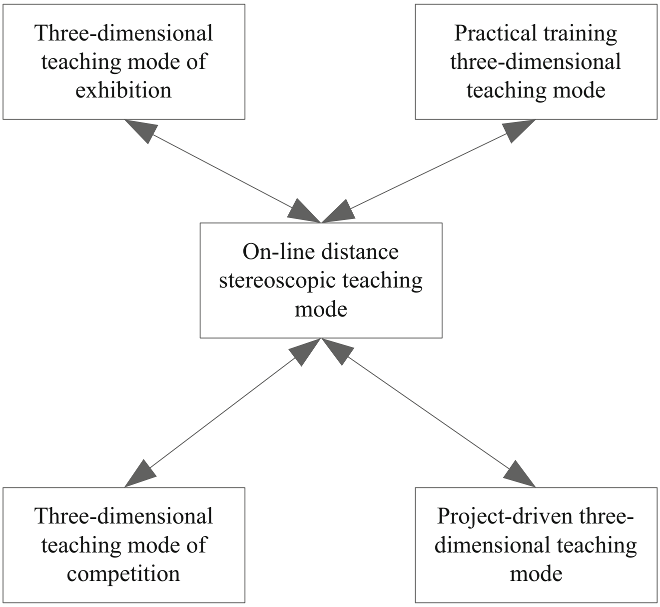


Fig. 5. Framework of online distance stereoscopic teaching platform

go to relevant exhibitions to conduct serious market research and user analysis research, so as to form a more detailed user analysis research report. These reports must include the division of target users, consumption characteristics of target users, physiological and psychological characteristics of target users, aesthetic cognition and values of target users, etc.; Third, according to the user report, students design and conceive the sketch scheme; Fourth, screen and optimize the sketch scheme; Finally, determine the final scheme and carry out the detailed design.

3.2 Competition Three-Dimensional Teaching Mode

The basic goal of design practice teaching based on design competition is to train students' innovative design ability and initially establish the idea that design needs to solve practical problems. The basic process of the model is as follows: First, according to the requirements of teaching tasks and time, teachers collect relevant design competitions that meet the requirements of course time and theme; Second, teachers analyze the requirements of relevant design competitions and assign design tasks to their students; Third, students choose the design competition theme according to their own actual situation; Fourth, the conception and optimization of design power; Fifth, design refinement; Finally, design feasibility analysis.

3.3 Three Dimensional Teaching Mode of Practical Training

The basic goal of design practice teaching based on off campus training base and on campus experimental platform is to cultivate students' engineering consciousness. As an engineering major, students of industrial design must strengthen the training of engineering knowledge such as materials, structure and processing technology, so that their design works can be quickly transformed into products and commodities. The basic process of the model is as follows: First, according to the curriculum requirements and the existing conditions of the experimental teaching demonstration center's existing on campus experimental platform and off campus training base, the teachers select the appropriate design theme and give it to the students; Second, after receiving the design task, students are familiar with the various properties of materials on the campus experimental platform, especially the surface texture of materials including vision and touch; Thirdly, we should be familiar with and master the structure principle and realization force of similar products on the campus experimental platform; Fourth, innovative design or improved design of materials and structures; Fifth, go to the training base inside and outside the school to further understand the material and structure, and discuss and exchange the material, structure and processing technology with the enterprise engineers, so as to make their own design more in line with the reality; Finally, the design of a case of improvement and improvement.

The practice site includes the practice site inside the school and the practice site outside the school, as shown in Table 1.

Table 1. New engineering foundation practice site

Serial number	1	2	3
Name	Industrial Design (Mechanical) principle and innovative design experiment	Mechanical parts and mapping design training room	Metal technology training base
Basic conditions	There are 2 groups of mechanical principle display cabinet, 2 groups of mechanism innovation design platform and 1 group of hydraulic experiment platform	There are 10 small reducers, one group of experimental platform for car engine, chassis and gearbox, and several parts inspection tools	Mechanical processing, mechanical assembly, plastic products processing, casting, forging, welding, heat treatment and other production conditions
Practice teaching content	Mechanical design basic course training, mechanical innovation design experiment	Mechanical design, professional cognitive practice, mechanical mapping practice	Cognitive practice of industrial design, cognitive practice of professional basic courses
Practice site	Campus experimental site	Campus experimental site	Off campus experimental site

3.4 Project Driven Three Dimensional Teaching Mode

The goal of the project driven design studio and the practice mode based on industry university research cooperation is to cultivate students' ability to solve practical problems in design from works to products and commodities. The ability involves online automatic question answering function. Community seminar is a community place for teacher-student exchange activities. It should provide services for students, teacher-student exchange, teacher organization, seminar, community management, etc. In order to let more student users participate in the discussion, maximizing the interactive teaching function is the basic goal of the design of the discussion and answering community. When the user enters the discussion reply community, the registration, login, community classification, publish list, and online automatic question answering process will be displayed, as shown in Fig. 6.

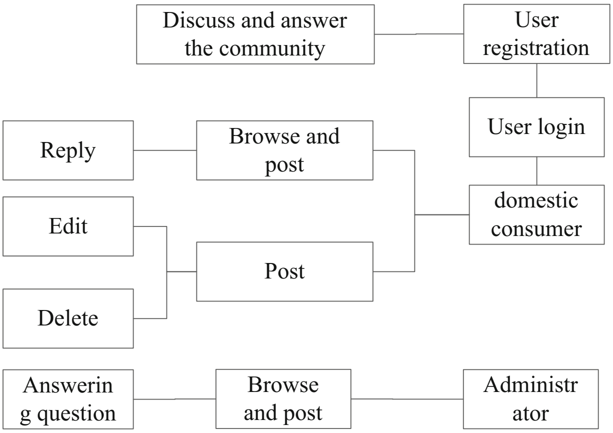


Fig. 6. Online automatic question answering process

Online automatic question answering has the basic function of posting. Students can express their personal questions, learning experiences and opinions in the learning process through the organization, guidance and management of teachers; Teachers can reply according to students' posts (answer questions, adjust teaching ideas and strategies). Community users can be divided into two categories: Ordinary users and moderators (administrators). Students are ordinary users, teachers are managers, users can be classified according to teaching category, and can participate in the teaching discussion of this course. As the manager of the classroom community, teachers have the right to answer questions and delete classroom posts.

The implementation process of practical teaching mode: First, the teacher team undertakes the design project; Second, the design task decomposition, a group of students engaged in product appearance design; Third, the second group of students design the material and structure of the product; Fourth, the first group and the second group of students carry out the coordinated design of modeling and structure; Fifthly, make product model and prototype in professional factory; Finally, the manufacturing and marketing of products.

4 Experiment

Experimental testing is an important process in software engineering, which is the key step to ensure the rationality of the research on the construction of online distance three-dimensional teaching platform for industrial design major in colleges and universities.

4.1 Test Content and Method

The test content includes the platform program running and platform security, and is tested on Pentium (R) 4cpu 2.0 GHz processor, Windows XP SP3 operating system and MySQL 4.1 database.

The test method is as follows: Black box test is used to check whether each function works normally. In the process of testing, the program is regarded as a box that can not be opened. Regardless of the internal structure, the program interface is tested to check whether the program function is in accordance with the requirements and specifications, and whether the program can properly accept the input data and generate correct information.

4.2 Experimental Results and Analysis

Black box test is carried out for the system, and corresponding operation is carried out for the designed system, traditional classroom and satellite TV teaching. The content of black box test is shown in Table 2.

Table 2. Black box test content

Test time	Test content
2019–03-05 9:00	Log in the tutoring interface and use the system
2019–03-05 9:05	Online automatic question answering
2019–03-05 9:10	Using the system without login
2019–03-05 9:15	Online automatic tutoring

The content of the black box test is as follows: 200 students are selected for the test, of which 50 are correct information and 30 are error information. The main reasons for the error information are interface login number error and data submission error.

According to the actual needs of users, the black box test results of the three systems are shown in Table 3.

Table 3. Black box test results of three systems

Content	Tradition classroom	Satellite TV teaching	Distance stereoscopic teaching platform
Can members register normally	Can	Can	Can
Can non members register normally	Can	No	Can
Can you register information normally	No	Can	Can
Can teachers and students communicate normally	No	No	Can
Can teachers organize normally	No	Can	Can
Can the seminar go on normally	No	Can	Can
Can the community be managed normally	Can	No	Can
Can the course be browsed normally	No	No	Can
Can I access online normally	Can	No	Can
Can I submit questions normally	Can	Can	Can
Can the problem be solved normally	No	No	Can

It can be seen from Table 3 that most of the black box test contents failed in the traditional classroom counseling method, and five of them passed; Most of the contents of black box test failed in the satellite TV teaching method, and five of them passed; All black-box test contents using the remote three-dimensional teaching platform have passed.

Taking the practical training of mechanical design foundation course as an example, three methods are used to compare and analyze the counseling efficiency, and the results are shown in Fig. 7.

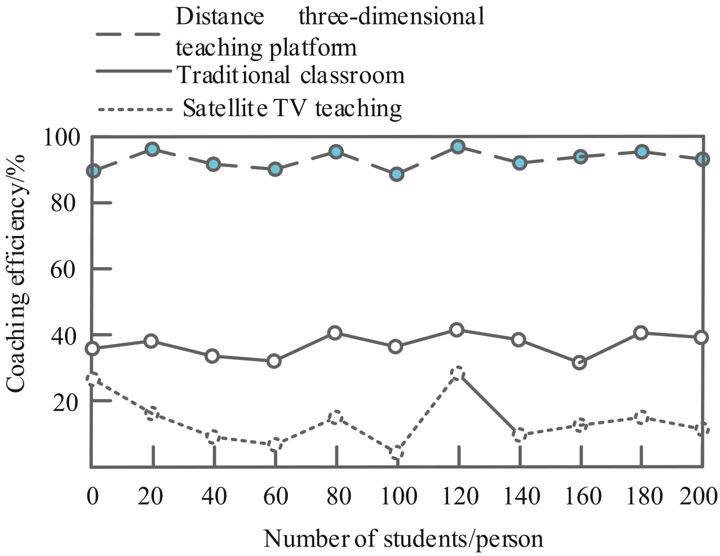


Fig. 7. Comparative analysis of the efficiency of three kinds of counseling methods under the practical training of mechanical design foundation course

As can be seen from Fig. 7: Using traditional classroom, the highest counseling efficiency is 42%, and the lowest is 35%; The highest efficiency of using satellite TV teaching method is 30%, and the lowest is 5%; The maximum tutoring efficiency using the remote three-dimensional teaching platform is 99%, and the minimum is 88%. From this, we can see that the use of the platform is more efficient.

Taking the mechanical innovation design experiment as an example, three methods are used to compare and analyze the counseling efficiency, and the results are shown in Fig. 8.

As can be seen from Fig. 8: Using traditional classroom, the highest efficiency was 49%, and the lowest was 26%; The highest efficiency of using satellite TV teaching method is 18%, and the lowest is 8%; The maximum tutoring efficiency of using the remote three-dimensional teaching platform is 92%, and the minimum is 80%. From this we can see that the use of the platform is more efficient.

4.3 Empirical Conclusion

We should adhere to the combination of theoretical teaching and practical teaching, scientific research and experimental education, project-based curriculum reform and project-based practical teaching, deepen the reform of practical teaching, and strive to improve the teaching contents and methods of experimental training. This paper introduces the basic knowledge of industrial design, design projects and design innovation topics into the field of practical teaching, and constructs a practical teaching form integrating teaching, learning and doing with theory and practice.

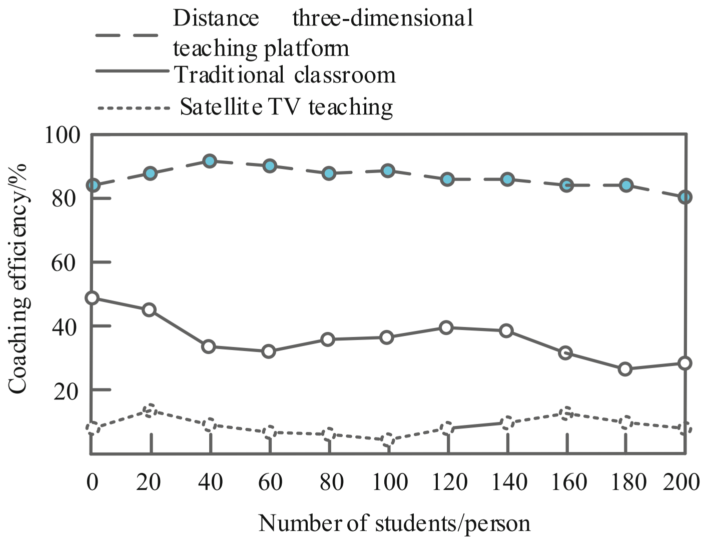


Fig. 8. Comparative analysis of the efficiency of the three methods under the mechanical innovation design experiment

(1) To develop and cultivate the practical teaching project of the integrated teaching and learning, whether it is the basic course of art design or the basic course of mechanical design, all the teaching contents that need to enter the practical teaching link are designed according to the project requirements, and the experimental training instructions are compiled to test the students' learning effect according to the project requirements.
(2) Create a training environment similar to the actual enterprise culture, and establish a practice environment according to the actual enterprise culture. The rules and regulations of the practice site are "imitated" by the enterprise to ensure that the practice teaching is not divorced from the actual production.
(3) To build a highly skilled and high-level experimental and practical training teachers team. We should strengthen the training of practical teaching teachers, cultivate and bring up a group of practical teaching teachers with professional teaching ability, practical innovation level and hard work ability. Practical teaching teachers should have academic qualifications and skills requirements. For practical teaching teachers, we should establish enterprise rotation training system, keep in touch with enterprises, and constantly improve the level of practical teaching. Teachers should often go to enterprises to learn about the progress of technical skills of relevant courses, and constantly update the practical teaching content. Professional teachers should continuously obtain practice projects and design projects from society to provide new resources for the integration of theory and practice teaching.

5 Conclusion

The idea of three-dimensional practical teaching mode of industrial design major solves the problem of training students' practical design ability at all stages in theory, and plays an important role in promoting students' comprehensive quality and improving their employment competitiveness after graduation. Distance design education has the flexibility and diversity of teaching, at the same time, it needs modern scientific and strict management to protect high-quality teaching and graduation standards. The course setting should be reasonable and orderly, and the top and bottom should be consistent, especially in the guidance link. After the courseware of each course is played, it is necessary to help students digest in time, so as to ensure the progress of learning and the quality of teaching. For the teaching situation, the teaching center should have detailed information records, especially the students' homework, credits obtained, and examination results, which should be input into the students' electronic files respectively for the basis of inquiry and final graduation evaluation. The teaching center communicates with the students regularly, discusses the situation of teaching and learning, sums up experience, and communicates with the host school in time, so as to continuously improve the teaching and make the students' achievements reach the established training standards. However, the practice mode of design studio based on project driven and the practice mode based on industry university research cooperation are still in the stage of exploration and practice, and we hope to continue research and practice in the future design practice teaching.

Fund Projects. Undergraduate teaching reform and research projects of Shenyang University of Aeronautics and Astronautics "Teaching reform of «Design engineering 3» based on design patent output from the perspective of OBE" and "Teaching reform exploration of «Design engineering 3» based on innovation and practice of the product organization design".

References

1. Lastre-Acosta, A.M., Palharim, P.H., Barbosa, I.M., et al.: Removal of sulfadiazine from simulated industrial wastewater by a membrane bioreactor and ozonation. J. Env. Manag. **271**, 111040 (2020)
2. Solis, F., Sinfield, J.V.: Designing for big X: characterizing design for major challenges. Int. J. Eng. Educ. **34**(2B), 801–823 (2018)
3. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training, pp. 1–374. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-49625-2
4. Da-Wei, C., Chao, L., Shun, W., et al.: Research and application of multimedia digital platform in the teaching of college physical education course. J. Intell. Fuzzy Syst. **34**(2), 893–901 (2018)
5. Yamada, R., Ogura, K., Kimoto, Y., et al.: Toward the construction of a technology platform for chemicals production from methanol: D-lactic acid production from methanol by an engineered yeast Pichia pastoris. World J. Microbiol. Biotechnol. **35**(2), 1–9 (2019)
6. O'Donnell, M., Sweeney, E.: The design, construction and validation of an innovative and low-cost ophthalmotrope: a kinetic anatomical teaching apparatus to demonstrate the movements of the eye. Int. J. Surg. 55–65 (2018)
7. Zhang, Z., Min, H.: Analysis on the construction of personalized physical education teaching system based on a cloud computing platform. Wirel. Commun. Mob. Comput. **2020**(3), 1–8 (2020)

8. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
9. Wang, W., Mandal, D.: Research on the construction of teaching platform of drama film and television literature based on IoT. J. Intell. Fuzzy Syst. **37**(4), 1–8 (2019)

Design of Online Visual Interactive Teaching System Based on Artificial Intelligence Technology

Jie-lan Zhang(✉)

Jiangxi Teachers College, Yingtan 335000, China

Abstract. Based on the research results obtained, an online visualized interactive teaching system based on artificial intelligence technology is designed. The tools and technologies used in the system include Windows XP Professional SP3, Eclipse Flex SDK 4, etc. The RIA scheme based on Adobe Flex technology system is adopted as the client, and the development architecture adopts MVC pattern. Data access is implemented by JDO. The designed system running environment includes the server running environment and the client running environment. System function modules include system setting module, teaching resource management module, electronic whiteboard programming module, controller module, online visual interactive teaching module, database module. The interactive teaching of online visualization is realized by combining hardware and software. The test results show that the system has high throughput, short request waiting time and short request processing time, which proves that the system has good performance.

Keywords: Artificial intelligence technology · Visualization · Interactive teaching system · Development environment

1 Introduction

The concept of interactive teaching is: in modern interactive education, in order to achieve the predetermined learning goal, students interact and interact in self-learning with teachers, classmates and others, with various teaching resources, and with media such as computers and the Internet [1]. From this concept, we can see that mutual communication and interaction are the essential characteristics of teaching interaction. Modern interactive education is the application of teaching interaction, to achieve the new form of education under the mutual exchange and interaction, thereby improving teaching effectiveness and achieving teaching objectives [2]. According to the difference between the subject and the object of interaction, generally speaking, interaction includes three levels: student-curriculum interaction, student-teacher interaction and student-student interaction. Experts in the field of pedagogy generally believe that modern interactive teaching is more efficient and more effective than traditional face-to-face

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 90–102, 2021.
https://doi.org/10.1007/978-3-030-84386-1_8

teaching by adopting more convenient and efficient network communication technology and multimedia technology to realize the interaction between teachers and students and between classmates because of their absence [3]. At the same time, the continuous development of our country's education has created a huge education information market. The interactive teaching system with the characteristics of "distance, interaction and cooperation" is gradually becoming an important development direction in the field of scientific research and application of modern education informationization in our country, and extends to various educational fields. With the deepening of teaching reform and the development of computer technology and application, the traditional teaching model can not meet the needs of modern society. Interactive teaching system have become a new generation of education technology which combines computer networks and multimedia technology. On this basis, the diversified teaching mode has been developed and used and achieved good results. Interactive teaching system, is the use of modern computer network technology as the transmission carrier of teaching content, make full use of multimedia technology, in the LAN or WAN teaching activities management, arrangement and implementation. Its advantage is that it has a good communication channel, can fully promote students, students and teachers between the exchange and communication, and second, it is flexible learning form, content can be visited at any time. All of these are necessary to improve the teaching quality of a course. The advantages of interactive teaching system are obvious, and its development prospect is immeasurable, which is worthy of our research, application and promotion. Under this background, the interactive teaching system is studied, and an online visual interactive teaching system based on artificial intelligence technology is designed.

2 Design of Online Visual Interactive Teaching System Based on Artificial Intelligence Technology

Using artificial intelligence technology to realize online visual teaching, the system function is shown in Fig. 1.

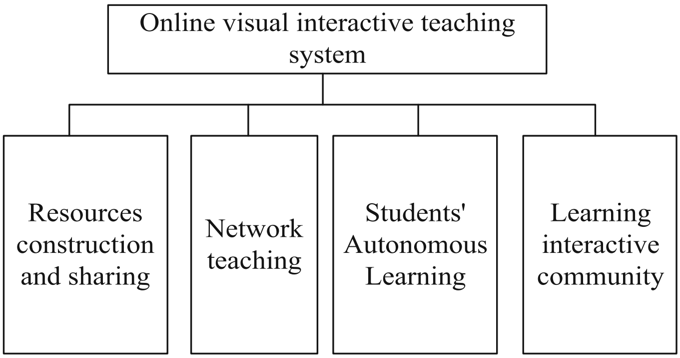


Fig. 1. Systems function diagram

2.1 Selection of Development Tools

The selection of development environment plays a very important role in the successful implementation of the project. Appropriate tool collocation and perfect server configuration need to be fully combined with the actual needs and the specific needs of users, comprehensively considering the benefits and costs to make trade-offs. The tools and technologies selected by the system are shown in Table 1 [4].

Table 1. List of system tools and technologies

Serial number	Project	Data
1	Operating system for development	Windows XP Professional SP3
2	Development tools and SDK version	Eclipse
3	Web server	Flex SDK 4
4	Database server	Apache + Tomcat + Axis
5	UML and database modeling tools	MS SQL Server
6	Client	Microsoft Office Vision 2003

2.2 Architecture Design

The RIA solution based on Adobe Flex technology system is used as the client, which is different from the traditional B/S interactive teaching system. After the server software is configured and distributed, the client user only needs to access the URL address of the Flex application on the pre-configured server by using the browser with Flash plug-in support, so as to realize the "zero" installation and "zero" configuration of the client. Users can directly access the Web server through the campus network, users of the public network or users of the outside campus, can directly access the Web server, and can also access the internal WEB server through the campus network through the VPN [5].

The development architecture adopts the MVC pattern, and from the front end to the back end is the Flex client presentation layer (. swf), the client-side business logic layer (. as-> .swf/. swc) and the server-side business logic layer (. jsp), the database access abstraction layer (JDO) and the back-end data storage persistence layer. This design model makes the structure of the system clear, the functional modules at all levels work together and perform their own duties, which is very conducive to system function expansion and future maintenance and upgrading.

2.3 Data Access Layer Design

Data access is implemented by JDO. For developers, the great benefit of using JDO is that storing data objects requires no additional code at all, because JDO provides transparent object storage and shifts this mundane routine to the JDO product provider, allowing developers to focus on business logic implementation [6].

2.4 Operating Environment Design

1. Server-side operating environment
   CPU: Intel E5200
   Memory: 4 GB
   Network environment: Campus network
   HDD: 2T7200 to HDD 2, RAID1 array
   System: Windows Server 2003

The above server configuration, for an ordinary class size of online interactive teaching activities, has been enough. Considering that there may be video sharing and playback for multiple classes and online interactive teaching, or in the case of high concurrent users, the server memory may be increased appropriately according to the actual needs, or the gigabit network card with better throughput may be replaced in order to obtain better throughput and concurrent volume of the whole system.

In addition, a large amount of audio, video or other document resources will be accumulated after a long time use of the interactive teaching system, which will occupy a large amount of hard disk space and can be used to expand the capacity of the server hard disk at an appropriate time to meet the demand for resource growth.

2. Client operating environment

The only requirement is that the client machine must have a browser that supports Flash Player, such as Internet Explorer, Firefox, Chrome, Safari, or Opera.

In addition, if you need to use electronic whiteboard interaction, you need to consider the client and the teacher's computer mouse sensitivity and precision.

Furthermore, if there is an online voice interaction or video sharing, playback situation, the client and teachers need to be equipped with available headphones for voice or video communication.

2.5 Functional Module Design

System Setup Module Design
System setup module is divided into user management, role and authority management, access control management, login interface management and other 4 small functional modules [7].

Among them, user management to create, delete and edit basic user information, such as user name, password, and can view the user's login and operation history.

Role and privilege management: Users add, delete and modify roles, and can change the permissions associated with the role, and can also add or delete users under the role.

Role-based access control includes three concepts: user, user group and function, which are the basis of system dynamic easy-to-use user privilege management. Role-centered access control model can effectively separate the users from the functions of the system, so that the users and permissions are not directly related, but the role is used as the middle layer of users and permissions, which can increase the flexibility of configuration. Users in a system can belong to one or more user groups; permissions can also be associated with one or more user groups; and an action permission can be associated with one or more roles. A user's permissions are essentially a union of all the permissions of all the roles to which the user belongs. After the user logs in, the system can read the authority configuration and the user group information, constructs the user function menu. In addition, when trying to access each authority module, the access legitimacy of the current logged-in user to the authority module is also detected.

A role is an abstract association concept that is created for system security. All users within a role have identical permissions configurations [8]. Roles can be flexibly set (added or deleted) according to the needs of the interactive teaching system, and similarly, users and their associations can be arbitrarily added and deleted without restriction.

Login interface management: in the interactive teaching system login interface, need to enter the correct user name and password to login. If the user does not enter a username or password, or if password authentication fails, the appropriate message is given and the user's login history is recorded on the server side. When the user name and password are correct and the user authentication is completed, the login history is also recorded, and the user's role list is read, user permissions are assigned, the main menu is initialized and the main interface is displayed according to the system settings.

Design of Teaching Resource Management Module

The teaching resource management module is a background content management module of the system, which is digitized by the teachers or special administrators according to the needs of the teaching content, and then uploaded, published, and set the appropriate authority, so that the appropriate students can browse. Which mainly meet the file upload, format conversion, the corresponding records of information and related work [9].

Electronic Whiteboard Programming Module Design

Electronic whiteboard programming module is used to program the writing demonstration and interactive communication of online interactive teaching. The electronic whiteboard brush binding implementation code is as follows:

```
Bind the user-set color and line width values for the brush
BindingUtils.bindProperty (this, "_ penLineWidth," hsplw, "value");//Bind the brush line
BindingUtils.bindProperty (this, "_ penLineColor", cpplc, "selectedColor");///Binding brush color
```

Where the value of the variable penLineWidth represents the thickness of the brush line and the value of the variable penLineColor represents the color of the brush line (hexadecimal, such as 0xff0000).

```
//Set Flex space and bind its associated property values
< mx: HSlider = "hsplw" value = "{_ penLineWidth}"/ >
< mx: ColorPicker id = "cpplc" selectedColor = "{_ penLineWidth}"/ >
```

Controller Module

The controller module designs three controllers, which are HttpServer controller, code classification controller and online integrated development environment controller. The HttpServer controller is mainly responsible for HTTP request parsing and response. Libevent is a low-level web library and is also an open source, lightweight, high-performance web library. Libevent has the following features: lightweight, high performance, network-focused, event-driven, cross-platform; support for multiple operating systems; support for events such as signals and timers; support for multiple I/O multiplexing methods. Libevent is a typical event-driven design pattern-reactor model, which has the advantages of simple and efficient programming interface, fast response, strong scalability, high reusability and so on.

In view of these features and advantages of libevent, the system employs libevent to develop a lightweight and efficient http server that acts as an HttpServer controller responsible for receiving http requests from the front-end web, parsing http requests and processing them, while handing over specific requests to other controllers for processing and returning the results to front-end browsers for display [10]. The main steps of the HttpServer controller implemented with libevent are as follows:

(1) Creating servers.
(2) Register the controller with the server.
(3) Open the server, listen on port 80, and wait for the http request.
(4) Upon receipt of the http request, the http parameters are parsed and the request is forwarded to the corresponding controller.
(5) The controller calls the corresponding processing function according to the parameters.
(6) The processing function shall call the model to process the business logic as needed.
(7) The controller reads the result of the model and returns it to the http server.
(8) The http server organizes the results into packets and returns them to the front-end browser.

Figure 2 is a class diagram of the system implementing HttpServer, which is explained in Table 2. In Step 2 of the HttpServer, you need to register additional controllers, the Code Classification Controller and the Online Integrated Development Environment Controller, whose class diagrams and explanations are shown in Fig. 3, Fig. 4, and Table 3.

Design of Online Visual Interactive Teaching Module

The online visualization interactive teaching module can realize the online visualization interactive teaching function. In order to realize the interactive teaching function of online visualization, it needs the cooperation of several sets of devices, and the main devices needed.

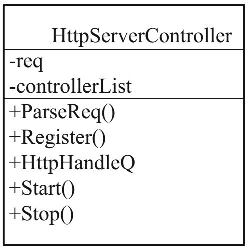


Fig. 2. Httpserver controller class diagram

Table 2. Explanation of httpserver class diagram

Serial number	Class	Explain
1	REQ	This property is the request link
2	CONTROLLERLIST	This attribute is the controller list, that is, the controller registered in step 2. at present, the system only registers the code classification controller and the online integrated development environment controller
3	PARSEREQ	This function is responsible for resolving the request link REQ, getting the request address and request parameters, and passing them to the corresponding controller
4	REGISTER	This function is responsible for registering other controllers
5	HTTPHANDLE	This function is responsible for responding to the HTTP request, processing the request or transferring it to other controllers for processing, and then returning it to the requester
6	START	To start the service, perform step 3
7	STOP	Out of service

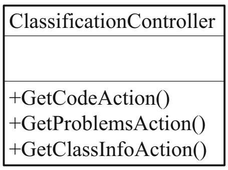


Fig. 3. Code classification controller class diagram

Including the teaching scene video capture system composed of the student panorama camera, the teacher mid-shot camera, the tracking host computer, the student tracking camera and the teacher tracking camera; the video playback system composed of the

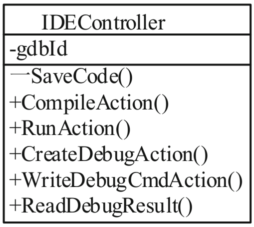


Fig. 4. Controller class diagram of online integrated development environment

Table 3. Description of code classification and controller class diagram of integrated development environment

Serial number	Class	Explain
1	GETCODEACTION	This function is responsible for the processing of the request to get the source code
2	GETPROBLEMS	This function is responsible for the processing of the request to obtain the topic information
3	GETCLASSINFOACTION	This function is responsible for the processing of the request to obtain the classification information
4	GDBID	This attribute is the ID of GDB. after the GDB debugger is created, an id corresponding to a request will be generated to prevent the same request from creating multiple GDBS at the same time
5	SAVECODE	This function saves the code submitted by the front end to a file
6	COMPILEACTION	This function is used for compiling request processing
7	RUNACTION	This function is used to run code request processing
8	CREATEDEBUGACTION	This function is used to debug code request processing
9	WRITEDEBUGCMDACTION	This function is used to write debug command request processing
10	READDEBUGRESULT	This function is used to read debugging results and request processing

projector, the electronic whiteboard and the large screen; the teaching scene audio playback system composed of the wireless microphone, the pickup device and the noise suppressor; the audio playback system composed of the mixer, the power amplifier and the sound box; the audio playback system composed of the audio playback system, the video playback system, the teaching computer and the recording host computer. Codec is the "throat" of communication in online visual interactive teaching. Only when the local video, audio and computer display signals are encoded, can they be input into the communication host and transmitted out; only after the signals from each other are decoded can they be restored to images and sounds. The communication host computer is the hub of the communication system. On the one hand, it transmits the live video, audio and teaching computer display signals collected by one party; on the other hand, it transmits the video, audio and teaching computer display signals collected by the other party; and the programmable central controller is used to switch the screen to display the signal source.

Database Module Design

The system database adopts MYSQL database. MySQL is an open source relational database management system (RDBMS). The MySQL database system uses the most commonly used database management language, Structured Query Language (SQL), for database management, which has the following characteristics:

1. Large data with tens of millions of records may be processed.
2. Support common SQL statement specifications.
3. High portability, simple and compact installation.
4. Good operation efficiency and network support with rich information.
5. Simple debugging, management and optimization (compared with other large databases).

The database module covers the database structure as follows:

1. User service: user table, user expansion table, organization table, privilege table, role table, log table, user corner table, etc.
2. Booking service: booking information table, classroom information table, classroom equipment table, statistics table, etc.
3. Equipment services: equipment information table, equipment classification table, interface configuration table.

3 Simulation Experiment

3.1 Experimental Design

The system test platform constructed is as follows:

Platform server hardware environment:

CPU: Intel i5 processors;
Memory: 8G;
Equipped with sound card, headset, video capture equipment (camera) and other multimedia equipment.

Platform system software configuration:

WIN7 32-bit, WIN7 64-bit, WIN8.132-BIT, WIN8.164-BIT, WIN1032-BIT and WIN1064-BIT systems;
Platform browsers: IE10, IE11, Chrome.
MCU Multipoint Controller: Cisco MCU Controller.
Smart Classroom: Educational Large Screen and Related Equipment.
Terminal Equipment: Cisco Education Terminal.

The installation of the system mainly includes the installation of the booking platform of the teaching system, in which the system includes the booking service and user service, the installation of control service, the way of using the same installation package (exe form) for installation, the installation with one key and the instructions for use shall be marked.

On the system test platform, the online visual interactive teaching system based on artificial intelligence technology is tested.

After the system runs, the throughput, request waiting time and request processing time are tested and compared with each other using the AB test tool that comes with APACHE.

3.2 Experimental Results

The throughput test results of the online visual interactive teaching system based on artificial intelligence are shown in Table 4 under the condition of different concurrent numbers in response to the default WEB directory.

Table 4. Throughput test results

Serial number	Serial number	Throughput (REQS/S)
1	1	4055.35
2	2	3452.29
3	5	4229.63
4	10	4863.50
5	20	8080.25
6	30	8279.98
7	50	8687.23

(*continued*)

Table 4. (*continued*)

Serial number	Serial number	Throughput (REQS/S)
8	100	8687.23
9	150	4578.72
10	200	1621.00
11	500	398.26
12	1000	292.24

Table 5. Test results of request waiting time

Serial number	Serial number	Throughput (REQS/S)
1	1	0.264
2	2	0.528
3	5	1.157
4	10	2.534
5	20	3.060
6	30	4.979
7	50	8.483
8	100	10.998
9	150	23.552
10	200	185.479
11	500	1238.055
12	1000	3350.076

The test results of request waiting time are shown in Table 5.
The test results of request processing time are shown in Table 6.

Table 6. Test results of request processing time

Serial number	Serial number	Throughput (REQS/S)
1	1	0.264
2	2	0.219
3	5	0.263
4	10	0.249

(*continued*)

Table 6. (*continued*)

Serial number	Serial number	Throughput (REQS/S)
5	20	0.130
6	30	0.144
7	50	0.180
8	100	0.200
9	150	0.271
10	200	0.729
11	500	2.576
12	1000	3.306

According to the test results in Table 4, Table 5 and Table 6, the throughput of online visual interactive teaching system based on artificial intelligence technology is higher, while the request waiting time and request processing time are shorter.

4 Conclusion

The online visual interactive teaching system based on artificial intelligence technology has realized the purpose of online visual interactive teaching. However, due to many factors, such as the development technology and practical application framework adopted by the subject, the time of the subject is in a hurry and the software testing environment and so on, the research of the subject is not deep enough and perfect. We will try our best to study in the future. In the process, we should conduct further exploration and research.

Fund Projects. Source: General Project of Jiangxi Provincial Department of Education Science and Technology.

Research Title: Research and Practice on the Construction of Maker Service Base for College Students Based on Mobile Internet of things.

Project Number: 171223.

References

1. Whitlock, A.M., Brugar, K.A.: Teaching elementary social studies during snack time and other unstructured spaces. J. Soc. Stud. Res. SciVerse ScienceDirect **43**(3), 229–239 (2019)
2. Ahuja, S., Pandey, A.: Assessing the effectiveness of structured teaching on knowledge of hand hygiene among healthcare workers. Clin. Epidemiol. Global Health SciVerse ScienceDirect **7**(3), 396–398 (2019)
3. Cesur, K.: Opinions on the use of magic card tricks in teaching english to young learners. Trakya Eitim Dergisi **10**(1), 285–297 (2020)
4. Erbaş, M.K., Hüseyin, Ü.N.L.Ü.: Prediction validity of teaching efficacy on task-centered anxiety: a study on physical education teacher candidates. Kuramsal Eitimbilim **13**(4), 701–715 (2020)

5. Dndü Neslihan, B.A.Y., Eker, P.T., Alsnanolu, F.: Pre-service teachers' opinions about teaching practice course. Anadolu niversitesi Eitim Fakültesi Dergisi **4**(1), 1–20 (2020)
6. Sel, B., Szer, M.A.: Change and continuity perception skills in social studies curriculum in Turkey and America within the scope of teaching historical time. Uak niversitesi Eitim Aratrmalar Dergisi **6**(1), 1–19 (2020)
7. Kayhan, N., Akçamete, G.: The effect of one teach one observe model on effective teaching skills of classroom teachers. Yaadka Eitim **33**(2), 151–168 (2019)
8. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
9. Breen, C., Zhu, T., Bond, R., et al.: The evaluation of an open source online training system for teaching 12 lead electrocardiographic interpretation. J. Electrocardiol. **02**(3), 454–461 (2016)
10. Liu, J.: Construction of real-time interactive mode-based online course live broadcast teaching platform for physical training. Int. J. Emerging Technol. Learn. (iJET) **13**(06), 73 (2018)

Design of Management Accounting Online Teaching System Based on Virtual Simulation Technology

Shu-yang Zhang(✉), Xi Chen, and Pei-jun Han

SIAS University, Zhengzhou 451150, China

Abstract. In view of the low security of the management accounting online teaching system, this paper puts forward the design of the management accounting online teaching system based on virtual simulation technology. The overall module of management accounting online teaching system is designed by using virtual simulation technology. Combined with the detailed design of online classroom module, video management module, course management module and user management module, the design of management accounting online teaching system is realized. The test results show that the online teaching system of management accounting based on virtual simulation technology meets the expected results and has higher security.

Keywords: Virtual simulation technology · Management accounting · Online teaching · System design

1 Introduction

With the vigorous development of the Internet and multimedia technologies, the online education industry began to emerge [1]. With the help of the Internet, computer technology and multimedia technology, the new teaching mode has a significant and far-reaching impact on the overall structure of education, and is a trend for online education in the future.

Traditional offline classroom teaching requires teachers and students to co-exist in a classroom, and online education through the network and multimedia to break the traditional teaching methods. Teaching and learning are fully decoupled because of the use of audio, video, documents, and other things that can be stored permanently online. Teachers and students do not need to teach in class at the same time. As long as teachers record the content into video and audio, and upload the corresponding courseware, students can learn through these materials at any time and any place. In traditional teaching activities, teaching resources, especially those of high quality, are often concentrated in large and medium-sized cities, famous universities and colleges, small cities and remote areas, especially in rural areas where the economy is backward, and teaching resources are extremely scarce [2, 3]. The imbalance of economic development leads to the imbalance

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 103–117, 2021.
https://doi.org/10.1007/978-3-030-84386-1_9

of education level, and online education is to break the imbalance through the Internet and multimedia technology. Through online teaching, quality teaching resources can be shared across the country. In the traditional teaching, teaching progress, teaching content and all other things are under the control of teachers, students can only passively adapt. In the online teaching environment, students can freely control their learning progress according to their ability and understanding of the learning content, and can freely choose the courses according to their interests and characteristics, which can fully mobilize their active initiative. The content of the traditional curriculum is often stable, which makes it easy to disconnect from the rapid development, often the teaching of learning has long been outdated and obsolete [4]. Online teaching can be updated at any time to learn the content. With the help of Internet technology, the latest cutting-edge information and technology can quickly become teaching content. At the same time, the teaching method is no longer limited to the simple course explanation, and can be rich in teaching activities through multimedia technology.

Online education has a variety of different means of teaching technology. The technical platform, no matter what kind of teaching methods need stable operation, good scalability, reasonable cost-effective online education products. New Oriental School has made it clear that it will be a provider of educational content in the future, rather than an online platform, because education is a non-standardised product compared to the established vertical search industry, and because educational institutions differ in their structure. At present, the online education industry on the market model and technology, it is difficult to completely replace the offline learning effects and experience.

Based on the above research background, this paper applies virtual simulation technology to the design of management accounting online teaching system, and designs four parts: online classroom module, video management module, course management module and user management module respectively. Finally, the overall performance of the design system is verified by performance test.

2 Overall Module Design of Management Accounting Online Teaching System

The goal of this paper is to create a virtual classroom like a real classroom, where teachers and students can fully interact with each other, including video and audio communication, using a whiteboard (the blackboard of a real classroom) to demonstrate and write, and being able to practice and explain exercises on the spot. Make students feel as if they are immersed in an offline church, instead of learning by themselves, and are unable to solve difficult problems in time. Teachers can also timely understanding of students' acceptance of knowledge, and according to the circumstances at any time to adjust the progress of lectures. In this way, both in teaching and learning, can achieve good results.

Interactive teaching is one of the most important functions of our system, but as a complete online teaching system of management accounting, it should also provide such functions as course management, course content production and uploading, course assessment, etc. [5].

As a teacher, we can complete the management accounting curriculum planning, courseware management, exercise assessment, and can also carry out on-site teaching and after-the-fact teaching. Basically, there is a need to cover the teaching and assessment functions of a teacher throughout the course from start to finish [6]. As students, they may add corresponding courses to this system, participate in management accounting online classes at the prescribed time for interactive teaching, and in some cases (for example, teachers and students are absent due to business), they may watch the teaching of previous courses or relevant materials through the on-demand system. Students can practice the exercises under the assessment system and submit the exercises to the teacher for feedback. Specifically, the functions that this system should include are shown in Fig. 1.

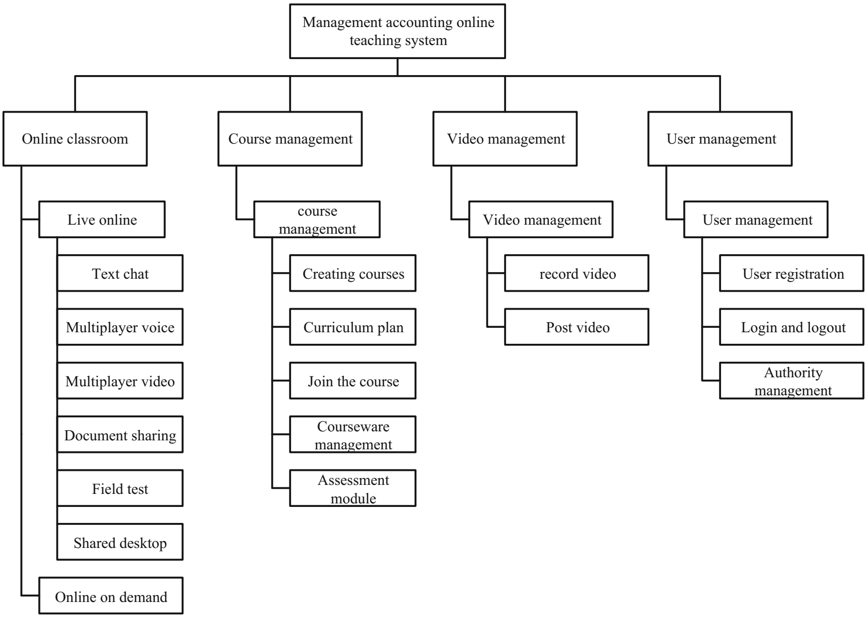


Fig. 1. Function module diagram of online teaching system

2.1 Detailed Design of Online Classroom Module

Red5, as the core server, needs to handle the real-time interaction of all clients. It needs to support the functions of instant text chat, voice chat, video chat, document presentation, etc. In the online live broadcast of accounting [7]. The application architecture of the server is shown in Fig. 2.

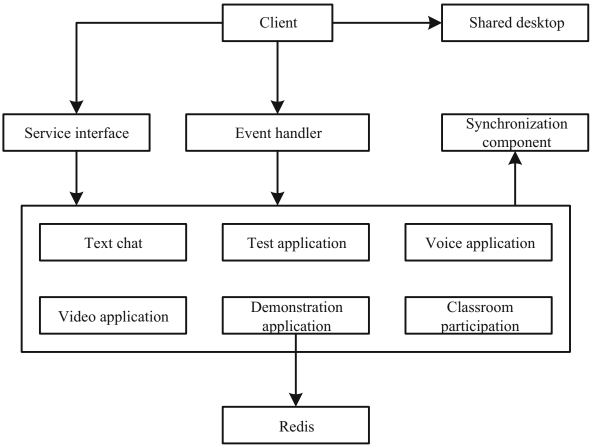


Fig. 2. Application architecture diagram on the Red5 server

The functions of each module are explained as follows:

Clients
That is, the Flash client, the user live module online interface to interact directly. It needs to interact with the server to synchronize the state of this client to other clients.
Event handlers
Used to handle client access and exit, as well as installation of various applications and synchronization components.
Service interface
It is primarily responsible for the client's remote method scheduling (RPC), which enables the client to invoke the server's methods as if they were local methods.
Synchronization components
The purpose of the synchronization component is to synchronize all clients, using shareObject to update and synchronize state between clients and servers. ShareObject, which is a shared object, is divided into local and remote shares. Synchronization components use remote shared objects, so that state updates on one client can be synchronized directly to other clients via the server shared object.
Desktop sharing
The Desktop Sharing Component, which provides the ability to transfer the presenter client desktop and associated operations to other clients, is implemented in detail below.

2.2 Detailed Design of Video Management Module

Video management is mainly video recording. In the management accounting online teaching system, video recording is widely used, and the system mainly solves two major problems: some students are unable to attend the course on time due to time constraints; students still have doubts and want to watch the course video again [8] after the completion of the course.

Through the recording and broadcasting system, not only improve the utilization of learning resources, but also meet the demands of students to study independently according to their own time.

Teachers use the system to open the camera recording video. The video will be saved in the system, and uploaded to the corresponding courses, students can watch the on-demand class online.

Teachers request recordings via Nginx and upload the corresponding documents to the Tomcat server, which delegates document conversion and communicates with the Redis server via Redis messages. The Red5 streaming media server interacts directly with the Flash recording client to process user input video streams.

The overall architecture of the video recording is shown in Fig. 3.

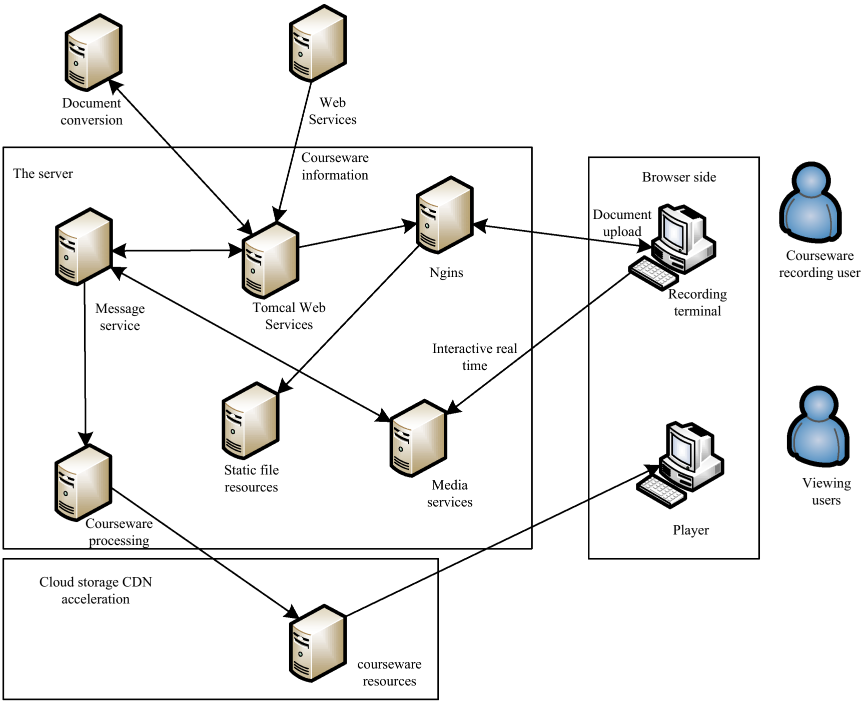


Fig. 3. Architecture diagram for video recording

The recorded video will be uploaded to the cloud storage service after being processed by the Ruby courseware processing module, and other users can access the cloud courseware resources for on-demand [9].

Video recording and broadcasting, on the whole, is divided into five stages: collecting, archiving, grabbing, publishing and on-demand.

1. Collection stage: the collected events in the chat, document demonstration, electronic whiteboard, video, voice and other modules shall be sent to the server message bus

in real time. Media builds push video, audio, and desktop sharing streams to the server side.

2. Archiving stage: subscribe to events in the message bus, archive them to a file or database, and extract the original media files to a specified location without affecting the class.
3. Crawling and processing stage: extract original events/media files, based on configuration rules, transcode operations, and process them into multi-specification media packages. In the future, editing functions can be supported, such as cutting and deleting part of the contents, and monitoring and operation of the processing process can be supported.
4. Release stage: release the generated courseware to the designated location based on the configuration and make local backup.
5. On demand stage: used for viewing customizable courseware through Flash client on demand according to downstream system media specifications.

Video recording can record the content of the teacher's lecture, which provides convenience for storing teaching resources. Video-on-demand is beneficial to students' learning and provides them with a wealth of resources. Students can choose their own learning time to study.

2.3 Detailed Design of Course Management Module

Curriculum management module mainly includes creating curriculum, setting curriculum plan, joining curriculum, courseware management and assessment system, etc. Note that the system does not have the function of "deleting curriculum". The main consideration is that, even if a curriculum is completed, it is necessary to retain for review or review, etc., basically there is no need to delete a curriculum; and the only need to delete a curriculum may be to create the curriculum information errors, etc., but this can be modified by re-editing the curriculum, and there is no need to delete the curriculum. No deletion function is provided to ensure that "erroneous deletion" will not occur from the system; and if some special circumstances do occur and a course is to be deleted, it can be deleted by directly manipulating the back-end database by the system administrator, but the function will not be open to general users [10].

Creating courses is a feature that is visible only to the administrator/teacher role. Teachers can create courses through this function, and give courses associated courseware (PPT, video, etc.).

When creating the course, the associated courseware is optional, and some courseware can be associated with the courseware when it is created, or can be associated with the courseware after the creation. When creating a course, you can choose to import the list of students for the course, or you can add students after the course has been created, or you can add students through student application and teacher approval.

The specific implementation process for creating the course is shown in Fig. 4.

Joining the course is a function that students need to use. Students can apply to join a course after they have selected it from a list of courses. After the teacher approves the application, they can join the course, see the details of the course, watch and download the courseware, and then watch the course online or on demand.

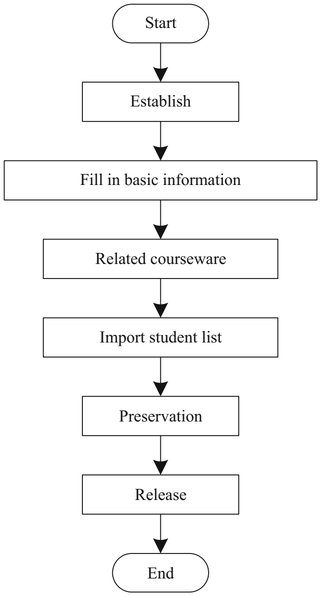


Fig. 4. Course management flowchart

The flow chart of students joining the course is shown in Fig. 5.

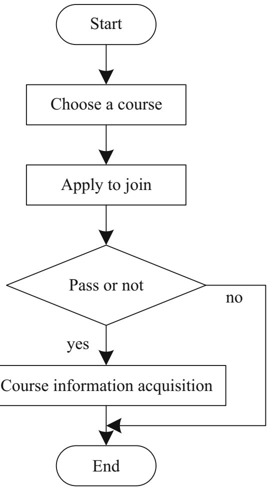


Fig. 5. Student participation flowchart

The process of joining the course is simple. If the teacher approves the application, the students can get the information about the course, watch the VOD and download the courseware at any time. If the approval does not pass, the process ends. Students can contact their instructor offline to find out why or to reapply.

2.4 Detailed Design of User Management Module

User Registration Module

User registration function we mainly use its Baidu user unified registration program, registration function needs a total of five corresponding interfaces. Including a session service interface, get the recommended user name interface, SAPI registration interface three.

The steps are as follows: register the data verification interface, obtain the recommended user name interface, apply for sending the SMS verification code interface, verify the verification code and user registration interface, and session service interface.

Session Service Interface Usage: Since the user should be logged in directly after the registration is completed, a parameter named bduss will be returned when the authentication code and the user registration interface return the successful status. After this parameter is used to request Session Service Interface, aid, username and other information will be returned, and then the user can be logged in by transmitting the successful information, aid and username to the client.

User Logout Module

Login and logout module is one of the most used modules in this teaching system. If the user wants to get the corresponding privilege, he must login to authenticate before he can get the privilege. Teachers, students, and administrators use their own usernames and passwords to verify their identities and whether they have permissions. The system login schematic is shown in Fig. 6.

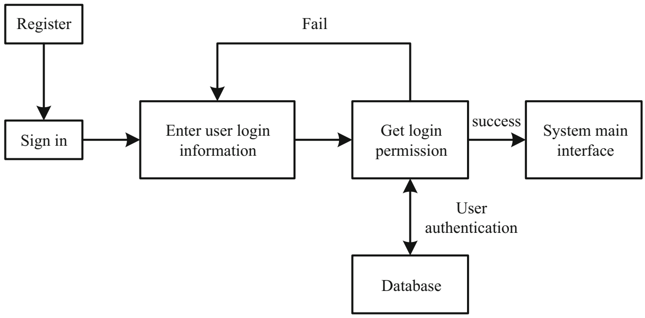


Fig. 6. User login schematic

The user login module is divided into three parts.

1) User operation interface: mainly the graphic interface and logical design that the user operates, and the password can be checked;
2) Database: MySQL is used, and the server uses Tomcat;
3) Java class: Realize the operation of adding, deleting, changing and checking database.

User logoff is the operation to log off the system after the user has successfully logged on. So, when you logoff, you will check whether the user is logged on or not. If it is logged off, you can log off the system.

3 Test Analysis

3.1 Functional Testing and Analysis

After the completion of the development, through the most basic test cases to verify whether the system can meet the needs of online teaching system.

Before testing, the test environment should be configured. The deployment of the test environment should be configured according to the requirement of online deployment, and the real online scenario should be simulated.

Online Classroom Module

Online classroom is mainly divided into online live streaming and online on-demand. The main test points of online live streaming are text chat, audio and video chat, document sharing, on-site testing and desktop sharing. The main test point of online on-demand is on-demand video. The testing method adopts role-based method to test the corresponding functions. Teachers use these tests as shown in Table 1.

Table 1. Teacher test case table of online broadcast module

Serial number	Input	Expecting results	Result
1	Upload handouts in handout management	Use the handout correctly after uploading successfully	In line with expectations
2	Teacher opens mic voice	Mic sound is turned on	In line with expectations
3	Adjust mic volume	Mic volume changes with the adjustment	In line with expectations
4	Turn on the headset	The headset is turned on	In line with expectations
5	Adjust the sound level of the headset	The sound of the headset changes with regulation	In line with expectations
6	Select to turn on the camera	It can collect the camera information of teachers	In line with expectations
7	Turn off the camera	Show teacher's default Avatar	In line with expectations

(*continued*)

Table 1. (*continued*)

Serial number	Input	Expecting results	Result
8	Click Share desktop	Teacher desktop shared	In line with expectations
9	Use the tools in the toolbar to write and draw	The operation is successful and can be displayed correctly	In line with expectations
10	Some students raise their hands and the teacher clicks on it	Students can speak	In line with expectations
11	Some students raised their hands and the teacher refused	Students are not allowed to speak	In line with expectations
12	Enter text in the discussion area	Students can view the teacher's speech	In line with expectations
13	Click to view online students	Show all online students	In line with expectations
14	Select upload document in data area	The document can be uploaded successfully	In line with expectations

The main test used by students is shown in Table 2.

Table 2. Student test case table of online live broadcast module

Serial number	Input	Expecting results	Result
1	Students click the "handout" button	View the handout of the teacher's current speech	In line with expectations
2	Click preview	Preview the entire handout	In line with expectations
3	Turn on mic sound	Mic sound is turned on	In line with expectations
4	Disable mic	Mic sound is disabled	In line with expectations
5	Adjust mic volume	Mic volume changes with the adjustment	In line with expectations
6	Turn on the headset	The headset is turned on	In line with expectations
7	Mute the headset	The headset is muted	In line with expectations
8	Adjust the sound level of the headset	The sound of the headset changes with regulation	In line with expectations

(*continued*)

Table 2. (*continued*)

Serial number	Input	Expecting results	Result
9	Select to turn on the camera	It can collect students' video information	In line with expectations
10	Turn off the camera	Show the default picture of the student	In line with expectations
11	Students click and raise their hands	The teacher looked up the students who raised their hands	In line with expectations
12	In the discussion area, students input text to send	Speech sent successfully	In line with expectations
13	Click to view online students	Show all online students	In line with expectations
14	Click download in the data area	The document can be downloaded successfully	In line with expectations
15	Enter the answer and submit the test	Upload the answers to the teacher	In line with expectations

The conclusion is drawn through the test, and the online classroom module test is passed.

Video Management Module

The main function of video management is to record and release video. The specific test is shown in Table 3.

Table 3. Test case table of video management module

Serial number	Input	Expecting results	Result
1	Click video recording	The video starts recording	In line with expectations
2	Click stop	Recording pause	In line with expectations
3	Click save	Save the current recording	In line with expectations
4	Click publish	The recorded content can be published	In line with expectations

The conclusion is drawn from the test, and the video management module has passed the test.

Course Management Module

Courseware management module is mainly a module that teachers and administrators can operate. The main test function points are to create and edit courses, create course plans, manage courseware, and arrange and correct homework. The teacher's specific test is shown in Table 4.

Table 4. Teacher test case table of curriculum management module

Serial number	Input	Expecting results	Result
1	Create a new course and input the relevant information about the course	Successful new courses	In line with expectations
2	After the creation is successful, click publish	Publish successfully, front desk students can view the course	In line with expectations
3	Create new courseware and input relevant information of courseware	Courseware created successfully	In line with expectations
4	Online classroom selection recording and broadcasting	Producing recording and broadcasting courseware	In line with expectations
5	Click on course management	Get course list	In line with expectations
6	Click courseware management	Get courseware list	In line with expectations
7	Click Create course plan and submit	The front desk can see the course plan	In line with expectations
8	Click to assign homework and ask questions	Students can see homework information	In line with expectations
9	Click to correct the assignment	See the homework and input the comments	In line with expectations

The administrator specific test is shown in Table 5.

Table 5. Administrator test cases of course management module

Serial number	Input	Expecting results	Result
1	Create a new course and input the relevant information about the course	Successful new courses	In line with expectations
2	After the creation is successful, click publish	Publish successfully, front desk students can view the course	In line with expectations
3	Create new courseware and input relevant information of courseware	Courseware created successfully	In line with expectations
4	Click on course management	Get course list	In line with expectations
5	Click courseware management	Get courseware list	In line with expectations
6	A course is suspended in the course management	The course has been taken off the shelves	In line with expectations

The test results show that the user management module has passed the test.

User Management Module

The user management module is mainly the entrance to the system. If you want to get the corresponding permissions, you need to go through this module. The detailed test is shown in Table 6.

Table 6. Test case table of user management module

Serial number	Input	Expecting results	Result
1	Registered users	Login was successful	In line with expectations
2	Enter the student's user name and password to log in	Login successful, enjoy the corresponding rights of students	In line with expectations
3	Enter the teacher's user name and password to log in	Login successful, enjoy the corresponding authority of the teacher	In line with expectations
4	Enter the administrator user name and password to log in	Login successful, with the corresponding authority of the administrator	In line with expectations

(*continued*)

Table 6. (*continued*)

Serial number	Input	Expecting results	Result
5	Enter the wrong user name and password	Login failed, you can view the basic information about the platform	In line with expectations

The test results show that the user management module has passed the test.

3.2 Safety Test and Analysis

Since the teaching system is a product developed externally, it is necessary to carry out security test on it. In the process of testing, we mainly find security loopholes and their repair, as shown in Table 7.

Table 7. Statistics and repair of security vulnerabilities

Vulnerability types	Specific description	Repair situation
Information leakage vulnerability	The interface leaks the user's email address, which does not conform to the passport security specification	Fixed
Arbitrary file upload vulnerability	The interface allows arbitrary files to be uploaded. Although they are stored in BCS, attackers can upload HTML, resulting in persistent storage XSS, phishing, etc.	Fixed
CSRF attack vulnerability	Multiple interfaces do not defend against CSRF attacks. Csrffilter has been written before, but it is not applied to all data writing interfaces	Fixed
Storage XSS vulnerability	The main reason is that rich text does not filter out dangerous tags and attributes, which leads to JS code execution during display	Fixed
Privilege bypass vulnerability	URL access control and resource usage control	Fixed
Http401 phishing vulnerability	Since the SRC source of rich text img is not judged, attackers can introduce malicious addresses	Fixed

After security testing, the existing security problems of the system have been repaired to meet the online requirements.

4 Conclusion

This paper proposes the design of management accounting online teaching system based on virtual simulation technology. Through the detailed design of the online classroom module, video management module, course management module and user management module, the research of this paper is realized. The results show that the system has higher security.

References

1. Pan, W.-T., Huang, C.-E., Chiu, C.-L.: Study on the performance evaluation of online teaching using the quantile regression analysis and artificial neural network. J. Supercomput. **72**(3), 789–803 (2016). https://doi.org/10.1007/s11227-015-1599-1
2. Breen, C., Zhu, T., Bond, R., et al.: The evaluation of an open source online training system for teaching 12 lead electrocardiographic interpretation. J. Electrocardiol. **02**(3), 454–461 (2016)
3. Liu, J.: Construction of real-time interactive mode-based online course live broadcast teaching platform for physical training. Int. J. Emerging Technol. Learn. (iJET) **13**(06), 73 (2018)
4. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
5. Hoad, K., Kunc, M.: Teaching system dynamics and discrete event simulation together: a case study. J. Oper. Res. Soc. **69**(5), 1–12 (2017)
6. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
7. Lee, A.W.M., et al.: Lecture rule no. 1: cell phones on, please! A low-cost personal response system for learning and teaching. J. Chem. Educ. **90**(3), 388–389 (2013)
8. Rani, S., Kumar, P.: A sentiment analysis system to improve teaching and learning. Computer **50**(5), 36–43 (2017)
9. Erstad, B.L., Oxnam, M.G., Miller, T.P., et al.: Issues and opportunities on implementing an online faculty review system. Am. J. Pharm. Educ. **82**(3), 6911 (2018)
10. Feyereislova, S., Nathan, D.: G214 the best way to teach developmental assessment – a single blinded randomised study comparing teaching models. Arch. Dis. Child. **98**(Suppl. 1), A96–A96 (2013)

The Design of Interactive English Online Education System Based on B/S Structure

Ying-di Xi[1](✉), Ying Lin[1], and Yangbo Wu[2]

[1] College of Foreign Languages, Xinyu University, Xinyu 338000, China
[2] College of Mathematics and Computer, Xinyu University, Xinyu 338000, China

Abstract. Aiming at the problem that the signal attenuation rate obtained by the existing online education system is too large, a free speech interactive English online education system based on B/S structure is designed. The hardware part uses single chip microcomputer as the main controller, expands the interface outside the sensor, and designs the hardware circuit structure. B/S structure is built in the software part, the online interactive algorithm of free speech interactive English is constructed, and the system design is completed. After setting up the system test environment, the traditional system and the online education system designed in this paper are tested. The results show that the signal attenuation rate of the online education system designed in this paper is the smallest.

Keywords: B/S structure · Free speech interaction · English online education · Signal attenuation rate

1 Introduction

Online education refers to the use of advanced digital methods to convert text, pictures, and videos into data that can be stored and converted, and transmitted via the Internet, which is convenient and efficient interactive teaching. With the rapid development of information technology, the coverage and transmission rate of the Internet have increased substantially. This has laid a solid foundation for the large-scale application of P2P technology in video transmission, which can transmit smooth video remotely and interact with low latency. On the one hand, the development of the fixed network has broken the technical bottleneck of the popularization of online education. On the other hand, the rapid deployment of domestic 5G mobile communication technology has also pushed the large-scale promotion of online education to a new peak [1]. The online education system, also known as the distance education system, is a product of the information age. Its characteristics are: to achieve personalized and efficient teaching methods that teach students in accordance with their aptitude. It is a revolution to the traditional teaching mode; it breaks through the limitations of traditional "face-to-face" teaching. The seeker provides a way of learning with scattered time, free arrangement of learning, resource sharing, a wide geographical area, and interactive learning.

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 118–129, 2021.
https://doi.org/10.1007/978-3-030-84386-1_10

Compared with traditional education, online education has many outstanding advantages. The latter has wide coverage, high resource sharing, low deployment cost, and supports personalized teaching. At present, in order to promote the healthy development of online education, the state has issued a series of regulations, standards and preferential policies to create a standardized and active promotion environment for the development of the online education system. It is foreseeable that online education will develop substantially. As an emerging field, whether in terms of system or technology, online education has many topics that need to be discussed in depth. Among them, how to achieve a resource-sharing, scalable and highly interactive online education system is the future of online education The key to rapid development [2]. The innovation of the research is that modern distance education is a new form of education with the development of network technology and multimedia technology. It is the third generation of distance education after correspondence education and radio and television education. Its implementation makes learners not limited by time and place, which greatly facilitates students' learning.

2 Online Education System Hardware Design

2.1 Design the Main Controller Structure

The single-chip microcomputer is used as the main controller to control and process some special educational interactive calculation processes. Design the input environment indicator unit and output unit. The two units carry the input and output of virtual reality technology. The overall hardware design circuit frame diagram is shown in Fig. 1 below:

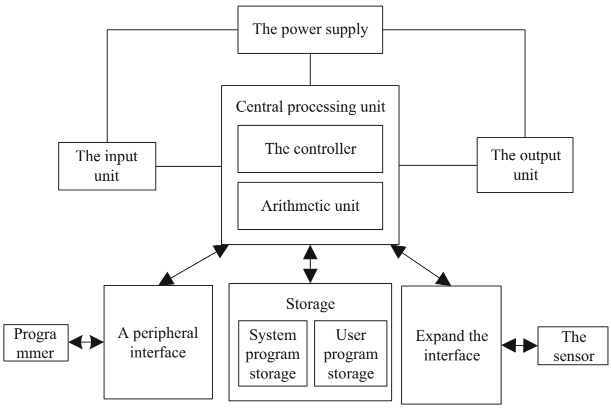


Fig. 1. Hardware composition diagram

According to the above Fig. 1, the hardware of the design system mainly designs the central processing unit, memory, input/output interface, design equipment, communication interface and power supply. The controller adopts a microcontroller based on a single-chip microcomputer. The single-chip microcomputer has a simple structure and powerful programming function, which can carry continuously changing English interactive data.

The data function module is designed. The data function module is designed as an education data module, an exchange module and an online education module. The three modules collect data separately and then perform digital-to-analog conversion. The three modules are uniformly connected to the data transmission unit to facilitate unified transmission and unified processing of the converted data [3]. In order to ensure the safety and reliability of the processing process, the sensor adopts the SP12 multifunctional sensor. The internal clock of the sensor is designed. Two oscillators are placed inside the sensor. The low-power oscillator with an oscillation frequency of 2.5 kHz is placed in the internal clock. An oscillator with an oscillation frequency of 2 MHz is used in the data function module.

Under the sensor structure shown in the figure above, the sensor is connected to an external expansion interface to help input actual educational data to the central processing module. The external input part of the central processing module is connected to the computer keyboard, and the keyboard inputs data to complete the input of the design data. The memory is designed into two modules, the system program memory and the user program memory. The system program memory is mainly responsible for storing the system data obtained by the programmer, and the user program memory is designed to record the data of teaching interaction. Using a hard disk drive with a capacity of 2G, control its single-disk capacity to 512M. Design the hardware circuit structure, and finally complete the design of the system hardware.

2.2 Design the Hardware Circuit Structure

The system circuit part is mainly designed for clock circuit, reset circuit and power circuit. When designing the clock circuit, a magnetic bead FBI needs to be connected in series with the input end of the power supply to filter out high-frequency noise on the signal line and power line, and reduce the impact of spikes on the system [4]. Connect a filter capacitor C44 between the power supply and ground to filter out the interference of the noise signal, and then connect a 33Ω resistor in series with the output to filter the signal to ensure the output of a high-level clock signal with a duty cycle of 50%. The clock signal circuit The connection diagram is shown in Fig. 2 below:

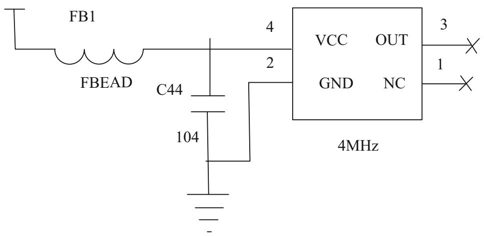


Fig. 2. Clock signal circuit connection diagram

The reset circuit uses the power management chip TPS3307-33, connects the pins SENSE1, SENSE2, and SENSE3 on the chip. The threshold voltages of the design pins

SENSE1 and SENSE2 are 4.55V and 2.93V respectively, and the voltage of the SENSE3 pin is designed to be 1.25V. After the two pins SENSE1 and SENSE2 are divided by resistors R19 and R20, they are connected to the SENSE33 pin. The connection of the reset circuit is shown in Fig. 3 below:

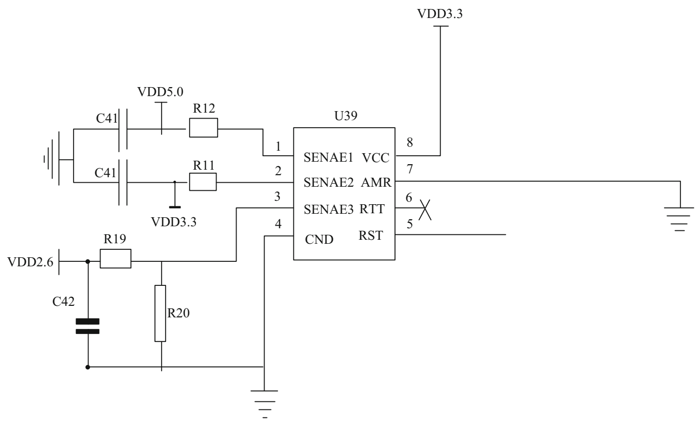


Fig. 3. Reset circuit design diagram

When designing the circuit of the power supply part, the external power supply inputs a DC voltage of 9–12V, and the analog digital 5.0 V voltage supplies power to the digital device, and the reference voltage in the reset circuit is adjusted to a high-precision voltage. In order to prevent a relatively large change in the operating current of a component, causing disturbance to other parts, power is supplied to the driving part of the component separately [5]. The remaining part of the voltage is transformed by a

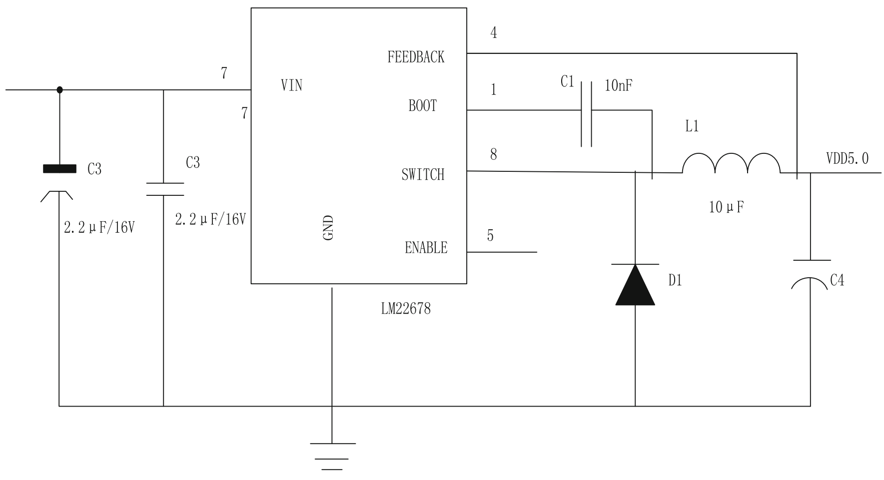


Fig. 4. Power supply circuit

linear regulator on the basis of 5.0V. The detailed system power circuit design is shown in Fig. 4 below:

After designing the hardware of the main control part of the system, connect the designed three-part circuit to complete the design of the hardware part of the online education system.

3 Online Education System Software Design

3.1 Build B/S Structure

The B/S structure is the browser and server structure [6]. The user's working interface under this structure is realized through the WWW browser, and only a small part of the transaction logic is realized by the front end. The main transaction logic should also be realized on the server side, forming the so-called three-tier 3- The tier structure, the designed database structure is shown in Fig. 5 below:

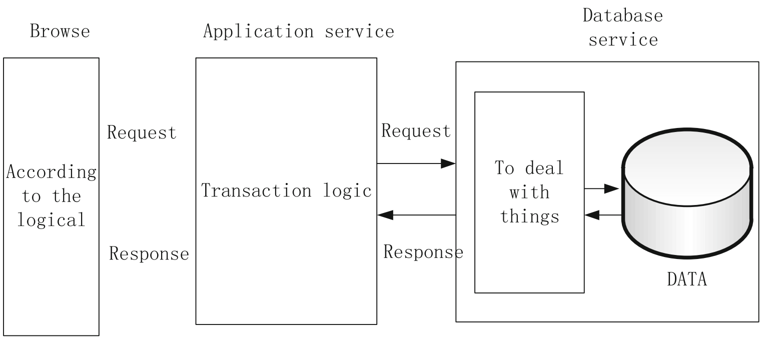


Fig. 5. Set B/S structure

Under the B/S structure built in the above figure, the client is located on the first layer, which is different from the client in the C/S structure. The client only retains a web browser (such as IC or Navigator, etc.). There is no need to store any applications, and in the C/S mode, each user must install the application on the client before using it, configure the parameters of the client, and provide information about the server [7]. At the same time, users also need to participate in the maintenance and management of the client software. If the user's working platform is different, then the corresponding Client terminal must be specially developed according to the characteristics of different platforms [8]. Located in the second layer is the application service layer, which is composed of one or more servers. The Web server is also in this layer. The function of Java Application Server is to process the business logic in the application. This layer has excellent scalability, The number of servers can be adjusted at will according to the needs of the application to prevent object sharing conflicts, avoid object call failures, ensure the granularity and availability of objects, and manage the life cycle of objects. The biggest feature of the Browser/Server structure is that the client unit adopts the browser, which eliminates the time consumed when calling the database [9, 10].

3.2 Building an Interactive Algorithm

According to the needs of different online education users, the attributes of information-based teaching resources are delineated, and after the entities of the teaching resources are contacted by the ER diagram, they are converted to the selected DBMS record type [11, 12], which is constructed into a sub-mode, which is regarded as the interface between the application and the resource database summarizes the data at the interface and integrates it into a data set A to construct a data transfer function, which can be expressed as:

$$A(s) = \frac{\omega^2}{s^2 + Q} \tag{1}$$

Among them, s represents the data transmission time, Q represents the amount of transmitted data, and ω represents the buffer parameter. According to the above transmission process, assuming that the hardware structure has the same sensitivity to each incoming data, an attribute parameter r is set, and the quantity relationship of the parameters can be expressed as:

$$r^2 = (1 - e_{11})\left(1 + \frac{e_{11}(a_{11} + e_{21})}{2}\right) \tag{2}$$

Among them, e_{11} and e_{21} respectively represent the amount of data transmission at different moments, and a_{11} represents the sensitivity parameter [13]. Under the control of this attribute parameter, a shared signal delay parameter is set to form a fluent interactive attribute mode, which can be expressed as:

$$\begin{pmatrix} u_{k+1} \\ v_{k+1} \end{pmatrix} = P\begin{pmatrix} u_k \\ v_k \end{pmatrix} + E_2\begin{pmatrix} 1 & j \\ 0 & \kappa \end{pmatrix} \tag{3}$$

Among them, u_k represents the data stability parameter, v_k represents the data transmission speed, j represents the delay parameter, κ represents the sensitivity of the hardware structure to the data, k represents the signal transmission time, and P represents the fluent interactive attribute parameter[14]. Under the control of different signal transmission times, in order to unify the data mode of online education resources, the above processing acuity parameters and delay parameters are normalized. The processing process can be expressed as:

$$G = f\frac{T}{\kappa j} \tag{4}$$

Among them, f represents the operating frequency of the hardware component, and T represents the operating cycle. Set the above-mentioned work cycle as the actual interactive cycle, and send educational data to the system hardware structure according to this cycle [15]. Based on the above process, the design of the B/S-based interactive English online education system is finally completed.

4 System Test

4.1 Experiment Preparation

After the system is deployed to the cloud server, the operating environment and related test tools needed to achieve the most basic system functional requirements and system-related performance tests are as follows (Table 1):

Table 1. Test environment and tools prepared

Serial number	Name	Parameter
1	Server	CentOS 7.3, 1 core CPU, 2G memory, 1 Mbps bandwidth
2	Browser	Firefox 73, IE 11, Chrome 80
3	Operating system	Windows 10
4	Test machine	PC
5	Test tools	LoadRurmer

Under the test environment and tools shown in the table above, build the system test environment as shown in Fig. 6 below:

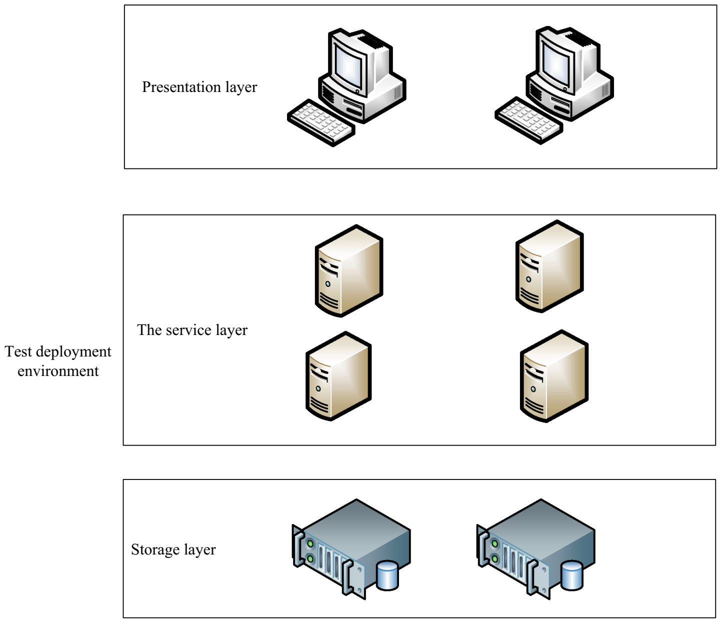


Fig. 6. The deployed test environment

In the test environment deployed in the picture above, the presentation layer is composed of the client Angular single-page application miepweb and the management Angular single-page application miepAdmin web, each of which deploys an instance, on the one hand, to provide access to static resources (the source code of the single-page application includes html, js, css, images, etc.) and on the other hand, each container has a request broker nginx service, which dynamically distributes requests to four MiepService containers, and the service layer is a cluster of four Miepakka services composed of four MiepServices. The storage tier consists of mongodb and EventStore database instances. After the software structure is debugged, experiments are carried out by using the educational system in reference [4], the educational system in reference [7] and the designed educational system to compare the performance of the three educational systems.

4.2 Experimental Results and Analysis

Based on the above experimental preparations, using the same test environment, using JMeter as the stress test tool, the input and query interfaces are used for stress testing, and the throughput and performance of the system are evaluated through the test for the insertion energy of one of the services. For the performance of writing API, we select the job title management of the course learning module for insert performance test. We use the constantly changing number of request threads, insert 2000 pieces of data for each test, and get the throughput rate of each insert to evaluate concurrent requests. The relationship between the number and the system throughput rate. Perform insert request stress test on /api/w/quiz. The set test process is shown in Fig. 7 below:

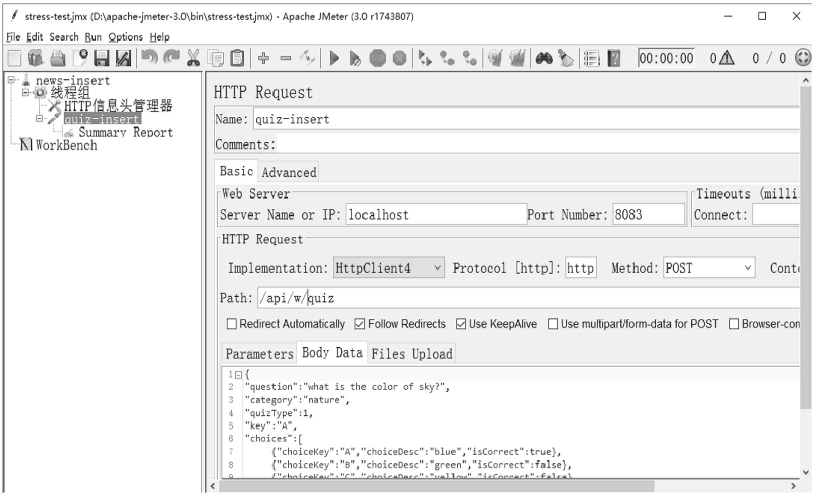


Fig. 7. The set test process

JMeter created a thread group to simulate the number of concurrent online users. We tested this using 20, 40, 60, 90, 120, 150, 180, 200, 220, 250, 280, 300, and configured the calling server API at http request: http://localapi/host/quiw/quiz and the method used for the request was POST. Summary Repot is used to generate the results of the test, giving Throughput data. Under the three online education systems, the throughput results for the three education systems are shown in the following table (Table 2):

Table 2. Performance test results of three online education systems

Threads	Throughput (records/sec)		
	Reference [4] systems	Reference [7] systems	Education system designed in the article
20	11.3	14.5	17.3
40	8.6	13.2	17.8
60	11.1	12.6	17.9
90	8.9	13.7	18.7
120	10.9	12.9	19.5
150	10.7	13.6	18.9
180	10.7	13.2	18.5
200	11.7	13.5	17.7
220	11.1	13.9	16.9
250	9.8	14.8	16.2
280	11.3	14.6	15.3
300	8.6	12.8	15.3

From the values shown in the table above, we can see that under the control of the three online education systems, the load value generated by the reference [4] system is around 10.39, the throughput of the system is small, the throughput value generated by the reference [7] system is around 13.60, the throughput value is large, and the throughput result of the online education system designed in this paper is around 17.5. Compared with the two existing online education systems, the throughput value of the online education system designed in this paper is the largest and the data that can be processed is the largest.

In the above experimental environment, set the command name and data size of Changyan Interactive English, as shown in the following table (Table 3):

Table 3. Set command name and size

Command name	Acquisition frequency/MHz	Data size/M
Instruction 1	50	4.9
Instruction 2	55	2.2
Instruction 3	60	3.2
Instruction 4	65	4.1
Instruction 5	70	4.9
Instruction 6	75	4.9
Instruction 7	80	4.4
Instruction 8	85	2.5
Instruction 9	90	2.5
Instruction 10	95	4.4

After transforming the instructions set in the above table in the three online education systems, calculate the data transmission speed of the three online education systems according to the response time of the instructions in the system, and the results are shown in the following table (Table 4):

Table 4. Data transmission time of the three education systems

Command name	Transmission speed/Mbps		
	Reference [4] systems	Reference [7] systems	Education system designed in the article
Instruction 1	16.6	34.9	42.3
Instruction 2	15.2	34.6	44.5
Instruction 3	21.9	29.6	38.1
Instruction 4	16.1	25.7	39.3
Instruction 5	15.6	32.4	43.5
Instruction 6	19.3	21.7	40.4
Instruction 7	18.1	33.9	42.4
Instruction 8	15.7	27.8	42.9
Instruction 9	15.4	30.2	37.2
Instruction 10	19.1	30.5	42.1

From the transmission speed shown in the table above, it can be seen that under the same transmission data size, the three online education systems showed different transmission capacities, and the average transmission speed in the reference [4] was about 17.3 Mbps, with a lower transmission speed compared with that in the table. The average transmission speed of the educational system in reference [7] is around 30.1 Mbps, which greatly improves the ability of the drawing system to transmit data. The average transmission speed of the online education system designed in this paper is about 41.2 MBPS. Compared with the two existing online education systems, the actual transmission speed of the system is the fastest.

Keep the above experimental environment unchanged, set a signal interference of 1 to 10 m outside the three online education systems, and use an oscilloscope to measure the frequency of the collected signals under the control of different online education systems, and generate signals according to signal interference equipment at different distances Interference obstruction, the attenuation rate of the online education signal is calculated, and the final attenuation rate results of the three online education system signals are shown in Fig. 8 below:

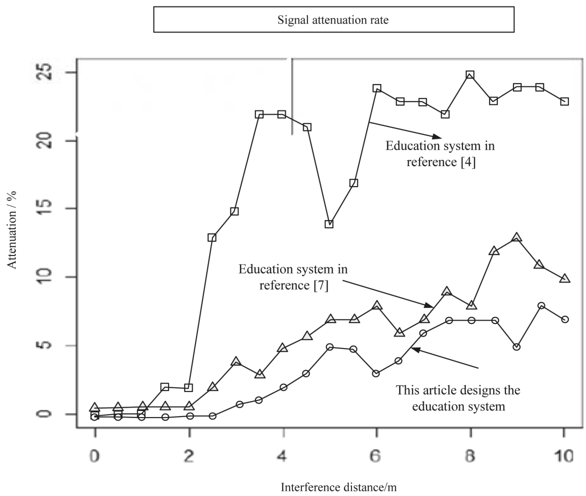


Fig. 8. The attenuation rate of the signals collected by the three online education systems

From the attenuation rate result shown in the figure above, the data signal collected by the education system in reference [4] has the largest transmission attenuation rate under different transmission distances. At a transmission distance of 10 m, the final transmission attenuation rate is 25%about. The online education system 2 in reference [7] maintains a relatively stable transmission attenuation rate between 0 and 4 m, but at a transmission distance of more than 4 m, the signal attenuation rate rises linearly, and the final attenuation rate is 10%about. The attenuation rate value of the education system designed in the article shows a stable change with the increase of the transmission distance. At a transmission distance of 10 m, the attenuation rate of the collected signal is about 5%, and the value of the attenuation rate of the transmitted signal is the smallest.

5 Conclusion

The future development trend of education is modern distance education. Distance education uses today's advanced communication technology and computer network technology to deliver multimedia data, audio, video and other information in non-real-time or real-time, in an interactive or visual form of distance education. As a teaching method, distance education will be used more and more by everyone. Therefore, its development will become more and more perfect.

References

1. Han, L., De, H., Yao, H.: Design of online motion ability evaluation system based on complex network. Mod. Electron. Tech. **41**(02), 116–119 (2018)
2. Chen, J.-y., Wang, Z., Chen, J.-y., et al.: Design and research on intelligent teaching system based on deep learning. Comput. Sci. **46**(S1), 550–554+576 (2019)
3. Zhang, L., Li, Y.-F.: Labeling system design of the information architecture for the elderly's distance education website. Packag. Eng. **39**(24), 237–243 (2018)
4. Wen, S., Zhang, S., Chen, Z., et al.: Design of measurement and control system based on online instrument for melt index with fuzzy PID. China Measur. Test. Technol. **44**(03), 97–101 (2018)
5. Yuan, J.-C., Guo, T., Wang, S.-N.: Design of wireless low power on line monitoring system for shearer. Coal Eng. **50**(08), 18–20 (2018)
6. Wang, Y.-B., Hao, Y., Li, Q., et al.: Design and application of on-line chemistry experiment safety examination system. Chin. J. Chem. Educ. **39**(14), 72–74 (2018)
7. Zhong, W., Li, D., Zhang, J., et al.: Design of wearable brain-computer interface system based on dry electrode. J. Xi'an Jiaotong Univ. **54**(06), 66–74 (2020)
8. Pan, H.-G., Mi, W., Deng, J., et al.: Closedoop brainachine interface system design based on improved singleoint information transmission model. Control Theory Appl. **37**(02), 395–404 (2020)
9. Wang, Z., Wang, S., Guo, D., et al.: Method on video optimal transmission in on-site operation monitoring system of electrical power system. J. Electric Power Sci. Technol. **35**(01), 169–175 (2020)
10. Xie, Y., Song, Z.-H., Jian, F.: Design and realization of SE/AIP training simulator based on simulation platform. Comput. Simul. **37**(07), 20–22 (2020)
11. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
12. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mobile Netw. Appl. **24**(1), 1–4 (2019)
13. Khan, M.M., Rahman, S., Islam, S.: Online education system in Bangladesh during COVID-19 pandemic. Creat. Educ. **12**(2), 441–452 (2021)
14. Al-Odeh, M.: What universities in the Middle East can learn from the American online education system. Int. J. Inform. Commun. Technol. (IJ-ICT), **9**(1), 31–40 (2020)
15. Tamim, S.R.: Analyzing the complexities of online education systems: a systems thinking perspective. TechTrends **64**(1), 740–750 (2020). https://doi.org/10.1007/s11528-020-00538-9

Design of Online Management System for Painting Teaching Based on Artificial Intelligence Technology

Dong-dong Suo(✉) and Yi-jia Shang

Zhengzhou Technical College, ZhengZhou 450121, China

Abstract. In order to better improve the quality of teaching, the design of an online management system for painting teaching based on artificial intelligence technology is proposed. The hardware structure configuration of the teaching management system is optimized and perfected, and the system software operation process is optimized to improve the system management function. Ensure the effect of system operation and improve the quality of painting teaching. Finally, it is confirmed by experiments that the online management system of painting teaching based on artificial intelligence technology has high operational safety and reliability in the actual application process, and fully meets the research requirements.

Keywords: Artificial intelligence technology · Drawing teaching · Online management

1 Introduction

With the teaching reform as the research background, combined with the preliminary exploration of drawing teaching management of drawing courses in various schools in ur country. After investigating and analyzing the operating status of the painting teaching management system in various schools, it is found that most schools have not perfected the teaching management mechanism of painting courses. The traditional painting teaching online management system based on Web technology is used for painting courses teaching. In the system structure, add an automatic reset circuit; avoid the outflow of drawing resource information, reduce the interdependence between modules, use Web technology, improve the system management function structure, use the fitness function, refine the curriculum management plan, and complete the drawing teaching management system design. However, the management scope of this method has certain limitations, which to a large extent limits the development of painting courses [1].

Based on this, through analysis and research combined with artificial intelligence technology, the painting teaching management system is optimized to reduce the learning pressure of teachers and students, encourage students to study enthusiasm in the learning process, cultivate students' active participation and initiative, and let students We actively understand and explore, increase the emotional communication between teachers and students, so as to promote the coordinated progress of the entire teaching process.

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 130–142, 2021.
https://doi.org/10.1007/978-3-030-84386-1_11

2 Online Management System for Painting Teaching

2.1 System Hardware Configuration

In the design process of the drawing course teaching management system, we should first analyze the current drawing teaching management system requirements and the business process of the system, so as to summarize the functional requirements and non-functional requirements of the drawing course teaching management system. The following aspects should be paid attention to in the design process of artificial intelligence drawing teaching resource management system: The system provides remote access to the network function, which is convenient for users to access all the material resources of the system anytime and anywhere, and provides a standardized and safe interface for applications [2]. Based on this, data processors and interface configurations need to be added to the hardware configuration. Considering the growth of system resources and storage of large amounts of data, the system must support decentralized data management. Based on this, the system hardware structure needs to be optimized first. The specific structure is shown in Fig. 1:

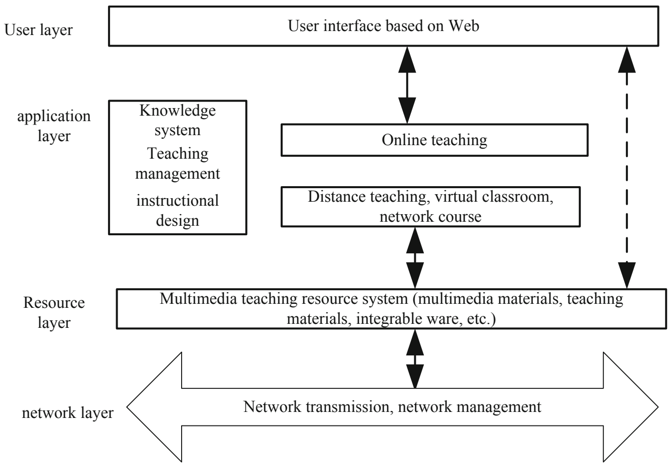


Fig. 1. Overall system architecture

As shown in Fig. 1, the artificial intelligence drawing teaching resource management system consists of a database server, a web server, and an on-demand server. The subsystem can be established on the same server according to the actual situation of other services to reduce hardware consumption. The painting teaching system is designed with B/S and browser/server architecture [3]. Combined with the current tensorflow js launched by goggle, the use of B/S mode can solve the problem of applying deep neural network models to mobile terminals, and can also improve the compatibility and portability of the online management system for painting teaching [4]. The overall architecture adopted by the interactive stick drawing teaching system is shown in Fig. 2.

Among them, the Nginx and Gunicorn modules are non-functionally added according to the final deployment of the painting teaching online management system [5].

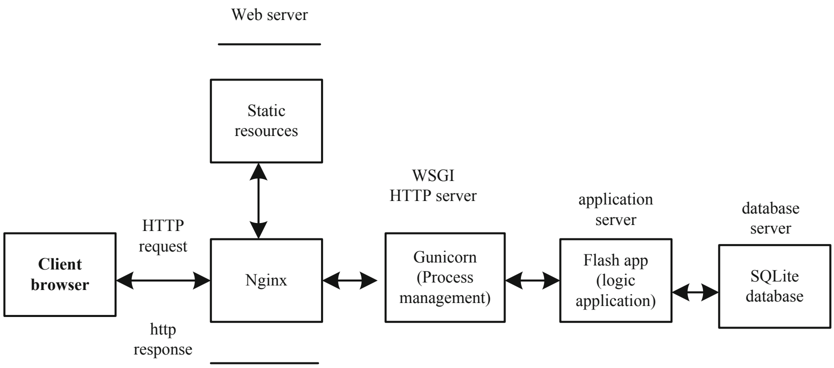


Fig. 2. System overall B/S architecture diagram

According to the B/S architecture of the system, users use the teaching function through the browser web page, the server will process the corresponding http request and return the corresponding response, and the Nginx and Gunicorn modules are responsible for load balancing, asynchronous processing and other operations [6]. System management teaching materials can be divided into online running teaching materials and local running teaching materials according to the daily classification management method.

The teaching material information in the artificial intelligence database needs to collect and manage the specific address and file name of the teaching material, and save the teaching files in the hard disk to sort out and record the information. Determine the use of authorized artificial intelligence teaching materials according to the user group name and different permissions [7]. In order to ensure the effect of system operation, the data processor structure is optimized. The specific system database management architecture is shown in Fig. 3:

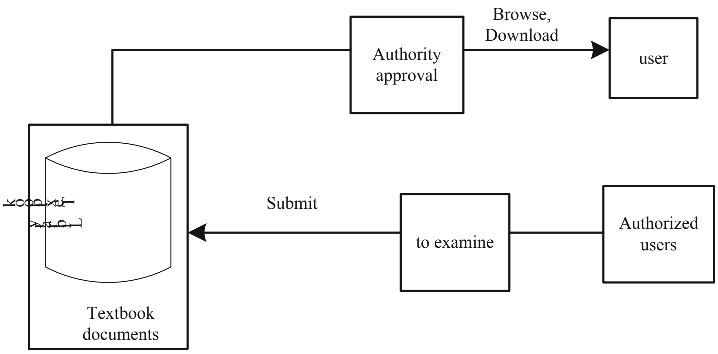


Fig. 3. Data processor structure

In the structured system design method, the method used is the description table of the IPO diagram and the system flow chart to design the overall function and detailed function of the system [8]. The system hardware configuration structure is relatively simple, the maintenance is simple, and the work efficiency is high. After the information is submitted, the web page can be opened immediately. The authorized user can be the creator of the teaching material or the teacher. Based on this, the system hardware structure is optimized to ensure the system operation effect.

2.2 System Software Function Optimization

The drawing course teaching management system is mainly to assist teachers in teaching. The drawing course teaching of the teacher and the course learning of the students are connected through the system. By analyzing the needs of the drawing course teaching management and the function of the design, the drawing course teaching management system is determined The most important thing about the top-level data stream of the painting course teaching management system is that it can collect and classify relevant information such as course resources for teachers and students, so that teachers and students can learn the latest art information, participate in online learning and testing, and let teachers and students Carry out the needs and characteristics of interactive communication to design the overall structure of the system [9]. In order to realize the basic functions of the painting course teaching management system, and to be able to carry out and manage in an orderly manner, standardize and unify, divide the labour management of different modules, and finally implement it by the system. The overall functional structure of the drawing course teaching management system is shown in Fig. 4.

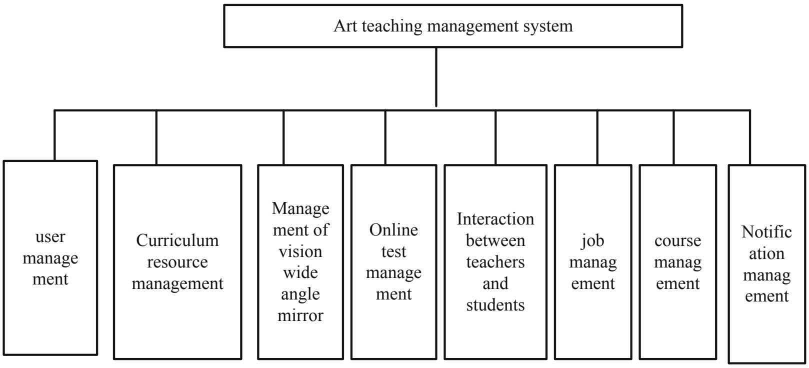


Fig. 4. The overall functional structure of the drawing course teaching management system

As shown in Fig. 4, the system is divided into 8 modules: user management, course resource management, wide-angle lens management, online test management, teacher-student interaction, homework management, course management, and notification management. Among them, user management is mainly to realize the functional requirements of corresponding operations for all users of the drawing course teaching management system.

Curriculum resource management is mainly to realize the functional requirements of uploading relevant materials and information of the course to the Internet, and to provide students with the functional requirements for downloading and viewing. The visual wide-angle lens management is mainly to realize the functional requirements that can be presented in the course results of the painting course teaching management system. Online test management is mainly to realize that teachers can accurately master [10], the functional requirements of students on the learning status of painting courses, and the interaction between teachers and students is a very important functional requirement in this system. This function can not only enhance students' understanding of painting courses. The interest can also enable students to cultivate their sentiment, increase their knowledge, and broaden their horizons; homework management is mainly to realize the functional requirements of the release and submission of homework. Teachers can release homework according to the class situation and urge students to complete homework in time. Students can directly view the results of homework corrections in this module, and the results will be saved in the student account information [11]. Curriculum management is mainly to realize the functional requirements for recording the progress of students' learning courses. Students can download courseware, and teachers can monitor the progress of students' learning and remind students of their progress; notification management is mainly to implement the functional requirements for issuing notifications during the teaching process and record The process of the next operation, standardize the process of notification issuance. Based on this, the functional structure of the job management module is optimized as shown in Fig. 5:

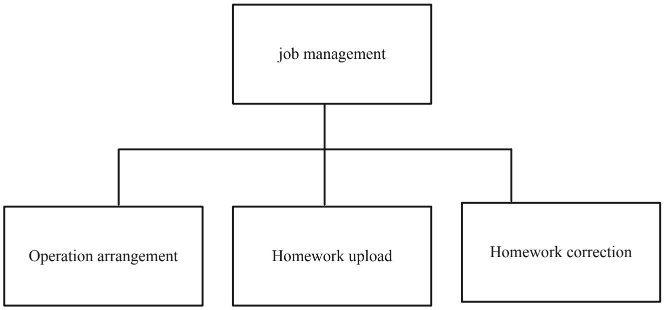


Fig. 5. Functional structure diagram of job management module

As shown in Fig. 5, the functional structure diagram of the course management module. This part of the module includes course subject management and learning progress management. In order to be able to improve and pay attention to the curriculum concept of teachers in curriculum management, and to promote the growth of a professional teacher, it is necessary to strengthen the implementation of curriculum management in a school [12]. Mainly to expand the enthusiasm of students. The prerequisite for constructing curriculum management well is student-oriented. In addition, the implementation of curriculum management requires training for some teachers, so that a complete management plan can be developed, allowing teachers and students to rationally use the resources on the Internet to create better and favorable conditions for painting teaching.

2.3 Realization of Online Management of Painting Teaching

Software information resource management plays an important role in the teaching system. In the process of optimizing the software function of the drawing teaching management system, the theory, concept, content, etc. must be combined with the traditional teaching mode, but the main teaching is based on the campus network. Mainly, the traditional teaching mode is supplemented, the courses are arranged reasonably, and the new software engineering technology is arranged in the new software engineering technology to transfer the knowledge to the students perfectly. The establishment of courses is very necessary. Including specific software management subjects and software configuration subjects, focusing on making software engineering, teaching software quality knowledge through network teaching [13]. The establishment of systematic practice courses is also very necessary. Through the campus network, students can independently understand the content of software engineering courses, innovate and develop corresponding software engineering designs, and actually participate in software development projects. Simulations are conducted in the form of groups, with the theme of improving software functions, through the campus The real-time live broadcast of the Internet enables more students to participate in it, so as to improve the students' interest in drawing learning and the quality of teaching management.

In the online management system of drawing teaching, both teachers and students must pass the design of teaching curriculum resource management module to be able to implement it. This module can be divided into course resource upload, course resource release, course resource cataloging, course resource research, course resource query statistics, course resource download. The upload of data, the download of related files, and the notification of announcements must all be included in the course resource management module. In addition, it is about how to select and set up the relevant information of the course materials and how to delete, modify and reduce the relevant information content., There should be a relevant teacher in charge to write. Based on this, the functional structure of curriculum resource management is further optimized, as shown in Fig. 6:

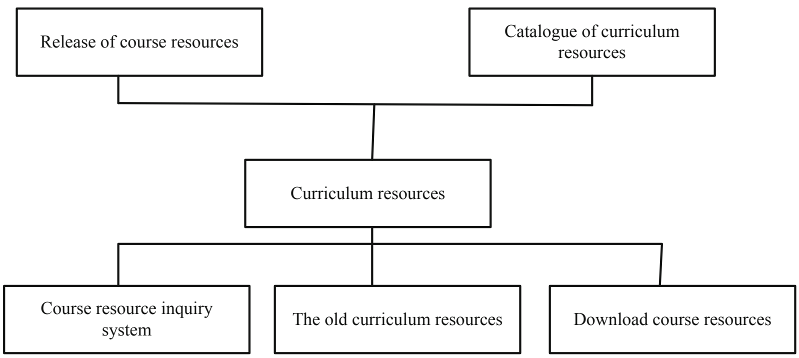


Fig. 6. Course resource management module

Online test management includes exam content management, exam management, scoring management, and score management. This part of the module can add, modify and delete the existing test questions in the question bank. Students can choose the type of questions related to them to conduct a comprehensive and complete online test according to their actual ability and the type of questions the teacher is giving. Course planning in the course of teaching content can be set up by the teacher to set the parameters of the test questions (test scores, overall level of difficulty, test time, etc.). Teachers can also manage the entire test process and specific time. If you want to manipulate the student' s learning activity status in a timely manner and grasp the students' understanding of the teaching content, they must grasp the student's dynamics through online testing. If you want students to view their own academic performance and evaluation of teachers, and clearly recognize the problems in their work, students can also practice their own exam content through online tests, which can also be better Clearly clarify the level of learning the students have mastered for the course. Modules such as selecting test questions, answering questions, teacher's evaluation of students, and comprehensive test results are all included in the online test. Based on this, the online test information management function structure is further divided, as shown in Fig. 7:

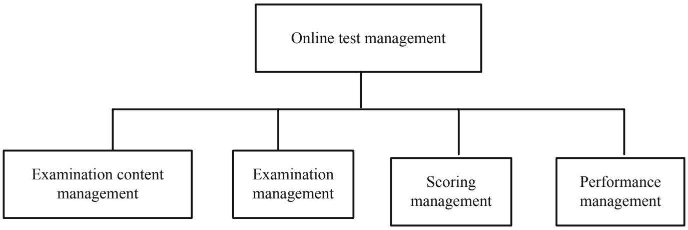


Fig. 7. Online test management module

The online test management module includes course subject management and learning progress management. In order to improve and pay attention to the curriculum concept of teachers in curriculum management, and to promote the growth of a professional teacher, it is necessary to strengthen the implementation of curriculum management in a school. The main thing is to mobilize the enthusiasm of the students. I personally think that the curriculum management must be built well, and the premise is to be student-oriented. The implementation of curriculum management also requires training for some teachers, so that a complete management plan can be formulated so that teachers and students can use more resources on the Internet to create better and favorable conditions. Further plan the main categories of course management, as shown in Fig. 8:

Further design the system notification management module, which includes the planning of four sub-modules. Notice management, notice withdrawal management, notice reading management, notice withdrawal management. The scope of the notice is very common, whether it is in public places, units or campuses, it can be seen everywhere. It shows that the notice can play a very important role. Most of it is used for the arrangement of course announcements. Students' affairs, in addition, they will also make requirements and affirmations for some related information, especially the required procedures for the

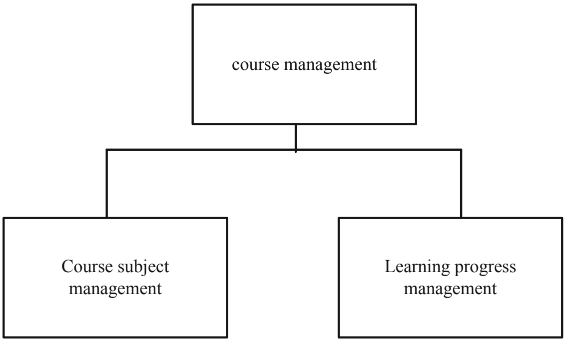


Fig. 8. Course management module

transfer of certain requirements, so that students can be more clear about the tasks they want to perform. The key is that the things to be described must be Brief description. The notification management module is shown in Fig. 9:

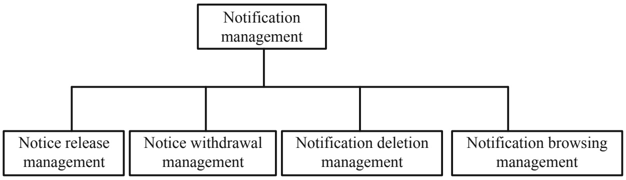


Fig. 9. Notification management module

From the perspective of the business process and the corresponding data flow diagram, if you analyze from the demand analysis, you can obtain user registration diary, user login diary, student information, user privileges, teacher information, published resources, and course resource catalog table., Courseware materials, homework, delete resource records, download records, art policy trends, latest art exhibition information, master catalog tables, well-known works catalog tables, test questions, completed test questions, corrected test questions, transcripts, query records, teachers Messages, student messages, questions, answers, homework content, completed homework, list of student grades, homework results, course resources, course list, student learning progress, announcement notice, withdrawn announcement, deleted announcement, announcement browsing history etc. According to the relationship of each entity obtained between business processes, it can be seen and determined that the entities can obtain their respective attributes. Based on this, the system operation process is further optimized to ensure the accuracy of evaluating students' drawing ability. In real painting teaching, professional teachers generally check the students' current completion progress and accuracy in real time, and give certain guidance. The purpose of this system to realize the function of evaluating painting is to evaluate the current painting works of students, and then give feedback to the students. Based on this, the system operation fluency is further optimized, and the specific steps are shown in Fig. 10:

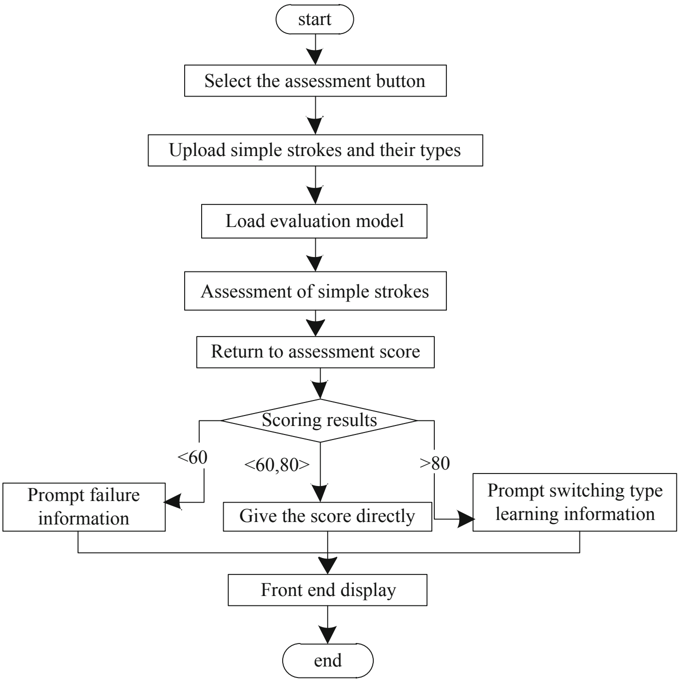


Fig. 10. Flow chart of teaching management

The analysis and design of the drawing course teaching management system is open and shared. By applying some of the above-mentioned comprehensive related technologies, they form a joint system development and design. The completed work generally summarizes the following aspects. According to the teaching management system of the painting course according to the work needs, the research background of this course system and the research status and future prospects of the course system at home and abroad are differentiated. In addition, the necessary prerequisites for building a curriculum system should be discussed based on the characteristics of drawing teaching in primary and secondary schools and the current management situation. The overall structure design idea of the drawing course teaching management system is to use the principles and methods of software engineering to conduct a systematic demand analysis and design. Through the analysis of business requirements, functional requirements, data requirements and non-functional requirements, business flowcharts, data flow diagrams and data dictionaries are used to model teaching management requirements. The drawing teaching management has carried out detailed analysis in various business processes, distinguished the use of drawing teaching course management system in the process of performance demand analysis, and gave a model for each data flow diagram. Finally, it mainly focuses on the research of some related design systems of this subject and the shortcomings in the system design. It also looks forward to the next step of planning and development to ensure the operation effect of the system.

3 Analysis of Experimental Results

In order to comprehensively test the functions, performance, safety, and reliability of the drawing teaching management system, according to the use of this system, the school and the technical developers of this project will jointly test the network environment: local area network, virtual private network, the client uses P3 Above host computer, memory 128M or above, hard disk above 10G, server end adopts HP30001 software environment: client operating system Windows 2000 Windows XP, server end installs software according to the design plan. Further standardize the system operating environment, as shown in Table 1:

Table. 1 Test environment description table

Configuration name	Test environment 1	Test environment 2	Test environment 3
OS	Ubuntu18.04	masOS10.13	Windows 10 $\times$ 64
CPU	Intel(R) Xeon(R)	Intel core i5	Intel Core i5
GPU	1080Ti	Nothing	Nothing
Memory	32G	8G	8G
Flag version	1.0.2	1.0.2	1.0.2
Tensorflow version	1.2.0	1.2.0	1.2.0
CUDA version	9.0	/	/
Browser	Chrome	Chrome	IE

The system research and development adopts java language, the operating system is Windows 10, according to the actual application situation, carries on the local area network test, selects the operation parameter corresponding to 4 hosts to set up, as shown in Table 2.

Table. 2 Experimental parameter settings

Test tools	Memory size/G	Hard disk size/G	Control system	Set quantity
The server	4	500	Linux	1
Host A	2	250	Win10	1
Host B	4	300	Win8	1
Host C	4	300	Win6	1

The traditional online management system for drawing teaching based on Web technology is compared with the time spent in the running process of this system to verify the efficiency of this design system. The result is shown in the figure (Fig. 11).

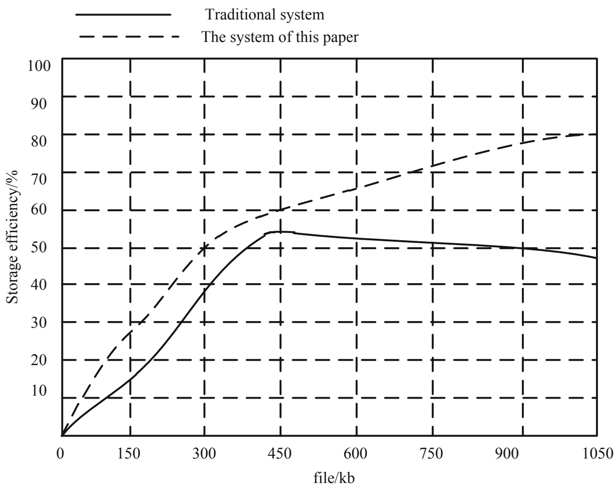


Fig. 11. Comparison of data management performance between the two systems

The traditional system and the time spent in the operation of the system in this paper are compared to verify the efficiency of the system designed in this paper. The result is shown in Fig. 12.

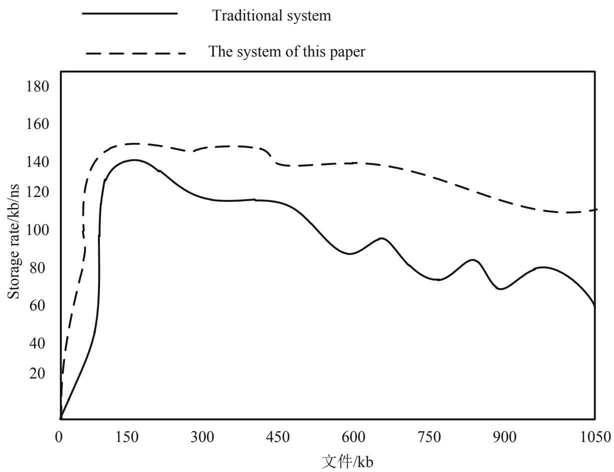


Fig. 12. Comparison of storage rates between the two systems

Based on the above detection results, it can be seen that in the actual operation process of the online management system for drawing teaching based on artificial intelligence proposed in this paper, it has better management efficiency and faster running speed, which can just achieve effective management of massive drawing teaching data. Improve teaching quality and guarantee teaching effect. After the above-mentioned series of experimental tests, it can be concluded that the system design is reasonable.

4 Concluding Remarks

On the basis of in-depth analysis of the current status of the teaching management system of painting courses, through scientific and reasonable exploration, practice and planning of the system hardware structure and software operating functions, the system operation performance is effectively improved, and the management layout and planning of the system system are carried out. And the system optimizes the management information and functions of different modules, and establishes the database table structure for the planning of the overall framework of the system. Finally, the analysis and design work done is summarized, and the future direction of the system is expected to be improved, To better improve the management effect of drawing teaching information and guarantee the quality of drawing teaching.

References

1. Gao, Y., Du, Y., Sun, B., et al.: The large-small group-based consensus decision method and its application to teaching management problems. IEEE Access **7**, 6804–6815 (2019)
2. Farag, S.G.: Computer laboratory teaching management system for improving teaching and learning. Int. J. Online Eng. (iJOE) **14**(9), 182 (2018)
3. Medini, K.: Teaching customer-centric operations management - evidence from an experiential learning-oriented mass customisation class. Eur. J. Eng. Educ. **43**(1), 65–78 (2018)
4. Liu, S., Liu, D., Srivastava, G., et al.: Overview and methods of correlation filter algorithms in object tracking. Complex Intell. Syst. (2020) https://doi.org/10.1007/s40747-020-00161-4
5. Pan, C.: A painting teaching mode based on STEM theory. Int. J. Emerg. Technol. Learn. (iJET) **13**(8), 159 (2018)
6. Zhang, L.: Illustration design teaching mode based on virtual wall painting technology. Int. J. Emerg. Technol. Learn. (iJET) **14**(3), 190 (2019)
7. Li, Y., Zhang, D., Guo, H., et al.: A novel virtual simulation teaching system for numerically controlled machining. Int. J. Mech. Eng. Educ. **46**(1), 64–82 (2018)
8. Gong, W.: An innovative english teaching system based on computer aided technology and corpus management. Int. J. Emerg. Technol. Learn. (iJET) **14**(14), 69 (2019)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mobile Netw. Appl. **24**(1), 1–4 (2019). https://doi.org/10.1007/s11036-018-1136-6
10. Li, S., Qi, W., Xiong, Y.: Optimization of computer aided teaching system for packaging design major. Comput.-Aided Design Appl. 69–79 (2020)
11. Zheng, H., Perez, Z.: Design of multimedia engineering teaching system based on internet of things technology. Int. J. Contin. Eng. Educ. Life-long Learn. **29**(4), 293–305 (2019)
12. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)

13. Liu, Q., Zeng, L.: Design and application of experimental teaching system driven by big data technology in economics and management majors. Int. J. Emerg. Technol. Learn. (iJET) **15**(11), 56 (2020)
14. Bist, A.S., Febriani, W., Lukita, C., et al.: Design of face recognition AttendX for recording student attendance data based on artificial intelligence technology. Solid State Technol. **63**(2s), 4505–4518 (2020)
15. Luo, Y.: Artificial intelligence model for real-time monitoring of ideological and political teaching system. J. Intell. Fuzzy Syst. **40**(1), 1–10 (2020)

Design of Online Teaching System for Innovation and Entrepreneurship of Finance Major Based on Big Data

Tong Sun(✉)

Department of Economics, Shenyang Institute of Science and Technology, Shenyang 110167, China

Abstract. The currently proposed online teaching system for financial innovation and entrepreneurship has a limited scope and a long period of time. Based on big data technology, a new online teaching system for financial innovation and entrepreneurship is designed. The system hardware includes memory, central processing unit, input device and output device. The memory includes the teacher-side memory and the student-side memory. The central processing unit mainly includes three parts: logic unit, control unit and input/output unit. The software has designed big data server program and database program respectively. In order to verify the effectiveness of the teaching system, a comparative experiment was designed. The results show that the financial innovation and entrepreneurship online teaching system based on big data can effectively expand the scope of assistance and shorten the time of assistance.

Keywords: Big data · Finance · Professional innovation · Online teaching

1 Introduction

At present, in the process of talent training, university finance majors have all been integrated into the content of innovation and entrepreneurship education, and innovation and entrepreneurship activities have become more abundant [1]. However, the design of the talent training system is not integrated with the entire industrial innovation chain. First, the design of the entrepreneurship education system for finance majors is not systematic. Undergraduate innovation and entrepreneurship education is limited to the corresponding course modules in the talent training plan, and cannot be designed according to the actual needs of students in the first to fourth grades. Second, innovation and entrepreneurship education mainly depends on the two links of college theory teaching and practical teaching. The subject is single, and it is impossible to start from the needs of the entire industrial innovation chain and form a joint education force through the government, financial industry, financial institutions, research institutions, etc., to jointly realize the cultivation of innovative spirit and innovative ability [2].

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 143–153, 2021.
https://doi.org/10.1007/978-3-030-84386-1_12

In order to innovate the education model and upgrade the education system, my country uses computer technology to construct an online teaching system for innovation and entrepreneurship in finance, and uses the advantages of computers to assist teachers and students in teaching and learning. Computer technology is a widely used distributed application decoupling, which is used to realize the information exchange between the client and the server. It uses application programs, script programs, and plug-in technologies to achieve more powerful information exchange.

Traditional methods include an online teaching system for financial innovation and entrepreneurship based on data mining technology, which uses data mining algorithms to obtain the teaching goals of financial innovation and entrepreneurship, and constructs a teaching system; an online financial innovation teaching system based on information analysis, through the analysis of financial data, obtains Set out teaching goals. Traditional online teaching systems have many faults and unstable connections. Therefore, in order to optimize the shortcomings of traditional online teaching systems, this paper designs a financial innovation and entrepreneurship online teaching system based on big data based on big data technology. From the perspective of software and software, the system's physical equipment and application programs are designed in detail, which is of great significance for improving teaching effects, strengthening teachers' evaluation of students, and providing students with a good distance teaching network environment. It can also promote big data technology. Further development.

2 The Hardware Design of the Online Teaching System for Innovation and Entrepreneurship of Finance Majors Based on Big Data

Computers are the material basis for the online teaching system for innovation and entrepreneurship of finance majors based on big data technology. In the process of online teaching, computers are the communication medium between teachers and students. The teaching logic is shown in Fig. 1 below:

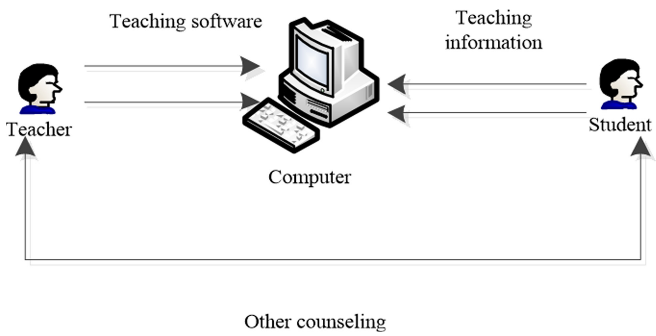


Fig. 1. Online teaching logic diagram

The hardware structure of the system is shown in Fig. 2:

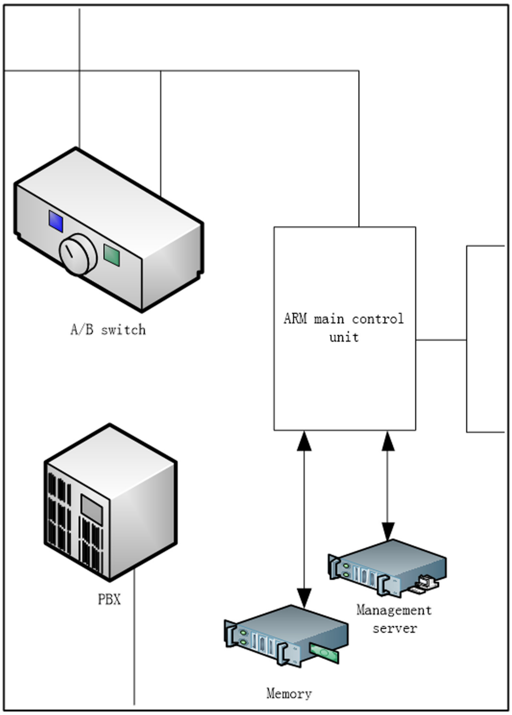


Fig. 2. System hardware structure

2.1 Memory Design

The memory is the instruction holder, which is mainly used to store the multiple instructions issued by the teacher and the multiple instructions replied by the students. Therefore, the hardware is divided into two types: teacher-side memory and student-side memory, but the function is the same. The main function of the embedded computer is to enhance the overall endurance and anti-interference ability of the embedded computer remote-assisted teaching system. In the application process of the system, the memory will first typeset and reprint the code commands input by the teacher in sequence. Transmitted to the next hardware of the system, when the received code instructions are too many or too cumbersome to be transmitted at one time, the memory will retain the code instructions that have not been transmitted and keep the integrity of these code instructions at all times Sexuality and activity. After the code instruction being transmitted is completed, the memory will transmit the reserved code instruction again in order and ensure the perfect connection between the two before and after. The connection error will not be higher than 0.001 s, so it will not This has an impact on the teaching system designed in this article, and the hardware for students' code instructions will also play the same role, that is, to complete the complete transmission of the code instructions while ensuring the integrity and continuity of all instructions [3, 4].

2.2 Central Processing Unit

The central processing unit, also known as the CPU, is one of the core hardware of the system designed in this article. The processor is mainly composed of three unit parts, namely the arithmetic logic unit (ALU), the control unit, and the input/output unit. Its specific structure The picture is shown in Fig. 3:

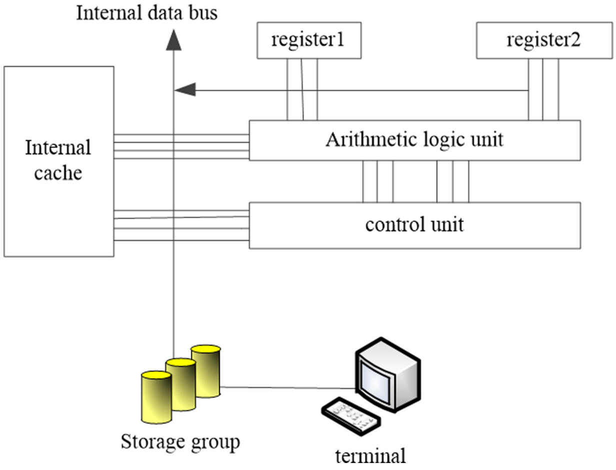


Fig. 3. Central processing unit composition structure diagram

In the process of working, the hardware processor will first continuously accept the code instructions sent by the memories at both ends through the arithmetic logic unit and unitize these instructions. The reason for unitization is that the unitized instructions will be better. Incorporated into the overall operation of the central processing unit, greatly improving the overall operation and work efficiency of the central processing unit [5, 6].

The main function of the arithmetic logic unit is to perform operations and comparisons on all unitized code instructions and finally typeset functional modules. It will gradually list all possible items of the unitized code instructions during the calculation process and then proceed step by step. Excluding the most definite unitized code instructions in the end, when all the unitized code instructions are determined, the arithmetic logic unit will integrate these unitized code instructions to obtain a set M, and then pass the set through the transmission/input unit. To the control unit for processing [7].

The control unit is a functional block that is mainly responsible for managing the overall actions of the unitized code instructions. When the control unit receives the unitized code instruction set M, it will decompose and analyze the unitized code instructions in the set M according to the order, and finally The obtained data is processed into action to obtain the most clear unitized code instruction, and then transmitted to the memory at both ends for both parties to receive and respond [8].

2.3 Input Devices and Output Devices

The input device and output device of the financial innovation and entrepreneurship online teaching system based on big data technology designed in this paper are the teacher's input and output device and the student's input and output device. The main function of the input device is to transmit the code instructions of the memory to The central processing unit of the system is used for calculation and analysis, and the main function of the output device is to transmit the unitized code instruction set M of the central processing unit to the memory. The difference from the input device is that the output device has a unitized code instruction set. The number-conversion converter that transforms M into code instruction set N [9].

3 Software Design of Online Teaching System for Innovation and Entrepreneurship of Finance Major Based on Big Data Technology

The program is the lead of the financial innovation and entrepreneurship online teaching system based on big data technology. Students and teachers interact through the program running on the computer. By writing the program, the entire auxiliary teaching process can be controlled to realize the teaching function. Therefore, this article On the basis of the system hardware, design related software to cooperate with the hardware to work together. The main software design includes a big data server based on big data technology and a database based on big data technology [10, 11].

Big data server is currently the most widely used server with the most comprehensive performance. Based on big data technology, it refers to a computer that provides browsing of teaching information for the embedded computer remote assistant teaching system based on big data technology in the corresponding network environment Program, students and teachers can send teaching requests, teaching files and other data information through the server. Generally speaking, a big data server includes four working processes: establishing a connection, sending a request, sending a response, and closing the connection. The working principle is as follows 4 shows (Fig. 4):

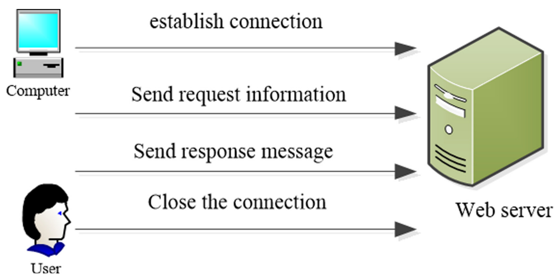


Fig. 4. Working principle of big data server

Among them, the establishment of the connection is to connect the big data server and the browser through a network protocol, and the user can log in to the browser to see if the connection is established. Sending requests means that users send requests to the big data server through the browser, such as login requests, access requests, teaching requests, and other required requests. After receiving the request, the big data server uses related algorithms to calculate and process the request, and finally transmits the result to the browser through the network protocol, and displays the requested content while displaying the result. After the end, disconnect the connection between the big data server and the browser, and maintain and upgrade the big data server [12, 13].

The database is an electronic file cabinet that stores teaching-related information. The teacher and student can add, download, update, and delete files in the database. The database can be divided into online learning database and online exam database according to system requirements. A form of storing online learning data and online exam data of students and teachers. In order to more clearly show the attributes between various types of information in the database and conceptualize it, the E-R diagram is used to describe its basic attributes [14, 15]. The specific E-r diagram of an online learning database based on big data technology is shown in Fig. 5:

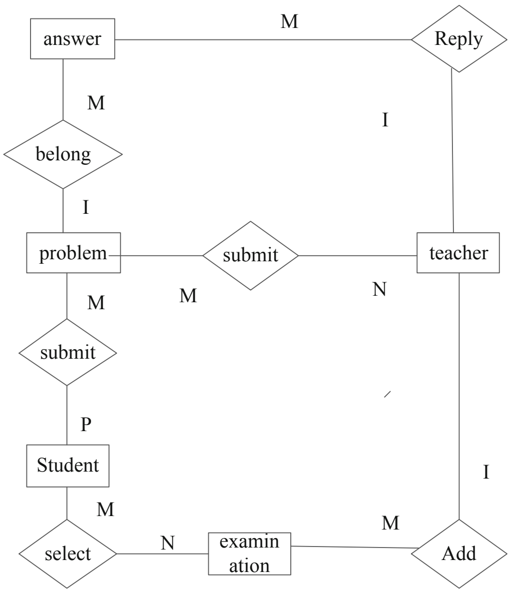


Fig. 5. E-R diagram of online learning database based on big data technology

By observing the above figure, we can clearly understand that the online learning subsystem database is composed of multiple tables, which are class, test, answer, announcement, management, tutorial, tutorial number, teacher, question, system setting, user, and data table. Each table of "class" has a special meaning. These tables represent the students' personal information, usual test results, classroom teaching notes and other necessary materials. The data administrator of each table can add and delete data according to the students' learning situation. The unique advantage based on big data technology is that if other attributes are changed during the learning process of students, by entering the database system and changing the corresponding attributes, the data in the previous learning process can be retained and the new model can be continued. Learning.

The online examination subsystem database based on big data technology designed in this paper also consists of 13 tables, as shown in Table 1:

Table 1. Database subsystem table

Serial number	Name
1	admin
2	department
3	exam database
4	exam
5	degree exam news
6	exam news_ log
7	exam_ score
8	exam subject
9	exam_ test
10	exam tetuser
11	user
12	waitforpass

The examination subsystem database and the student online learning subsystem database have the same characteristics. The administrator can change the attributes and data content of each table at any time to achieve the purpose of remote assistance based on computer technology. Among them, the most unique advantage of the student examination subsystem database is that for the internal examination questions of the storage system, free administrators can view them only through fingerprint authentication, but not through passwords, which ensures the fairness of student examinations. On the other hand, the student examination subsystem database based on big data technology can review some objective questions on student examination papers, which reduces classroom work and improves classroom teaching efficiency.

4 Experimental Research

In order to verify the effectiveness of the financial innovation and entrepreneurship online teaching system based on big data technology proposed in this article, the system is compared with the traditional financial innovation and entrepreneurship online teaching system based on data mining technology and the financial innovation based on information analysis. Entrepreneurship online teaching system conducts experiments to compare teaching scope and auxiliary time.

Table 2. Experimental parameters

Project	Parameter
Question number length	5
Auxiliary level	Level 3
Full score	100
Difficulty ratio	Medium

Set the experimental parameters as shown in Table 2:

According to the above experimental parameters, a comparative experiment was carried out. Provide teaching guidance for different difficulty ratios and compare the scope of assistance. The experimental results obtained are shown in Table 3:

Table 3. Scope of teaching system

Knowledge point difficulty	Online Teaching System for Innovation and Entrepreneurship of Finance Major Based on Data Mining Technology	Online Teaching System of Innovation and Entrepreneurship for Finance Majors Based on Information Analysis	Financial innovation and entrepreneurship online teaching system based on big data technology
Knowledge points are more difficult	95%	70%	65%
Knowledge points are moderately difficult	97%	82%	75%
Knowledge points are easier	99%	90%	74%

According to Table 3, the financial innovation and entrepreneurship online teaching system proposed in this paper based on big data technology can effectively expand the scope of system assistance, adopting different assistance methods for different knowledge points, and when the difficulty of the knowledge points is different, traditional auxiliary system assistance The scope is much smaller than the auxiliary scope proposed in this article.

The auxiliary time proposed in this paper is shown in Fig. 6:

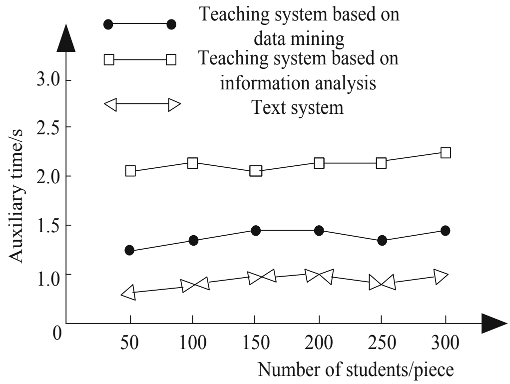


Fig. 6. Results of auxiliary time experiment

Observing Fig. 6 we can see that, compared with the traditional auxiliary teaching system, the financial innovation and entrepreneurship online teaching system proposed in this paper based on big data technology has shorter auxiliary time, can distinguish information in a short time, realize assistance, and has extremely strong assistance The ability and auxiliary effect are better, and it is more suitable for practical applications.

Digital circuit and logic design is to make virtual experimental instruments and equipment more authentic in the virtual simulation experiment teaching environment, and make the virtual simulation experiment teaching multi-dimensional data visualization environment more suitable for the real teaching environment. The specific design process is:

(1) Right-click the virtual simulation experiment teaching page to pull out the display bar and properties window anywhere
(2) Select different experimental instruments according to different experimental operations, click the desired instrument, left-click and click use. The virtual simulation experiment teaching multi-dimensional data visualization system will automatically select the operator to perform multi-dimensional processing to make the operating instrument have a three-dimensional effect.
(3) When the experimental instrument is added to the experimental platform, the operator can perform the experimental operation. If the operation is wrong, the experimental instrument will be damaged like the real instrument, which increases the operator's understanding of the experiment.

Virtual simulation experiment teaching multi-dimensional data visualization system teaching environment screen test, because in the operating environment with the increase of the number of operations, the page needs to continuously change the screen, so the test is mainly to detect whether there will be a white screen in the virtual simulation experimental teaching operating environment Or the situation of stuck screen. The test of this article selects the additional tool test. It only needs to transmit the operating video of the operator in the virtual simulation teaching system. The tool will automatically detect it. If there is a white screen or a stuck screen, the test tool will emit a red light. If the conversion is normal, a green signal light is displayed. In order to avoid contingency, this experiment adopts an experiment process of 100 operators. The test result is shown in Fig. 7:

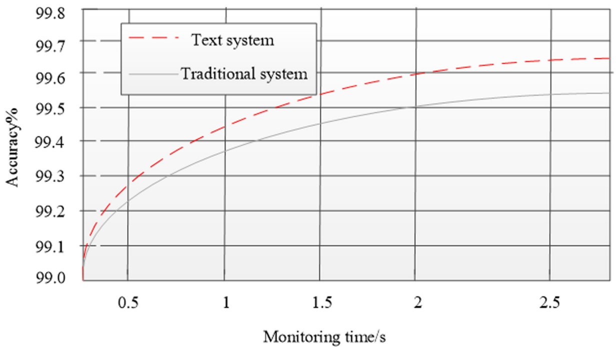


Fig. 7. Screen conversion test results

As shown in Fig. 7, after many tests, the virtual simulation experiment teaching environment shows an average of 1.5 s when the screen transition stays, which is a normal phenomenon. If it exceeds 3 s, it proves that the virtual simulation experiment teaching multidimensional data visualization system has problems. The linux browser has high security and few viruses. The system itself will perform virus detection and cleaning to reduce the probability of virus attacks. The E-R model can fully reflect the internal and external relationships of various types of information, and can also quickly screen out stored information. The security design of the teaching system proposed in this paper adopts the authorization mechanism based on role characteristics, which can efficiently save the data information of the operator and the server, and ensure the stable operation of the teaching multi-dimensional data visualization system. The system administrator will analyze and update the data in the database regularly. And backup. In summary, the optimized teaching system in this paper can construct a more rigorous teaching virtual environment.

5 Conclusion

Based on big data technology, this paper designs an online education system for financial innovation and entrepreneurship based on big data technology. It uses computer as the medium and software program as the leading factor. The memory, central processing unit, input and output devices are designed in detail. Application programs such as physics foundation and big data server and database realize the remote embedded auxiliary teaching system, which provides convenience for students' remote online examination and online learning, and not only enables teachers to more accurately and clearly understand the true abilities of students, Accurate evaluation in order to specify a reasonable teaching plan, but also to enable students to obtain better educational resources at home and provide them with a good teaching environment.

Fund Projects. Supported by The China Association for Non-Government Education of Liaoning (No. LMJX2021283).

References

1. Barcia, M., Kesidou, E.: Innovation and entrepreneurship as strategies for success among Cuban-based firms in the late years of the transatlantic slave trade. Bus. Hist. **60**(3–4), 542–561 (2018)
2. Grillo, C., Ferreira, F.A.F., Marques, C.S.E., et al.: A knowledge-based innovation assessment system for small- and medium-sized enterprises: adding value with cognitive mapping and MCDA. J. Knowl. Manag. JKM-08–2017–0332 (2018)
3. Usai, F., O'Neil, K., Newman, A.: Design and empirical validation of effectiveness of LANGA, an online game-based platform for second language learning. IEEE Trans. Learn. Technol. **11**(1), 107–114 (2018)
4. Durak, H.Y.: Digital story design activities used for teaching programming effect on learning of programming concepts, programming self- efficacy, and participation and analysis of student experiences. J. Comput. Assist. Learn. **34**(6), 740–752 (2018)
5. Castro, M., Scheede, C., Zermeño, M.: The impact of higher education on entrepreneurship and the innovation ecosystem: a case study in Mexico. Sustainability **11**(20), 5597 (2019)
6. Malik, T.H., Huo, C.: Entrepreneurial state vs liberal market: Chinese comparative advantage in the transformation of national science to technology artefacts. Chin. Manag. Stud. **13**(3), 550–573 (2019)
7. Chen, Feng-Wen., Long-Wang, F., Wang, K., Tsai, Sang-Bing., Ching-Hsia, S.: The influence of entrepreneurship and social networks on economic growth—from a sustainable innovation perspective. Sustainability **10**(7), 2510 (2018)
8. Garcia-Morales, V., Martín-Rojas, R., Lardón-López, M.: Influence of social media technologies on organizational performance through knowledge and innovation. Baltic J. Manag. **13**(3), 345–367 (2018)
9. Gao, Q., Xu, J., Tao, Z., et al.: Exploration and analysis on the psychological capital of entrepreneurship and the deviant innovation behavior of employees. Front. Psychol. **11**, 1880 (2020)
10. Beynon, M., Jones, P., Pickernell, D.: The role of entrepreneurship, innovation, and urbanity-diversity on growth, unemployment, and income: US state-level evidence and an fsQCA elucidation. J. Bus. Res. **101**, 675–687 (2019)
11. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
12. Liu, S., Li, Z., Zhang, Y., Cheng, X.: Introduction of key problems in long-distance learning and training. Mobile Netw. Appl. **24**(1), 1–4 (2018). https://doi.org/10.1007/s11036-018-1136-6
13. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training, pp. 1–374. Springer, Heidelberg (2018). https://doi.org/10.1007/978-3-319-93719-9
14. Cancino, C.A., Merigó, J.M., Urbano, D.: et al.: Evolution of the entrepreneurship and innovation research in Ibero-America between 1986 and 2015. J. Small Bus. Manag. (2), 1–31 (2020)
15. Tok, E.: The incentives and efforts for innovation and entrepreneurship in a resource-based economy: a survey on perspective of Qatari residents. Sustainability **12**(2), 626 (2020)

Design of Economics Course Teaching System Based on Online and Offline Mixed Mode

Tong Sun(✉)

Department of Economics, Shenyang Institute of Science and Technology, Shenyang 110167, China

Abstract. In recent years, many colleges and universities have adopted economics course teaching systems to assist classroom teaching, but there is a shortage of teaching resources in traditional teaching systems, which leads to poor teaching effects. Therefore, the design of an economic course teaching system based on the online and offline hybrid mode. In terms of hardware, memory chips and FPGA chips will be selected and applied to the original system hardware framework. Expand and optimize the design of economic course resource integration module, economic teaching resource query module and economic course teaching module to realize the basic functions of the system. So far, the design of the economics course teaching system based on the online and offline hybrid mode is completed. Construction of the system test link, through comparison, we can see that the use of this system is better.

Keywords: Teaching system · Memory · Curriculum resource integration · Course inquiry

1 Introduction

With the popularization of computers and mobile devices, learning forms are no longer confined to the traditional classroom teaching mode, and gradually develop towards media and network, and online education has become the general trend. As a kind of online course, the excellent resource sharing course serves university teachers and students as well as social learners. The purpose is to promote the co-construction and sharing of high-quality course teaching resources. The curriculum resource system created by it is more suitable for network communication and promotes the improvement of professional curriculum teaching quality. It is of great significance to research on the construction of online and offline hybrid courses based on the network platform. The improvement of quality plays an important role [1, 2].

Teachers play a leading role in teaching knowledge in traditional classroom teaching and online teaching, and guide students to learn through a variety of teaching methods. Teachers in the classroom will be restricted by factors such as class hours. Online classrooms have achieved effective extension and supplementation of teachers' classrooms, and have the advantage of rich teaching resources and not limited by time and space. Students can realize the autonomous learning process through online classroom. Blended

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 154–164, 2021.
https://doi.org/10.1007/978-3-030-84386-1_13

learning integrates a variety of different teaching methods. In addition to the integration of face-to-face teaching and online teaching, it also includes the integration of multiple learning methods and the integration of multiple modern education technologies [3, 4], giving full play to the leading role of teachers at the same time Ensure the main status of students. Through multi-angle integration, relying on the network-assisted teaching system, the initiative and enthusiasm of students can be effectively improved, and a teaching system that integrates theory and practice can be formed.

In the system designed this time, the system users are divided into different user roles according to the different needs of the users, and on this basis, the user permissions are limited [5]. System administrators are responsible for designing the basic information of the system; teachers can manage materials, homework, question bank, work sharing, forums, etc., set test parameters and realize online examinations; students can use the system for online learning, Submit homework, share works, exams and mutual assistance exchanges, etc. The system flexibly links the main functional modules of online teaching, test question training and academic feedback through the knowledge map built in the background, providing teachers with more intelligent guidance Features. The test question training environment not only provides students with functions such as automatic test paper exercises and special exercises, but also provides teachers with convenient question bank management tools, which reduces the teacher's question bank management burden [6]. The economics course teaching system based on the online and offline mixed mode provides a new direction for the classroom teaching process of economics.

2 Hardware Design of Economics Course Teaching System

Aiming at the problem of excessive shortage of teaching resources in the original economics course teaching system, in this study, the online and offline hybrid mode will be used to increase the knowledge reserve in the system. In order to improve the adaptability of the hardware, the hardware framework is optimized, as shown in Fig. 1.

According to the optimization results, complete the hardware design process of the design system. At present, multiple languages and technologies can be used to complete the development of the website. The design mode needs to be based on rationality as the basic principle to complete the compilation, classification and summary of the system. The system needs to include code, design modules, upgrade system functions, etc. [7], code compilation It should meet the system functions, complete the establishment of the effective structure of the software project, and solve the problem of being vulnerable to attacks when revising or upgrading the system.

2.1 Memory Chip Design

In order to better solve the problem of processing a large number of teaching resources in the economics course teaching system, CAM memory is added as its dedicated storage device in the system hardware design. CAM memory chip [8, 9] can search a large amount of data in parallel, and compare the data in the CAM chip with the search

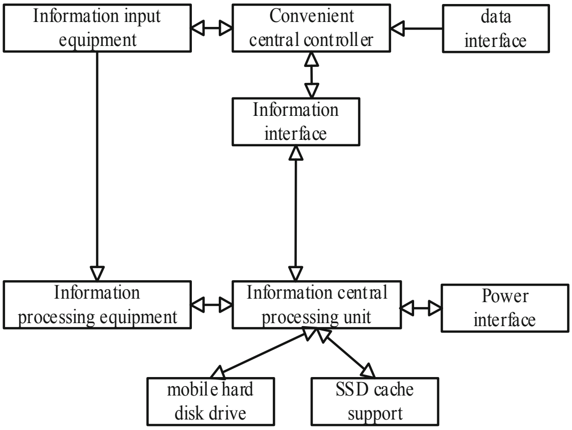


Fig. 1. The hardware optimization structure of the economics course teaching system

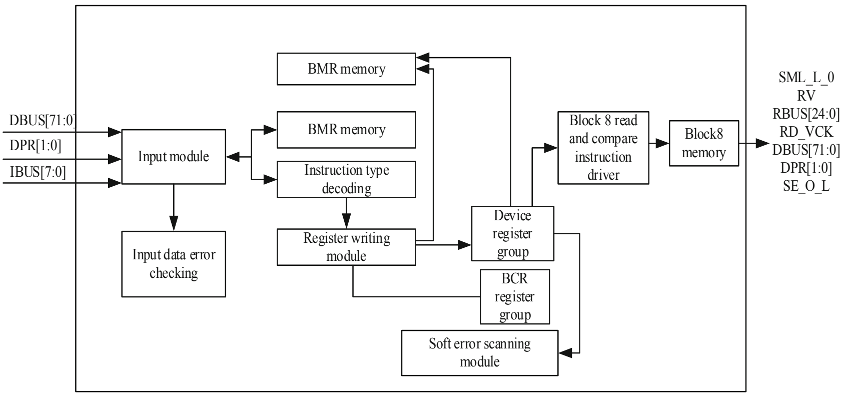


Fig. 2. Internal structure of dedicated memory chip for CAM module

keywords, and grab the physical address of the search matching item in the system. The internal structure of the chip is shown in Fig. 2.

The data read by the CAM chip is compared with all items in the table, and a decision is made quickly in the logical database where one or more classified data packets and their corresponding IP addresses are located. No matter whether the data item is found or not, when the comparison is over, the obtained data pin is a valid conclusion. If the searched data item is found, the pin is valid, and the data related to the match can be output at the same time; if it is not found, the bus continues to maintain a high impedance state, further expanding the storage depth for the CAM chip. The design of adding a CAM chip to the teaching system improves the speed of data writing while reducing the time spent on teaching resource integration and retrieval operations.

2.2 FPGA Chip Design

On the basis of adding a CAM chip to the system design above to improve the retrieval speed of a large amount of data in the economics course teaching system, further adding an FPGA chip to the system hardware design. The FPGA chip can be reconfigured according to different resource integration scenarios to provide the system with sufficient data integration flexibility and accuracy. The internal structure of the FPGA chip can be seen in Fig. 3. Due to the continuous improvement of the integration of FPGA chips, the operation speed of the chips also increases, and the communication between the FPGA chip and the system processor becomes simpler and more accurate.

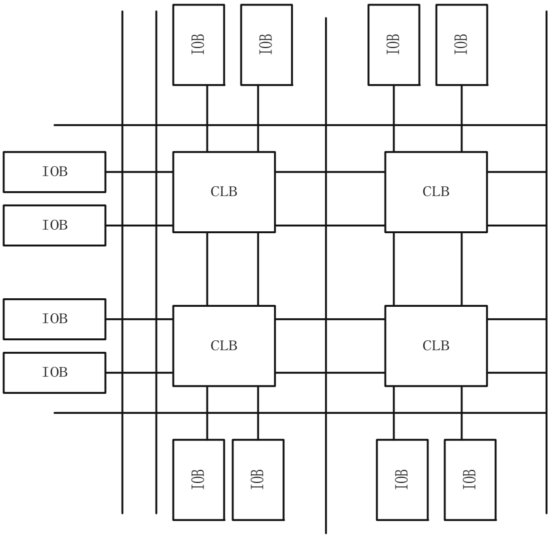


Fig. 3. FPGA chip internal structure

The FPGA chip is connected to external circuits through the I/O module, and uses its internal CLB module to support the programming of the system software part to realize combinational logic and sequential logic. The BRAM embedded in the FPGA chip further expands the application range of the chip, and improves the flexibility of chip use and the accuracy of data resource capture [10]. The FPGA chip is embedded with multiple soft core and hard core modules, which can improve the software and hardware coordination capabilities of the resource intelligent integration system to a certain extent, and provide technical support for the design and operation of system software. Because FPGA is a kind of semi-custom resistor circuit in the field of ASIC, it not only solves the local phenomenon of system hardware customized circuit grabbing fixed mode, but also overcomes the limitation of the limited number of resistor circuits of the original system programmable device; and FPGA chips are abundant The digital logic resources are further combined with the CAM memory chip to replace the discrete digital chip in the original system, reduce the BOM cost, solve the limitation of the hardware in the original system that cannot be parallelized, increase the operating rate of network bandwidth, and meet the requirements of system real-time resource integration.

3 Software Design of Economics Course Teaching System

3.1 Module Design of Economic Curriculum Resource Integration

Aiming at the problem of poor integration of curriculum resources in the original system during use, this part of the performance will be optimized in this research. Based on the complexity and diversity of teaching resources, similarity processing is mainly used in this research to complete the integration process of teaching resources.The set teaching resource data can be expressed as a, b, where p represents the number of variables when the data a and b are both 1, q represents the number of variables when the data a is 1, b is 0, and t is the data The number of variables when the values of a and b are both 0, s represents the number of variables when the value of a is 0, and the value of b is 1, and the degree of dissimilarity between data a and b can be expressed as a simple matching coefficient:

$$d(a, b) = \frac{q + t}{p + q + t + s} \tag{1}$$

When calculating the dissimilarity of two binary variables, the value of p coefficient can be ignored, and the Jaccard coefficient [10, 11] is used to complete the dissimilarity calculation process between the data, then the Jaccard coefficient between the curriculum resource data a and b can be expressed as:

$$d(a, b) = \frac{q + s}{q + t + s} \tag{2}$$

In the same way, the degree of dissimilarity between resource data a and b of general categories can be obtained by simple matching calculation. Set e to represent the number of a and b with the same attribute value, f is the number of all attribute values, then the degree of dissimilarity between teaching resource data a and b can be expressed as:

$$d(a, b) = \frac{f - e}{f} \tag{3}$$

In addition, the integration of this method can analyze and process teaching resource data of different structures. The difference between data g and h of different dimensions can be expressed as:

$$d(g, h) = \sum_{i=1}^{i=n} \beta(g_1, h_1) \tag{4}$$

In formula (4), if $g_1 \neq h_1$, then $\beta(g_1, h_1) = 1$; otherwise, $\beta(g_1, h_1) = 0$. Using formula (4), the teaching resources are integrated, and the integrated teaching resources are classified and stored.

3.2 Setting of Teaching Modules of Economics Course

After the user logs on to the platform, teachers can manage the courseware of this course online, assign and modify homework, upload courseware-related materials, and publish relevant information. Students can browse corresponding course content, complete homework online, ask questions to teachers, etc.

The biggest feature of this function is to provide a suitable learning mechanism. Designing a course is like making a flowchart [12]. The learner starts to answer the question after reading the course content. When the answer is correct or another answer is selected, the system will enter the content of a different page to give more information. Further or more shallowly display the content, adjust the progress so that the learner can complete the learning goal, the main things that need to be set are:

(1) Course name;
(2) Range of points;
(3) The number of questions presented on each page;
(4) Course opening hours;
(5) Course content (edited with embedded HTML editor);
(6) Question description and the linked page after answering each question;

In addition to the above content, two parts of network teaching material design and course announcement are added to this module. Online teaching materials publish course content, edit and delete course content according to chapter needs. Teaching can add chapters, edit and delete chapters; you can add courses [13–15]. Course announcement: instant message about a course. Teachers can post, modify, and delete course announcements. After entering the online learning environment for the first time, students first check the label, that is, master the basic methods and skills of online course learning, and make their learning steps clearer.

3.3 Design of Query Module for Economic Teaching Resources

When using the economics course teaching system, students need to make corresponding course queries, but the performance of this part of the original system is poor, and the problem of abnormal query results often occurs. In response to this situation, a targeted design was launched in this research.

In this design, the data in the course resources is set to the form of data packets, and the waiting time of the queried data packets can be calculated in the form of formulas. The specific calculation process is shown in formula (5):

$$t_{wait} = |d - v| * t_i \tag{5}$$

In formula (5), d represents the sending interval between two query data packets, v represents the corresponding communication distance, and t_i represents the time granularity. According to literature research, the maximum value of t_{wait} can be understood as $t_i * v$, and the minimum value can be zero. Formula (5) can complete the time control management in the process of teaching resources query. At the same time, set the corresponding program in this module.

Through the above content, complete the inquiry process in the use of the system, and provide convenience for students' use. Incorporate the optimization results of the software modules set above into the original module construction and combine them with the system hardware. So far, the design of the economics course teaching system based on the online and offline hybrid mode is completed.

4 System Test Analysis

4.1 System Test Environment Design

In this study, in order to verify the effect of the design system in the article. In this link, two common systems on the market are selected for comparison with the design system in the article. When the three systems are undergoing comparison tests at the same time, a reasonable test environment needs to be set to ensure the stability of the test process. Therefore, the system test environment adopts a distributed architecture, which includes one server as the master node and three data processing servers as nodes to realize the efficiency and stability of data calculation (Table 1).

Table 1. System test platform architecture

Name	Hardware configuration	Operating system
Main controller	8-core CPU 6G memory	CentOS 7.0
	10G hard drive	
	2M bandwidth	
Node 1	8-core CPU 6G memory	CentOS 7.0
	10G hard drive	
	2M bandwidth	
Node 2	8-core CPU 6G memory	CentOS 7.0
	10G hard drive	
	2M bandwidth	
Node 3	8-core CPU 6G memory	CentOS 7.0
	10G hard drive	
	2M bandwidth	

In this system test, the test platform will be used to complete the test process and obtain the use effect of the design system in the article. In order to ensure the use of the teaching system test platform, the experimental network is set as shown in Fig. 4.

Install the test platform in the above-mentioned test network, and use it to complete the system test process, and obtain the corresponding test results for comprehensive analysis.

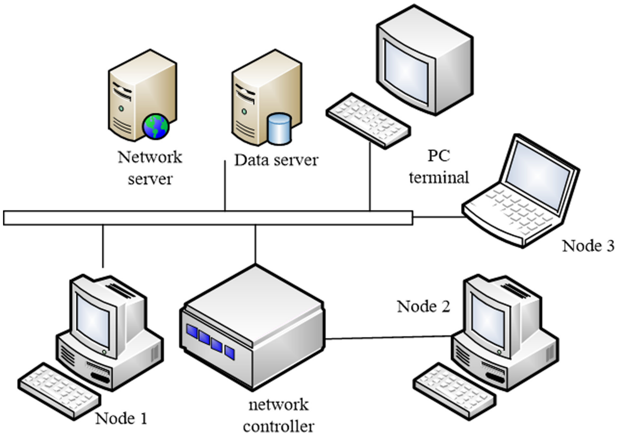


Fig. 4. System test network

4.2 System Test Plan

Two classes of the same course are opened in one semester, after completing the unit study. First of all, let all students accept the pre-test before online learning. For the convenience of operation, it was carried out in the form of roll-out. After the test results were summarized, the students with middle grades were regarded as the subjects of this experiment. They are divided into two classes. In order to ensure the objectivity of the experiment, the students are first merged together and redistributed into three groups on an average basis of the S type, which are respectively used as the experimental group and the control group.

In the process of this system test, the design system in the text and the three teaching systems currently in use are used to analyze the learning situation of students. In this system test, the results of student performance improvement, teaching resource query accuracy, and teaching resource processing time were used as comparative indicators in the test. In this system test, multiple tests will be used to improve the accuracy of comparison. Use the system test plan set above to complete the system test and obtain effective system test analysis results.

5 System Test Analysis

The accuracy and processing time of the three systems were tested, and the results are shown in Fig. 5 and Fig. 6.

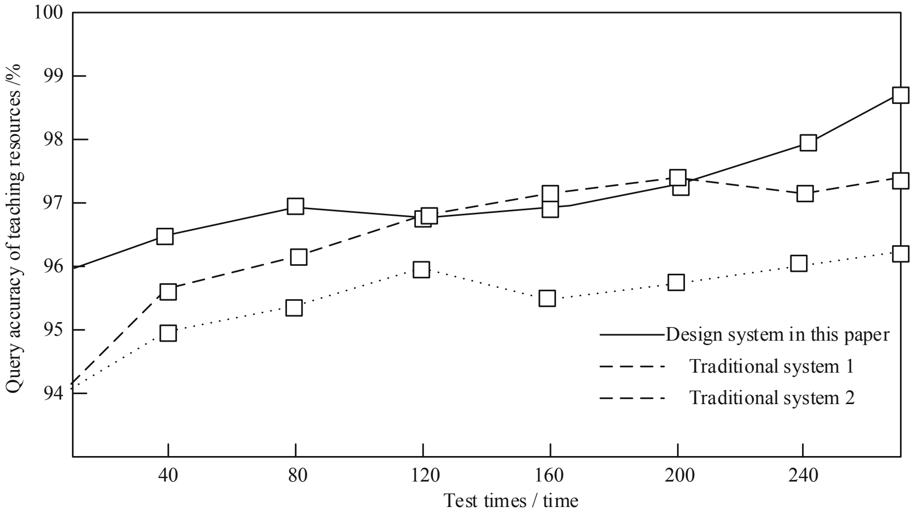


Fig. 5. Teaching resource query accuracy test results

According to the system test results, it can be seen that the teaching resource query accuracy of the design system in the article is high. Because of the high resource integration capability of this system, the high accuracy of the test results is guaranteed. It can be seen from the two systems currently in use that due to insufficient resource integration capabilities, the accuracy of querying teaching resources has been seriously affected, the query accuracy is low, and the system processing results are not highly reliable.

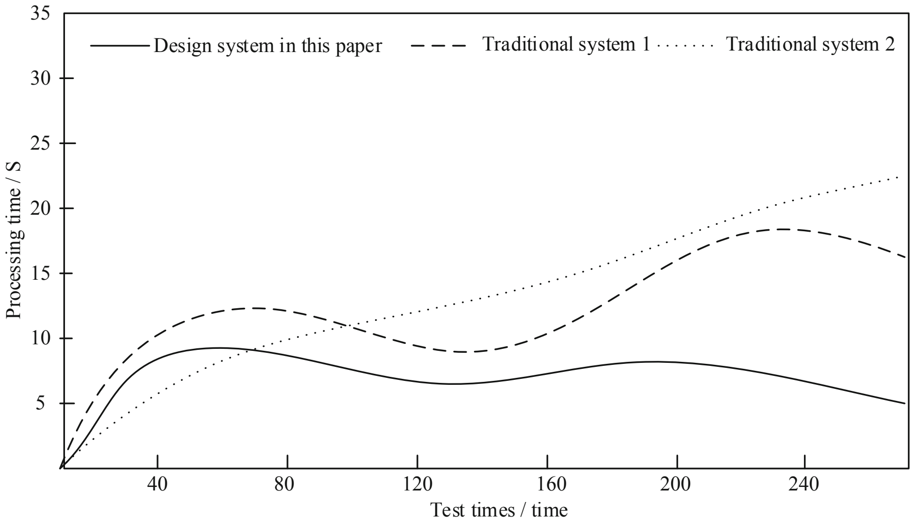


Fig. 6. Teaching resource query processing time test results

The test results show that the teaching resource query processing time of the design system in the article is shorter than that of the current system. Through the comprehensive research and analysis of the teaching system, it can be seen that the module with the longest running time of this system is the link of teaching resource integration. Because the design system in the article has a strong ability to integrate teaching resources, it can be seen from this round of testing that the system handles the design system in the article. The time is shorter and the teaching resource query efficiency is higher.

Based on the results of the double number three-part test, it can be seen that the use effect of the design system in the article is better than the current economics course teaching system in use.

6 Conclusion

The application of the teaching model designed in this research provides advanced methods for the teaching of economics courses, and the quality of economics teaching is guaranteed and improved. In order to achieve the purpose of adaptive teaching, courseware producers need to design diversified teaching content and design diversified teaching strategies to suit the different learning characteristics of each learner. Use various methods to express and present courseware content to meet the needs of each learner. Therefore, it is necessary to apply the educational theories such as "mastery teaching" and "constructivism" to the spirit of teaching strategies, reform teaching methods, and design diversified teaching strategies to achieve the purpose of adaptive teaching.

Fund Projects. Supported by Science Foundation of the Educational Department of Liaoning Province (No. 20191362112).

References

1. Cheng, W., Li, N.: Online and offline teaching models based on cloud class in higher vocational microbiology teaching. Microbiology **45**(04), 927–933 (2018)
2. Luo, L.: Design of online and offline hybrid intelligent assistant teaching system. Microcomput. Appl. **35**(08), 105–108 (2019)
3. Liu, H.: Research on "online+offline" teaching method of regional economics based on problem-based learning. J. Chongqing Univ. Arts Sci. **38**(02), 118–125 (2019)
4. Xu, Y.: Research on design and practice of "online+offline" English blended teaching mode. J. Changchun Univ. **30**(08), 121–124 (2020)
5. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training, pp. 1–374. Springer, Heidelberg (2018). https://doi.org/10.1007/978-3-319-93719-9
6. Liu, S., Li, Z., Zhang, Y., Cheng, X.: Introduction of key problems in long-distance learning and training. Mobile Netw. Appl. **24**(1), 1–4 (2018). https://doi.org/10.1007/s11036-018-1136-6
7. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
8. Zhong, H., Binxu, Q.: Design and implementation of curriculum teaching file system based on laravel. J. Dongguan Univ. Technol. **25**(03), 111–117 (2018)
9. Cui, S., Li, S., Shao, F.: Implementation of signal and system teaching based on system view. J. Jixi Univ. **18**(06), 21–24 (2018)

10. Li, M., Zhou, X., Xia, Y., et al.: Design of automobile instrument testing teaching system based on machine vision. J. Chongqing Univ. Sci. Technol. (Nat. Sci. Ed.), **22**(02), 80–82+117 (2020)
11. Chen, X., Y., Liu, Shao, R., et al.: Design and implementation of auxiliary teaching system of power electronics technology. J. Anqing Norm. Univ. (Nat. Sci. Ed.) **25**(01), 108–112 (2019)
12. Zhang, J., Wang, P.: Design and implementation of course design automatic scoring system. J. Electr. Electron. Educ. **41**(04), 149–152 (2019)
13. Gao, H.: Engineering training based on virtual simulation technology. Comput. Simul. **37**(07), 391–393+408 (2020)
14. He, G.: Blended teaching mode of art course based on objective achievement scale. Int. J. Emerg. Technol. Learn. (iJET) **15**(13), 289 (2020)
15. Yu, Y., Qi, A.: Five stars teaching mode of sports training based on APP microcourse. Int. J. Emerg. Technol. Learn. (iJET) **15**(6), 152 (2020)

One Belt, One Road Background, International Logistics Professional Online Training and Education System Design

Ming Qin(✉) and Jun Fu

School of Economics and Management, Jiangxi Tourism and Commerce Vocational College, Nanchang 330114, China

Abstract. In the traditional teaching system, when the number of concurrent users is high, the system takes up more CPU resources in the process of running, which leads to the performance degradation of the system in the process of working. Therefore, an online training and education system for international logistics specialty is designed. In the system, the user layer, interactive display layer, business processing layer, application support layer and data layer are designed. In the hardware aspect, the overall design diagram of the hardware structure is designed, and the crystal oscillator circuit is studied in detail. In the software aspect, UML is used for visual modeling, and UML is introduced Net framework as the core component of system development; in the database design, the database structure table is established, and the database query optimization is carried out. The system test results show that the designed system has smaller CPU occupancy and more stable memory usage.

Keywords: One belt · One road · International logistics · Online training · Education system

1 Introduction

In recent years, due to the acceleration of the globalization process, the trade links between countries are getting closer and closer, and the demand for international logistics is growing rapidly. International logistics needs to follow the theory of international division of labor and cooperation, adapt to the international requirements, with the help of international logistics network, logistics technology and logistics facilities, to complete the exchange and circulation of goods in different countries and regions. With the deepening of China's reform and opening up, China's demand for modern logistics technology and equipment is also increasing. Therefore, in-depth understanding and research on international logistics are essential skills for students majoring in e-commerce [1, 2]. "One Belt And One Road" international channel, with the core city as the support, with the key economic and trade industrial park as the cooperation platform, to jointly create a new channel of international economic cooperation including China, Russia, China, Central Asia, West Asia and China, Indo-China Peninsula and other international economic cooperation corridors. Bangladesh-China-India-Myanmar Economic Corridor.

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 165–175, 2021.
https://doi.org/10.1007/978-3-030-84386-1_14

"One belt, one road" links up the three major regions of East, central and West, forming a two-way international radiation space layout with the core of our territory as the core, enhancing the depth of economic development and industrial layout, and fostering the growth pole of economic development in less developed areas. As one belt, one road and other national strategies promote the rapid development of foreign trade and economic cooperation, the overall efficiency of domestic logistics nodes will be significantly improved, and a three-dimensional international logistics infrastructure system will be formed, taking ports and air ports as the center, and railway, highway and waterway as the network. Foreign research on international logistics simulation teaching system started earlier, and the simulation teaching system of international logistics course has been established for many years and reached a stable stage [3, 4]. International logistics involves buyers, sellers, banks, production enterprises, storage enterprises, freight forwarders, shipping agents, transport teams, port yards, customs, tally companies and inspection and Quarantine Bureau. In the process of international logistics management, how to set the operation authority of each role and divide the functions of the system is the most complex part of the international logistics business simulation teaching system. In the original teaching system, when there are more concurrent users, the system takes up more CPU resources in the process of running, which leads to the performance degradation of the system. Therefore, this paper designs an online training and education system for international logistics specialty. The specific research ideas are as follows:

Firstly, the user layer, interactive display layer, business processing layer, application support layer and data layer are designed.
Secondly, the overall design block diagram of hardware structure is designed, and the crystal oscillator circuit is studied in detail.
Then, in the aspect of software, UML is used for visual modeling, and UML is introduced as the core component network framework of system development;
After that, in the design of database, the database structure table is established and the database query optimization is carried out.
Finally, summarize the full text.

2 One Belt, One Road Background, International Logistics Professional Online Training and Education System Design

The overall architecture of international logistics business simulation teaching system is divided into five levels: user layer, interactive display layer, business processing layer, application support layer and data layer. The user layer mainly includes three roles: teacher, student and system administrator [5, 6]. The system administrator carries out the relevant operation in the system management module, the teacher carries out the relevant operation in the experimental task management module, and the students carry out the relevant operation in the international logistics business management module. The overall architecture design of the international logistics business simulation teaching system is as follows (Fig. 1):

As shown in the figure above, the international logistics business simulation teaching system mainly includes five layers: user layer, interactive presentation layer, business

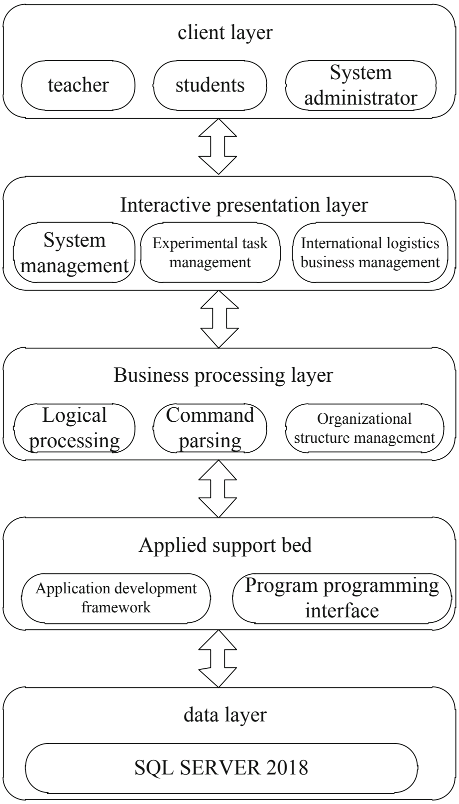


Fig. 1. Overall architecture design diagram

processing layer, application support layer and data layer. Among them, the user roles involved in the user layer include teachers, students and system administrators; the interactive presentation layer mainly consists of system management, experimental task management and international logistics business management; the business processing layer mainly includes logic processing, instruction parsing and organizational structure management; the application support layer mainly consists of application development framework and program programming The database of international logistics business simulation teaching system is SQL Server 2018.

2.1 Hardware Design

The system is developed with .Net technology, the web server is Windows 2003 server operating system, IIS6 is installed to publish web pages, and the database server is Windows 2003 server operating system. The client only needs the ordinary computer with IE6.0 browser. The overall design diagram of the hardware structure of the system is as follows (Fig. 2):

In the hardware design, crystal oscillator circuit is the key circuit in the hardware circuit of the system. The memory in the system will double the frequency through external

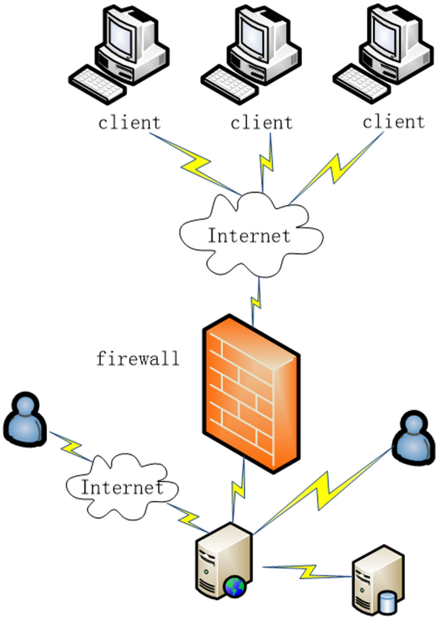


Fig. 2. Overall design of hardware structure

crystal oscillator. According to the requirements of memory, two crystal oscillators with different frequencies are designed to adapt to the working mode and sleep mode, and the frequencies are 17.354 MHz and 36.574 MHz respectively. The principle of crystal oscillator circuit is shown in the figure (Fig. 3):

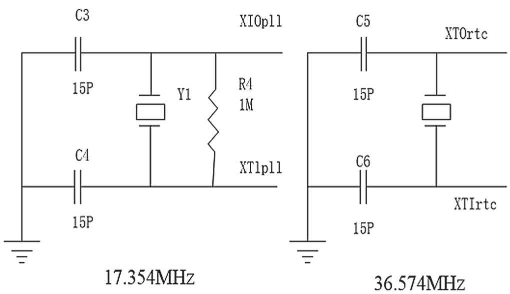


Fig. 3. Crystal oscillator circuit diagram

For most of the crystal oscillator, the corresponding controller is integrated in the system, so the crystal oscillator circuit structure is relatively simple. However, after welding the circuit board, there may be false soldering or short circuit, so it is necessary to debug the circuit. Before the system is powered on as a whole, the jumper [7, 8] near the power supply circuit should be cut off, that is, the main board should be powered off. Use a voltmeter to measure whether the output voltage of the conversion circuit is

3.3V. When the measured voltage is normal, plug in the jumper to continue debugging. After the circuit is powered on, the oscillograph is used to capture the waveforms of the two crystal oscillators to verify whether the parameters are correct and whether the captured waveforms are in the normal range. So far, the hardware design of the system is completed.

2.2 Visual Modeling

Unified Modeling Language (UML), also known as unified modeling language or standard modeling language, is an OMG standard that started in 1997. It is a graphical language that supports modeling and software system development. It provides modeling and visualization support for all stages of software development, from requirement analysis to specification, to construction and configuration. This system uses UML modeling technology to design. The important content of UML can be defined by the following five kinds of diagrams: (1) use case diagram, which describes the system function and points out the operator. (2) Static diagram, including class diagram, object diagram and package diagram. (3) Behavior diagram, describing the dynamic model of the system and the interaction between the constituent objects. (4) Interaction diagram, describing the interaction between objects. (5) The component diagram describes the physical structure of the code component and the dependency relationship between the components. UML modeling process can be divided into four stages: initial stage, refinement stage, construction stage and handover stage. This paper adopts .Net development platform .NET development platform is a programming model with tools and an environment for developing, deploying and running .NET applications. It mainly includes three aspects: ASP .NET, CLR and .NET framework class. .NET framework class (system class) provides a variety of core functions suitable for different language environments, and provides a large number of core functions that can be used when constructing asp NET applications (and non asp NET applications). Like all other .NET classes, system classes exist as assemblies. An assembly in .NET is similar to a com DLL or an EXE file -- it is an executable file that holds class code. For example, the math class, including its properties and method definitions, is located in the mscorlib. DLL assembly. As the core component of the .NET development platform, the .NET framework provides an environment for building, transplanting and running web services and other applications. .NET component is a precompiled class module with DLL extension. At run time, the program is activated by the user and loaded into the memory. .NET components are used to create network and windows applications, which enable the functions required by an application to be displayed externally [9, 10]. NET platform also includes web form, which is a standard interface that can be downloaded from the Internet. A web form contains text boxes for users to enter data. The user can then submit the form to the receiver. A crucial part of .NET platform is network server. A collection of web server query protocols and standards. The application program can use the network server to exchange data through the computer network. ASP .NET is the main development language to realize web application under .NET framework. It is a program framework based on general language and can be used in a web server to build powerful web application. The basic architecture of ASP .NET is as follows (Fig. 4):

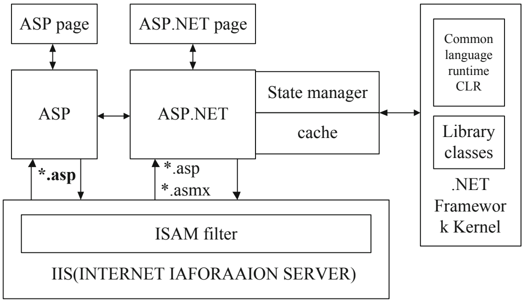


Fig. 4. Basic architecture of ASP .NET

In the process of visual modeling, using ASP .Net can have high scalability, ASP .NET has many improvements in providing greater scalability. Server to server communication has been greatly enhanced, which makes it possible to allocate an application proportionally on several servers [11]. An example of this is the ability to run XML parsers, XSL transformations, and even resource consuming session objects on different servers. In addition, in the process of compiling code, the first request to the ASP .NET page on the server is to compile its ASP .NET code and save a cache backup in memory. The result, of course, is a huge performance improvement. In addition, it is easy to configure in the process of modeling, and the configuration of ASP .NET can be completed through the pure text file. Configuration files can be uploaded and modified while the application is running. There is no need to restart the server. There are no metabase and registration challenges. It also has some advantages in the development process, and does not need to restart the server to configure and replace the compiled code. ASP .NET simply redirects all new requests to new code.

2.3 Design Database

In the process of establishing the database, MySQL language is used to develop and complete the establishment of each function data table. In the process of designing the database table, we need to analyze the needs of the database. The database is the basis of the whole teaching multiple information display system. Therefore, according to the overall architecture of the system and the design of the functional modules in the system, the database table needs to include the basic information table of students and teachers, the information table of professional classes in Colleges and departments, the resource table of grades and courses, and so on, The database structure table designed in this paper is obtained (Table 1):

The design of the database table needs to be reasonable according to the index and other related situations, and it is described in detail from the field and field type of the database table. Data access is to obtain data from the database through specific tools, and users can add, modify and delete the required data. Generally speaking, data access is to CRUD the data in the database: Create, Retrieve, Update and Delete. The standard of comprehensive database query optimization is to provide a shorter response time when multiple users query concurrently. Therefore, the system must realize load balancing

Table 1. Database structure table

Name	Data type	Default value
User name	Varchar	Null
Password	Varchar	Null
Gender	Varchar	Null
ID number	Varchar	Null
Date of enrollment	Datetime	Null
Contact information	Int	Null
Professional class of the Department	Int	Null
Photo	Varchar	Null
Course number	Int	Null
Course name	Varchar	Null
Class information	Varchar	Null
Course credit	Int	Null
Record number	Int	Null
Score	Float	Null
Student evaluation	Varchar	Null
Resource name	Nvarchar (max)	Null
Collection number	Int	Null

to maximize the efficiency of the system. When the access to the application system reaches the peak, the response speed of the system does not fluctuate significantly. So far, the design of the system is completed.

3 System test

3.1 Build System Test Platform

In order to verify the validity of the system designed in this paper in terms of business logic and function, in the system performance test, the response time of transactions, the number of concurrent users and system resources are tested, and the system performance is analyzed. Because the system designed in this paper uses B/S (Browser/Server) mode design, the Web Server uses IIS6.0, the development technology uses IIS6.0ASP.NET architecture combined with SQLServer2018 database. In the test process, the commercial stress test tool LoadRunner 8.0 was used to simulate the concurrent operation of users and test whether the CPU and memory performance of the system was stable under multiple concurrent operations when a large number of users logged in at the same time. Parameter configuration of the test environment is shown in the following Table 2:

In the process of system testing, the selected testing tool is the English version of HP LoadRunner 8.1, and its working mode order is: first record the script, then set the scene,

Table 2. Test environment requirements

Environment	Parameter	Describe
Virtual Server Environment	Purpose of the host	Online examination System application server
	OS	Win 2003 Server
	quantity	1
	CPU	1
	memory	1G
	Corresponding IP	192.168.1.104
Client environment	Purpose of the host	Pressure load generator
	models	PC
	The operating system	Window Xp
	CPU	P4
	memory	512M
	Browser version	IE7.0
	Corresponding IP	172.16.68.2

run the test in the obtained scene, and finally summarize and analyze the test results. In the process of system performance testing, in order to verify that the performance of the designed system has been improved compared with the original system, we need to use the system in this paper and the original system for experiments. When simulating a large number of user loads, it can be achieved by changing the relevant parameters. In order to make the test process more real and reliable, we set a data concurrent collection point in advance and enable IP shielding to simulate the real concurrent state of a large number of users in the running process of the system. In order to make the experimental results more reliable, we can continue to pressurize the system during the experiment, and set the scene according to the actual needs. The test tool LoadRunner used in this paper can provide powerful report analysis function, which can analyze the parameters of the system and the server in detail, and generate reports. The process of virtual user login scenario in system test is as follows:

(1) Log in the international logistics professional online training and education system; (2) input the virtual user name and password to complete the login; (3) input the relevant menu navigation from the online training and education system, enter the online education and training through the online course connection, and exit the system after completing the course learning. In this process, in the process of testing the number of concurrent users, the initial number of concurrent users is designed to be 20. In the follow-up process, the number of concurrent users is gradually increased. First, start 2, and increase 2 every 5 s. After reaching the specified number of users, it will continue to run for about 5 min.

3.2 Test Results and Analysis

Under the above experimental conditions, the CPU usage of the two systems in the test process is obtained, as shown in the figure below (Fig. 5):

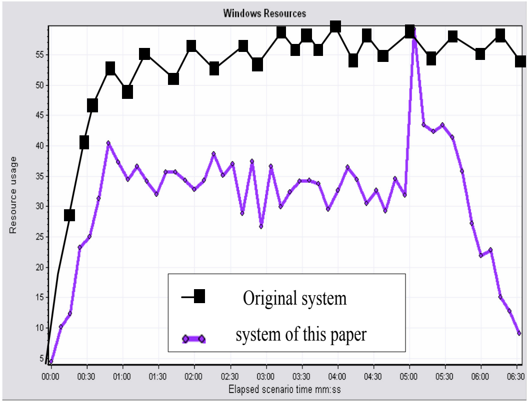


Fig. 5. CPU usage of the two systems

As can be seen from the above figure, in the whole process of scene testing, the system in this paper has a high peak value of about 80.1% in about 5 min and 13 s during the execution of the simulated scene %In the whole test process, the average CPU utilization rate of the system server in this paper is 31.3%, and the average CPU utilization rate of the original system is 58.2%. Generally speaking, the CPU performance of the two systems in the test process is balanced, but the CPU utilization rate of the system in this paper is smaller.

During the test, the memory usage of the two systems is shown in the following figure (Fig. 6):

As can be seen from the above figure, the number of logged in users increases with the passage of time in the test process. In the data analysis of the original system, we can see that the remaining physical memory of the original system decreases continuously. From the beginning of the test to the end of the test, the maximum value of the remaining memory is 232 m, and the minimum value of the remaining memory is 212 m. According to these two data, we can deduce that the length of the test is longer In the test time of 5 min, the remaining available amount of the original system memory is reduced, the average available physical memory is about 222 m, and the utilization rate of memory is about 57%. In the system designed in this paper, the maximum and minimum values available in the test process are 228 m and 223 m respectively, and the memory utilization rate is about 56%. There is no obvious performance bottleneck in the test process of the two systems. Generally speaking, the memory of the two systems is enough, but the overall trend of the memory usage of the original system is declining. In the follow-up process, if more concurrent numbers are used, the problem of insufficient memory may

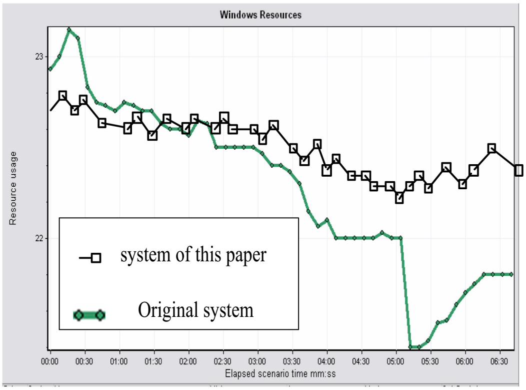


Fig. 6. Memory usage

appear. To sum up, in the process of testing, the performance of the system designed in this paper is improved to a certain extent compared with the original system.

4 Conclusion

The main task of the online training and education system of international logistics specialty is to realize the online education based on Internet and oriented to logistics specialty. When the students log in to the system, they can carry out distance learning at any time, and the system administrator can maintain all kinds of relevant course information, so that the users and operators of logistics talent training distance education system can obtain certain social and economic benefits.

References

1. Cui, W., Lin, X., Ge, H., et al.: The practice and reflection of innovative college students' party course education under the background of "internet+"—taking the "pioneer online" handheld party school APP education of Anhui agricultural university as an example. J. Anqing Norm. Univ. (Soc. Sci. Ed.) **38**(06), 121–125 (2019)
2. Huang, R., Zhang, M., Shen, Y., et al.: Research on the core elements of running a huge scale of cyber-learning: a case study of "disrupted class, undisrupted learning" supported effectively by online education. E-educ. Res. **41**(03), 10–19 (2020)
3. Shen, H.-X., Hao, D.-K., Jiang, J.-J.: Online teaching practice of "suspending classes without stopping learning" and thinking of post-epidemic online teaching reform—taking Shanghai Jiao tong university for example. Mod. Educ. Technol. **30**(05), 11–18 (2020)
4. Bai, R.-f.: Analysis and research on the use strategy of web-based foreign language online learning system. Tech. Autom. Appl. **39**(11), 151–153+158 (2020)
5. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training, pp. 1–374. Springer, Heidelberg (2018). https://doi.org/10.1007/978-3-319-93719-9
6. Peng, Y., Jiang, H., Zheng, Y., et al.: Training and examination system of university laboratory safety. Educ. Chin. Med. **37**(02), 48–50 (2018)

7. Liu, S., Li, Z., Zhang, Y., Cheng, X.: Introduction of key problems in long-distance learning and training. Mobile Netw. Appl. **24**(1), 1–4 (2018). https://doi.org/10.1007/s11036-018-1136-6
8. Gao, S., Li, S., An, L., et al.: Research on hybrid teaching mode of "MOOC+" for international logistics bilingual course. Logist. Technol. **38**(03), 147–151 (2019)
9. Li, J., Xu, H.: Deepening the integration of industry and education to promote the connotative development of higher vocational education. Liaoning High. Vocat. Tech. Inst. J. **21**(10), 9–12+50 (2019)
10. Ekerol, G.S.: Senior executives opinions regarding educational competencies of university graduate young labor force: logistics education case. J. Qual. Res. Educ. **8**(3), 1–18 (2020)
11. Olei, B.A., Iacobici, R.I.: Logistic and transportation challenges in education. Adv. Eng. Forum **34**(1), 261–266 (2019)

Online Education System for Innovation and Innovation Courses Based on Big Data from the Perspective of Rural Revitalization

Chun-ni Zheng[1](✉) and Ru Yan[2]

[1] Chongqing Chemical Industry Vocational College, Chongqing 401228, China
[2] Inner Mongolia Vocational College of Chemical Engineering, Huhhot 010010, China

Abstract. The key to promoting rural development lies in the introduction of outstanding talents. Higher vocational colleges are mostly local schools and are closely related to local rural development. To this end, a research on the design of an online education system for innovation and innovation courses based on big data under the perspective of rural revitalization is carried out. The system design includes four parts: related technical analysis, frame design, functional module design and system testing. After testing, it is concluded that the system functions and performance meet the requirements, which provides important help for the "village revitalization" to cultivate high-quality rural talents.

Keywords: Rural revitalization · Big data · Double innovation course · Online education system

1 Introduction

China is a big agricultural country, and the issues of agriculture, rural areas, and farmers have always been the top priority of the national strategy. In early October 2018, the Central Committee of the Communist Party of China and the State Council issued the "Strategic Plan for Rural Revitalization (2018–2022)" (hereinafter referred to as the "Plan"). The "Plan" made a phased plan for rural revitalization strategies from the national strategic level. And carried out a systematic deployment, including the following specific deployments for strengthening the talent support for rural revitalization: first, to vigorously cultivate new professional farmers; second, to strengthen the construction of rural professional talents; third, to give play to the supporting role of scientific and technological talents; fourth, to encourage all sectors of society to devote themselves to rural construction; fifth, to innovate the introduction and use mechanism of rural talent cultivation [1]. As an important highland for talent training, colleges and universities have accumulated experience, resources, and connotations in fulfilling the functions of talent training and serving the society.

In order to better promote talent training in colleges and universities, this paper takes the opportunity of innovation and entrepreneurship, namely "mass entrepreneurship

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 176–190, 2021.
https://doi.org/10.1007/978-3-030-84386-1_15

and innovation", and proposes an online education system for mass entrepreneurship courses based on big data from the perspective of rural revitalization. By analyzing the requirements of rural revitalization development on human resources and the advantages of higher vocational colleges in serving the society, this paper designs an online education system of mass entrepreneurship and innovation courses based on big data, in order to provide a steady stream of new forces for its "rural revitalization".

2 Related Technologies

2.1 Streaming Media Technology

Streaming media refers to the transmission of compressed video or audio content over the network and play it immediately, rather than saving it on the hard disk. Through the use of streaming media technology, users can play without waiting for the entire file to be downloaded. Because streaming media sends data in the form of a continuous data stream, it can be played in real time when the data arrives, so that it can be downloaded and played while the user can pause, fast forward or rewind. Streaming media technology allows the server to monitor what users are watching and how long they are watching, while at the same time making effective use of network bandwidth. When the user's computer plays a media file, it will continue to download and buffer other content from the streaming media server. Play and download happen at the same time. Except for a short initial buffering, the process is almost invisible to the viewer. When the network download speed is lower than the playback speed, the player will use a small section of data in the buffer, which can avoid the interruption of playback and ensure the playback quality [2].

The mainstream streaming media protocols are RTMP and HLS. RTMP is an open protocol developed by Adobe Systems for audio, video and data transmission between Flash players and servers [3]. RTMP has good real-time performance, but it is limited to Flash players.HLS is an HTTP-based streaming media transmission protocol implemented by Apple. Since the data is transmitted through the HTTP protocol, there is no need to consider firewall or proxy issues. However, the disadvantage of HLS is that its delay is generally higher than that of ordinary live streaming protocols.

Adaptive HTTP code rate is abbreviated as HAS (HTTP Adaptive Streaming), which is a transmission protocol based on HTTP protocol that can perform code rate adaptation. RTSP/RTP streaming media technology and HTTP progressive download technology have their own advantages, but also have their own shortcomings. The HAS technology is proposed to merge the advantages of the two. The HAS technology actually divides the media data into blocks and provides slices of multiple bit rates on the server side. The progressive download technology of HTTP is used for transmission. In the broadcast control, the slice files of the corresponding bit rate are selected according to the network conditions.

DASH (Dynamic Adaptive Streaming over HTTP), also known as MPEG-DASH, is the first international standard streaming solution based on HTTP protocol with adaptive bit rate, organized by MPEG (Moving Picture Experts Group) in 2010 Started development and became a draft international standard in January 2011. The MPEG-DASH international standard ISO/IEC23009-1:20120 was released in April 2012. The second edition of MPEG-DASH in July 2013 has been approved for inclusion in the First Amendment, including supporting event messages and multimedia descriptions.

MPEG-DASH is a kind of HAS technology. It proposes a hierarchical file structure organization to store video slice files on the server. In order to describe these structures, MPEG-DASH specifically defines the media presentation description file MPD (media presentation description), This file is based on XML format. The purpose of the MPEG-DASH standard is to unify the current HAS technology, and it summarizes the current HAS technology.

2.2 HTMLS Technology

HTML5 is an HTML standard formulated by the World Wide Web Consortium (W3C), and the latest HTML5.1 standard will be officially released soon. HTML5 adds new technical standards, so that the browser can achieve more diversified and more powerful website applications. At the same time, HTML5 adds many new tag elements to the mobile terminal, making it possible to achieve cross-platform through the browser. HTML5 is not only used to display the content of page elements, it also provides browsers with new native implementation standards such as multimedia and animation. Many new features have been added to HTML5, such as canvas elements for painting, video and audio elements for multimedia, and Websocket technology for communication between browsers and servers. The following is a brief introduction to the HTML5 video playback technology, Canvas canvas technology and Websocket technology used in this article.

HTMLS video playback technology has the following advantages: support ABR (Adaptive Bitrate), ABR can effectively reduce buffering time, can use media source expansion to make videos and live broadcasts play smoothly in many browsers; support VP9 codec, VP9 Codec can effectively save bandwidth, loading time and file size; Encrypted Media Extensions, through the combination of this extension and normal encryption measures, the video can be easily configured to protect multiple content on different platforms. The support simplifies the inconvenience caused by the encryption protection and the high integration of content in the video transmission, and can reduce the lag in the video playback. According to the above content, the use of HTML5 to play videos or live video broadcasts does not require flash plug-in support, and there is no security problem, which can improve video continuity and cross-platform to a certain extent.

A very useful feature of HTML5 is the Canvas element for painting, which can realize the electronic whiteboard function of the online education system. Canvas has many drawing functions and image processing methods, such as brushes, rectangles, circles, and characters, which provide new processing methods for web page drawing and image processing. Traditional Web drawing development is implemented through flash, VML, and other technologies. VML technology uses an XML document to describe the drawing. The declarative drawing method of the XML-based drawing language cannot meet the performance requirements of complex drawing operations, such as Pixel-level drawing capabilities required in Web games. The HTML5 canvas element makes up for this shortcoming. The canvas has a JavaScript-based drawing API. Developers can use the JavaScript scripting language to perform a series of command-based graphics drawing operations in the canvas. The HTML5 canvas element can directly use JavaScript scripts to draw on the Web page without any third-party plug-ins.

Before the advent of HTML5, instant messaging based on the B/S architecture was realized through long rotation training. The shortcomings of this method are obvious. Most of the requests sent are useless, waste a lot of traffic and bandwidth, and consume server resources, which puts a lot of pressure on the server. With the introduction of the HTML5 standard, websocket provides a new web communication technology. websocket can provide low-latency, high-performance two-way data communication between client and server. It subverts the request processing response mode of previous web development, and provides a real sense of the client request, server push data mode, especially suitable for real-time data interactive application development. Therefore, the web client of the interactive chat platform of this system is implemented by using HTML5 websocket technology.

3 System Structure

In the current development process of network distributed application systems, two different but parallel system structures are continuously developing. One technical route is the traditional application system, namely Client/Server (C/S) structure, and the other It is a Browser/Server (B/S) structure based on the Internet.

The C/S structure, that is, the client/server structure (see Fig. 1), is a well-known software system architecture. By reasonably assigning tasks to the Client and Server, the communication overhead of the system is reduced, and both ends can be fully utilized. Advantages of the hardware environment. Early software systems mostly used this as the preferred design standard [4].

The B/S structure, that is, the browser/server structure, is a change or improvement of the C/S structure with the rise of Internet technology (see Fig. 1). Under this structure, the user interface is completely realized through the WWW browser, and part of the transaction logic is realized on the front end, but the main transaction logic is realized on the server side, forming the so-called 3-tier structure and B/S structure, which mainly uses the mature WWW browser technology, combined with the browser's multiple Script languages (VBScript, JavaScript) and ActiveX technology, uses a universal browser to achieve powerful functions that originally required complex special software to achieve, and save development costs. It is a brand new Software system construction technology. With Windows98/Windows2000 implanting browser technology into the operating system, this structure has become the preferred architecture of today's application software.

In the C/S mode. Client (client) is responsible for providing expression logic, displaying user interface information, accessing database servers, etc., and Server (server) is used to provide background data management services. In the B/S mode, there are client and server, and the client is mainly used for browsing information.

The biggest advantage of the B/S mode is that it can handle real-time events more flexibly without being restricted by time and region. For the online education system, the fundamental purpose of its design is to realize remote paperless real-time education. The system requirements are not restricted by region, and there are more flexible real-time requirements, so this system adopts B/S structure to design [5].

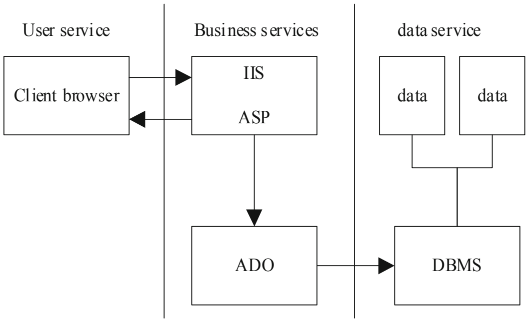


Fig. 1. B/S structure

In comparison between the two, the B/S structure completely adopts the Web environment, and the technology is popular and advanced. The client only needs a standard Web browser, and other applications are stored on the Web server and downloaded when needed. This is the real meaning In the B/S structure, the server is responsible for providing information and requested data to the user, the client uses the IE browser to display the information from the server, and the server controls the content and layout of the information. The development of this online education system adopts a Web-based B/S structure and makes full use of the advantages of this structure to realize the construction of an online teaching platform.

4 System Function Design

4.1 User Management Module

(1) Teacher module
After the teacher logs in, he can make an announcement (only the class where the teacher is the teacher can see the announcement, and he has the permission to edit and delete personal announcements), upload files (the system will record the teacher number, so that students can find this teacher to download, Has the ability to upload and delete personal resources to upload and delete the classes taught and the courses taught by yourself, with search limits), review student work (select your own search, score statistical analysis, delete-one system will set the logo "Teacher delete", But the teacher himself will not be able to view it in the future), answer student questions (choose the class you teach and the course you teach to answer, have question query search, delete permissions, delete is a system will set the logo "Teacher delete", The teacher himself will not be able to view it in the future).

(2) Administrator module
The administrator has the authority to change users, to add, delete, and modify users, and to manage assignments and problems (there is a query search function, mainly delete functions, but the assignment or problem identification must be "Teacher delete " Or "student delete"), have the authority to organize resource courseware (have query search function and delete function, and have the authority to modify the description of the resources uploaded by themselves) and upload authority

(the resource system uploaded by the administrator will Set as a public resource, convenient for users to choose to download), announcement publishing and management permissions (mainly the permissions for publishing announcements and editing announcements).

(3) Stuoddent mule

After logging in, students can check the announcements, submit assignments (check the assignments posted by the teacher, and complete them in a timely manner), ask questions (select teachers and courses to ask questions, targeted questions, and get more credible answers), upload resources (You must designate a teacher to upload, and the designated teacher will have all the permissions to upload resources, mainly for teachers to view), download resources (you can choose public resources and select teacher resources for download) [6].

4.2 Online Interactive Module

This module is further divided into modules such as teacher online Q&A, students staying in high school, and student homework submission. Teachers' online Q&A is a way for teachers to communicate with students through the Internet, discuss learning, and communicate with students in a remote place to solve student problems in a timely manner; student staying in high school is to ensure that students can stay high and let teachers online You can see it first, and return the same opinions to the students as soon as possible. This module is a form of leaving a high profile; student submission of homework, in order to understand the student's learning situation, can be viewed by doing homework, the submission of homework is done through the FTP server [7]. After the student enters with the student ID and password, there is a space on the server to save the student's homework. Students can upload their own work to the teacher for correction. The online interaction module is shown in Fig. 2:

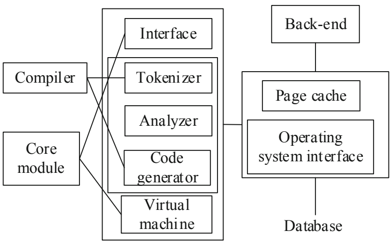


Fig. 2. Structure of online interaction module

4.3 Course Content Management Module

Online learning courses are different from traditional offline teaching models. The traditional offline teaching model can give students textbooks and face-to-face teaching in the classroom at the beginning of the course, while the online course teachers and students may not be the same in time and space. It is possible that the 100 students of elective courses are in To view this course at different times or with different learning progress, teachers need to enter the relevant content and materials of the courses they have opened into the system so that these students can view them according to their learning progress.

The course content management module contains 3 sub-functions: chapter setting, chapter content setting, and chapter homework setting.

Chapter Setting: Teachers who start the class can set up the corresponding chapter structure according to their own course outline. The system provides "New Chapter", "New Section", "Chapter Modification", "Section Modification", and "Delete". For example, the teacher who starts a class now needs to add "Chapter One Java Programming Guide" under In the section "1.1 History of Java", click the "Chapter One Java Programming Guide" menu bar, click "New Section" in the upper right corner of the chapter menu bar, enter "1.1" in the section number, and enter the section name "Java History", click "Enter and Submit", and the system will generate the corresponding section [8].

After the initiating teacher has set the overall course outline, if you want to adjust a certain chapter, such as changing the order of Chapter 3 and Chapter 4, find "Chapter 3" in the chapter list and click "Edit", In the pop-up page, enter "4" in the chapter number and save; find "Chapter 4" in the chapter list, click "Edit", enter "3" in the chapter number in the pop-up page and save. The system will automatically change the order of chapters, and the course catalogs that students see will also be changed.

After the initiating teacher sets the overall course outline, if a chapter is found to be redundant, the chapter should be deleted as a whole. Find the chapter in the chapter list, click "Delete", the system will pop up "Do you want to delete Chapter 5?" Click "OK to delete", the system will delete all the content of Chapter 5, including the nodes under Chapter 5 The content of the courseware and the exercises will be deleted and cannot be restored. This chapter will also be deleted from the course catalogues that students study and see. Since the delete operation cannot be recovered, it should be done carefully.

Chapter content setting: After setting the corresponding chapter of the course, the teacher can enter and edit the content of the corresponding chapter. According to the traditional teaching mode, the system provides several courseware content formats. Teachers can import courseware in the following formats, PPT, Word, pdf, video, and pictures. You can also use URL links to import course materials from other websites, or you can use them The online text editor provided by the system can edit the course content text.

One chapter can import multiple courseware. Teachers who start the class can click "Add Content", then enter the content name +.lava historical introduction video, select the content type "Video", click "Upload" to select the corresponding video in their computer system The file is uploaded successfully. Teachers can also add other types of files again in the same chapter, such as entering the content name "Java related history" and selecting the content type "Text", the system will pop up an online text editor corresponding to the start of the class. Enter the corresponding text content and click "OK to add new content" after completion, the save is successful. At the same time, when students study this chapter, they can see the two courseware content set by the teacher, and click the corresponding courseware name. You can enter the courseware of this chapter [9].

Chapter Assignment Setting: After the initiating teacher has set the content corresponding to the course chapter, he can arrange the assignment of the corresponding chapter. According to the form of traditional teaching mode, teachers will usually assign homework to test students' learning effect after class is over. The system also provides the function of assigning homework online, and the initiating teacher can assign the exercises corresponding to the chapters according to the needs of the course.

The homework question types supported by the system are mainly standardized test questions, including single-choice questions, multiple-choice questions, and true or false questions. Teachers can click "Add Question" to enter the corresponding question name, question content, question options, correct answers, and scores. Generate corresponding exercises. Since the system is an online intelligent correction of homework, which is different from offline teachers' manual correction of homework, the exercises do not support the intelligent judgment of essay questions for the time being.

In order to facilitate teachers to set up homework exercises, the system provides the function of batch importing homework exercises. Teachers can edit the corresponding word file and save it offline according to the exercise mode provided by the system. After editing, click "Import word exercises in batches", select the word file in the system, and click "Upload". The system will automatically parse the word and insert it into the background database in batches. For batch-imported homework exercises, if the teacher needs to modify or delete some content, you can find that title and click "Edit" or "Delete" to enter the editing mode of a single exercise.

4.4 Online Teaching Module

(1) Video live teaching

Video live teaching is the main teaching method. The live teaching mainly includes three functional modules: live video, voice interactive platform and electronic whiteboard. Among them, teachers use live video to explain the content of the course, and can perform some auxiliary operations similar to "blackboard" through the electronic whiteboard; the voice interactive platform can enable teachers and students to conduct real-time and efficient interactive communication.

There are two main ways for teachers to share video resources during live video broadcasting. One is to call the device's camera to collect video resources, and the other is to share the teacher's computer screen. The system also provides a video recording function, which is convenient for teachers to upload course teaching videos for on-demand use.

The voice interactive platform is divided into a free discussion area and a question and answer area, and the form of communication can be text or voice. The free discussion area is mainly for students to discuss freely. In order to maintain the order of the classroom, it is necessary to limit the frequency of students sending messages here. During the live video broadcast, teachers and students can interact in the Q&A area. Teachers can ask questions in the Q&A area and invite students to answer; students can also make requests during the live broadcast, and ask questions after obtaining the teacher's permission [10]. In the Q&A area, teachers and students can

communicate in the form of voice messages to facilitate the description of problems and improve communication efficiency [11]. The permission of the question-and-answer area is controlled by the teacher. Students can only send messages in the question-and-answer area with the teacher's permission [12].
The electronic whiteboard is an auxiliary tool for teachers to teach. It provides teachers with some tools such as diagrams, drawings, brushes, and provides some advanced animation display functions for some subjects [13]. During the live broadcast, teachers can perform operations such as writing on the blackboard in the electronic whiteboard to achieve the effect of the blackboard in the offline classroom, which helps to improve teaching efficiency and enables students to better understand the teaching content [14].

(2) Video on demand teaching
On-demand classroom is when teachers upload teaching videos to the system for students to watch on their own. Compared with live teaching, the form of on-demand teaching is more flexible. Students can watch it repeatedly and can interrupt learning at any time [15]. After students join a course, they can watch the teaching videos in the course. At the same time, the system adds a non-real-time interactive discussion area to the on-demand classroom [16]. Students and teachers can leave messages under the video to discuss problems encountered during the video watching.

4.5 Exam System Module

The module is divided into exercise questions, simulated test papers, final examination papers, test paper answers and other modules [17]. Practice questions, this module is used for students to practice when learning, students can practice according to the chapters or types of questions, and can also be done during review; simulation test paper is used by students in the final review, when students finish the course, they can automatically generate test papers and carry out simple tests according to the situation [18]; The final examination paper is only opened by the teacher at the end of the term. According to the situation of each course, the question bank is updated, and the students have the right to open the paper for examination within the specified time, and return to the answers of the paper.

5 System Implementation and Testing

The last chapter discussed in detail the design and realization of the main functional modules of the online education system. On the basis of system implementation, this chapter tests the various functional modules of the online education system and the overall performance and operating status of the system (Table 1).

5.1 Test Environment

Table 1. System test environment

Category	Project	Name	Configuration
Hardware environment	Service-Terminal	Processor	Intel Pentium IV 1.6GHz or higher
		RAM	256 MB
		Hard disk space	80 GB
		Graphics card	SVGA display adapter
	Client	Processor	Intel Pentium 166MX or higher
		RAM	32 MB
		Graphics card	1 GB
		Graphics card	SVGA display adapter
Software Environment	Service-Terminal	Operating system	Windows NT Server 4.0 or Windows 2000/Windows 98
		Network protocol	TCP/IP
		Web server	Internet Information Server 5.0
		database	Microsoft
		Browser	Internet Explore
	Client	Operating system	Windows 98/ME/2000/XP
		Network protocol	TCP/IP
		Database	Microsoft SQL Server 2000
		Browser	Internet Explore 5.0

5.2 System Function Test

The functional modules of the online education system are mainly divided into online teaching module, user management module and course management module. Among them, the online teaching module mainly tests the video live broadcast function, the video on demand function, the voice interactive platform and the electronic whiteboard; the user management module mainly tests the user registration and login functions, the personal information maintenance function and the teacher qualification function; the course management module mainly tests the addition of teachers Courses, add course plans, upload course resources and other functions. Different roles are used to test the corresponding functions during the test (Tables 2, 3 and 4).

Table 2. Test cases of online teaching modules

Enter	Desired result	Result
The teacher creates a live video room	Created successfully, start live broadcast	In line with expectations
Teacher chooses camera live broadcast	Live video source becomes camera	In line with expectations
Teacher chooses to share screen live	The live video screen is the teacher's computer screen	In line with expectations
Student requests to speak	Teacher receives student's request to speak	In line with expectations
Teacher allowed to speak	Students can send messages	In line with expectations
The teacher refused to speak	Students cannot send messages	In line with expectations
Students are sending messages in free discussion	Other students receive news	In line with expectations
Teachers use electronic whiteboard	Draw selected graphics on the page	In line with expectations
Student on-demand video	Students on-demand video can be watched	In line with expectations
Students leave comments in the comment area	Page content display comment content	In line with expectations

(1) Test cases for online teaching modules
(2) User management module test case
(3) Test cases of course management module

Through the above test cases, it is concluded that each functional module of the online education system has passed the test.

5.3 System Performance Test and Analysis

The performance test of the online education system mainly includes two aspects: 1 the performance of the browser client HTMLS video player; 2 the performance of the system under high concurrency.

(1) HTMLS video player performance test
The browser video player in this article is implemented based on HTML5, and is used to play MPEG-DASH protocol streaming media. First of all, from the perspective of intuitive user experience, due to the use of native HTML, no Flash plug-ins, etc., the loading speed of the video player is relatively fast, and there is no waiting for the player to load; in terms of cross-platform, PC browsers and mobile You can watch the video normally in any browser. Then, regarding the

Table 3. Test cases of user management module

Enter	Desired result	result
User registration	User registration is successful	In line with expectations
Student user login	Successful login, showing student user interface	In line with expectations
Teacher user login	Successful login, showing the teacher user interface	In line with expectations
Administrator user login	Successful login, showing the administrator user interface	In line with expectations
Modify Personal Information	Personal information updated successfully	In line with expectations
User applies for teacher qualification	Add an application to the administrator task list	In line with expectations
The administrator agrees to the teacher qualification application	User role changed to teacher	In line with expectations
Enter the wrong username and password	Login failed, return failure message	In line with expectations

Table 4. Test cases of course management module

Enter	Desired result	result
Teacher creates courses	Course created successfully	In line with expectations
Teacher adds lesson plan	Lesson plan added successfully	In line with expectations
Teacher uploads course resources	Successfully uploaded course resources	In line with expectations
Teachers modify course information	Course information updated successfully	In line with expectations
Teacher revises lesson plan	Course plan information updated successfully	In line with expectations
Teacher release course	System course page displays the course	In line with expectations
Teacher delete class	The system pops up twice to confirm the deletion	In line with expectations
Students join the course	Successfully joined the course, with the course permissions	In line with expectations
Student withdraws from the course	Successfully exit the course, cancel the permission of the course	In line with expectations

resource consumption of personal devices, since this article does not implement streaming media services based on other protocols, it cannot be compared with the case of using the Flash plug-in to play streaming media. This article chooses another method for comparison and places it on the server. Two 10-min video files, an MP4 file with a size of 63.6MB and a SWF file with a size of 46.2 MB, and then use HTML5 video tags and Flash to play in the web page respectively to test the system memory occupied by the browser, as shown in Fig. 3. Among them, 0 means the memory occupied when opening the browser with only one blank page tab.

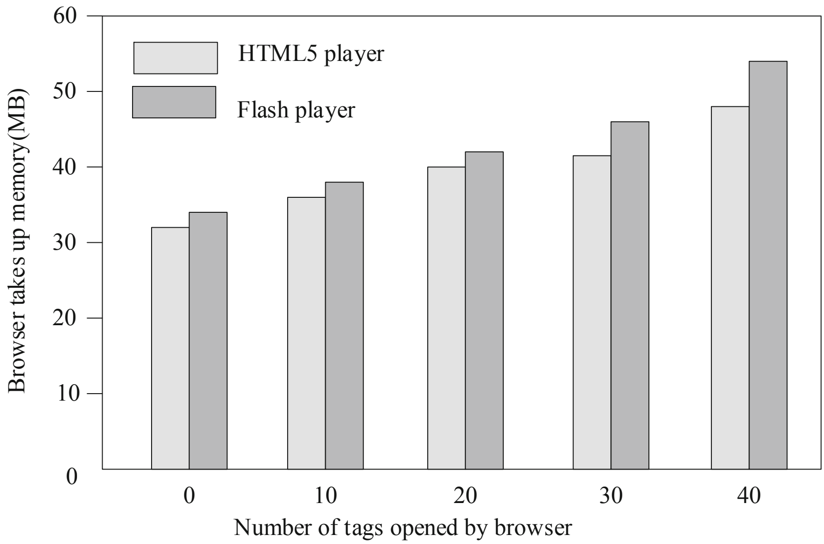


Fig. 3. Client memory usage

It can be seen from the data that the browser occupies less memory when playing videos with HTML5 video, so it can be predicted that in the actual streaming media system, using HTML5 video players will consume less system resources and have better performance.

(2) System performance under high concurrency
The performance of the system in the case of high concurrency mainly refers to the number of simultaneous online users that the system can withstand, the number of simultaneous live video courses and the number of simultaneous live video watching. This article mainly measures the performance of the system under concurrent conditions from the two aspects of server load and request response time under concurrent conditions. The load of the system under concurrent conditions is tested here. Since the server cluster system can improve the performance of the system through expansion, only a single server is tested here. After testing, when the number of concurrent requests is set to 50, the CPU usage instantly rises to about 25% for concurrent requests, increases the number of concurrent requests to

100, and the peak CPU usage reaches about 60%. When the number of concurrent requests increases to 200, the CPU usage The rate reached 100%. Therefore, it is estimated that a single server can support a maximum of about 200 concurrency. In actual use, expand the server to increase the system capacity and improve the concurrency of the system.

6 Conclusion

In order to realize the revitalization of the countryside, it is very important to cultivate local talents with intelligence, technology and management, especially the new type of professional farmers who love agriculture, know technology and are good at management. To this end, in order to cultivate the talents needed for rural revitalization, an online education system for innovation and innovation courses based on big data is designed. The system has been tested that each functional module works normally and the performance is also good, but the system still has some shortcomings. First of all, most of the front-end functions of the system are implemented based on the HT'MLS standard, and a newer version of the browser is required. Although most browsers currently support HTMLS better and better, there is still a certain market share. Browsers cannot support HTMLS well, such as IE5 and IE9, so in an actual system, in order to ensure the compatibility of the browser, it is necessary to provide a compatible solution for each function of the system.

Fund Projects. Key projects of Humanities and Social Sciences in Chongqing Chemical Industry Vocational College, Exploration on the integration of "innovation and entrepreneurship" education and professional education in higher vocational business major from the perspective of Rural Revitalization, Project number: HZY2020-SKZD02.

References

1. Zhang, T., Ding, Q., Hu, Q., et al.: Towards rural revitalization strategy for housing in gully regions of the loess plateau: environmental considerations. Energies **13**(12), 3109 (2020)
2. Wang, L., Huang, R.: English teaching platform based on online education technology and licensure and master's program technology. Int. J. Emerg. Technol. Learn. (iJET) **14**(16), 154 (2019)
3. Lin, P.H., Wooders, A., Wang, T.Y., et al.: Artificial intelligence, the missing piece of online education? IEEE Eng. Manag. Rev. **46**(3), 25–28 (2018)
4. Ming-Xia, W.: Construction of "responsibility-oriented" education system of corporate social responsibility in colleges. J. Interdiscip. Math. **21**(2), 369–376 (2018)
5. Su, G.: Analysis of optimisation method for online education data mining based on big data assessment technology. Int. J. Contin. Eng. Educ. Life-long Learn. **29**(4), 321–335 (2019)
6. Misra, S., Maskeliūnas, R., Damasevicius, R., et al.: Artificial intelligence, smart classrooms and online education in the 21st century: implications for human development. J. Cases Inf. Technol. **21**(3), 66–79 (2019)
7. Leonor, U.C.R., Cuauhtemoc, L.M.: Neural networks for predicting student performance in online education. IEEE Lat. Am. Trans. **16**(7), 2053–2060 (2018)

8. Zheng, S.Y., Jiang, S.P., Yue, X.G., et al.: Application research of an innovative online education model in big data environment. Int. J. Emerg. Technol. Learn. (iJET) **14**(8), 125 (2019)
9. Wang, W., Zhang, P., Zeng, C.Z.: Construction of learning behaviour tracking analysis model for MOOC online education platform. Int. J. Contin. Eng. Educ. Life-Long Learn. **30**(1), 1 (2020)
10. Khalil, A., Shaltout, M., Costa, S.: Identifying opportunity for online education to address HIV/HCV knowledge gaps in health professionals and students in Egypt. Ann. Glob. Health **84**(4), 580 (2018)
11. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
12. Liu, S., Li, Z., Zhang, Y., Cheng, X.: Introduction of key problems in long-distance learning and training. Mobile Netw. Appl. **24**(1), 1–4 (2018). https://doi.org/10.1007/s11036-018-1136-6
13. Epp, D.A., Kubota, T., Yoshida, M., et al.: Promoting patient care through communication training in a pre-clerkship pharmacy education course in Japan. Am. J. Pharm. Educ. **83**(21), 121–129 (2019)
14. Jong, P.G.M.D., Hendriks, R.A., Luk, F., et al.: Development and application of a massive open online course to deliver innovative transplant education. Transp. Immunol. **26**(3), 45–53 (2020)
15. Hwang, C.S.: Using continuous student feedback to course-correct during COVID-19 for a nonmajors chemistry course. J. Chem. Educ. **97**(9), 78–83 (2020)
16. Denis, A., Fadyl, E., Pierre, E.: Characteristics and postoperative course of tinnitus in otosclerosis. Otol. Neurotol. **24**(1), 48–51 (2019). Official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology
17. Soil carbon sequestration in bermudagrass golf course fairways in Lubbock, Texas. Agron. J. **112**(1), 55–62 (2020)
18. Canavese, D., Motta, I., Marinho, M., et al.: Health and sexual rights: design, development, and assessment of the massive open online course on lesbian, gay, bisexual, transgender, and intersex health promotion in Brazil. Telemed. e-Health **26**(10), 147–152 (2020)

Research and Application of Teaching Resources

Design of Online Sharing System for College Writing Teaching Resources in the Media Age

Li-jun Yun(✉) and Ming-sheng Li

Baotou Teachers College, Baotou 014030, Inner Mongolia, China

Abstract. The traditional online resource sharing system does not describe the information data association semantics enough, which leads to a long resource search time. To solve this problem, this paper proposes an online sharing system of college writing teaching resources in the era of media. In terms of hardware design, C/S architecture and HDFS distributed architecture are adopted to design the overall structure of the system and optimize the data processing chip and data integrator; In the aspect of software design, it configures lightweight database, stores writing teaching resource data orderly, describes teaching resource by association, selects the optimal integration path, aggregates the shared associated data, calculates the optimal sharing path, and transmits teaching resource to the visiting users. The experimental results show that the degree of revealing the relevance of data nodes in the design system is higher than that of the two traditional systems, which improves the integration efficiency of writing teaching resources and shortens the search time of the same type of resources.

Keywords: Teaching resources · Online sharing · Hardware design · Software design

1 Introduction

At present, writing teaching resources have become the focus of school construction, which has a great impact on educational informatization. Teachers and students have increased their dependence on online teaching resources. However, due to the rapid increase in the number of teaching resources, the efficiency of searching teaching resources is poor. Aiming at this problem, an online sharing system of writing teaching resources is designed.

In foreign countries, the research on the sharing of teaching resources is earlier. Through the system mode, service mode and economic mode, using the relationship characteristics from description to analysis, the cooperation between different school districts is realized, and the quantitative and qualitative methods are adopted to sort out and share information resources. Domestic research on teaching resource sharing has also made great progress, building a technical platform for excellent teaching resources, using literature analysis and case analysis to summarize teaching resources, providing dynamic and easy to expand resources through private cloud mode, and information

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 193–204, 2021.
https://doi.org/10.1007/978-3-030-84386-1_16

resources can be virtualized, which is the teaching information resources to be transmitted, Provide computers and other equipment as required. Combined with the above theory, the traditional resource sharing system is improved, the resource processing chip and integrator are optimized, the associated semantics of database resource information are integrated, the associated teaching resources are associated together, and the search time of teaching resources is shortened.

2 Design Method of Online Sharing System for College Writing Teaching Resources in the Media Age

2.1 Hardware Design of Online Sharing System for Writing Teaching Resources

Design the Overall System Architecture

Using C/S architecture and HDFS distributed, the overall architecture of resource sharing system is designed. The HDFS API interface is called to store and read the teaching resources of writing. The basic information of users is stored in the database, and the resource data is uploaded, downloaded and shared through the web service interface. The mode of four-tier architecture is as follows: interface presentation layer, which is mainly used for system interface design, including control layout, content display, interaction design, etc.; business logic layer, which is mainly used to realize business logic of each function point, plays a bridge role between interface presentation layer and data access layer, encapsulates business logic code in the system into logical functions In the teaching resource sharing system, for the sake of data security, the data access layer does not participate in the direct interaction with the database server, but through the WCF service mode, the database operation is independent, forming a separate In the database proxy server, the system only needs to call this service in the data access layer; in the infrastructure layer, in order to further increase the encapsulation of program code, the data fields in the program are encapsulated into different classes of the model layer, so as to facilitate the frequent use of data fields by other architecture layers [1, 2].

NF is adopted in infrastructure layer_ 5270m4 server, install multiple virtual hosts on it, deploy and install Hadoop system cluster, and install elasticsearch distributed search engine to locate resource data. On the underlying infrastructure, virtualization technology is used to build a private cloud, and VMware vCenter service is deployed and installed. The host resources with esxi are clustered and integrated to form a hardware resource pool, including computing resources, storage resources, network resources, and so on Client client is used to manage the hardware resource pool on the server side. The hardware resources in the resource pool are virtualized into several independent virtual machines to provide resource sharing services [3]. So far, the design of the overall system architecture is completed.

Design Neuron Chip

Neuron chip is an important hardware device in the online sharing system of writing teaching resources. It controls user access and realizes the upload, transmission, search and download services of teaching resources. Neuron chip includes mci43120 and mc143150 series. Mc143150 series supports external memory and is suitable for complex application in control system. Mci43120 has ROM, does not support external memory, only stores writing teaching resources. There are three 8-bit CPUs in the chip, namely MAC CPU, network CPU and application CPU. The specific structure is shown in Fig. 1

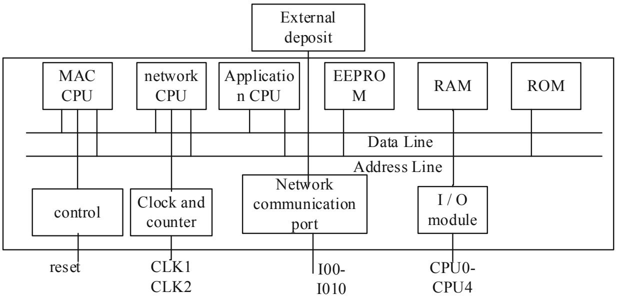


Fig. 1. Neuron chip structure

I/o0 -- I/O10 represents 11 programmable input and output pins, and service pin is used to identify users. According to different access devices, neuron chip has 34 working modes to choose, so as to flexibly configure the upload and download modes of teaching resources. CLK1 and CLK2 are 16 bit timing counters. CLK1 inputs teaching resources and outputs them from I/o0 channel through a multi-channel selection switch in I/O4 ~ I/O7. CLK2 can only input from fixed channel I/O4 and output from I/o0 channel. CP0 ~ CP4 represents five information data management, and its management configuration is divided into three different interfaces: differential mode, single mode and special mode, so that the resource online sharing system can adapt to the reading and transmission of different file formats.

Mac CPU is neuron chip medium access control processor. It communicates with network CPU through shared RAM network buffer, controls physical layer and data link layer of shared system, and completes conflict through hardware driving data transmission link [4]. The network CPU is the network processor of the chip, which controls the network layer, session layer and presentation layer of the sharing system, and completes the functions of route addressing and network management. The network CPU and MAC CPU share the network buffer in RAM, and the firmware performs the operation of user code and user code call. Through sharing the application buffer and network CPU in the memory, the network CPU searches and transmits information data, and completes the application service of teaching resources. So far, the design of neuron chip is completed.

Design Teaching Resource Data Integrator

According to the online sharing service function of teaching resources, the data integrator of the system is optimized. The overall construction of the integrator is divided into five modules: core, associated interface, power supply, network function and peripheral circuit. Svb12f762 chip is selected as the integrator, and its configuration should meet the circuit requirements of the integrator. The level conversion is carried out through the svb12f762 chip, so that the integrator can maintain high level all the time when the bus is idle and reduce the reflected signal. An isolation link is added to the data integrator interface to transmit the correlation integration signal of digital resources from the signal line, and isolate the interference signal, so as to ensure the stability of the communication signal in the process of Digital Resource Association integration [5]. The overall framework of the data integrator is shown in Fig. 2

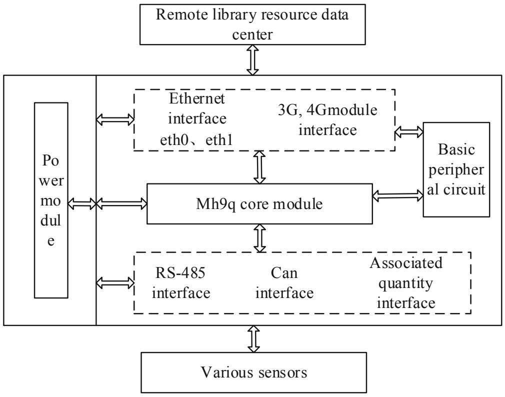


Fig. 2. Framework of data integrator

As shown in the figure above, the core module uses the mh9q core data board produced by Freescale company to build 4 GB EMMC flash and 2 GB memory to collect the information data of writing teaching resources, and collect them to cortex-a9 four core processor, and drive the resource data through Ethernet and can bus interfaces, so as to support the operation of data association and integration. In the optimization of the power module, the data integrator uses 24 VDC power input to make the collector face the industrial general interface. The power module is connected with the neuron chip to convert the transistor transistor logic level signal. The level is directly connected with the input and output interfaces of the core module, and the can transceiver of writing teaching resources is added to stabilize the output of 5 V power supply, so as to realize the overall optimization of the data integrator [6]. So far, the hardware design of the system is completed.

2.2 Software Design of Online Sharing System for Writing Teaching Resources

Design Teaching Resource Database

According to the functional requirements of the hardware of the resource system, a lightweight database is configured to store the information data of teaching resources in an orderly manner, and record the operation status of the system's associated integrated digital resources. DAQ is embedded in the hardware of data integrator_ status_ TB table and data_ store_ TB table, where DAQ_ status_ TB is used to store the running state,

Table 1. DAQ_ status_ TB configuration

Field name	Field meaning	Field type
start_time	Serial number of data association integration interface	Blob
sensor_num	System operation status	Interger
ID	Ms level, time stamp	Interger
daq_serial	Auto increment primary key	Interger
status	Serial number of various sensors	Text

Table 2. Data_ store_ TB configuration

Field name	Field meaning	Field type
Raw_data	Serial number of Digital Resource Association integration	Text
sensor_number	Raw data	Interger
store_date	Association type	Blob
daq_type	Consolidated data	Text
Process_data	Auto increment primary key	Interger

data_ store_ TB is used to store all kinds of writing resources. The details are shown in Table 1 (Table 2).

Using MySQL database and concurrent operation, we can directly access the data files of writing teaching resources. To simplify the access process, users send access requests through text/htm1; charset = UTF-8//in the PHP processing module of the database, then process the PHP script, parse the data of the book digital resources, read and write the data configuration file through login BTN > submit-text2//, receive the return information of PHP script, and finally generate var export (LIST1, 10) -catch//displays data to the entire web page to monitor the data in the database. So far, the design of library digital resource database is completed.

Describe the Relevance Semantics of Teaching Resources

Using ontology semantics, the teaching resources stored in the database are processed by data, and the terms, descriptors and titles related to the teaching resources are described by association semantics to obtain descriptive metadata. Firstly, according to the naming standard of cool URIs formulated by the semantic web, the writing teaching resources are named by URIs. With the help of various description methods provided by FRBR, a vocabulary set of associated data is created to describe the semantic ontology of teaching resources [7]. The specific types are shown in Table 3.

Table 3. Classification criteria of digital resources association semantics

Semantic name	Subnet type involved	segmentation criteria
Hirarchy	P-P; K-K; M-M	Genus
Citation relation	P-P; M-M	entity
Correlation	P-P; K-K; M-M	Integral part
Equivalence relation	P-P; K-K; M-M	synonymous
Attribute relation	P-P; P-K; K-K; M-M	Synonymous
Discuss the relationship	K-K; K-M; M-M	synonym
See relation	P-K; K-K; K-M; M-M	Antonymy

According to the contents of the above table, the progressive transformation mechanism of teaching resources association semantics is constructed, and the corresponding sub network types are selected. Then it describes the associated semantics of teaching resources. With the help of entity extraction mechanism and d2rq transformation tool, the writing teaching resources are transformed into RDF metadata. On this basis, new semantic descriptive metadata is created. Finally, combined with the characteristics of online resource sharing, the publishing mode of associated data is selected to expand the teaching resources of writing, and a network environment with stronger Resource Association and scheduling is constructed. Combined with service and associated data, the integration system can link internal and external resource data. So far, the description of digital resource association semantics is completed.

Integration Path of Computing Teaching Resources

According to the user access and retrieval information, optimize the associated data network, select the optimal resource integration path, take the path as the link path of the associated data, add and modify the writing teaching resource data. First of all, the association semantics is standardized, and the frequency of different semantic query words is counted. Then the core query words are determined, and the four attributes of the core query words are determined. Then, the similarity between different writing teaching resources and the word is calculated.If the similarity distance formula is used, the similarity calculation formula Q is as follows:

$$Q = \left(\sum_{i=1}^{4} \left(a_k - a_j \right)^k \right)^{\frac{1}{k}} \tag{1}$$

In the formula, i are the four attributes of the core query words and a is the associated data of the writing teaching resources. k, j are the visualized spatial dimension of the data and the quantified value of similarity distance, where $j = 2$ or 3 are taken. When $k = 1$, it represents the real distance between the core query word and the spatial dimension. When $k \neq 1$, it is the bounded distance, representing the total absolute wheelbase on the spatial dimension [8]. By transforming formula (1), it is found that the optimal path to transform the infimum distance S is as follows:

$$S = \frac{1}{c^Q} \tag{2}$$

By calculating the sharing path of information resources, the integrated writing teaching resources are transmitted to the visiting users. In the formula, c refers to the frequency of the associated data of teaching resources and the core query words. When $0 < c < 1$, the optimal path value S is between (0, 1). The smaller the value, the closer to 0; when $c < 1$, the smaller the value, the closer to 1 [9]. According to the occurrence frequency of different resource associated data, the value k, j of two link parameters is determined to make the value reach the limit value S, and the final path of the conversion data's definite bound distance is obtained. The path is used to transform the associated data of teaching resources, and the optimal mode of resource integration is obtained. Finally, the query words that are not closely related to the associated semantics are eliminated, the service function of the associated data is improved, and the link path between the associated data and the resource ontology is mapped to form the integrated data of writing teaching resources, so as to complete the calculation of the integration path of teaching resources.

Choose the Best Sharing Path of Teaching Resources

Judge the sharing path of information resources, and transfer the integrated writing teaching resources to the visiting users. Firstly, the integrated writing teaching resources are virtualized. Through virtualization technology, multiple computers are logically virtualized into one computer, so that the shared services can run independently on the logical computer, and each logical computer can perform different operations, so that the storage resources and the host can be integrated to realize the digitization of writing teaching resources [10].Suppose that the service of the i shared path Q_{i} can satisfy the user's sharing request, the buffer idle value of the path receiving information resource is A_{i}, the transmission rate is λ_{i}, and the average transmission delay is μ_{i}, then the probability of k data blocks to be sent in the shared path at any time is Q_{ik}, and the relationship can be obtained as follows:

$$Q_{ik} = \begin{cases} \left(\frac{\lambda_i}{\mu_i}\right)^n A_i & n = 0, 1, \ldots, A_i \\ 0 & n \geq A_i \end{cases} \tag{3}$$

When the scope of this judgment $\frac{\lambda_{\mathrm{i}}}{\mu_{\mathrm{i}}}$ is less than 1, $\frac{\lambda_{\mathrm{i}}}{\mu_{\mathrm{i}}} < 1$, the sharing path of writing teaching resources is as follows:

$$Q_{\mathrm{i}} = \left(1 - \frac{\lambda_{\mathrm{i}}}{\mu_{\mathrm{i}}}\right) \Big/ \left[1 - \left(\frac{\lambda_{\mathrm{i}}}{\mu_{\mathrm{i}}}\right)^{\mathrm{A_i}+1}\right] \tag{4}$$

When $\frac{\lambda_i}{\mu_i} > 1$, if the average residence time of output data block is W_i, the average number of data blocks entering the shared path is T_i, and the average number of data blocks transmitted is L_i, then the shared path is:

$$Q_i = \frac{L_i}{T_i \lambda_i \times (1 - W_i)} \tag{5}$$

After determining the sharing path of information data transmission, the information resources are scheduled, and the shared resources are provided to users through the path. In the process of scheduling, it is necessary to deploy various applications of sharing services, improve the sharing program of digital sports information resources, so that users can access the writing teaching resources of colleges and universities through the cloud, so as to complete the selection of the optimal sharing path of teaching resources and realize the system software design. Combined with hardware design and software design, the online sharing system design of college writing teaching resources in the era of media integration has been completed.

3 Experiment and Analysis

The design system is recorded as experimental group A, and two groups of traditional online sharing system of teaching resources are respectively experimental group B and experimental group C. The integration effect and retrieval efficiency of the three groups of systems on teaching resources are compared.

3.1 Experimental Preparation

This paper selects a university electronic library, extracts writing teaching resources as experimental elements, uses Stanford topic recognition model toolbox to annotate data resources semantically, and takes semantic annotated digital resources as experimental

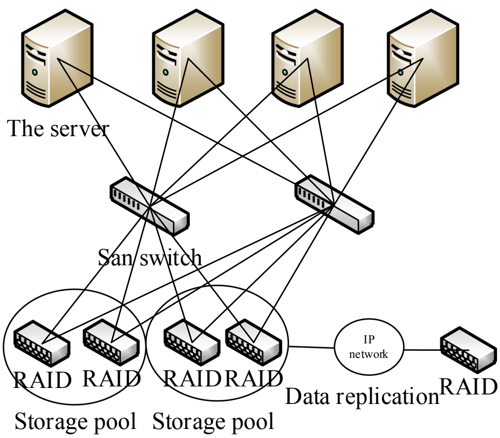


Fig. 3. Storage device of resource virtualization

objects. Three groups of experiments share their resources respectively. The storage device of group a resource virtualization is shown in Fig. 3

The windows host is configured with 2 GB memory, 2.50 ghz, 100 M/Gigabit Campus network card, 320 G SATA hard disk, and the operating system is windows7; the host server is configured with 2.13 GHZ, 4 G memory, Gigabit Campus network card, 1t SATA hard disk, Xeon four cores, the kernel version number is linnux 2.4.20–8, and the operating system is Linux RedHat 9.0. The related semantics of writing teaching resources are described in Table 4.

Table 4. Experimental data elements and their relationship

Entity	Element code	Associated element code
Practice on your own	P1	P2, P3, M2
Online course	P2	P1, K2, M1
Keyword analysis	P3	M2
Model text	K1	K3, P1, K2
Extracurricular reading	K2	M3, P1, M2
Summary of key points	K3	M2, K1, P2, M3
teacher commenting	M1	P2, M2,
Writing template	M2	P1, K2
Expert lecture	M3	K1, P2

The visualization of the relevance semantics of the writing teaching resources selected in the experiment is shown in Fig. 4

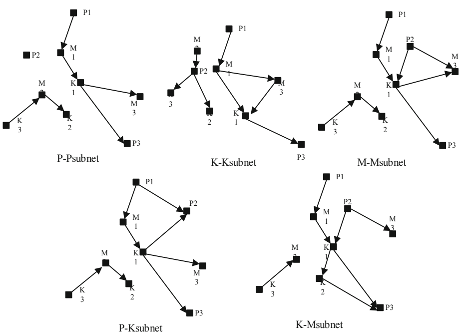


Fig. 4. Visualization results of resource association semantics

The semantic relations of nine node elements are obtained, which are correlation relationship, argumentation relationship and reference relationship. Selecting P-P, K-K and

M-M subnets to construct deep aggregation hypernetwork, the association relationship of different nodes can be obtained, as shown in Fig. 5.

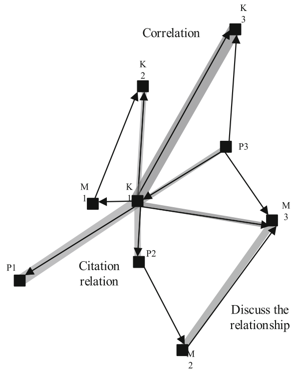


Fig. 5. Aggregated hypernetwork visualization results

The thickness of lines in the graph represents the strength of the relationship between different node elements. Three groups of experiments were conducted to obtain the visualization nodes in the deep aggregation hypernetwork, and the resource set of the integrated nodes was constructed by UCINET software.

3.2 Experimental Results

Results of the First Group of Experiments

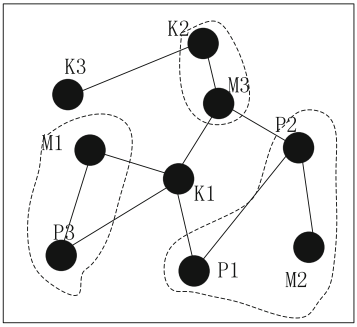
The results of the three groups of experiments for 9 node elements are shown in Fig. 6

As can be seen from Fig. 6, the node set of the resource set integrated by group B and group C is relatively loose. Group B constructs the association semantics of P2, M2 and K2, m3, while group C only constructs the association semantics of K2 and M3, and nodes P3 and M2 do not have a clear relationship with other nodes. However, there are more association relationships between nodes in group A than in group B and group C, and three associations of p1p2m2, k2m3 and m1p3 are constructed Semantics.

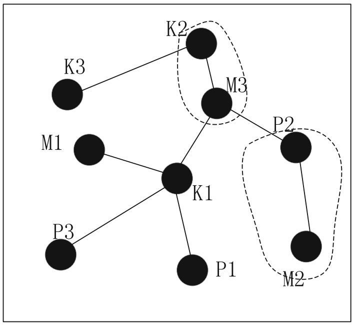
Results of the Second Group of Experiments

On the basis of the first group of experiments, we searched the related writing teaching resources, and the search time comparison results are shown in Table 5.

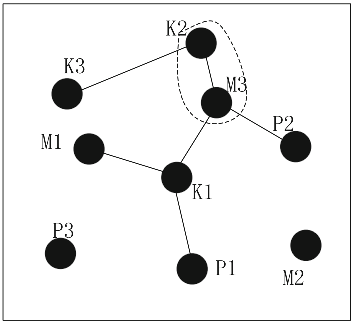
According to the data in Table 5, the average search time of group A is 4.1 s, and that of group B and group C is 11.5 s and 14.6 s respectively. Compared with group B and group C, the search time of group A is reduced by 7.4 s and 10.5 s respectively. To sum up, the degree of revealing the relevance of data nodes in this design system is higher than that of the two traditional systems, which improves the integration effect of writing teaching resources and shortens the search time of the same type of teaching resources.



(a) Results of group a construction



(b) Results of group B Construction



(c) Results of group C construction

Fig. 6. Comparison results of resource integration

Table 5. Resource search time comparison results (s)

Association Code	Group a search time	Group B search time	Group C search time
P1	4.3	11.2	13.8
P2	4.2	10.3	14.2
P3	3.9	11.5	14.9
K1	4.4	12.3	15.1
K2	3.8	10.2	13.8
K3	3.7	11.2	14.0
M1	4.2	12.9	14.2
M2	3.5	11.8	15.8
M3	4.9	11.7	15.3

4 Conclusion

The design system through the associated data and virtualization, deep aggregation of writing teaching resources, shorten the resource search time, improve the efficiency of resource sharing. However, there are still some deficiencies in this study. In the future, private cloud will be used to determine the optimal scale of resource sharing, so as to make resource sharing more stable and effective.

References

1. Mingfang, Z., Rui, T., Yu, X., et al.: The construction of excellent resources-sharing course platform of analytical chemistry and its application in online teaching. Guangdong Chem. Ind., **47**(15), 179–180+195 (2020)
2. Ying, F., Meng, L.: Design and research of online education course resource sharing based on cloud platform. Mod. Electron. Tech. **43**(1), 175–178 (2020)
3. Zeng, F.: Design and implementation of new engineering collaborative teaching platform. J. Guangdong Ind. Tech. Coll. **19**(3), 12–15+20 (2020)
4. Yongsheng, H., Sai, J., Jie, C.: Design of teaching platform based on meteorological big data and resource sharing. Comput. Technol. Dev. **30**(3), 132–136 (2020)
5. Hui, S., Ren, Y., Jun, C.: Research on the construction of online teaching and resource sharing management platform in Digital campus. China Med. Educ. Technol. **33**(1), 60–64 (2019)
6. Yuting, J.: Construction of distance learning resource sharing platform based on cloud computing. China Comput. Commun. **31**(21), 230–231 (2019)
7. Zhang, G.: A study on the sharing path of high-quality virtual simulation teaching resources in the view of regional integration. J. Jining Norm. Univ. **41**(6), 97–99: 103 (2019)
8. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
10. Liu, S., Lu, M., Li, H., et al.: Prediction of gene expression patterns with generalized linear regression model. Front. Genet. **10**(12), 120 (2019)

Design of Online Education Resource Sharing Model Based on Blockchain Technology

Li-ting Liu, Ran Ma, and Fei Gao(✉)

School of Information Science and Technology, Tibet University, Lhasa 850000, China

Abstract. The traditional online education resource sharing model has the defects of low control load and slow response time. Therefore, this study designs an online education resource sharing model based on blockchain technology. According to the principles of model construction, the framework of online education resource sharing model is built, and on this basis, the standards and granularity of online education resources are set. This paper selects the mode of "centralized management, distributed storage" to manage online education resources, analyzes the structure of blockchain, and realizes the transmission and access of resources based on the blockchain technology - equality network, so as to realize the sharing of online education resources. Take the "Computer Network" course as an example to build an experimental environment, make registered resources, and conduct educational resource sharing experiments. The experimental results show that compared with the traditional model, the proposed model has larger control load and shorter response time, which fully indicates that the proposed model has better resource sharing performance and is suitable for promotion and application.

Keywords: Blockchain technology · Online education resources · Resource sharing · Peer to peer network

1 Introduction

With the development of modern society, people increasingly hope that they can acquire knowledge in multiple fields and multiple disciplines without being restricted by space in their daily lives, which makes distance education emerge as the times require and continue to grow. As an important branch of distance education, online online education has entered thousands of households with the rapid popularization of the Internet. Obtaining knowledge through the Internet has also become one of the important means for countries to improve the education level of the people [1]. Statistics show that as of 2019, a total of 68 ordinary universities and colleges in my country have launched modern online education, opened 299 majors, built more than 20,000 online education resources and a batch of online education teaching and management system platforms, and established 9,000 There are a number of off-campus learning centers and teaching sites, of which a quarter are set up in the western region, extending high-quality education and teaching resources and support services to the western region, rural towns, urban communities,

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 205–217, 2021.
https://doi.org/10.1007/978-3-030-84386-1_17

various industries, enterprises, and military camps. Online education has promoted the popularization and informatization of higher education, and has become an important form of diversified, lifelong, networked and open continuing education in China [2].

However, while creating great value, online education network also exposes some problems. Although the websites providing online education services have their own high-quality education resources, they are still restricted by the region and service ability. In the whole Internet ocean, they are like isolated islands of information. Although each has its own advantages, they can not communicate with each other and it is difficult to realize the sharing of educational resources. It is an urgent problem for the people to integrate and share these resources [3]. In order to solve the above problems, we can introduce the resource sharing mechanism into the field of online education, manage the self-contained network education resources distributed in various regions, and provide a simple discovery and effective use mechanism to realize the sharing of educational resources.

According to the existing research results, the existing online education resource sharing models, such as the ontology-based distance education resource sharing model and the model, etc., have complex computing processes and are difficult to carry out distributed management of resources, thus having the defects of low control load and slow response time. In order to solve the shortcomings of the above traditional model, this study designed an online education resource sharing model based on blockchain technology. Among them, the blockchain technology is encryption technology, hash algorithm, hash function pointer, digital signature technology, binomial tree structure and P2P network propagation, etc., using a consensus mechanism to achieve decentralized authentication and supervision of business activities and distributed Bookkeeping, to realize the non-repudiation proof of the main behavior and content of business activities, and the use of time stamp technology in the block to ensure the traceability of the block content in time.

2 Design of Online Educational Resource Sharing Model

2.1 Construction of Online Education Resource Sharing Model Framework

Before building an online educational resource sharing model framework, it is first necessary to clarify the design principles of the model, then conduct a specific analysis of the various problems faced by the model, and finally make a reasonable design for each problem.

In order to enable the design model to provide various services stably and reliably, certain constraints are required to balance the creative efforts of application development and the standardization requirements of software design during model design and development. Therefore, the following principles should be followed when designing the model:

Principle 1: follow a unified open technology architecture. Open technical architecture has become the mainstream of information technology development. Facing the continuous expansion of model scale, the difficulty of model development organization is

becoming higher and higher, and the construction and management of super large application model are full of challenges. Therefore, it is necessary to follow the open technical architecture system in model design [4];
Principle 2: maintain a unified common basic resource model. The object managed by the model is the key component of the whole model. With the realization of multi-dimensional management view, the access to all management objects will inevitably be involved. Therefore, in the model design, we should establish a unified object model and dictionary, standardize the management and maintenance of public infrastructure resources, and create conditions for resource sharing.

Through the above description, the online education resource sharing model framework is built, as shown in Fig. 1.

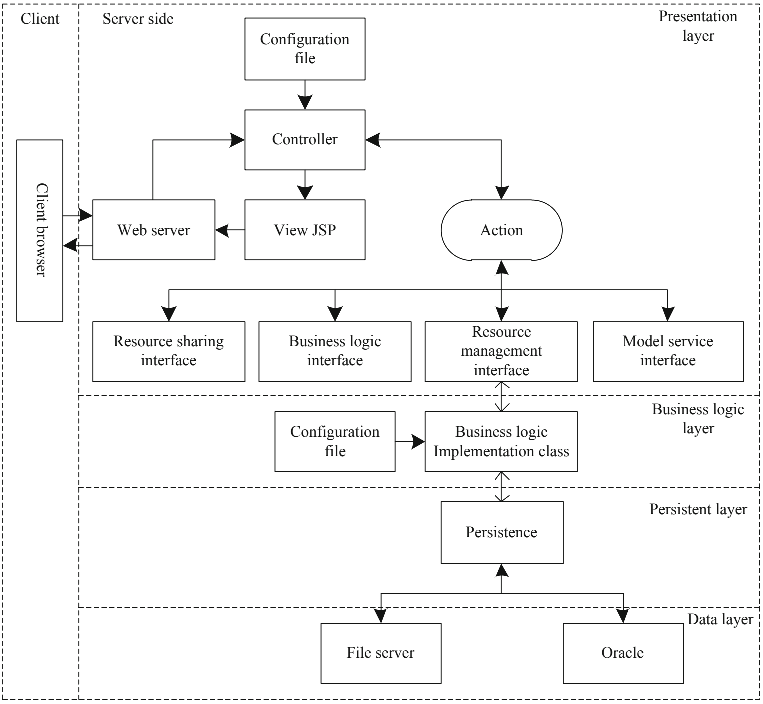


Fig. 1. Framework of online education resource sharing model

2.2 Resource Standard and Resource Granularity Setting

Based on the online education resource sharing model framework built above, set resource standards and resource granularity to prepare for the realization of subsequent resource management and sharing.

The development of online educational resources with reference to relevant standards is a way to solve the problem of co-construction and sharing of online educational resources [5, 6]. At the meeting to promote the implementation of educational technology standards, when analyzing the difference between the SCORM standard and the CELTS standard, Professor Zhu Zhiting pointed out that "the two are actually compatible. If the SCORM standard is truly complied with, the CELTS standard is actually complied with. Zheng Li from the Computer and Information Management Center of Tsinghua University said: "The product will be compatible with many popular international standards, and the fundamental point is to follow the basic national standards." Therefore, domestic products should first consider following our national standards. Therefore, the research adopts the national standard CELTS standard system for standardization. The standardized processing flow of educational resources includes steps such as description, organization, and packaging.

CELTS Learning Object Metadata Specification (LOM) is used to describe online education resources. The data elements of the learning object are organized in a tree structure, which is divided into three parts: "root node", "middle node" and "leaf node". Of these, only the "leaf node" has a specific value.

Learning objects can be described according to the learning object metadata provided by the LOM specification, but the specification does not specify how the metadata can be represented in a way that is computer readable. XML documents are easy to be transmitted and exchanged on the Internet. Therefore, CELTS, the XML Binding Specification for Learning Object Metadata, was selected as the standard for describing the basic information of learning objects that can be transmitted on the Internet.

For the content packaging of online educational resources, the CELTS content packaging specification is adopted. The content packaging information specification regulates the naming of the content manifest file: the learning content published in accordance with the content packaging information specification standard must include a content manifest file, and this file is named celtsmanifest.*, if there is no such file, the resource package will not be deal with. The content manifest file and its supporting files should be placed in the root directory of the package exchange file or package image. The content packaging information specification also specifies the elements of the content list in detail, such as name, corresponding English name, description, binding, multiplicity, type and remarks [7].

Based on the description of metadata information, the content packaging information specification defines a reasonable and effective way to organize and package learning content, which is easier to effectively manage, share, exchange and retrieve resources. Therefore, this study takes it as the final standardization specification of resources. The XML description standard corresponding to content packaging information specification is CELTS, which is the XML binding specification of content packaging [8, 9]. This study will be designed in strict accordance with this specification in the process of resource production and resource standardization verification.

Learning objects refer to various entities for learning. A course, a picture, a set of question banks, a video, etc. can all be considered as learning objects. Learning objects can be divided according to the size of the granularity. Low-granularity resources refer to individual entities. Such entities have no internal organizational structure, such as text, pictures, and videos. High-granularity resources are composed of low-granularity resources with internal Learning objects with complex organizational structures, such as courses or question banks; medium-grained resources are somewhere in between, and have internal organizational structures, but they tend to be relatively simple.

The definition of resource granularity is shown in Fig. 2.

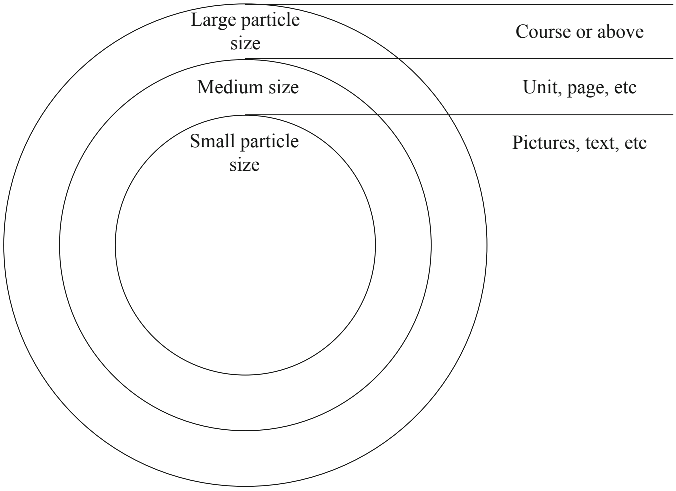


Fig. 2. Definition of resource granularity

The LOM specification and content packaging specification do not care about the issue of resource granularity. The LOM specification and CP specification can be used to describe and package any granular resources. However, for standardized resource sharing, only packaged resources can be published and used on the model. The model designed in this research supports resources of various granularities, such as: videos, courseware, texts, online courses, etc. At the same time, considering the issue of mutual recognition of credits, only resources with a granularity above the curriculum can achieve the goal of mutual recognition of credits. Therefore, this study stipulates that if the resource type uploaded and registered is “online course” or above, in the metadata information of the course element, the cost value of the sub-element of the rights element is set to “course specific credits”, and this value for other low-granularity resources Set to “resource value points or other virtual currency number”, the use of virtual currency means no actual charge, which shows the principle of resource openness.

2.3 Online Education Resource Management

Centralized and distributed storage, as two storage methods often used in resource storage, have their own advantages and disadvantages. This study combines centralized and distributed storage to form a “centralized management, distributed storage” storage mode, so as to improve the efficiency of resource retrieval and management under the premise of decentralized resource center access pressure [10]. Specifically speaking, this storage method is to store the low granularity physical file resources in the user upload package transmission files in various management models, and for non-standard resources, each resource file is directly stored in each existing learning model, and the resource description information and resource package related information are stored in a centralized way. The unified management mode is shown in Fig. 3.

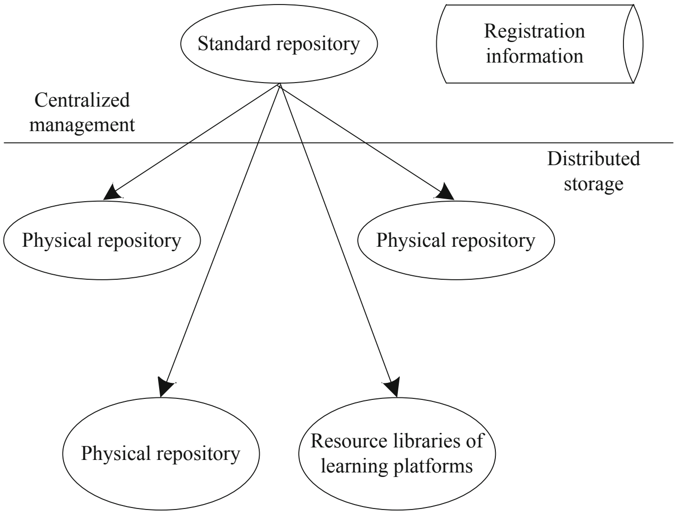


Fig. 3. "Centralized management, distributed storage" mode

The "standard resource package" is stored in the standard resource library. The standard resource package depends on the "physical resources" in the physical resource library, that is, low-granularity resources, and the "registration information" comes from the description information in the "standard resource package" [11].

The management model of learning resources is divided into three levels:

Level 1, the resource production layer. Users conduct standardized resource development according to standardized specifications or resource production software, complete resource production, and register through the resource registration interface;
Level 2, the resource storage layer. Provide resource registration interface, conduct content standardization and legitimacy audit on uploaded resources, store resources and store resource metadata information after passing the audit;
Level 3 is the resource publishing layer. The registered resources can be published on the Web platform for users to search and access.

Combined with the "centralized management, distributed storage" mode and the hierarchical management model of learning resources, the model resource management process, that is, the resource flow process, is obtained. The resource management process is divided into the following six steps:

Step 1: the resource producer packages the physical resources distributed in different places according to the standard specifications, forms the resource bundle, and collects the access address of each low-granularity resource in its own learning model;

Step 2: the resource package is uploaded to the model through the registration interface provided by the resource sharing model. According to the interface provided by the model, non-standard resources form resource description files and register resources in the model;
Step 3: the resource sharing model carries out standardized detection of resources. Through the detection, metadata information is extracted, and the metadata information is stored in the registration information database. At the same time, the low granularity resources are stored in the distributed physical resource repository;
Step 4: the resource sharing model stores the resource package into the standard resource package library;
Step 5: if the resource passes the approval of the resource sharing model, the model obtains the resource metadata information from the registration information base and publishes it to the model for users to use;
Step 6: the resource details obtained by the user are obtained from the resource package by the model.

2.4 Online Education Resource Sharing Based on Blockchain Technology

Based on the resource standards, resource granularity and management mode set above, blockchain technology is introduced to realize the sharing of online education resources. The specific implementation process is as follows:

The structure of the blockchain is divided into a block header and a block body. The data in the block is the transaction record stored in the merkle tree. The construction of a Merkle tree is a process of calling recursively to calculate the hash value. The calculation rule is usually SHA256 or MD5. Due to the binary tree characteristics of the merkle tree, the merkle tree has good scalability and can record a large amount of information in several layers.

The block header includes the root value of the merkle tree, the hash value of the previous block, timestamp, random number, and version number.

Hash value is a very important attribute in the block header. The hash value of the previous block obtained by hash calculation ensures that the block is stored in chain. At the same time, this value also ensures that the block information can not be tampered with. Because the calculation process needs to combine the characteristics of the current block, if you want to modify the information in a block, you need to modify the information of all blocks after the block, and this needs to cost a lot. Therefore, the hash algorithm ensures the security of the model.

Timestamp is another important component of the block structure. Since there is no central server in the network, there may be a delay in the time between each node. In order to avoid the occurrence of information asymmetry, it is necessary to detect the nodes in the model. The time includes long and transaction storage. The entire node block is designated as the priority block, and other nodes discard their own blocks and use the priority block instead. The timestamp stores the blockchain in time sequence to facilitate block sorting and block query. Combined with the hash value, the separation of the generation block order and the model time can be realized, and the purpose of distributed storage can be achieved.

Blockchain has the following characteristics:

Characteristic 1: Security. The distributed storage of blockchain ensures the decentralization of data interaction and avoids human intervention. If you want to tamper with the data in the blockchain, you need to control 51% of the nodes in the whole network. On the data transmission level, if the attacker outside the node wants to hijack the data through P2P network to tamper and then send, it is very difficult to crack the private key in encrypted transmission. At the information integrity level, if you want to modify the information of a node, you need to modify all the information in the remaining chain. These are obtained by strict encryption according to the hash algorithm, and the security is guaranteed because the hash algorithm is irreversible.

Characteristic 2: Transparency. Blockchain has the characteristics of searchability, traceability, and block chain timing. The completed behavior information is fully recorded and can be checked. Any node can query any block information in the blockchain, which greatly improves the transparency of interaction [12].

Characteristic 3: Participation. The generation and storage of blockchain depend on user nodes. If the nodes are insufficient or the participation is not high, the integrity of the blockchain cannot be guaranteed: when querying or calling the blockchain, if the amount of data stored by the selected node fails to meet the expectation, there will be missing blocks in the collected whole chain. In addition, in the process of blockchain storage, new blocks are constantly generated, and new data need to be stored constantly, which will have a certain pressure for each node participating in the behavior. Although the participation ensures the independence in the interactive communication, it also brings potential overhead and security risks to the model itself.

Blockchain technology mainly includes peer-to-peer networks, encryption algorithms, and hash algorithms. Based on online education resource sharing needs, peer-to-peer network blockchain technology is selected as the supporting technology for this research.

The role of P2P network in blockchain is to connect all nodes, so as to ensure that any two nodes can establish interconnection communication without relying on a third party, and transmit data information in the form of broadcast, so that the model can run normally. There are two key concepts in P2P networks:

One is broadcasting mechanism. In P2P network, there is no centralized special node and hierarchical structure in theory. Each node will undertake the work of network routing, verifying information, disseminating information, discovering new nodes and so on. The way of blockchain publishing information is broadcast, and the information generated in the network will be broadcast to all nodes. In the process of broadcasting, the node will verify whether the message is legal, and then judge whether to broadcast to the adjacent nodes. As long as the information is received by more than 51% of the nodes, the information is considered to be passed and can be recorded in the new block. If the node judges that the information is wrong, it discards the information and terminates the broadcast operation. In addition to the verification of transaction information, P2P broadcast mechanism is also used to confirm the permissions of nodes. By calculating the dynamic random number and having the most complete record, the nodes broadcast the new block data to the whole network. Other nodes discard their own blocks, receive the block data obtained through broadcasting, and store the new block into the blockchain after verifying the authority. The broadcast mechanism implemented in this research will be realized through the network process broadcast mechanism, that is, using socket management framework, the block information and legal education resource information will be transmitted to the nodes except themselves.

Second, the consensus mechanism. There is no centralized centralized management model in the blockchain network. It is all the participating nodes that play a key role. The problem to be solved by blockchain technology is to let the nodes interact to form a storage system that is simple, easy to use, low cost and can be grouped and managed.

Whether the two points of data consistency and data availability can be guaranteed in the resource sharing network model are two factors to be selected in the model design. In online education resource sharing, the POW consensus mechanism is used to ensure the consistency of the data, that is, the method of “mining” calculation is adopted: the nodes participating in the calculation use the traversal calculation method to withdraw a random number according to a certain hash rule. It is satisfied that the hash calculation result of the current block header is less than a certain number. The node that obtains the random number obtains the authority, and the calculation process ensures the security of the consensus and the consistency of the data. The blockchain technology of this research will adopt a more reasonable Pos mechanism, that is, the integrity of the block information recorded by the node will determine the degree of difficulty in the consensus process. As long as the node has relatively complete blockchain data, the consensus process will be calculated. The power consumption will be greatly reduced, so as to prevent the learner from interfering with the calculation of the learning part when using it.

Through the above blockchain technology, the application of equation network, the sharing of online education resources is realized, which provides a reliable support for the development of China’s education field.

3 Experiment and Result Analysis

In order to verify the performance difference between the online education resource sharing model based on blockchain technology and the traditional model, the MATLAB software platform is used to design the experiment. The specific experiment process is as follows.

3.1 Construction of Experimental Environment

The experimental environment is shown in Fig. 4. Using a PC as the web server, using a PC as the database server, using PC as the physical resource storage server, and using PC as the client.

In the experimental part, Tomcat is selected as the Web container and Oracle 10g is selected as the database server. At the same time, the project was built according to the model architecture, and MyEclipse was selected as the auxiliary tool for project development in this study.

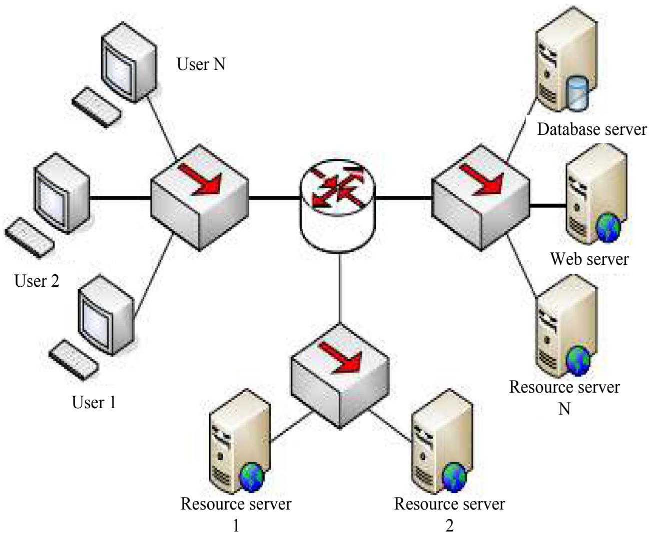


Fig. 4. Experimental environment

3.2 Resource Production Registration

The experiment took the "computer network" course as an example, and made the "computer network" course according to the steps of standardized resource production.

First, analyze the structure of the "computer network" course, which is mainly divided into two units, each unit is divided into four modules, and each module contains varying amounts of content, as shown in Fig. 5.

After analyzing the structure, prepare the low granularity resources. After the preparation of resources, we describe the resources. We use the standardized resource description tools provided by the model, which can greatly reduce the cost of learning XML. In addition, "animation demonstration", "video lecture" and "learning test" are remote resources stored on Web server, while "knowledge map" and "electronic courseware" belong to physical resources and need to be packaged and uploaded. When the resources are packaged, the correctness of their respective positions should be ensured.

For resource packs that do not conform to the specification, the model will prompt accordingly, such as lack of celtsmanifest.xml file, or celtsmanifest.xml file syntax error. Using the model's resource standardization tool to automatically generate celtsmanifest.xml can reduce the possibility of grammatical errors, but the relative scalability is not strong. Manually writing xml by yourself has strong scalability, which also increases the probability of corresponding errors. If there is no error in the resource detection, the model will prompt that the resource upload is successful.

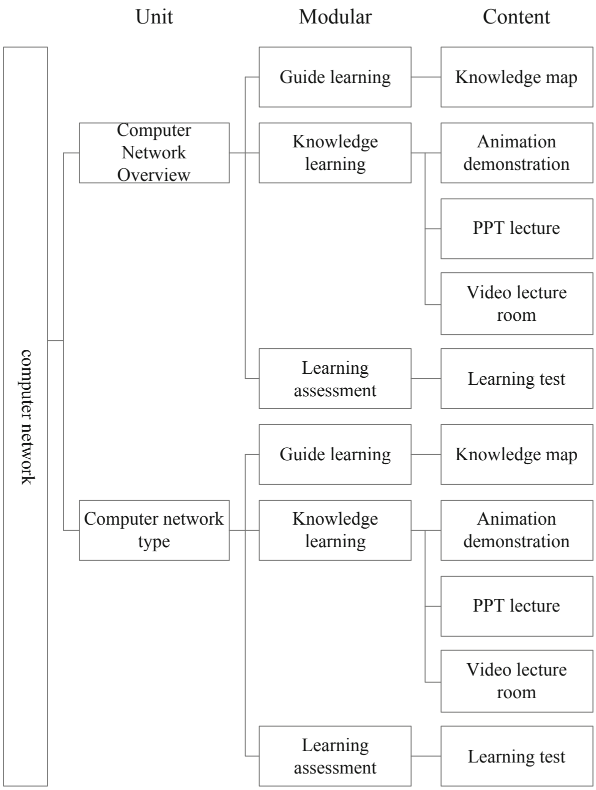


Fig. 5. "Computer network" course structure

3.3 Analysis of Results

According to the experimental environment and registered resources, the experimental data are input into SPSS software for centralized processing. Finally, the model performance evaluation data is obtained, as shown in Table 1.

As shown in Table 1, compared with the traditional model, the control load of this model is larger and the response time is shorter, which fully shows that the resource sharing performance of this model is better.

Table 1. Model performance evaluation data table

(1) Control load data		
Number of experiments/time	Control load (MB)	
	Paper model	Traditional model
1	425.46	301.25
2	462.13	302.54
3	495.58	325.48
4	480.25	315.42
5	501.49	395.48
6	528.45	345.20
7	546.21	385.74
8	498.57	401.20
9	462.01	401.28
10	429.78	400.17
(2) Response time data		
Number of experiments/time	Response time (s)	
	Paper model	Traditional model
1	10.25	15.49
2	10.32	11.25
3	10.00	15.49
4	9.56	16.00
5	9.81	15.40
6	10.25	15.27
7	11.54	15.09
8	11.59	14.53
9	11.90	16.28
10	10.57	16.84

4 Conclusion

Aiming at the problems of low control load and slow response time existing in the traditional online education resource sharing model, a new online education resource sharing model is constructed by applying block chain technology. This model greatly improves the model control load and reduces the model response time, which proves that it has strong load capacity and fast response speed, which can provide users with better online education resource sharing experience, and also lays a foundation for the development of education resource sharing in China.

References

1. Xu, Z., Yang, D., Li, W.: Microgrid group trading model and solving algorithm based on blockchain. Energies **12**(7), 1292 (2019)
2. Zhang, J.: Interaction design research based on large data rule mining and blockchain communication technology. Soft. Comput. **24**(21), 16593–16604 (2020)
3. Alcarria, R., Bordel, B., Robles, T., et al.: A blockchain-based authorization system for trustworthy resource monitoring and trading in smart communities. Sensors **18**(10), 3561–3561 (2018)
4. Bartholomew, S.R., et al.: Factors influencing student success on open-ended design problems. Int. J. Technol. Des. Educ. **28**(3), 753–770 (2018)
5. Jiang, X., Yu, F.R., Song, T., et al.: Blockchain-enabled cross-domain object detection for autonomous driving: a model sharing approach. IEEE Internet Things J. **7**(5), 3681–3692 (2020)
6. Zou, J., Ye, B., Qu, L., et al.: A proof-of-trust consensus protocol for enhancing accountability in crowdsourcing services. IEEE Trans. Serv. Comput. **12**(3), 429–445 (2019)
7. Rawat, D.B.: Fusion of software defined networking, edge computing, and blockchain technology for wireless network virtualization. IEEE Commun. Mag. **57**(10), 50–55 (2019)
8. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): E-Learning, E-Education, and Online Training, pp. 1–374. Springer International Publishing, Heidelberg (2018)
9. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
10. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
11. Hu, P., Zhao, C.L., Liang, Y.Z., et al.: Research and development of PEI interactive evaluation model for online educational resource. Educ. Res. **24**(2), 113–120 (2018)
12. Fan, Y., Liu, M.: Design and research of online education course resource sharing based on cloud platform. Mod. Electron. Tech. **43**(1), 175–178 (2020)

Conflict Coordination Method of Heterogeneous Educational Resources Sharing Based on Blockchain

Jiang Li, Xiao-tian Yang, and Fei Gao(✉)

Tibet University School of Information Science and Technology, Lhasa 850000, China

Abstract. In order to improve the resolution of resource sharing conflicts, a blockchain-based heterogeneous education resource sharing conflict coordination method is proposed. Build a distributed mobile agent dynamic collaboration network based on blockchain to provide a new distributed computing model. Design the process of the distributed mobile dynamic collaboration network, including the system process of "create" behavior, the system process of "invite" and "accept/reject" behavior, the system process of "update" and "complete" behavior, the system process of "query" and the "response" behavior system process. Based on the distributed mobile dynamic collaboration network, the conflict coordination model of heterogeneous education resource sharing is designed to realize the conflict coordination in heterogeneous education resource sharing. Through comparative experiments, it is verified that the conflict resolution degree of this method is higher than that of traditional methods, and the conflict coordination performance is improved.

Keywords: Blockchain · Heterogeneous educational resource sharing · Conflict coordination · Mobile agent

1 Introduction

To realize the sharing of high-quality education resources among colleges and universities can alleviate the shortage of high-quality education resources, improve the overall quality and level of education in Colleges and universities, and also enable colleges and universities in the new situation to continuously explore new development and seek new breakthroughs in the sharing of high-quality education resources [1, 2]. Research on the methods of sharing conflicts of heterogeneous educational resources can promote the improvement of high-quality educational resource sharing measures in colleges and universities, and further promote the development of higher education. However, there are often conflicts in the sharing of heterogeneous educational resources, so the coordination has become a key research issue in the sharing of heterogeneous educational resources [3].

At present, the coordination and resolution of resource sharing conflicts mainly include the governance method of regional water resources sharing conflicts from the

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 218–229, 2021.
https://doi.org/10.1007/978-3-030-84386-1_18

perspective of policy network theory. Based on the theoretical perspective of policy networks, the discussion of regional water resources sharing conflicts is carried out. By clarifying the main body of the governance network of regional water resources sharing conflicts, analyze the interaction and behavior of intergovernmental networks and issue networks involved in the policy process. Apply the policy network theory to the process of regional water resources sharing conflict management, and explore how the network subjects play a role in the process of policy formulation and implementation through network analysis. Research on context aware based association analysis and recommendation model of learning resources, combined with context aware technology and multi-level, multi relationship association algorithm to realize personalized recommendation of learning resources, explored the process of behavior feature analysis and extraction based on context aware, and elaborated the mechanism based on context description and association recommendation, In order to improve the quality and effect of resource sharing service. Although the above methods can achieve resource sharing coordination, there is a problem of low conflict resolution.

In order to solve the problems existing in traditional methods, the blockchain is applied to the research of conflict coordination of heterogeneous educational resources sharing, and a new method based on block chain is proposed. The innovation points of this method are as follows:

(1) In order to provide a new distributed computing model, the dynamic cooperation network of distributed mobile agents is constructed based on blockchain technology.
(2) The process of distributed mobile dynamic collaboration network is designed, and the conflict coordination model of heterogeneous educational resource sharing is designed to realize the conflict coordination in heterogeneous educational resource sharing.
(3) Through comparative experiments, it is verified that the conflict resolution degree of this method is higher than that of traditional methods, and the performance of conflict coordination is improved.

2 Blockchain-Based Heterogeneous Education Resource Sharing Conflict Coordination Method

2.1 Construction of Distributed Mobile Dynamic Cooperation Network

The distributed mobile agent dynamic collaboration network is constructed based on the blockchain to provide a new distributed computing model. In this model, each mobile agent represents a mobile user. The mobile agent is in the wireless communication network and the intelligent mobile terminal. With the support, it will have the ability to perceive changes in the environment, service resources and their changes, and to make independent decisions and communicate with each other [4].

In the dynamic cooperative network model of distributed mobile agent, the agents involved in computing can be divided into two types: Mobile (user) agent and service (provider) agent. Among them, the service agent is static, it only publishes the service plan, accepts the service reservation and the scheduled change; the mobile agent is different from the service agent, it first formulates the itinerary plan based on the personal goal and the related service agent's service reservation, on this basis, it cooperates with other mobile agents, dynamically optimizes its own travel plan, and according to the travel plan, it changes the service plan from one to the other. When a location moves to another location, the mobile agent has the ability of cooperative optimization and mobility.

The dynamic cooperation and optimization capability between mobile agents is the main feature of the distributed mobile agent cooperation network model, which increases the flexibility and complexity of computing [5]. In order to distinguish each other, all mobile agents have a globally unique identifier, and it will not change during its life cycle.

Life Cycle Design of Mobile Agent

Whether it is a service agent or a mobile agent, they enter its cycle cycle from the beginning to the end when they are created. The life cycle of an agent defines its different life states and the transition states between states [6]. The difference is that mobile agents can take the initiative to enter the migration state. In the distributed mobile environment, in order to facilitate one mobile agent to confirm whether it can invite another related mobile agent to join the dynamic cooperative network, the life cycle of mobile agent is divided into the following five states:

(1) Initial state: When the mobile agent enters the wireless network environment and is created, it enters the initial state. The mobile agent in the initial state can either choose to develop a personal action plan or leave the mobile environment. If a mobile agent has formulated a personal action plan, its state will automatically migrate to the cooperative state; if it chooses to leave the mobile environment, its state will automatically migrate to the offline state.

(2) Cooperative state: A mobile user in a cooperative state indicates that this user hopes to establish a dynamic collaboration network with other mobile users to improve their personal action plan according to a collaboration strategy. When a mobile user initiates a creation or has joined a dynamic collaboration network, its state will automatically migrate to the locked state; if it does not want to cooperate with other mobile users, it can change its own state to a satisfied state or an offline state [7].

(3) Locked state: If a mobile user is in a locked state, it indicates that it is cooperating with other mobile users in a dynamic collaborative network. Until it exits the current collaboration network, it cannot join other dynamic collaboration networks. When it exits the current collaboration network, its status will automatically shift to a cooperative state.

(4) Complacency: complacency indicates that current mobile users do not expect to cooperate with other users at the moment. Mobile users in the satisfied state will refuse to join all dynamic collaboration networks unless they re migrate their personal status to cooperative state.

(5) Offline state: indicates that the user has left the mobile environment and the life cycle has ended.

The five state transition diagram reflects the changes and relations among the five states in the mobile agent life cycle. The five state transition diagram is shown in Fig. 1 below.

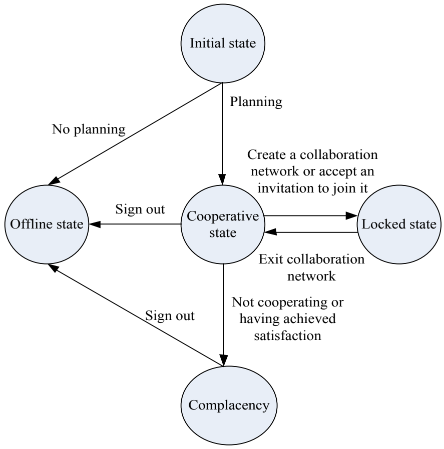


Fig. 1. Five state transition diagram

Design of Interaction Mode Between Mobile Agents

In its life cycle, mobile agent needs to interact with the external environment, which includes not only the interaction between mobile agents, but also the interaction between mobile agents and service agents. In order to express its interactive semantics, the following communication modes and message modes are formulated.

Create: Mobile users create a dynamic collaboration network.

Invitation: Invite relevant mobile users to join a dynamic collaboration network created by sharing a variable.

Accept/Reject: Mobile users accept/reject invitations from other mobile users to join a dynamic collaboration network.

Update: In the dynamic collaboration network, notify its sub-node users to modify their personal action plan.

Completion: In the dynamic collaboration network, notify the parent node user that he has completed the modification of his personal action plan.

Exit: Indicates that the mobile user is ready to exit the current dynamic collaboration network.

Inquiry: Indicates that the current mobile user wants to learn about the reservation of the service plan from a certain service provider, and can also inquire about the actual mobile users that affect the current mobile user plan.

Response: Indicates that the service provider is responding to a mobile user's inquiry request for service plan reservations or other related information [8].

Message Pattern Design

The message mode between mobile agents is designed, that is, the message transmission format is: nameID: State:Action.

The message passing format between service provider and mobile agent is: nameID: action.

Among them, nameID represents the ID of the mobile agent participating in the cooperation or the ID of the service provider, state represents a certain state of the mobile agent in five states, and action represents the actions that the agent in a certain state can perform and the action that the service provider can perform. For example, at this time, a message passing format is agent 1: Cooperative State: accept/reject, which indicates that mobile agent 1 is in cooperative state at this time. It can accept or reject the invitation sent by other mobile users to join a dynamic collaboration network. The cooperative mobile agent can perform the create and accept/reject operations respectively, and the locked mobile agent can perform the invitation and exit operations.

2.2 Network System Process Design

Design the process of the distributed mobile dynamic collaboration network, including the system process of "create" behavior, the system process of "invite" and "accept/reject" behavior, the system process of "update" and "complete" behavior, the system process of "query" and The "response" behavior system process.

Combined with the mobile user life cycle state, the system flow chart under different interaction behavior states can be obtained. The "create" behavior is sent by mobile users. Because they share a certain variable, the mobile users in the cooperative state send a message of "create" dynamic collaboration network to the service provider, requesting to create the network for cooperation [9]. The system flowchart of the create behavior is shown in Fig. 2.

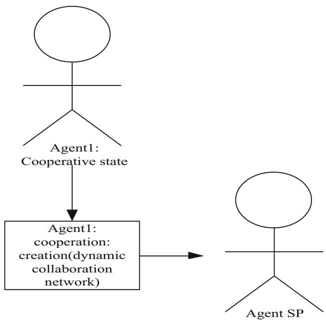


Fig. 2. System flow chart of "create" behavior

When a mobile user is in a "cooperative state", because a certain variable is shared, the relevant mobile user of this variable can be invited (at this time, the relevant mobile user must be in the cooperative state to send the invitation) to join the created collaboration network. After weighing, the relevant mobile user can choose to "accept" or "reject" the invitation. If the invitation is accepted, the relevant mobile user can use the The user status is set to "locked", otherwise it is still cooperative. The behavior system flow chart of "invite" and "accept/reject" is shown in Fig. 3.

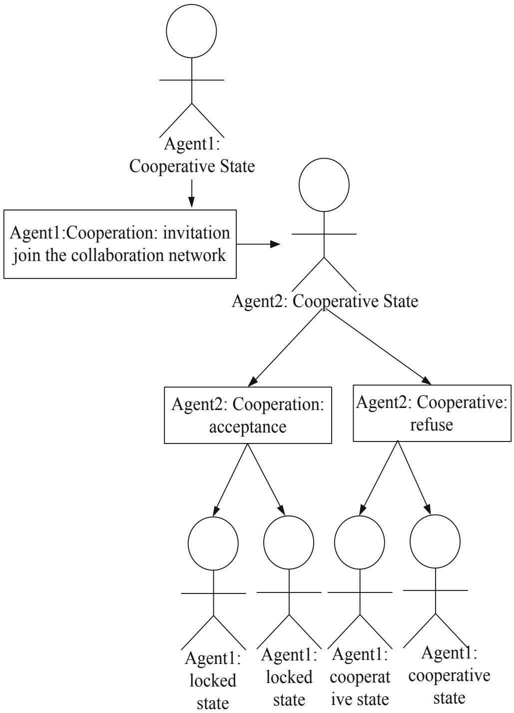


Fig. 3. "Invite" and "Accept/Reject" behavior system flowchart

The mobile user in the locked state sends the "update" message of the shared variable to the relevant mobile users participating in the cooperation in the collaborative network platform that affect the shared variable. After the relevant mobile user accepts the update, the service provider modifies the relevant information and will "complete" The information is sent to the mobile user, and after the mobile user information is updated, the respective status is set to the cooperative state. The system flowcharts of "update" behavior and "complete" behavior are shown in Fig. 4 and Fig. 5 below, respectively.

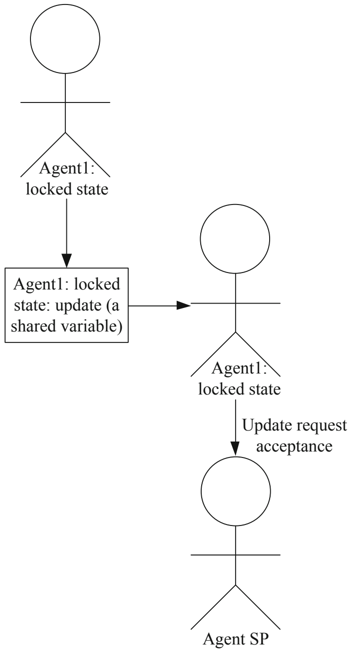


Fig. 4. Flow chart of "update" behavior system

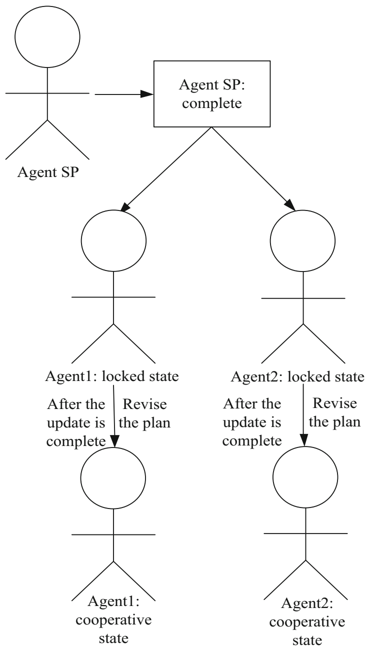


Fig. 5. "Complete" behavior system flowchart

When mobile users are in a cooperative state, they can query the service provider for information about mobile users that affect a certain shared variable and other service reservations, and the service provider will also send a response message to the mobile users regarding relevant information. The flow chart of the "query" and "response" behavior system is shown in Fig. 6 below.

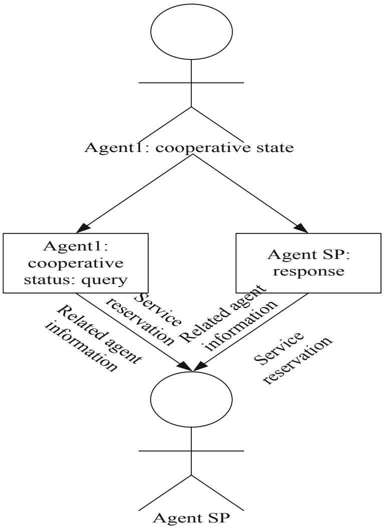


Fig. 6. Flow chart of "query" and "response" behavior system

2.3 Conflict Coordination

Based on the distributed mobile dynamic collaboration network, the conflict coordination model of heterogeneous education resource sharing is designed to realize the conflict coordination in heterogeneous education resource sharing. The conflict coordination model of heterogeneous educational resources sharing is composed of resource working state monitoring module, resource life cycle management module, resource conflict coordination management module and event processing module.

Resource Working Status Monitoring Module

The resource working state monitoring module is connected to the equipment resources in the system. No matter what kind of equipment resource, it will have its working state, and can use the finite state machine to describe the working state model. The resource working state monitoring module is based on the finite state machine, According to the resource's working state transition diagram, to monitor the working state of the allocated resources, because the state of the resource is dynamic and may change at any time, so it can be monitored and updated in real time to facilitate the life of the resource The cycle management module and conflict management module are used as reference [10]. The application developer models the resource state machine, which is related to the application. After the modeling, the custom state machine code is generated. On the one hand, it reduces the workload of the application developer and reduces the difficulty. On the other hand, it standardizes development standards and facilitates RSM. Unified management.

Resource Lifecycle Management Module

The resource life cycle management module is mainly responsible for the allocation, searching, adding and deleting resources of sharing heterogeneous educational resources, as well as reminding of resource conflicts. The most important part is the acquisition, allocation and release of resources. The resource life cycle management module also records the operation of the currently allocated and shared heterogeneous educational resources, monitors which applications occupy the allocated resources and the time allocated to the applications, and contacts the resource working status detection module to detect whether the resource has completed the task, and can send a message to inform the lifecycle manager to release the resources. The application sends out the use resource message and applies for resources to the lifecycle manager module. The lifecycle manager finds the resources that can realize its functions, including idle and allocated resources. If there are idle resources directly allocated and no idle resources are available, the resource lifecycle management module allocates the allocated resources to the application for reuse according to the resource status monitoring and conflict detection.

In view of the limited resources of the physical world, applications connect multiple underlying resources, and resource connections that are no longer needed or completed tasks should be released to ensure the stability of the model and ensure that other applications can complete tasks. Therefore, resources must be Manage complex life cycle scenarios. The solution used is to separate resource use from resource management and add an independent life cycle manager, which is only responsible for managing and maintaining resources.

Resource Conflict Coordination Management Module

The resource conflict coordination management module is responsible for the inspection and resolution of conflicts in the sharing of heterogeneous educational resources. For time-triggered control, the order of tasks in the queue can be preset according to the order of time, and control messages can be sent to control resources when the specified time is reached. This is a progressive control method. By allocating resources according to the overlap in time, avoid conflicts. Moreover, due to the complexity of the physical world, time-triggered control is not enough to change and control the physical world truly and effectively, and the time description is too absolute. If you simply consider the absolute time, the expected effect may not be achieved, and the application is easy Resources are released. At the same time, in event-driven control, the order of scheduling resources is often unknown and unreliable.

In the event triggered control, the action command after the event is triggered is put in the queue, and whether the action command can be executed is determined according to the running state and usage of the current resource. If the model is judged as a conflict event in the detection process, the analysis record is saved, and the mixed preemption strategy of resource resolution is called to schedule the tasks. The tasks that fail to preempt the resources and the tasks that are preempted are saved to the queue. After the resources are released, the tasks with high priority in the queue are scheduled. If the new task successfully preempts the resources, it will execute the previously saved action commands to deal with random events in real time, which ensures the ability to dynamically coordinate resources.

Event Processing Module

The event processing engine mainly consists of three parts: event collector, event sender, and event handler. The event handler processes the subscription to the event from the application, the event collector responds to the triggered event, and the event sender sends notifications to the application that has subscribed to the corresponding message. At the same time, after the conflict is resolved, the model uses the event processing engine to send notification messages to the applications that are preempted resources.

3 Conflict Coordination Experiment

3.1 Experimental Design

In the experiment, five universities were selected as samples to obtain their heterogeneous educational resource sharing and conflicts. The five selected colleges are D colleges, H colleges, J colleges, K colleges, and G colleges. These colleges are all in a densely populated area with certain shared practices, and the colleges are of different types.

In the experiment, the cooperation depth of dynamic collaboration network is set to 3, and the maximum number of sub nodes allowed under each node is 3.

In the experiment, several universities use the same network to share heterogeneous educational resources. The network topology of each university is shown in Fig. 7.

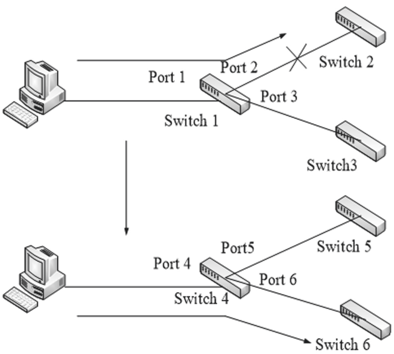


Fig. 7. Network topology deployed by each university

Use the blockchain-based method of heterogeneous educational resource sharing conflict coordination to coordinate conflicts in the sharing of heterogeneous educational resources in several universities, and obtain the conflict resolution data as experimental data. In order to make the experimental results comparable, the method of heterogeneous educational resource sharing conflict coordination based on situational awareness is used as the comparative method in the experiment to conduct comparative experiments. Also obtain the conflict resolution data of the heterogeneous educational resource sharing conflict coordination method based on context awareness as the comparative experimental data.

3.2 Experimental Result

The experimental data of the conflict resolution comparison between the blockchain-based heterogeneous educational resource sharing conflict coordination method and the context-aware heterogeneous educational resource sharing conflict coordination method are shown in Table 1.

Table 1. Comparative experimental data of conflict resolution

Proportion of conflict resources (%)	Conflict resolution rate (%)	
	Method based on blockchain	Context-based approach
2	98.36	92.01
4	98.29	91.98
6	98.25	91.98
8	98.22	91.97
10	98.21	91.97
12	98.19	91.95
14	98.18	91.90
16	98.18	91.89
18	98.16	91.89
20	98.15	91.88
22	98.12	91.86
24	98.10	91.84
26	98.07	91.84
28	98.02	91.83

According to the data in Table 1, with the gradual increase in the proportion of conflict resources, the conflict resolution of the method in this paper and the traditional method has shown a gradual decrease, but the conflict resolution of the method in this paper is significantly higher than that of the traditional method. The maximum value of resolution is 98.36% and the minimum is 98.02. The maximum value of conflict resolution of traditional methods is 99.01%, and the minimum is 91.83. Through the comparison, it can see that the method in this paper has a stronger ability to coordinate the sharing conflicts of heterogeneous educational resources.

4 Conclusion

Research on the methods of sharing conflicts between heterogeneous educational resources can promote the improvement of high-quality educational resource sharing measures in my country's universities and further promote the development of higher education. In this context, a blockchain-based method for coordinating heterogeneous educational resource sharing conflicts is proposed. The experimental results show that this method has improved the degree of conflict resolution, which is of great help to the improvement of the degree of heterogeneous educational resource sharing.

References

1. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
2. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
3. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**(99), 62412–62420 (2019)
4. Guo, S., Hu, X., Zhou, Z., et al.: Trust access authentication in vehicular network based on blockchain. China Commun. **16**(6), 18–30 (2019)
5. Zhong, L., Wu, Q., Xie, J., et al.: A secure large-scale instant payment system based on blockchain. Comput. Secur. **84**(7), 349–364 (2019)
6. Alcarria, R., et al.: A blockchain-based authorization system for trustworthy resource monitoring and trading in smart communities. Sensors **18**(10), 3561–3561 (2018)
7. Li, M., Shen, L., Huang, G.Q.: Blockchain-enabled workflow operating system for logistics resources sharing in E-commerce logistics real estate service. Comput. Ind. Eng. **135**(12), 950–969 (2019)
8. Yilong, Y., Quan, Z., Peng, L., et al.: MicroShare: privacy-preserved medical resource sharing through microservice architecture. Int. J. Biol. Sci. **14**(8), 907–919 (2018)
9. Michiel, A.J., Veldman, J., Fazi, S., et al.: Evaluating resource sharing for offshore wind farm maintenance: the case of jack-up vessels. Renew. Sustain. Energy Rev. **109**(7), 619–632 (2019)
10. Zhao, B., Meng, D., Hou, R., et al.: Venice: an effective resource sharing architecture for data center servers. ACM Trans. Comput. Syst. **36**(1), 1–26 (2019)

Teaching Resource Sharing System of Real Estate Management Course Based on Data Mining

Qian Peng(✉) and Yi-pin Yan

Faculty of Management, Chongqing College of Architecture and Technology, Chongqing 400000, China

Abstract. The traditional teaching resource sharing system saves a high repetition rate of teaching resources, and there is a problem of limited shared data capacity, resulting in low response efficiency of the sharing system and unable to meet user needs. With regard to the above issues, a data mining-based real estate management course teaching resource sharing system is designed. On the basis of the optimal design of the collector and memory of the system hardware, the system software part is designed. Use data mining technology to mine course-related teaching resources, and use Hadoop to realize resource storage and retrieval, and complete system design. The comparative experiment proved that the system can effectively shorten the response data by about 43%, and the stability of the system is better. It plays a certain role in promoting the better development of real estate management courses.

Keywords: Data mining · Real estate management · Course teaching resources · Resource sharing · System design

1 Introduction

In the current situation of rapid development of information technology, the amount of data is growing rapidly every day, and the amount of data generated by the education industry is also growing every day. If colleges and universities still adopt a single server to build an ordinary website to share teaching resources, it obviously can not meet the users' needs for information and personalized teaching resources [1]. Because this kind of single server based on ordinary website sharing related professional teaching resources, there are problems such as sharing data capacity limit and computing processing capacity limit [2]. With the increase of the number of users and the amount of course resource data uploaded, the storage space of the system is becoming more and more difficult to expand; When the user visits increase too much, a single server is easy to overload, resulting in slow upload, download and search of teaching resources; the data processing capacity of a single server is limited, and it can not process tasks Distributed processing can not recommend some high-quality course teaching resources to users, and it is difficult for users to retrieve course resources. In addition, the repetition rate of resources stored in

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 230–240, 2021.
https://doi.org/10.1007/978-3-030-84386-1_19

the traditional course teaching resource sharing system is very high, a large number of resources are wasted, and the system managers rarely introduce new resources, and the original resources are difficult to be fully utilized, resulting in the increasing operation cost of the system [3]. Another part of the university curriculum resource sharing system links teaching resources directly to the web page without any management. At the same time, this kind of system does not have the function of adding, deleting and modifying. When the resources need to be changed, it can only be done by modifying the web page link.

Faced with such a huge curriculum teaching data resource, due to the lack of means to mine the hidden knowledge behind the data, it is impossible to discover the relationships and rules existing in the data. As a result, teachers cannot know the effects of the students' learning courses, nor can they tell the students. To guide and adjust the teaching structure of the course, teachers can not improve the content of the course in time and improve the teaching effect. Data mining technology provides a good solution for this. Data mining extracts from a large amount of incomplete, noisy, fuzzy, and random practical application data that is hidden in it and people do not know in advance. But it is also a process of potentially useful information and knowledge [4]. The application of data mining in the learning and sharing of college professional curriculum resources is undoubtedly of practical significance. Therefore, taking the real estate management course as an example, in order to meet the teachers' demand for related resources when teaching real estate management courses, this article will design a real estate management course teaching resource sharing system based on data mining. The hardware of the system is designed through the collector and memory. On this basis, the data mining technology is used to mine the teaching resources related to the real estate management course. According to the HDFS provided by Hadoop, the big data processing framework, the resources are stored, and the stored resources are retrieved to complete the software design, Through hardware design and software design, the teaching resource sharing system of real estate management course based on data mining is designed. The effectiveness of the system is verified by simulation experiments.

2 Hardware Design of Real Estate Management Teaching Resource Sharing System Based on Data Mining

The establishment of course teaching resource sharing system is the basis to ensure that the real estate management course resources can be shared. It can truly allocate resources according to the needs of users, and it is the best means for users to obtain the most abundant resources when they are allowed. Aiming at the problems existing in the traditional sharing system, the hardware part of the sharing system is optimized and improved [5].

The hardware structure of teaching resource sharing system for real estate management course in Colleges and universities is shown in Fig. 1.

The system hardware in Fig. 1 applies data management technology to share educational resources. A large number of embedded products are added to the system hardware to improve the teaching quality and ensure the learning efficiency of students.

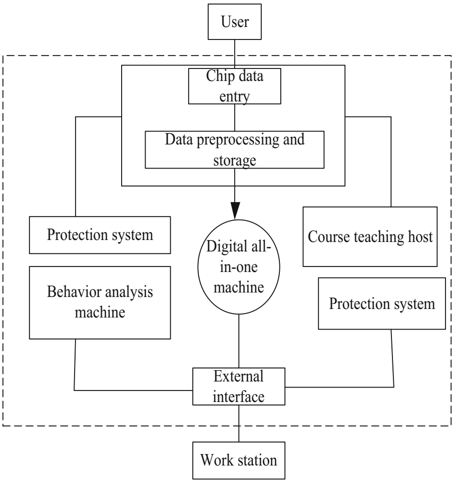


Fig. 1. Schematic diagram of system hardware structure

2.1 Collector Design

The teaching resource collector of real estate management course designed in this paper can achieve high-quality positioning acquisition, and compress the collected audio and video to achieve the low-power requirements of the system. The internal chip of the collector is cawdsz6852 chip, which has the characteristics of multi-functional multimedia applications. The collector has 8 parallel processors, 5 video multiplexing interfaces and 3 audio interfaces, which is convenient for acquisition, compression and transmission [6]. The collector is automatically connected with the wireless network, and the signal is transmitted to the wireless network data terminal after coding and synthesis, stored in the terminal and uniformly recorded in the hard disk. The structure of the collector is shown in Fig. 2.

When the collector in Fig. 2 collects video signals, SCLK is selected as the clock to record all signals. The VPO configuration mode in the collector is RAWD mode, and the input video is one channel video. When collecting GPS signal, TX data is used to send signal, RX data is used to receive signal, asynchronous signal interface is TDADA interface, the highest baud rate is 2.56 Mbyte/s, when collecting work is in progress, EM and FA are connected to receive signal, the sensitivity is 600 dBm, the positioning accuracy of GPS signal is very strong, the error rate is less than 4 m, it can locate high-speed mobile signal. The signal collector is connected with PCI and HPI, the bus interface is Ethernet interface, and the data path is connected with B3 and B19 through PCI bus to send and receive 10~100 m physical layer data. In order to realize the simultaneous transmission of three kinds of data networks, AP685 is added into the system, which supports the uplink rate of 3.5 Mbit/s and the downlink rate of 6.7 Mbit/s.

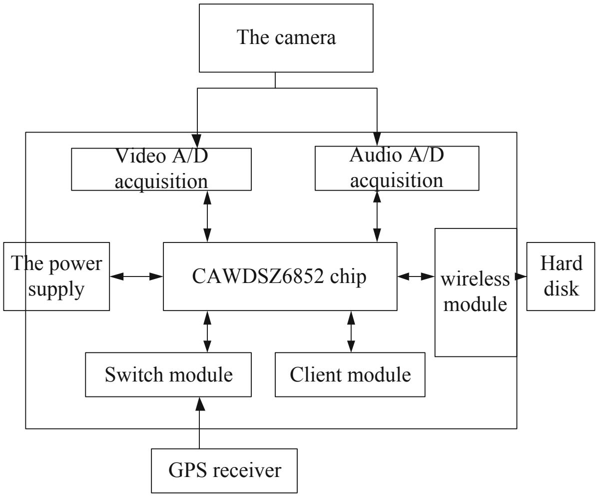


Fig. 2. Collector structure

2.2 Memory Design

In order to improve the storage efficiency of the memory, a flash memory with large storage range and low manufacturing cost is selected in this paper. A single chip microcomputer is added into the memory, which greatly increases the storage capacity and reduces the floor area. The memory structure is shown in the Fig. 3 below [7].

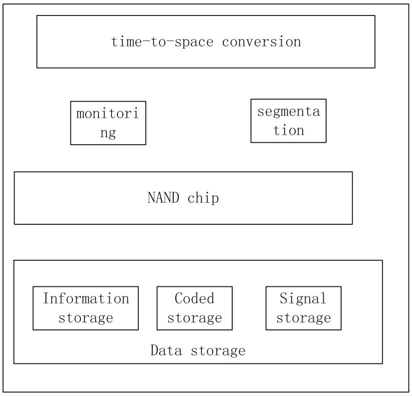


Fig. 3. Memory structure

There are 6 buses outside the memory, and each bus is connected to an FPGA interface, and different interfaces are connected to different signals. Among them, bus 1 connects signals in I/O mode, and the link bit width is 52. It is input and output in a two-way manner to achieve two-way data exchange. The remark method is I/O. Bus 2 connects the signal in OUT mode, the link bit width is 84, the signal is output in a one-way manner, and the control signal enters. Bus 3 connects the signal in BSC mode, the link bit width is 16, and the chip select signal is output in a unidirectional manner. Bus 4 connects the signal in CLAS mode, the link bit width is 6, and the signal is input in a one-way way to realize the board selection of the signal. Different types of signal input methods are different. Bus 5 connects the signal in busy mode, with the link bit width of 81 and the input mode as the busy signal input. Bus 6 connects signals in ADD mode, the link bit width is 27, and the address signal is output in a unidirectional manner.

On the basis of the hardware part of the course teaching resource sharing system designed above, the software part of the sharing system is designed using data mining technology to realize the sharing of teaching resources for real estate management courses.

3 Software Design of Real Estate Management Teaching Resource Sharing System Based on Data Mining

3.1 Course Teaching Resources Mining

A large number of teaching resources are stored in the Internet and university curriculum management database. These resources are accumulating and the number of resources is increasing. In order to improve the operation efficiency of the teaching resource sharing system of the real estate management course, this paper selects data mining technology to mine the teaching resources related to the real estate management course.

Decision tree is a commonly used and very important data mining method. The implementation of this algorithm is to use a top-down greedy algorithm to summarize a given data sample, extract classification rules from unordered data tuples, the root node of the highest level begins to recursively generate a tree structure, each branch node of the tree structure represents a test or selection result, through the reasonable classification of each selection result, continue this process until all attributes are traversed Finally, a decision tree is generated. The decision tree algorithm mainly includes two processes: constructing the tree and pruning the decision tree. The former refers to the input training data as the function value of the established algorithm, the output of different attribute values are generated into various branches, and each branch continues to perform recursive operations to the lower level, and finally forms a decision tree; for the newly established decision tree, there are quite a few The branch nodes are all generated because the input training sample data contains abnormal content composition, which is the reason why the decision tree must be pruned [8].

ID3 algorithm is selected to mine the teaching resources related to real estate management course. In many decision tree algorithms, ID3 is a basic algorithm formed earlier, it is a greedy algorithm, using the top-down recursive classification structure to generate decision tree. The model generation method of the algorithm is relatively simple, better robustness and higher classification accuracy. It has good classification and statistical ability for the non incremental data sample set in the process of network learning, and is more suitable for the data mining field of real estate management courses.

Let's start a brief discussion on the ID3 algorithm. ID3 uses information gain as the unit of measurement when selecting branch node attributes. Assuming that n_i is the number of resources belonging to category y_i in teaching resource data set S, and the total number of resources in S is count, the prior probability of each category is $P(y_i) = \frac{n_i}{count}, i = 1, 2, \ldots, m$. For the teaching resource data set S, the expected information of the resource data is [9]:

$$I(n_1, n_2, \ldots, n_m) = \sum_{i=1}^{m} P(y_i) \log_2 P(y_i) \tag{1}$$

In the calculation formula of information gain, it is necessary to carry out the weighted average of the data amount of the system teaching resources, and the parameter obtained is the information entropy. Suppose that attributes D_f and D_f have q different values, and S is divided into subset $\{S1, S2, \cdots, Ss, Sq\}$ of q; suppose that n_s represents the number of teaching resource data in Ss_i, and n_{is} represents the number of resource data belonging to category y_i in Ss. The entropy of teaching resource data set S divided by description attribute D_f is as follows:

$$E(D_f) = \sum_{s=1}^{q} \frac{n_{1s} + \cdots + n_{ms}}{count} I(n_{1s}, n_2, \ldots, n_{ms}) \tag{2}$$

Among them,

$$I(n_{1s}, n_2, \ldots, n_{ms}) = -\sum_{i=1}^{m} p_{is} \log_2(p_{is}) \tag{3}$$

In the above formula, p_{is} represents the proportion of teaching resource data y_i in subset Ss, $p_{is} = \frac{n_{is}}{n_s}$; $n_s = n_{1s} + n_2 + \ldots + n_{ms}$. For the entropy in formula (2), the smaller the entropy, the more accurate the separation of the data set.

Through the above formula, the information gain of D_f when dividing the teaching resource data set can be obtained:

$$Gain(D_f) = I(n_1, n_2, \ldots, n_m) - E(D_f) \tag{4}$$

By calculating the information gain of all the attributes, ID3 algorithm forms the test attribute of the teaching resource dataset from the attribute with the largest gain, and then generates the branch node. The branch node is marked as the index attribute and classified into the established teaching resource set of real estate management course to complete the data mining processing of the teaching resource of real estate management course.

3.2 Use Hadoop to Realize Resource Storage and Retrieval

In the real estate management course teaching resource sharing system, this article focuses on realizing the management of massive resource data. Therefore, this article uses the HDFS provided by the big data processing framework Hadoop to store resources. In the entire HDFS, cluster nodes are mainly composed of name nodes (Namenode) and data nodes (Datanode). Namenode has metadata management, file block management, fault management, interactive management and other functions, while Datanode mainly has data access and regular reporting., Data interaction and other functions. In the resource sharing system, the source of data has two parts, one is uploaded by the outside world through certain standards and formats, and the other is the result of computing and processing the data stored in HDFS [10–12].

In this system, the definition of teaching resources consists of two parts, the resource itself and the resource description information. When the user uploads the resource and fills in the resource description information according to the system requirements, when the user clicks the "Upload" button, the teaching resource itself and the resource description data are packaged by the system and uploaded to HDFS together. On the one hand, resource description information enables users to understand the basic situation of resources, but more importantly, these description information can be inverted through the system index, so that the resources can be quickly retrieved in massive data. The specific process is shown in the Fig. 4 below.

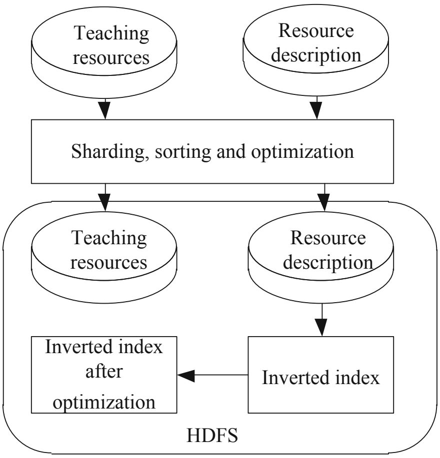


Fig. 4. Upload resources to HDFS

As can be seen from the above figure, in the specific processing process, resources will be segmented, sorted and optimized. After the operation of this part, resources will be segmented into blocks, and these data blocks and copies will be saved in the Datanode on HDFS. In HDFS, the size of the default data block is 64 MB. The purpose of building a replica of the data block is to establish redundancy and ensure the security of the data stored in HDFS. In Hadoop cluster environment, the output of data is to copy the data stored in HDFS to the client in some way. Specifically, there are two ways. One is to use the command. For example, after receiving the "download" command at the Namenode, the node will write the data to the local client in the form of stream. The other is to perform parallel retrieval and output the required data after merging. Either way, MapReduce calculation provided by Hadoop can be used to speed up data processing.

In Hadoop, MapReduce framework itself provides parallel execution mode. Once there is a retrieval requirement, jobtracker will start multiple tasktrackers, and then perform parallel retrieval on multiple datanodes to obtain the required data resources. The parallel retrieval process in Hadoop is shown in the Fig. 5 below.

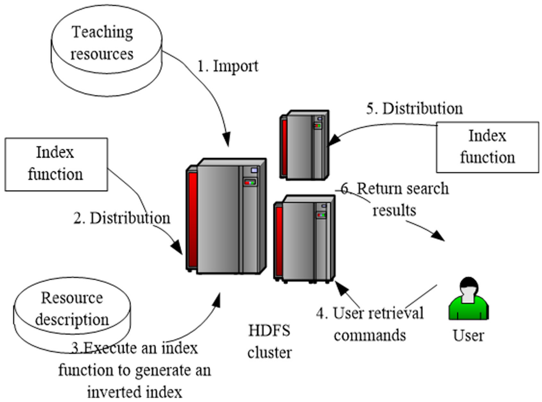


Fig. 5. Parallel retrieval

In the above figure, both generating inverted index and parallelized retrieval require the MapReduce framework, because these two tasks are run on multiple nodes, and the amount of calculation involved is very large. After the inverted index is generated through the resource description, once there is a search requirement, the Namenode will forward the request to the JobTracker, and the JobTracker will start the MapReduce calculation task, and then run on each Datanode to perform a specific search. After the result is returned, the Reduce function will The results are merged and returned to the user, thereby realizing parallelized retrieval tasks.

It should be noted that an inverted index can be regarded as a linked list array, which is the most commonly used data structure in a document retrieval system and consists of a series of (key/value) pairs. The specific index generation process is: read in the data stream, split the data through the Map operation, divide it into each Map, process the data into <keyword# resource name, initial word frequency (1)> and then merge the local results through the Combine operation. The key-value pair is converted into <keyword#total word frequency, resource name>, global merge is realized through Reduce operation, and the result is output <keyword*total word frequency, #resource name>. Through the above content, the design of the teaching resource sharing system for real estate management courses based on data mining has been completed.

4 System Performance Test Experiment

In order to ensure the security and stability of the system, the system must be strictly tested, and can only be used online after passing the test. In the test, we should try to find the system errors, so as to reduce the logic and functional defects or errors of each module in the system, so as to ensure that the system can correctly achieve the expected function.

Design comparative experiment, put the teaching resource sharing system of real estate management course based on data mining and the traditional teaching resource sharing system in the same operating environment, and test the performance.

4.1 Experiment Content

The real estate management course teaching resource sharing system based on data mining is set as the experimental group, and the traditional course teaching resource sharing system is set as the control group. The performance test experiment of resource sharing system compares the response time, data throughput and teaching resource sharing efficiency of the two systems, and makes a comprehensive analysis of the experimental indicators to draw the final conclusion.

The number of concurrent visits to the system generally does not exceed 1000 people, so the system simulates 100, 300, 400, 500, 800, 1000, 1200, 1500 virtual users to access the system front-end function page, and records the experimental group and the control respectively. The response time and throughput of the two groups of systems.

Use the processed teaching resources of real estate management courses as the objects for resource sharing between the two systems. Two sets of resource sharing systems are used to share resources respectively, and the efficiency of sharing of course teaching resources by different systems is counted.

4.2 Experimental Result

The response time and resource data throughput of the experimental group and the control group are shown in the following Table 1.

Table 1. Comparison of system response time and data throughput

Concurrent visits	The paper system			Traditional system		
	Minimum response time/S	Maximum response time/S	Data throughput/bit · s-1	Minimum response time/S	Maximum response time/S	Data throughput/bit · s-1
100	1.12	1.26	97.3	3.47	4.88	71.8
300	1.18	1.37	102.1	3.45	4.86	67.5
400	1.15	1.31	96.3	3.51	4.8	61.7
500	1.22	1.32	98.5	3.5	4.99	67.4
800	1.23	1.33	95.1	3.45	4.74	31.6
100	1.24	1.29	97.6	3.44	5.05	28.7
1200	1.26	1.36	95.1	3.48	5.14	27.5
1500	1.27	1.35	95.9	3.49	5.02	29.1

From the test results, it can be seen that the shortest response time and the longest response time of this system are far less than the traditional system. For further data processing, the average response time of this system is 1.27 s, and the average response time of traditional system is 4.21 s, which is about 43% shorter than that of traditional system. With the increase of users' concurrent access, the data throughput of traditional system is declining, and it drops sharply when the concurrent access reaches 800. However, the data throughput of this system is always stable. It shows that the stability of the system is better.

The comparison of the sharing efficiency of the two sharing systems for the same curriculum resources is shown in the Fig. 6 below.

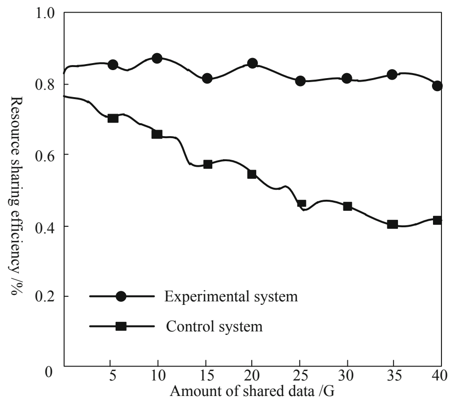


Fig. 6. System resource sharing efficiency

Analysis of the above figure shows that with the increase of shared resources, the sharing efficiency of the traditional system is declining, while the sharing efficiency of the system in this paper fluctuates, but the overall remains relatively unchanged. To sum up, the resource sharing system designed in this paper has faster response speed and excellent stability.

5 Concluding Remarks

With the deepening of education informatization, various network teaching resources of various schools are more and more abundant. On the one hand, these resources provide students with diversified learning methods and ways, and promote the teaching reform in the modern education environment. On the other hand, with the increasing amount of resources, it brings great challenges to the traditional resource management. In order to expand the scope of resource sharing, improve the efficiency of resource utilization, solve the problems of uneven distribution of teaching resources and the management and retrieval of massive data resources, a real estate management course teaching resource sharing system based on data mining is designed and implemented. System performance test experiments verify that the teaching resource sharing system designed in this paper has better performance.

References

1. Li, B.: On the construction and exploration of the teaching mode of intensive Japanese reading high-quality resources sharing course in Panya platform. J. Beijing City Univ. **04**, 25–28 (2020)
2. Ma, J., Li, Z., Cui, K.: Research on practice teaching evaluation based on data mining. Guide Sci. Educ. **08**, 143–144 (2020)
3. Zhang, H., Cui, Y., Yu, L., et al.: Study of classroom event logic graph of intelligent teaching based on method of data mining. J. Distance Educ. **38**(02), 80–88 (2020)
4. Han, L.: Research on personalized network teaching platform based on Web data mining. Comput. Era (01), 84–86+90 (2020)
5. Li, X., Wei, H.: Data mining simulation of multi-source spatial fusion under spatio-temporal constraints. Comput. Simul. **37**(01), 298–302 (2020)
6. Qiang, L.: Evaluation and optimization of personnel training mode in colleges and universities from the perspective of data mining technology. J. Dalian Natl. Univ. **22**(01), 92–96 (2020)
7. Liang, X., Jian, L.: Design of an auxiliary teaching system of advanced mathematics based on data mining. High. Educ. Sci. (05), 38–43 (2019)
8. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902–905 (2019)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
10. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): E-Learning, E-Education, and Online Training, pp. 1–374. Springer International Publishing, Heidelberg (2018)
11. Hailan, S.: Research on the application of CAI computer technology in the teaching of western art history. Int. Engl. Educ. Res. Engl. (2), 18–20 (2019)
12. Aikun, Y., Xiaolong, H.: On sharing model of teaching and learning resources in university town–a case study of university town of Fuzhou. J. Putian Coll. **26**(04), 103–108 (2019)

Design of Intelligent Cloud Teaching Resource Sharing Platform for Chinese and Korean Modern Ceramic Art

Hong Cai[1(✉)] and Yu-feng Men[2]

[1] Weifang Engineering Vocational College, Weifang 262500, China
[2] Dalian University of Science and Technology, Dalian 116052, China

Abstract. With the rapid development of information technology, ceramic art education information process continues to accelerate the development of the resulting problem is the explosive growth of data. At present, in the teaching process of Chinese and Korean modern ceramic art, the teaching resources are constantly developed, and the sharing platform of teaching resources is needed to complete the data transmission and sharing process. Therefore, it is necessary to design a new type of Chinese and Korean modern ceramic teaching resources sharing platform. Through designing the framework of Intelligent Cloud Teaching Resource Sharing Platform, setting the transmission method of Cloud Teaching Resource and setting the application network of Cloud Teaching Platform, etc. Through the comparison, it can be seen that the platform can effectively improve the insufficiency of the original platform and provide guarantee for the education process of Chinese and Korean modern ceramics.

Keywords: Resource sharing · Teaching platform · Network architecture · Data transmission

1 Introduction

As one of the most innovative, universal and penetrating hi-tech in the world, information technology is not only changing people's way of living, but also changing our way of learning. In order to speed up the construction of education informationization and cultivate innovative talents, schools have begun to vigorously carry out the construction of network resources platform, open network resources, and establish network and information resources sharing mechanism, so as to achieve the great teaching goal of education informationization driving education modernization. As a kind of marginal art form, ceramic art has its unique charm. This special art form developed from traditional art to modern art through the baptism and creation of the times, and developed from an art piece fully appreciated before to a new art language with modern flavor.

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 241–251, 2021.
https://doi.org/10.1007/978-3-030-84386-1_20

2 Existing Problems

However, there are still some problems in the construction of educational informationization of Chinese and Korean modern ceramic art. Some websites are only used as the platform of the school government affairs information release. Therefore, some educators began to learn from foreign experience, advanced technology to try to change this situation.

In the process of accelerating the development of ceramic art education information, the primary problem is the explosive growth of educational data. A large number of educational resources are being developed, posing new challenges to key technologies such as data storage, data analysis and data retrieval [1, 2]. How to ensure the expansibility of storage capacity and the performance of resource service is of great value to the teaching platform based on Web service and management.

Through literature research, we know that the digitization of teaching resources can make a great contribution to the sharing of resources among the public, and is conducive to the sharing of better resources by modern ceramic learners between China and Korea, so as to benefit those who love ceramic creation [3, 4]. Through the platform, learners can get teaching materials, teaching experience and educational ideas from other excellent universities, and students can cooperate in learning and share their learning results and experience, thus promoting the spread of the ideas of excellent teaching and learning among users. At the same time, it is also beneficial to innovate the network teaching mode of Chinese and Korean modern ceramic art, and provide a good resource foundation for developing high quality and high level distance education. Therefore, in this study, the design of China and South Korea modern ceramic teaching resources sharing platform, in order to promote the exchange and development of modern ceramic.Therefore, in this study, a sharing platform of teaching resources of modern ceramics between China and South Korea is designed to promote the exchange and development of modern ceramics. J2EE is used as the overall framework of the modern ceramic Intelligent Cloud teaching resource sharing platform in China and South Korea. The data transmission process is controlled by using the congestion control algorithm of datacast. Web2.0 is used as the main operation network of the design platform, and the sharing of modern ceramic teaching resources between China and South Korea is realized.

3 Design of Intelligent Cloud Teaching Resource Sharing Platform for Chinese and Korean Modern Ceramic Art

In this design, the basic structure of the intelligent cloud teaching resources sharing platform is set as follows (Fig. 1):

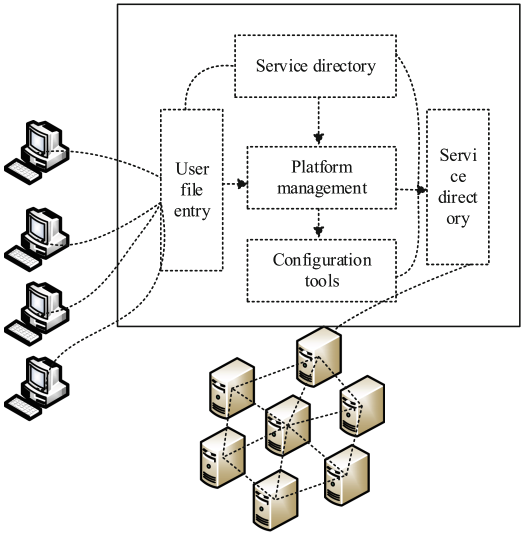


Fig. 1. Framework of intelligent cloud teaching resource sharing platform

According to the above structure, the network framework and data transmission control module of the intelligent cloud teaching resource sharing platform are designed to improve the use effect of the platform.

3.1 Design of Intelligent Cloud Teaching Resources Sharing Platform

In this design, J2EE [5] will be used as the sharing platform design framework. J2EE is a set of relatively new technical framework, including a lot of system development and deployment that can simplify and standardize the application, and further improve the security and portability of teaching resources sharing platform. At its core are a set of service architectures, various components, and technology-level specifications and guidelines for technologies that typically have common rules for good communication. At the same time, the resource sharing platform has good compatibility after using this technology, it is difficult to avoid the communication inside or outside the user network, and the performance of the back-end information is poor.

Through the literature research, we know that the current intelligent cloud teaching resources sharing platform needs to adapt to various new teaching business needs, and the information system of modern ceramic teaching resources in China and Korea has been built and put into use. Thus, the platform on the server side needs to be built incrementally. By using the J2EE architecture, the user's original teaching resources can be fully utilized, so IBM CICS, BEA TUXEDO Inprise VisiBroker and Netscape Application Server are added to the design platform. Because J2EE can get a wide range of technical support in the field of computing, and thus access to a large number of important teaching resources. On the premise that each user does not give up the existing resources, the user can fully own the portable J2EE, allowing it to enter the domain while the upgrade path. At the same time, the platform has good expansibility, adapts to all operating systems and hardware environment, and can fully meet the user's requirements.

3.2 Cloud Teaching Resources Transmission Method Setting

In the process of building the platform, choose Datacast congestion control algorithm [6, 7] to control the data transmission process. In order to use Datacast congestion control algorithm to mathematically model the data of the platform, assume that the switches in the platform are "shared" by some other receiving nodes, and under what circumstances the data source will receive a duplicate request packet. Through research, we know that the slowest switch holds the updated data, while the slowest switch holds the old data. If the cache of the last "shared" switch does not hold the requested data for the requested packet, it is not possible for other switches to hold the data. Therefore, the last "shared" network caching device is critical to cache loss. Define it as a critical cache point. When the last "shared" network cache device cannot answer the corresponding packet directly, the request packet is sent to the data source. A critical cache node is usually fixed in a given Steiner tree [8] because it is determined by the structure of the Steinex tree itself and the rate of receivers. Critical cache nodes do not change over time when the receiver rate is constant. From the above analysis results, the transmission process of ceramic teaching resources is embodied by mathematical model, as follows.

$$a_i^{ll}(t) = (1 - r(t))\frac{\alpha}{T} - r(t)\frac{a_i^l(t)}{2}\frac{a_j^l(t - d_1 - d_4)}{MTU} \tag{1}$$

$$a_j^l = \begin{cases} Q \\ \max\{Q, a_i^l(t - d_2 - d_3)\} \end{cases} \tag{2}$$

$$r(t) = \circ\{a_i(t - d_1 - d_2) - a_j(t - d_1 + d_3) > E + \alpha * MTU - (d_3 + d_4)Q\} \tag{3}$$

In the above formula, t represents the current time, a_i represents the current data location of the resource data source, $a_i^l(t)$ represents the derivative of the current data location of the resource data source, namely, the sending rate of the resource data source, $a_i^{ll}(t)$ represents the second derivative of the current data location of the resource data source, namely, the rate of change of the sending rate of the resource data source, $a_j(t)$ represents the current data location of the slowest recipient, Q represents the ideal rate of the slowest recipient, E represents the size of the cached data in the network device, MTU represents the size of a teaching resource packet, d_1 represents the delay from the critical cache node to the resource data source, d_2 represents the delay from the resource data source to the critical cache node, d_3 represents the delay from the critical cache node to the slowest recipient, and d_4 represents the delay from the slowest recipient to the critical cache node. According to this formula, the transmission time of ceramic art teaching resources can be obtained and controlled.

3.3 Platform Application Network Configuration

According to the above design results, WEB2.0 [9, 10] is used as the main running network of the design platform. WEB 2.0 is a new category of Internet applications relative to WEB 1.0. The main feature of WEB 1.0 is that users get information through browsers. WEB2.0 pays more attention to the interaction of users, users are not only the browsers of teaching resources sharing platform, but also the makers of teaching resources. [11–13] The fundamental difference between the network architecture of the design platform and the original one is that from the user's point of view, the experience brought to users is different. The following is a comparison of the two in terms of modes, basic components, tools, operating mechanisms, creators, applications, and forms. The main differences are shown in the following table (Table 1):

Table 1. Selection of network architecture and use of original platform network architecture

Type	Selection of network architecture	Original Platform Network
Mode	Simple spelling	Read and write
Components	Website	Publication of records information
Tools	Internet browser	Browsers, RSS readers
User population	Relevant Professionals	Ordinary users
Applications	Primary software applications	Full application
Morphology	Static	Dynamic
Operational mechanisms	Client server	Web server

In short, the transition from portal to personal, from content to application, from network information to personal, and from one-to-one to socialization is the transition of the original network architecture. In short, the original platform network architecture is no longer one by one hyperlinks, but the interaction between users platform.

Using the network architecture selected in this paper, the original platform network architecture can be expanded, from the point of view of information source, the information source of this design platform is more personalized and diversified. The information source of the original platform is mainly from the website builder, and the design platform of the text is not only from the content created by the user, but also from the sharing or grading of the content by the user to build a more perfect sharing system of teaching resources. The above network construction and design part of the effective combination, so far, China and South Korea modern ceramic teaching resources to share the intelligent cloud design platform.

4 Experimental Demonstration and Analysis

4.1 Experiment Setup

On this basis, the design process of the intelligent cloud of China and South Korea modern ceramic teaching resource sharing platform is completed. In order to verify the feasibility of Chinese and Korean modern ceramic teaching resource sharing platform in practical application, the test link of Chinese and Korean modern ceramic teaching resource sharing platform was established, and the effect of the platform was analyzed. In this experiment, we use the traditional teaching resource sharing platform to compare the functions of the platform. In order to ensure the consistency of the experimental process, the experimental environment is set as follows (Table 2).

Table 2. Parameters of experimental environment

Type	Category	Setting parameters	Quantity
Software	Collaborative control	ELKOE	1
Experimental Control Software	Development of experimental links	JAVA	1
	Database	MY SQL 2016	1
	Database upgrade package	SQL 2KSP4	1
	Network server	Apache-tomcat	1
Experimental environment hardware	CPU	Pentium3	1
	Hard disk	1TB above space	2
	Memory	4 GB or higher	1

In order to improve the depth of the study, the experimental environment is set to 4 G network model and 5g network model. 10 groups of experiments are carried out for each operation mode, each group repeated 10 times. In this experiment, the network structure is set as follows (Fig. 2).

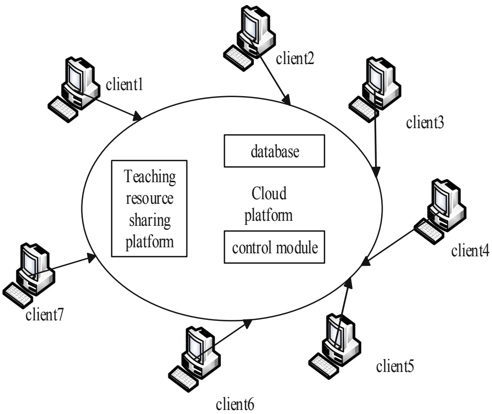


Fig. 2. Experimental network architecture.

The experimental network structure is set to the above form, and the experimental environment is combined with it. The corresponding experimental results are obtained according to the pre-set experimental comparison index.

4.2 Experimental Index Design

In the process of the experiment, the data transmission time, the accuracy and the recovery rate of Chinese and Korean modern ceramic teaching resources sharing platform are compared. Because some experimental indexes need to be obtained by calculation, the calculation process is set as follows.

Time for data transmission of teaching resources: t_1 means the processing time of the sending end, t_1 means the processing time of the sharing end, and T means the time for data transmission:

$$T = t_2 + t_1 \tag{4}$$

Using this formula, the transmission time of teaching resources can be obtained, and the data transmission ability of the designed platform and the traditional platform can be embodied.

Precision rate of teaching resources: J represents the precision rate during the use of the teaching resources sharing platform, G_1 represents the effective information obtained by the users after data sharing, and G_{ALL} represents the total number of teaching resources in the platform when the users use the resources sharing platform.

$$J = (G_i/G_{ALL}) * 100\% \tag{5}$$

This formula can be used to analyze the foundation effect of the platform, and the corresponding results are obtained.

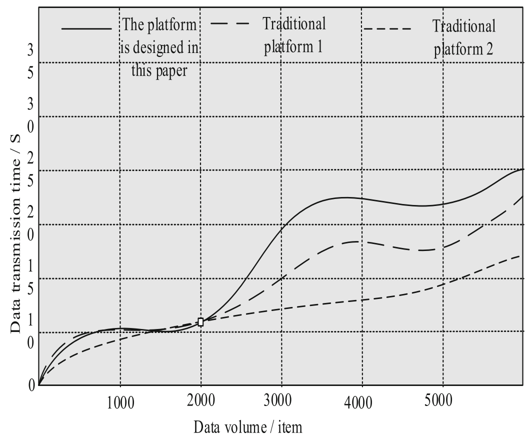
Recall: Set U to represent recall, K_i to represent the number of effective teaching resources available to users, and K_{ALL} to represent the total number of teaching resources that can be shared.

$$U = (K_i/K_{ALL}) * 100\% \tag{6}$$

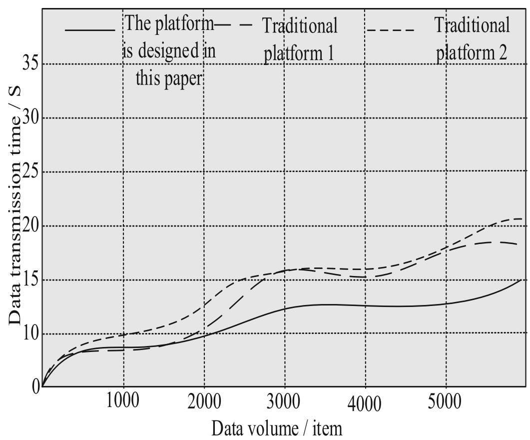
The recalling rate of the platform can be obtained by this formula, and the application effect of the designed platform and the original platform is analyzed. Using the above set of 3 sets of experimental indicators, this paper systematically analyzes the use of the design of Sino Korean modern ceramic teaching resource sharing platform, and verifies the scientificity of the design of Sino Korean modern ceramic teaching resource sharing platform.

4.3 Analysis of Experimental Results of Time-Consuming Transmission of Teaching Resources

From the above experimental results, it can be seen that the data transmission time of the designed platform is lower than that of the traditional platform in both network modes. In the process of experiment network change and data increase, the effect of the design



(a) Experimental Results of 4G Networks



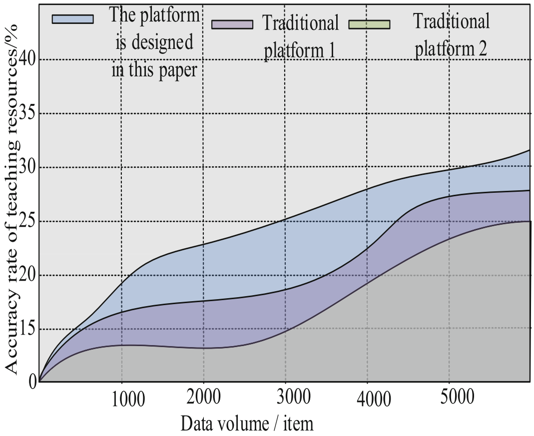
(b) Results of the 5G network experiment

Fig. 3. Experimental results of time-consuming transmission of teaching resources

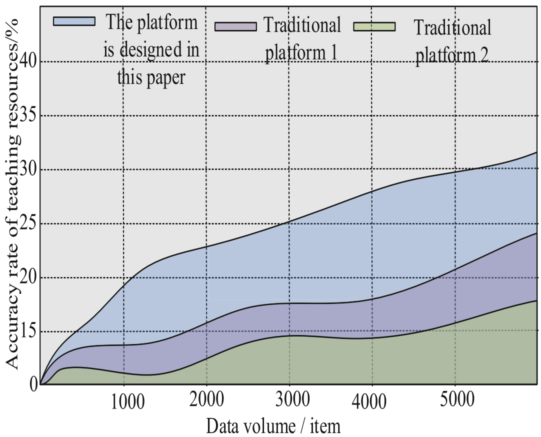
platform is more stable, and there is no fluctuation and abnormal, data transmission capacity is stable. The traditional platform has low adaptability in the transformation of network, but it appears to be stable in the process of data increase. Therefore, this platform has higher requirements for network conditions, and some abnormal problems will occur in the daily use (Figs. 3, 4).

4.4 Analysis of Experimental Results of Accuracy Rate of Teaching Resources

According to the above experimental results, the accuracy of teaching resources of the designed platform and the original platform can be obtained. By comparing the data, we can see that the design platform is better than the traditional platform, in different



(a) Experimental results of the 4G network



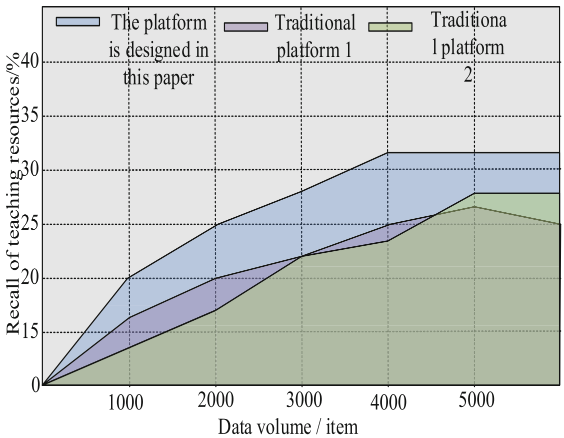
(b) Results of the 5G network experiment

Fig. 4. Experimental results of accuracy of teaching resources

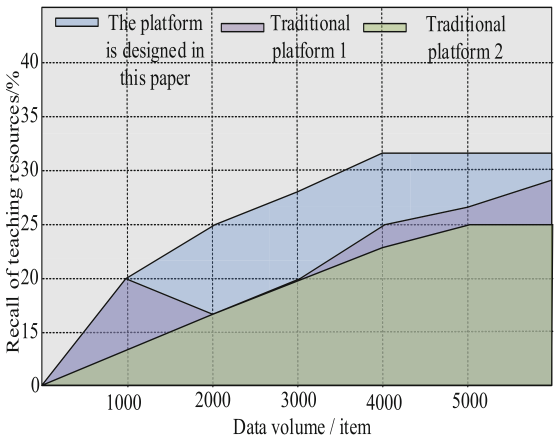
network environments, the design system of teaching resources accuracy and stability, will not affect the use of users. Compared with the design platform in this paper, the application effect of the traditional system is obviously lower, and it has a big fluctuation problem, which will affect the daily application. Therefore, the design platform in this paper has more advantages in the use process (Fig. 5).

4.5 Analysis of Experimental Results of Recall Rate of Teaching Resources

Through the literature research, we can see that the recall rate and precision rate of data are both negative growth, and can not achieve synchronous growth. Combining this principle with the experimental results of this part, we can see that the experimental



(a) Experimental results of the 4G network



(b) Results of the 5G network experiment

Fig. 5. Experimental results of recall of teaching resources

results of the Sino Korean modern ceramic teaching resource sharing platform are better, and its recall and precision rate meet the requirements of Sino Korean modern ceramic teaching resource sharing. The recall experimental results of the traditional platform are better than the accuracy experimental results, but the comprehensive experimental results are lower than the design of Sino Korean modern ceramic teaching resource sharing platform. Therefore, the Sino Korean modern ceramic teaching resource sharing platform designed in this paper is better than the traditional platform. At the same time, through the comprehensive analysis of the three groups of experimental results, we can see that the design of Sino Korean modern ceramic teaching resource sharing platform can be used as a tool for Sino Korean modern ceramic teaching.

5 Closing Remarks

This paper studies some problems of the intelligent cloud teaching resources sharing platform of Chinese and Korean modern ceramic art. Based on the construction and operation of the teaching platform at home and abroad, this paper deeply analyzes the development mode, management mode and resource sharing of the existing resources, and designs a solution to the problem of cloud teaching resource platform of pottery art.

In order to keep pace with the development of Internet technology and discuss the solution to the problem of the construction of teaching resource platform, this paper designs and realizes the Ceramic Art Intelligent Cloud Teaching Resource Platform based on cloud computing.

References

1. Fan, Y., Liu, M.: Design and research of online education course resource sharing based on cloud platform. Mod. Electron. Tech. **43**(01), 175–178 (2020)
2. Yang, W., Liu, X., Zhang, H., et al.: Analysis of research instruments sharing problem in key universities. Sci. Technol. Manag. Res. **39**(04), 72–78 (2019)
3. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
4. Liu, X., Wu, F.: Research on architectural design teaching based on network resource sharing platform: taking provincial excellent course of architectural design as an example. J. Archit. Educ. Inst. High. Learn. **28**(02), 131–137 (2019)
5. Meng, X., Ma, C., Yang, C.: Survey on machine learning for database systems. J. Comput. Res. Dev. **56**(09), 1803–1820 (2019)
6. Kong, F.: Open access resource construction and management based on blockchain. Inf. Stud. Theory Appl. **42**(05), 153–158 (2019)
7. Archives information resources. J. Jiyuan Vocat. Tech. Coll. **18**(03), 17–21 (2019)
8. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
9. Li, X.: Simulation of IoT information resources hierarchical sharing method driven by cloud trust. Comput. Simul. **37**(02), 411–415 (2020)
10. Maosen, X., Fang, M., Jiang, L.: Rule identification, individual learning and cooperative governance of community's com-mon-pool resources during the transition period. J. Anhui Norm. Uni. (Hum. Soc. Sci. Edit.) **47**(04), 141–149 (2019)
11. Ou, J.: Construction of shared curriculum resources for teachers' virtual learning community. J. Adult Educ. Coll. Hebei Univ. **21**(01), 33–38 (2019)
12. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): E-Learning, E-Education, and Online Training, pp. 1–374. Springer International Publishing, Heidelberg (2018)
13. Cao, X., He, Y., He, F., et al.: On the current status and characteristics of English excellent resource sharing courses. J. Sichuan Univ. Arts Sci. **29**(01), 155–160 (2019)

Design of Security Sharing System for Online Teaching Course Resources of Fine Arts Specialty

Li-na Dong[1(✉)] and Ji-wei Liu[2]

[1] School of the Arts, Tianjin University of Commerce, Tianjin 300134, China
[2] College of Design and Art, Shenyang Aerospace University, Shenyang 110136, China

Abstract. There are many kinds of teaching resources involved in online teaching courses for art majors. In order to further realize the sharing of all kinds of teaching resources, this paper proposes the design of resource security sharing system. However, due to the poor performance of the algorithms used in the traditional system, the concurrency performance and classification performance of the system can not meet the expectations. Therefore, a new online teaching course resource sharing system for art majors is designed. In hardware design, tracking hardware and RS323 bus circuit are designed. In the software design, TF-IDF weight clustering course resources are set, the load is distributed in a balanced manner, and the teaching database access tasks are allocated, and the P2P network is used to share system information. Experimental results: The concurrent performance of the system designed this time meets the expected set standards. Compared with the traditional design of teaching course resource security sharing system, the classification performance of the design system is better, which meets the requirements of online teaching course resource security sharing for art majors.

Keywords: Online teaching of art major · Course resources · Security sharing system

1 Introduction

Internet information technology drives the development of education, and a large number of teaching information course resources appear in the form of digitization. In order to facilitate the search, analysis and use of various teaching resources, the sharing concept is introduced into the teaching system, and a new teaching management mode is opened by establishing a sharing system [1]. The concept of sharing was first proposed by foreign professors Marcos Felson and Joan Spence, who advocated the use of a third-party platform to realize the sharing and exchange of regional information. Domestic scholars have also conducted in-depth analysis of regional economic sharing from different perspectives, and proposed different information sharing systems based on Internet of things technology. The literature in [2] proposes to utilize the technical advantages of

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 252–263, 2021.
https://doi.org/10.1007/978-3-030-84386-1_21

SOA, combined with the technical characteristics of Web Services, in J2EE and. NET environment to design and implement the interschool teaching resources sharing platform. However, the use effect of the sharing system designed in the literature is not ideal, and the convenience of the use of the existing sharing system is difficult to be guaranteed.

Therefore, according to the new classification algorithm and block chain technology, a safe sharing system of online teaching course resources for fine arts major is designed. The tracking hardware and RS323 bus circuit are designed, the course resources of TF-IDF weight recluster are set, the load distribution is balanced, the teaching database access task is assigned, and the system information sharing is realized by using P2P network. The experimental results show that the designed system has better performance and ideal application effect.

2 Hardware Design of Security Sharing System for Online Teaching Course Resources of Fine Arts Specialty

2.1 Design Tracking Hardware

In order to enhance the security of system data storage and data sharing, a hardware framework with traceable function is constructed, as shown in Fig. 1.

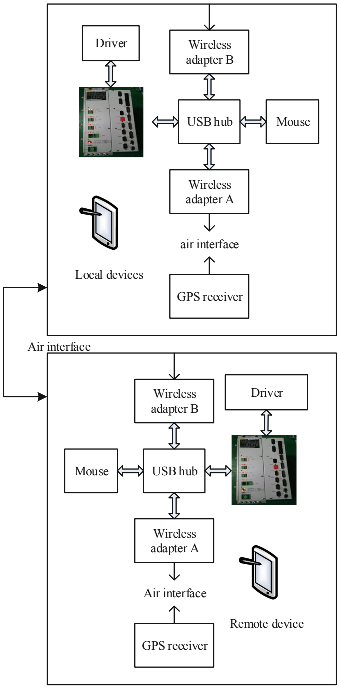


Fig. 1. Hardware framework with tracking function

The hardware added in the figure is the main carrier of the system tracking and positioning equipment. A series of operations, such as data storage, program running, information interface display and so on, should be carried out through the device. At the same time, other components of hardware cooperate with the hardware to complete the work. Connect wireless adapter A and GPS receiver to form a "wireless Intranet" to receive and update local data; The network connection between the local device and the remote device is established to form a "wireless external network" to realize the economic information sharing of multiple devices in the sharing system [3]. The selected GPS receiver should have the characteristics of fast positioning, high sensitivity and low power consumption. Therefore, the GPS model MTKMT3329 is selected to search multiple sharing terminals at the same time to obtain stable sharing demand signals and update the regional economic information to the sharing users in real time. Install the two hardware according to the designed framework, and test whether the equipment runs smoothly. So far, we have completed the design of the tracking hardware of the resource security sharing system for the online teaching course of art major.

2.2 Design of RS323 Bus Circuit

When the course resource security sharing system receives the course information access task, there are synchronous data transmission and asynchronous data transmission. Therefore, it is necessary to design RS323 bus circuit to ensure that the system can receive and transmit all kinds of information. On the basis of expanding the communication distance, the hardware can suppress noise and other interference information. Considering that the system is connected with the computer, MAX3232 chip is used as the transceiver chip in the RS323 bus circuit [4]. Figure 2 below is a structure diagram of the designed RS323 transceiver circuit.

The MAX3232 chip selected in Fig. 2 has dual channels, and its exclusive low dropout transmitter output stage, through two channels of receivers and two channels of drivers, realizes the data receiving and sending work with the data rate of 240kps, and ensures the working efficiency of the integrated system in processing massive intelligence data. So far, the hardware design of online teaching course resource security sharing system for art major has been completed.

3 Software Design of Online Teaching Course Resource Security Sharing System for Art Major

3.1 Setting TF-IDF Weights to Cluster Course Resources

It is known that the intelligent clustering management of digital resources of each course needs weight calculation. Therefore, by setting more independent TF-IDF weights, the intelligent clustering of the system is realized. TF-IDF weights are set to evaluate the influence of similar feature preference data on digital resources. When a search keyword appears frequently in one module of the system, but rarely in other modules, it shows that the keyword is more suitable for describing the first module, so we should give higher weight to such words [5]. Therefore, TF-IDF weights with weighted properties are used

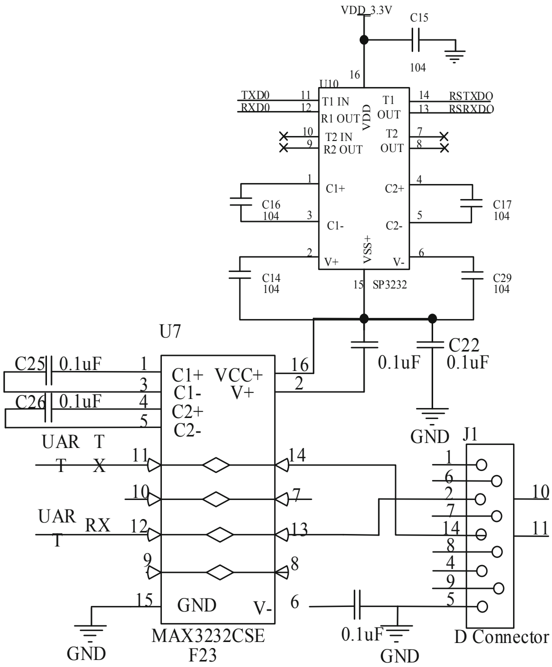


Fig. 2. RS323 transceiver circuit

to measure or evaluate the correlation between teaching tasks and teaching resource features, and independent numerical values are used to reflect the object content, which is different from other object features. According to the above idea, we can get the following equation:

$$\beta = k_1 q_s \cdot \lg\left(\frac{K}{k_2} + 0.001\right) \tag{1}$$

In the formula: k_1 represents the number of occurrences of search terms in teaching content when the characteristic value is q_s; k_2 represents the number of occurrences of eigenvalue q_s in all training sets; K represents all training sets. After the weights are obtained, the vector is standardized to make the sum of TF-IDF weights 1, and the formula is:

$$\beta_{ik} = \frac{\beta}{\sqrt{\sum_{k=1}^{n} \left[k_1 q_s \cdot \lg\left(\frac{K}{k_2} + 0.001\right)\right]^2}} \tag{2}$$

According to the independent weight β_{ik}, K-means algorithm is used to set the system intelligent clustering mode [6]. The following results are used to describe the calculation formula of the middle position when determining the cluster center:

$$\cos\,\alpha = \frac{\sum_{k=1}^{n} \beta_{ik}(s_i) \times \beta_{ik}(S_i)}{\sqrt{\left(\sum_{i=1}^{n} \beta_{ik}^2(s_i)\right)\left(\sum_{i=1}^{n} \beta_{ik}^2(S_i)\right)}} \tag{3}$$

In the formula, s_i represents the similarity of i teaching tasks; S_i represents the collection of digital resources. Part of the system clustering code is as follows:

```
Procedure 6: Reduce
//key: Central point //values: Collection of teaching resources
Vector sum;
for each Vector document in values
Vector new_center = sum/count;
Emit new_center
```

According to the above code, the system intelligently clusters digital resources to achieve the division of teaching contents of different art courses and provide a more perfect classification means for subsequent data sharing.

3.2 Balancing Load Allocation and Allocating Teaching Database Access Tasks

Based on the actual location of the access node of the database cluster, a threshold p is introduced. All the data to be processed in the database are divided into light load node and heavy load node according to the processing node. When the load value is $\mu > p$, the node is a heavy load node; When $\mu < p$, the node is a light load node. When the access task is executed, all nodes begin to execute the access task. Assuming that the light and heavy nodes are evenly distributed in the data space, the load value of the heavy load node is μ_1, the load value of the light load node is μ_2, and the total number of nodes in the related domain is m, the function expression of the average load is as follows:

$$\overline{\mu} = \frac{p_m + \cos\,\alpha \sum_{i=1}^{n} w_i}{m+1} \tag{4}$$

In the formula: p_m is the load value when the total number of nodes is m; w_i represents the data load corresponding to the i-th node [7]. In order to ensure that the selected nodes and the data transmitted to the visiting users are reliable, a control coefficient φ_m that can avoid load migration is introduced, and the load is calculated according to this coefficient. The calculation expression is:

$$h = \frac{\varphi_m(p_m - \overline{\mu})}{\sum_{i=1}^{n} \varphi_i} \tag{5}$$

In the formula: h represents the calculation result after load change; φ_i is the control coefficient for i related nodes. Under the control of the load, the system adjusts the operating parameters of the server through regular or irregular time conditions. According to the teacher's teaching content selection, the corresponding access request is sent to the control unit of the database, so as to achieve the goal of balanced allocation of access tasks. At this time, the allocation form of the allocated database centralized control unit for user access is shown in Fig. 3.

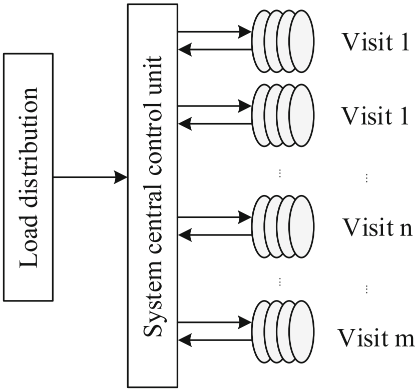


Fig. 3. Schematic diagram of distribution form

According to the figure above, on the basis of ensuring the load balance distribution, the client access is reasonably allocated, and the distributed access task allocation is realized [8].

3.3 P2P Network Sharing System Information

The underlying P2P network of the sharing system constructed by blockchain technology, its nodes are composed of national regions, and the users in each region are equal nodes with the same rights. It is known that when a new node is accessed in the network, other nodes in the network need to be identified in order to synchronize the blockchain. Therefore, the IP addresses of multiple nodes that can provide DNS services are written, and the DNS nodes are used to scan the active nodes in the network and record the IP addresses. When there are new nodes trying to join the blockchain network, random requests are sent to DNS nodes to obtain other active nodes in the network. But the node activity is strong, some nodes may not be online, so until the new node request is responded, the system can return the IP address list of active nodes. When a node joins the blockchain network for the first time, there is only one block on the local storage chain, and the node needs to download all the block data on the longest blockchain in the network. After the node is partitioned, the node randomly selects a node in the network for block synchronization, and the new node sends the request header information to the synchronization node, as shown in Fig. 4 [9, 10].

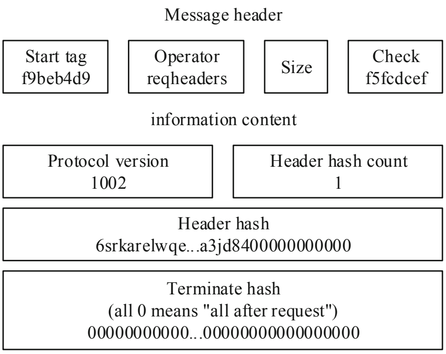


Fig. 4. Request header information

In the header hash value field of the request header information, the new node fills in its own block header hash, and fills in 0 in the cutoff hash value field to request the maximum number of block headers. After receiving the information shown in Fig. 4, the synchronization node replies to the header information, and the reply content is shown in Fig. 5 [11, 12].

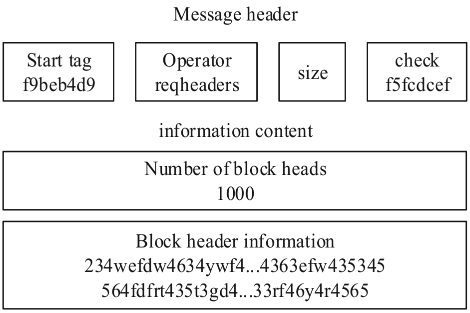


Fig. 5. Reply message

After receiving the reply from the synchronization node, the new node judges the correctness of the header hash according to the consensus mechanism and the target number. Repeat the above steps until the number of hash values returned by the synchronization node is less than the set header information. When the obtained header information belongs to the optimal blockchain in the network, the new node sends the request data to obtain the complete block information [13], as shown in Fig. 6.

The new node judges the accuracy of blocks according to the order on the blockchain. When the next block to be verified has not been obtained, the system needs to wait. If the block information has not been received, the new node will disconnect and send a request to other nodes until the complete information is obtained. According to the above-mentioned information sharing mechanism, the online teaching course resources of art specialty stored in double chain are shared. So far, based on the blockchain technology,

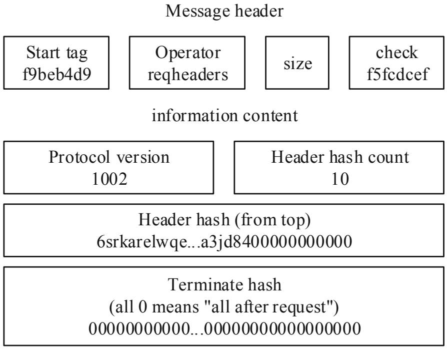


Fig. 6. Request block information

the design of online teaching course resource security sharing system for art major is realized.

4 Experimental Study

4.1 Experimental Preparation

Select the experimental equipment in line with the research, build a simulation test environment, test the integration system of the research by simulating the teaching request content initiated by the client, and test the pressure resistance ability of the system in the face of massive art curriculum resources. Using the Apache server software, the application test of the integrated system is carried out, and the request is sent by using the HTTPS protocol. The test is divided into five phases, and the fields used in each phase are shown in Table 1.

Table 1. Description of used fields

Serial number	Field	Remarks
1	Label	The element attribute name of the test tool
2	Samples	Number of requests
3	Average	Average response time
4	Median	Response time of 50% users
5	Min	User response time
6	Max	Maximum response time
7	Error/%	Error request rate
8	Throughput	Requests completed per second
9	Received KB/Sec	The amount of data received per second

The objectives of this experiment are as follows: In the case of stand-alone deployment, the maximum TPS value that can be obtained and whether TPS can reach the expected value are TPS: 500. After the completion of the above preparatory work, the system will run for 30 min to test whether the hardware of the system can work normally. If there is no problem, start the experiment.

4.2 Concurrent Performance Test

Start one process, and start 50, 100, 500, and 1000 threads for a single process respectively. Four groups of concurrent performance test results are shown in Fig. 7.

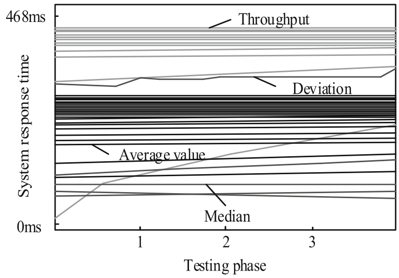
Count and export the data results of the four tests in Fig. 7, as shown in Table 2.

In this experiment, the pressure of the integrated system was tested, using 50VU, 100VU, 500VU and 1000VU as the load test conditions. Combining the test results in Fig. 7 and Table 2, it can be seen that under the four test conditions, Vusers are loaded at a speed of 500 seats/s and all are successful. Under the test time of 5 min, the user drops at 500 seats/s. In different scenarios, the response time of the first three groups was lower than the standard value of 3s. Under the test condition of 500VU, the response time is higher than 2.5s. According to the data display, the root cause of this problem is that after the number of concurrent users increases, the client appears link timeout, so the error rate of processing things increases. According to the above test results, when the number of concurrent clients is less than 500, the error rate of the integrated system is within a reasonable range, and the system response time is lower than the test standard, which meets the system design requirements.

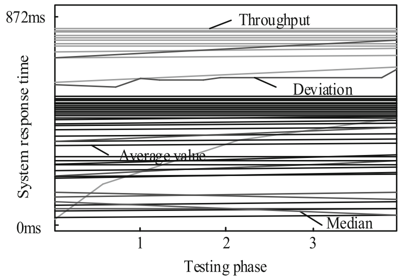
4.3 Classification Performance Test

After verifying that the designed system meets the basic requirements, the system is taken as the experimental group, and the integrated system under the traditional design is taken as the control group. Compare the integration quality of art teaching curriculum resources in different systems. The traditional system selected for this experiment is the system proposed in the literature [2]. In this literature, the security sharing system of teaching course resources based on SOA technology is designed, and the experimental results of the designed system are compared with the traditional system to verify the application effectiveness of the designed system. The integrated quality evaluation index is used as the basis for analyzing the system performance. The quality of integrating information resources in different systems is analyzed. Therefore, the accuracy measurement method is used to directly reflect the average absolute error of the error between the predicted value and the real score of a user, and calculate the root mean square error of the precision of the prediction result. The calculation results of the two parameters can be obtained directly by the following formula:

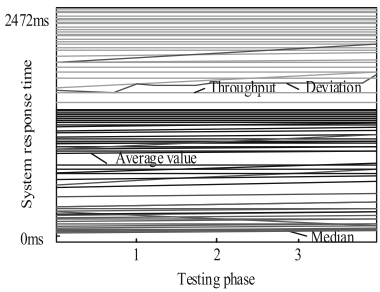
$$\begin{cases} MAE(f) = \dfrac{1}{|N|} \sum\limits_{u_i \in U} \left| u_i - u_i' \right| \\ RMSE(f) = \sqrt{\dfrac{1}{N} \sum\limits_{u_i \in U} \left(u_i - u_i' \right)^2} \end{cases} \tag{6}$$



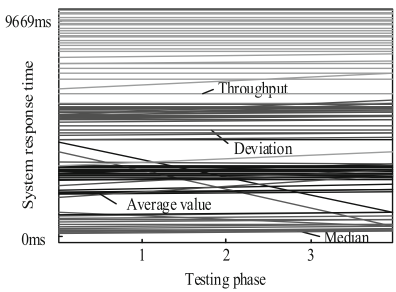
（a）50 concurrent performance test graph



（b）100 concurrent performance test graph



（c）500 concurrent performance test graph



（d）1000 concurrent performance test graph

Fig. 7. Concurrency performance test results of different concurrent numbers

Table 2. Result analysis table

Test content	50 concurrent	100 concurrent	500 concurrent	1000 concurrent
Total number of transactions	225009	216112	198184	98582
Jmeter Number of errors	379	1953	11048	32653
Response time of 90% users /ms	398	941	2792	10191
Throughput/sec	705	611	548	303
Average response time /ms	261	685	1514	3016

In the formula: $MAE(f)$ is the average absolute error of the error; $RMSE(f)$ is the root mean square error of precision of prediction results; N is the number of scoring items; u_i represents the user's true rating of the system; u_i' is the user's prediction score of the system; U represents the score set. When the calculated $MAE(f)$ and $RMSE(f)$ values are smaller, the more it shows that the curriculum resources of the shared system are more compatible with the integrated classification. Based on the above calculation, any five groups of data in movielens 100k data set were selected and trained and tested according to the ratio of 8:2.According to the above calculation formula, the integrated performance evaluation results of different resource sharing systems are obtained, as shown in Table 3.

Table 3. Performance comparison of different systems

Test group	The system designed in this paper		Traditional integration system	
	MAE	RMSE	MAE	RMSE
Data1	0.6302	0.9123	0.8997	1.5678
Data2	0.5999	0.8747	0.9152	1.7661
Data3	0.5994	0.8766	0.9008	1.7212
Data4	0.6033	0.8759	0.9009	1.7296
Data5	0.6152	0.8905	0.8997	1.5779

According to the above calculation results, the MAE value and RMSE value of the designed system are lower after the above formula calculation, which indicates that the system integrated art teaching curriculum resources in this study are closer to the set classification results.

5 Conclusion

The design of the security sharing system, based on the traditional sharing system, improves the system software and enhances the scalability of the original system. It is a new type of intelligent information sharing system which adapts to the development of the times. However, due to the loss of throughput, it is necessary to establish communication between nodes when studying the system throughput and node relationship, so as to show the linear relationship of test parameters to the greatest extent and reduce the operation error of the system.

Fund Projects. Undergraduate teaching reform and research projects of Shenyang University of Aeronautics and Astronautics “Teaching reform of «Design engineering 3» based on design patent output from the perspective of OBE” and “Teaching reform exploration of «Design engineering 3» based on innovation and practice of the product organization design”.

References

1. Xiajuan, S., Donghuai, G., Yuwen, N.: On higher education resource-sharing system from perspective of supply-side reform. Heilongjiang Res. High. Educ. **03**, 32–37 (2018)
2. Wei, H.: Research and design of digital document resource sharing system in university library. Electron. Des. Eng. **27**(14), 26–29+34 (2019)
3. Xi, L.: Design of MOOC idea based teaching resource sharing system for digital film and television production. Mod. Electron. Tech. **43**(16), 115–118 (2020)
4. Hao, Y., Ji, S., Cao, J.: Design of Teaching Platform Based on Meteorological Big Data and Resource Sharing. Comput. Technol. Dev. **30**(03), 132–136 (2020)
5. Liu, S., Lu, M., Li, H., et al.: Prediction of gene expression patterns with generalized linear regression model. Front. Genet. **10**, 120 (2019)
6. Jing, G.: Optimization of network resource sharing degree in information environment. Comput. Simul. **35**(07), 237–240 (2018)
7. Luo, J., Zeng, D., Pan, Z., et al.: Real-time statistics of access of teaching resource sharing system based on big data platform. Intell. Comput. Appl. **8**(03), 148–153+157 (2018)
8. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
9. Lanying, C.: Design and research of open education video cloud resource sharing system in the era of big data. Video Eng. **42**(12), 117–121 (2018)
10. Yuehu, W.: Research on the blockchain-based information resource sharing system. Sci. Tech. Inf. Dev. Econ. **3**(05), 42–47 (2018)
11. Shuyun, L., Meiqin, H., Wang, W., et al.: Connection and application of large instrument sharing system and national network platform. Res. Explor. Lab. **39**(02), 296–299 (2020)
12. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
13. Guo, Y., Zhang, X., Chuancheng, L., et al.: Research and design on the software system of co-constructing and sharing educational resources in the region. Comput. Eng. Softw. **41**(08), 21–23 (2020)

Check for updates

Statistical Model of Online Educational Resource Allocation for Coordinated Development of Regional Economy

Xin Tang(✉) and Jun-hao Qiao

Zhengzhou Technical College, Zhengzhou 450121, China
tangxin1132@yeah.net

Abstract. In order to improve the statistical ability of online education allocation resources, a statistical model of online education allocation resources for the coordinated development of regional economy is proposed. Based on the principle of comparability and practicability in the selection of statistical indicators of online education allocation resources, this paper constructs a statistical indicator system of online education allocation resources, assigns the weight of statistical indicator system of online education allocation resources by using the specific steps of analytic hierarchy process, and calculates the allocation level of educational resources of each school in six administrative regions by using the weighted index and model, According to the results of the cluster analysis of the types of school resource allocation, by introducing the difference coefficient, the balance of the allocation of various types of school education resources in the region is determined. Through the establishment of the statistical model of online education resource allocation, the statistics of online education resource allocation is realized. The experimental results show that the statistical model of online education resource allocation for the coordinated development of regional economy has relatively high statistical ability in terms of statistical efficiency and student satisfaction.

Keywords: Coordinated development of regional economy · Online education · Resource allocation · Statistical model

1 Introduction

The allocation of online resources refers to the optimal allocation of online resources, that is, to achieve the relative balance of market supply and demand by reasonable allocation of limited online resources, thus achieving sustainable economic development. The theory of optimal allocation of online resources holds that if the contradiction between the limited resources we have and can use and the unlimited demand for them can not be solved reasonably, human resources can not be used sustainably. Therefore, limited resources should be allocated to all levels of society in a reasonable proportion, and this kind of allocation can achieve the maximum use of resources. The theory of

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 264–276, 2021.
https://doi.org/10.1007/978-3-030-84386-1_22

optimal allocation of resources plays an important role in the process of social and economic development, so its essence has been constantly used for reference by other disciplines.

Statistics of online educational resources allocation is an important part of educational resources management in colleges and universities. It plays an important role in organization adjustment, education integration, curriculum design, subject construction and faculty construction. At present, online educational resources allocation statistics in colleges and universities is mainly based on the collection of basic information of various disciplines, and the establishment of online educational resources allocation files to meet the needs of filling in various statistical forms. The main body of the statistics of online education allocation resources in colleges and universities includes full-time teachers, scientific researchers, managers, teaching assistants and logistics staff.

The statistical difference of online educational resources allocation refers to the different treatment due to the individual situation of the educatees. The main idea is that the distribution and statistics of educational resources are not determined entirely by the average value. When designing the statistical model of online educational allocation resources, the statistics of resources is only considered in the quantity of educational allocation resources, but not in the interest of the educatees. In fact, the difference of online education allocation resources in the process of statistics and the different needs of individuals have become an important aspect of online education allocation resources statistics. It is necessary to recognize the difference of individual needs in different education when we study the basic theory and design the statistical model of online education allocation resources. Based on this, the society must be able to provide a variety of types and channels of educational resources to facilitate the individual education to choose, but also must respect the individual education. Although the diversity of educational resources in a certain level of performance differences, but each individual's personality and endowment of education has been free and adequate development, which also reflects the fairness from another level. Educational equity envisages the differences between the educated individuals, and abandons the mechanistic requirement for educational equality. On the one hand, it requires that both the educated individual and the educated individual receive the education that best suits them, which reflects both equality and difference. Since there are differences among the educated individuals, the allocation of educational resources should also reflect the differences, such as differences in school types, curriculum, or even teaching methods. Homogeneous education neglects the particularity of the educated individual and hinders the all-round development of the individual. Therefore, the concept of diversity and diversity must be upheld in the sustainable development of education [1–6].

Since the beginning of this century, the fair development of education in our country has made a big breakthrough. However, there is still a big gap between online and offline education quality and allocation of educational resources due to scientific and technological development. Under this background, many scholars have carried out the research on the unbalanced allocation of online education resources. According to the different types of online education resources, the statistics of online education resources is made, which greatly improves the satisfaction of students in the process of online education resources.

Based on the above research background, this paper designs a statistical model of online educational resources allocation. The innovation of the model lies in the cluster analysis of the types of school resources allocation. By introducing the coefficient of difference, the balance of regional educational resources allocation is judged and the balance of allocation is improved.

2 Design of Statistical Model of Online Education Allocation Resources

2.1 Construct the Statistical Index System of Online Education Allocation Resources

According to the scientificity and conciseness of the selection of statistical indicators, this paper omits or merges the indicators; according to the comparability and practicability principles of index selection, the indicators should be converted into relative values that can be compared, so the original statistical indicators should be transformed into relativity [7], and the specific meaning is shown in Table 1.

Table 1. Comparable composite indexes and their meanings

Index	Meaning	Index	Meaning
Average number of students in a class	Total number of students/total number of classes	Number of teaching computers for 100 students	Total number of teaching computers/total number of students * 100
Average value of fixed assets per student	Total fixed assets/total number of students	Average student's investment in informatization in last academic year	Total investment in informatization in last academic year/total number of students
Average floor area per student	Total school area/total number of students	Average stadium area per student	Total area of school sports venues/total number of students
Number of multimedia seats for 100 people	Total number of multimedia seats/total number of students * 100	Average area of teaching and auxiliary rooms per student	Total area of teaching and auxiliary rooms/total number of students
Average book collection per student	Total collection of general books/total number of students	E-book collection per student	Total collection of e-books/total number of students

(*continued*)

Table 1. (*continued*)

Index	Meaning	Index	Meaning
Teacher student ratio	Total number of full-time teachers/students	Proportion of teachers with intermediate and above titles	Total number of teachers with intermediate title or above/total number of full-time teachers
Proportion of teachers with bachelor degree or above	Total number of teachers with bachelor degree or above/total number of full-time teachers	Proportion of full-time teachers receiving information training	Number of full-time teachers receiving information training/total number of full-time teachers
Public funds per student	Total public expenditure/total students	Education funds per student	Total expenditure on education/total number of students

According to the availability and practicability of the index selection, through certain analysis, the index system composed of the following three levels and 16 composite indicators is formed to count the resource allocation level of online education.

According to the scientificity and conciseness of the statistical index selection, the indicators are omitted or merged, and the statistical index system of online education allocation resources is constructed by using the comparability and practicability principles of index selection.

2.2 Assignment of Weights of Statistical Index System of Online Education Allocation Resources

The analytic hierarchy process (AHP) is used to assign the weight of the statistical index system of online education allocation resources. The specific steps are as follows:

Step 1: Establish system hierarchy
Before determining the weight of the evaluation factors of the comprehensive allocation level of school basic education, it is necessary to arrange the target levels of each evaluation factor, and establish a systematic hierarchy structure, which includes three levels: target level (a), criterion level (b) and index level (c).
Step 2: Construct judgment matrix
Each element of each layer is compared with each other, and the more important judgment can be given to each factor. Then, all the judgments are represented by relevant values, so as to form a judgment matrix and assign certain values to the importance.
Step 3: Hierarchical single sort
Hierarchical single ranking refers to the ranking of the importance of each factor in the upper level. The square root method is used to calculate the maximum eigenvalue and

its corresponding eigenvector [8], and the calculation process is as follows:

$$M_i = \prod_{j=1}^{n} \alpha_{ij}, \quad i = 1, 2, \ldots, n \tag{1}$$

Where, *CV* represents the difference coefficient, *MN* is the average value of statistical indicators and *SD* is the standard deviation of statistical indicators

$$\overline{W}_i = \sqrt[n]{M_i} \tag{2}$$

$$W_i = \frac{\overline{W}_i}{\sum\limits_{j=1}^{n} W_j} \tag{3}$$

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(Aw)_i}{nW_i} \tag{4}$$

Step 4: Consistency test of judgment matrix
The consistency of the above results was tested, and the test formula was as follows:

$$CI = \lambda_{\max} - \frac{\mathrm{n}}{n-1} \tag{5}$$

$$CR = \frac{CI}{RI} \tag{6}$$

After each step of analytic hierarchy process, the final determined weight value is shown in Table 2.

Using the specific steps of the analytic hierarchy process, the weight of the online education resource allocation statistical index system is assigned.

2.3 Analyze the Balance of Online Education Resources Allocation

After constructing the statistical index system of online education allocation resources, it is necessary to make a balanced analysis on the allocation of online education resources of various schools under the background of coordinated development of regional economy.

The general distribution of data from the following three aspects is often studied. The first aspect is the concentration trend of data, focusing on the size of the aggregation of data and its central value; the second aspect is the discrete trend of data, focusing on the size of the dispersion of data and its central value; the third aspect is the skewness and kurtosis of data, mainly analyzing the shape of data distribution. The imbalance mentioned in this paper refers to the size of the difference between things, that is, whether the dispersion of data exceeds a certain degree, so the size of the dispersion between data can be used to judge the balance or imbalance between things [9].

There are many methods to measure the dispersion degree of numerical data in statistics. In this paper, combined with the previous research and the actual situation,

Table 2. Weight of statistical index system of online education resources

Indicator name	Weight value	Indicator name	Weight value
Average number of students in a class	0.1170	Number of teaching computers for 100 students	0.0623
Average value of fixed assets per student	0.0934	Average student's investment in informatization in last academic year	0.0614
Average floor area per student	0.0257	Average stadium area per student	0.0276
Number of multimedia seats for 100 people	0.0207	Average area of teaching and auxiliary rooms per student	0.0479
Average book collection per student	0.0385	E-book collection per student	0.0230
Teacher student ratio	0.0859	Proportion of teachers with intermediate and above titles	0.0584
Proportion of teachers with bachelor degree or above	0.0778	Proportion of full-time teachers receiving information training	0.0243
Public funds per student	0.1387	Education funds per student	0.0974

we choose standard deviation and difference coefficient to study the balance of the comprehensive level of primary and junior high school education resources allocation in six districts. If the unit of measurement is the same as that of the average, the standard deviation can be directly used for comparison. However, if the unit is different from that of the average, the standard deviation is not suitable for the difference degree of the comparative data, but the ratio between the standard deviation and the average should be used for comparison, which is the coefficient of difference. When we study the degree of difference, the standard deviation is absolute, while the coefficient of difference is relative. Obviously, when we study the difference of things, we can't simply rely on the standard deviation to judge. The coefficient of difference can eliminate the influence of different units or different averages on the comparison of differences between two or more samples, so the relative difference can better reflect the real situation of equilibrium. In this paper, the difference coefficient representing the relative difference is used as the index of equilibrium analysis.

In statistics and probability, the coefficient of difference is often called "coefficient of variation", "coefficient of dispersion" and "coefficient of standard deviation". It is a normalized measure of the dispersion degree of probability of data distribution. It is defined as the ratio of standard deviation to average value. The coefficient of difference is valid only when the average value of data is not equal to zero, and generally the average value applicable to data is positive However, the calculation process and results of the comprehensive level of educational resource allocation in this paper meet the applicability of the difference coefficient. The difference coefficient is calculated as follows:

$$CV = \frac{SD}{MN} \tag{7}$$

Where, MN represents the average value of statistical indicators, and SD represents the standard deviation of statistical indicators.

$$SD = \sqrt{\sum_{i}^{n} \frac{MN_i - MN^2}{n}} \tag{8}$$

Among them, MN_i represents the comprehensive allocation level of educational resources in each school, MN represents the average value of the comprehensive allocation level of educational resources in primary or junior high schools in a district, and represents the number of primary schools or junior high schools in a district.

The larger the difference coefficient is, the greater the difference between the research objects is; the smaller the difference coefficient is, the smaller the difference between the research objects is. In this paper, the larger the value of the difference coefficient, the more unbalanced the comprehensive level of the regional primary or junior high school education resources allocation; the smaller the value of the difference coefficient, the more balanced the comprehensive level of the regional primary or junior high school education resource allocation [10–12].

In order to more intuitively judge the balance of the comprehensive level of primary and junior high school education resources allocation in six districts, this paper uses the model to calculate the equilibrium index of different periods of social development according to the general understanding of the regional economic and educational development status, and through expert consultation and reference to previous research results [13–15], and taking into account the nonlinear characteristics of the gradual gradual increase of the index level The following recommended criteria are obtained for the values that should be reached, as shown in Table 3.

Table 3. Evaluation criteria of educational resources balance

Difference coefficient standard	2005–2010	2010–2015	2015–2020
Ideal standard	0.250	0.157	0.125
Good standards	0.300	0.188	0.150
Basic standards	0.350	0.219	0.175

Using the weighted index and model to calculate the allocation level of educational resources of each school in the six administrative regions. cluster analysis is conducted on the types of school resources allocation according to the results, and the balance of educational resources allocation of various schools in the region is determined by the coefficient of difference.

2.4 Establish Statistical Model of Online Education Allocation Resources

If there are $n(n \geqslant 1)$ schools in a certain area, the education resources owned by the first school are $x_i(1, i, n)$, and the corresponding number of students is $s_i(1, i, n)$. The value of educational resources owned by all school students in the whole region is $-\frac{\sum_{i=1}^{n} x_i}{\sum_{j=1}^{n} s_j}$, and the educational resources possessed $\overline{x_1} \cdots \overline{x_n}$ by the corresponding students of each school will be sorted from small to large after making a difference. The difference coefficient of average student resources among schools is as follows:

$$V = \frac{\sqrt{\frac{\sum_{i=1}^{n} (\overline{x}_i - \overline{x})^2 \times s_i}{n}}}{\overline{x}} \tag{9}$$

Suppose that the educational resources to be allocated to each school are as follows R: the first school should achieve the same average student resources D_1 as the second school, $\overline{x}_i'$ and $\overline{x}$ the second school should achieve the same average student resources D_2 as the third school, then:

$$D_i = (\overline{x_{i+1}} - \overline{x_i}) \times s_i, (n-1) \tag{10}$$

The resources allocated to the i school are:

$$S_{D_i} = \sum_{i=1}^{n-1} D_i \tag{11}$$

At that time, $R = S_{D_k}, (1, k, n-1)$ the online education resources allocated by the first to the k schools were as follows:

$$\begin{cases} R_1 = (\overline{x}_{k1} - \overline{x_1}) \times s_1 \\ R_2 = (\overline{x_{h1}} - \overline{x_2}) \times s_2 \\ \cdots \\ R_k = (\overline{x_{h1}} - \overline{x_k}) \times s_k \end{cases} \tag{12}$$

Because $\overline{x}_n > \cdots > \overline{x_{k+1}} > \overline{x_k} > \cdots > \overline{x_2} > \overline{x_1}$, the demand of the n school for online education resources is less than that of the first school, in this case, the amount R can only meet the demand of the first to the first school. Therefore, through the regulation of the county (District) government, the average level x of educational resources of $k+1$ school is unified to the n average level of the county (District), while the first school does not allocate educational resources.

At that time, $S_{D_k} < R < S_{D_{k+1}}, (1, k, n-2)$ the total number of students from the first school to the k school was $\mathrm{S}_k' = \sum_{i=1}^{k} S_i$, and the additional average student resources

$x'_k = \frac{(R - S_{Dh})}{S'_k}$, then the resources allocated by the first to the k school were as follows:

$$\begin{cases} R_1 = \left(\overline{x_{k+1}} - \overline{x_1} + x'_k\right) \times s_1 \\ R_2 = \left(\overline{x_{k+1}} - \overline{x_2} + x'_k\right) \times s_2 \\ \cdots \\ R_k = \left(\overline{x_{k+1}} - \overline{x_k} + x'_k\right) \times s_k \end{cases} \tag{13}$$

In this case, the amount R can only meet the needs of the first to the k school, and there is still a surplus, but the surplus can not meet the needs of the $k + 1$ school. Therefore, through the regulation of the district and county government, the average level of educational resources per student in k school is approached to the value of the regional average level, and the remaining amount x after distribution is evenly distributed to The number of students allocated to all schools is not allocated. $k + 1$ Schools to n do not allocate resources.

At that time $R \geqslant S_{D_{n-1}}$, the total number of students in the first to the $n - 1$ schools was as follows:

$$S_n = \sum_{i=1}^{n-1} S_i \tag{14}$$

The extra resources per student were as follows:

$$x'_n = \frac{\left(R - S_{D_{n-1}}\right)}{S'_n} \tag{15}$$

Then 1 to n the resources allocated to the school are:

$$\begin{cases} R_1 = \left(\overline{x_n} - \overline{x_1} + x'_n\right) \times s_1 \\ R_2 = \left(\overline{x_n} - \overline{x_2} + x'_n\right) \times s_2 \\ \cdots \\ R_k = x'_n \times s_n \end{cases} \tag{16}$$

The resources allocated to school i are:

The resources allocated by the i school are:

$$R_i = \overline{x_n} - \overline{x_i} + x'_n \tag{17}$$

In this case, the amount R is greater than the actual demand, and all schools can be evenly allocated according to the average level of school educational resources.

To sum up, under the background of coordinated development of regional economy, the statistical index system of online education allocation resources is constructed, and the statistical index system is assigned. Based on the analysis of the balance of online education allocation resources, the statistical model of online education allocation resources is established to realize the statistics of online education allocation resources.

3 Comparative Analysis of Experiments

In order to verify the statistical performance differences between the online education allocation resource statistical model oriented to the coordinated development of regional economy, the statistical model of online education allocation resource in literature [3] and the statistical model of online education allocation resource [4] in literature [4] are designed.

Step 1: collect the data of online education allocation resources respectively in the statistical model of online education allocation resources;
Step 2: analyze the weight of online education allocation resource data in the statistical index system of online education allocation resources;
Step 3: a resource statistician for the coordinated development of regional economy, using online education allocation resource statistical model to clean online education allocation resource data;
Step 4: according to the above processing steps, extract the characteristics of online education allocation resource data;
Step 5: test the statistical efficiency of online education resource allocation data. The test results are shown in Fig. 1.

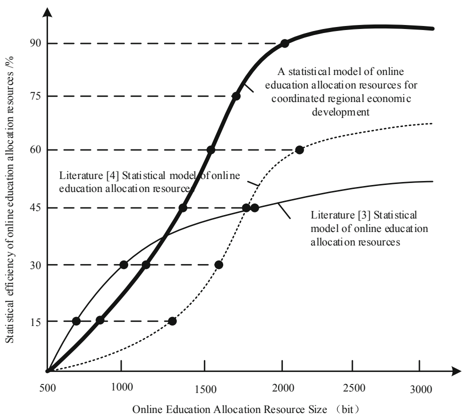


Fig. 1. Comparison results of statistical efficiency of online education allocation resources

As can be seen from the experimental results in Fig. 1, with the increase of online education allocation resources, the statistical efficiency of online education allocation resources is also increasing. The statistical efficiency of online education allocation resource statistical model oriented to the coordinated development of regional economy is far higher than the other two statistical models. Compared with the online education allocation resource statistical model in literature [3], online education allocation resource statistical efficiency in literature [4] is higher than that in literature [3] The statistical efficiency of setting up resource statistical model is relatively high. Because the statistical model of online education allocation resources in literature [3] pays more attention to manual operation and lacks intelligence in the application process, literature [4] lacks the depth of students' demand in practical application, which leads to the reduction of the statistical efficiency of online education allocation resources and faces regional economic coordination The developed statistical model of online education allocation resources can fully meet the needs of students for online education allocation resources, thus improving the statistical efficiency.

On the basis of meeting the statistical efficiency of online education allocation resources, we also need to verify students' satisfaction with online education allocation resources. We conducted a satisfaction experiment on the statistical model of online education allocation resources. We investigated 200 users each time, and adopted the statistical model of online education allocation resources oriented to the coordinated development of regional economy and the literature [3] online education allocation resource statistical model [4] the statistical model of online education allocation resources is used to analyze students' satisfaction. The comparison results of online education allocation resource satisfaction are shown in Table 4.

Table 4. Comparison results of personalized learning satisfaction

Number of surveys	Student satisfaction%		
	Literature [3] personalized learning recommendation system based on statistical model of online education allocation resources	Literature [4] personalized learning recommendation system based on statistical model of online education allocation resources	Literature [5] personalized learning recommendation system based on statistical model of online education allocation resources
1	48.32	68.74	92.84
2	53.18	64.58	94.36
3	49.65	58.79	95.18
4	50.34	69.62	96.14
5	51.62	71.07	92.42
6	50.37	65.37	98.54
7	49.68	68.35	99.83
8	49.15	64.82	94.67
9	48.36	68.79	97.21
10	50.19	64.31	86.49

It can be concluded from the experimental results in Table 4 that the same survey was conducted on 200 students. Due to the lack of intelligent operation in literature [3], the satisfaction of students was greatly reduced. The satisfaction of students using the statistical model of online education allocation resources in literature [4] was basically lower than 70%, and only one survey result was higher than 70%, which may be the result of this group of survey students on resources The demand of statistical model is low, and the student satisfaction of the statistical model of online education allocation resources oriented to the coordinated development of regional economy is generally higher than 90%, and even close to 100%. Therefore, we can get the statistical model of online education allocation resources for the coordinated development of regional economy, which can achieve the effect of students' satisfaction.

4 Conclusion

This paper puts forward a statistical model of online education allocation resources for the coordinated development of regional economy. Under the background of coordinated development of regional economy, the statistical index system of online education allocation resources is constructed, and the statistical index system is assigned. Based on the analysis of the equilibrium of online education allocation resources, the statistical model of online education allocation resources is established to realize online education allocation Statistics of resources. The experimental results show that the model has higher statistical ability.

However, due to the limited use of literature and the huge database of online education allocation resources, the design process of statistical model of online education allocation resources is not perfect and can not be widely applied to practice. In the future research, we need to further expand the scope of research and apply the statistical model of online education allocation resources to practice, Increase the feasibility of the model.

References

1. Liu, W., Maurer, H.P., Reif, J.C., et al.: Optimum design of family structure and allocation of resources in association mapping with lines from multiple crosses. Heredity **110**(1), 71–79 (2013)
2. Grüneberg, W.J., Abidin, E., Ndolo, P., et al.: Variance component estimations and allocation of resources for breeding sweetpotato under East African conditions. Plant Breeding **123**(4), 311–315 (2010)
3. Sun, L.: Driving mechanism of the coordinated development of regional economy-society-environment system based on grey incidence analysis model—a case study of Wanjiang urban belt. Mod. Econ. **11**(7), 1226–1244 (2020)
4. Panikkai, S., Azrai, M., Fahmi, F.N.: Model production of corn development for industrial needs and increasing economy. In: IOP Conference Series: Earth and Environmental Science, vol. 484, no. 1, p. 012137 (10) (2020)
5. Rejeb, H.B., Zwolinski, P.: Development of educational contents on circular economy and critical raw materials challenges. Procedia CIRP **90**(12), 759–765 (2020)
6. Sopilko, N.Y., Myasnikova, O.Y., Navrotskaia, N.A., et al.: Analysis and prospects for the development of regional energy integration of the Eurasian economic union countries. Int. J. Energy Econ. Policy **10**(5), 13–20 (2020)
7. Rubio, G., Lavado, R.S.: Acquisition and allocation of resources in two waterlogging-tolerant grasses. New Phytol. **143**(3), 539–546 (2010)
8. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)

9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
10. Liu, S., Lu, M., Li, H., et al.: Prediction of gene expression patterns with generalized linear regression model. Front. Genet. **10**, 120 (2019)
11. Yan, X., Song, W., Liu, C.: Social-spatial accessibility to urban educational resources under the school district system: a case study of public primary schools in Nanjing, China. Sustainability **10**, 2305 (2018)
12. Creighton, J.H., Berger, C., Johnson, J.E.: Key issues affecting oregon family forest owners: a scoping review of the literature and survey analysis of educational service providers. Small-Scale Forestry 1–17 (2019)
13. Wang, S.: Research on the fairness index and an empirical study of the basic education resources allocation: the case of primary schools in Xicheng District, Beijing. Comput. Econ. Soc. Syst. **1**, 122–129 (2018)
14. Zhao, L., Wu, D., Wang, Z., et al.: Spatio-temporal pattern and influencing factors of the allocation of rural basic education resources in China. Econ. Geogr. **38**(11), 39–49 (2018)
15. Cai, W., Huang, J.: Imbalance and adaptation: spatial pattern evolution of higher education resource allocation in China. Heilongjiang Res. High. Educ. (5), 28–34 (2018)

Design of Teaching Resource Integration System Based on Load Balancing Algorithm

Rou-jia Ji[1](✉) and Guang Tao[2]

[1] School of Science, Hubei University of Technology, Wuhan 430068, China
[2] Wuhan University of Bioengineering, Wuhan 430415, China

Abstract. Aiming at the problem of scattered resources and difficult interaction in the integration of teaching resources in colleges and universities, a teaching resource integration system based on load balancing algorithms is designed. The system optimizes the hardware configuration of the system through the WEB layer, service layer, service component layer, data access layer and data layer, and implements an integrated mode of cloud storage and cloud management of teaching resources through the use of load balancing algorithms. The simulation experiment results show that the teaching resource integration system based on the load balancing algorithm has relatively higher satisfaction and application advantages in the actual application process of teachers and students.

Keywords: Load balancing algorithm · Teaching resources · Resource integration

1 Introduction

With the deepening of teaching reform, whether it is the network courseware and teaching materials used in teaching activities, or the treatise, topic and expert lecture resources used in teaching research, these application resources are various and scattered, which brings some inconvenience to the use of users and causes the low utilization rate of resources. How to make effective use of resources Integration and resource sharing has become the primary problem of university information construction [1]. The education mode of network resources has broken the restriction of space and region on education, and developed the way of resource acquisition from classroom and library to the place that can be covered by network, which makes the acquisition of teaching resources more diversified. Compared with the traditional teaching mode, it has certain advantages. The integration of network teaching resources mentioned in this paper uses the mode of digital storage of teaching resources, which can be used for teaching The use of teaching resources processing, its operating environment is mainly the network system, the use of network database for educational resources storage, give full play to the educational function, in the form of digital signal for educational resources dissemination [2].

This paper first analyzes the research and application background of the system, and introduces the overall architecture design, data communication and storage methods,

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 277–290, 2021.
https://doi.org/10.1007/978-3-030-84386-1_23

and the detailed configuration and deployment process of the key function modules and cloud platform. The system realizes the integration mode of teaching resource cloud storage and cloud management by using load balancing algorithm. The system mode can distinguish the theme and type of resources when uploading resources, improve the efficiency of teaching resources integration and sharing, make the resource interaction between users intelligent and mobile, and thus optimize the integration method and quality of teaching resources in Colleges and universities.

2 Design of Teaching Resources Integration System

2.1 Hardware Configuration of Teaching Resource Integration System

At present, the educational resources of colleges and universities are very rich. In order to meet their own needs, each specialty has developed a system suitable for professional learning. However, the modules of each system can not operate with each other, so that the resources can only meet the needs of the system, resulting in resource waste and function redundancy to a large extent [3]. SOA Service architecture defines educational resources through standards, and realizes data resource sharing through input and output interfaces and information processing modules. It simply realizes the communication between heterogeneous systems, and makes the modules with similar functions reconstruct in the form of service modules, which improves the utilization efficiency of university resources.

SOA architecture encapsulates the services provided to users, including the information of service provider, the parameters of service interface call, the time of service provision and so on. Through the interface, we can clearly see the structure of the interface, with complete transparency. When calling the interface, you can directly use the object to call the interface by creating an object [4]. The SOA architecture module is divided into user interface module, management and report module, configuration and rule module, service bus module, service interface and service implementation module. The figure shows the SOA Service Architecture module diagram (Fig. 1).

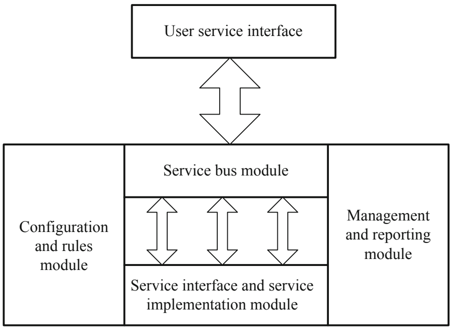


Fig. 1. SOA Service Architecture of the whole teaching resources system

System data warehouse includes two concepts: one is the integrated and stable collection of historical data, the other is the management technology that integrates the data distributed in different sites and business systems, which can provide effective data analysis and data support for decision-makers. The figure below shows the system structure of data warehouse (Fig. 2).

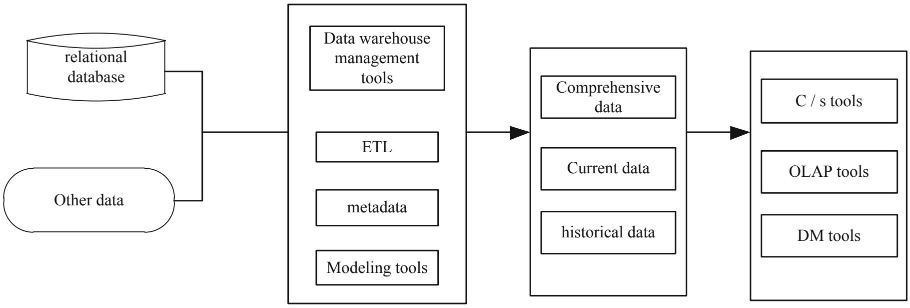


Fig. 2. System data processor architecture

When optimizing the hardware configuration of the teaching resource integration system, the middle layer appears in the data processor, which makes the massive data stream have enough buffer to ensure the stable operation of the large amount of data [5]. The architecture of teaching resource integration system is divided into presentation layer, service management layer, service layer, service component layer, data access layer and data layer. SOA is used to transfer data and information between each layer. The basic architecture of SOA is composed of data objects, data graphs, metadata and data relay services [6]. Data object is a component used to save data, which is mainly composed of attributes of data entities; data graph is a collection of multiple data objects, which is responsible for the change of data objects; data relay service is used for the management and call of services in the interface [7]. For the design of SOA architecture model of teaching resource integration system, the system architecture design should follow the service architecture of SOA, and the architecture design is as follows (Fig. 3):

Teaching resource integration system is divided into five layers: web layer, service layer, service component layer, data access layer and data layer.

Web layer is the interface provided by the system to interact with users, which is composed of presentation layer and control layer. The web layer is designed based on MVC framework and implemented by JSP/HTML {servlet [8]. Users request data to the system through the web layer, and input the corresponding request parameters in the web interface. The final return result is also displayed by the web interface.

The service layer is the encapsulation of the business logic of the system, mainly including course resource service, excellent course resource service and other services of the system. Through the encapsulation of service components, accessible service modules are formed to facilitate the implementation of business processes.

The service components implemented in the service layer are coarse-grained service modules. In the service component layer, each service module is refined into fine-grained

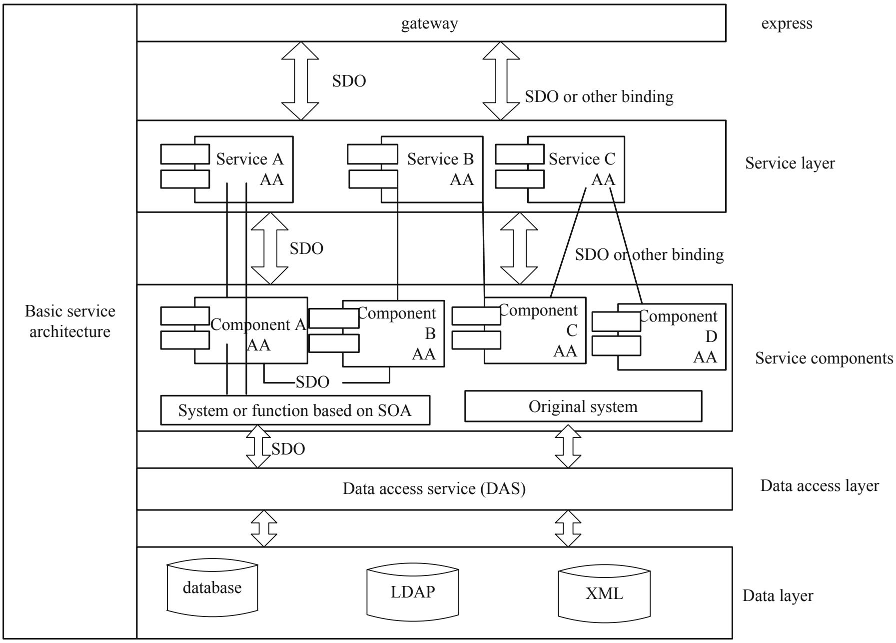


Fig. 3. System hardware configuration optimization

services to achieve a certain function [9]. In this layer, we need to call the SCA components involved in SOA architecture, integrate the teaching resources of different systems, and realize the interface of data interaction through encapsulation. For the newly developed teaching resource module, we use SOA to access the database.

Data access layer provides access interaction with underlying data. By encapsulating the interface that interacts with the data into the service component, the service component layer can access the data layer by calling the component.

The data layer stores and manages data resources for the system, and provides data interaction for the system.

2.2 Software Function Optimization of Teaching Resources Integration System

The functional structure of the system is set on the basis of user analysis and system function analysis. The teaching resource integration system is mainly divided into five modules: user management, system management, resource management, resource browsing and resource statistics. Resource management and resource browsing are the key functions of the teaching resource integration system. The specific functional structure of the system is shown in the figure below (Fig. 4):

To further optimize the function of resource integration management, the participants of teaching resource submission mainly refer to the objects that upload and publish teaching resources through the system. These participants hope that the system can realize the convenient upload and release processing function of teaching resources. The requirements of resource submission participants for the system function mainly include:

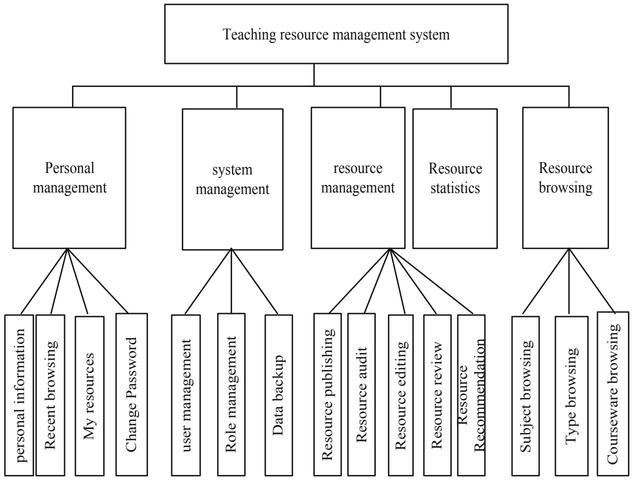


Fig. 4. System function structure optimization

distributed resource collection and submission function. It is hoped that after the system has completed the integration of the existing teaching resource management system of each department, the resource submission participants can realize the collection and submission of the number of teaching resources based on the system of their own departments, and the submitted teaching resources can be managed uniformly; standardized teaching resources can be used We hope that the system can establish a resource metadata description standard that meets the requirements of the unified management of teaching resources, and build a resource description template based on the metadata object, which can automatically record the type, size, upload time and other information of resources, which can be supplemented and improved by the submitting party; provide the function of in migration and conversion of uploaded teaching resources, and provide reference for those who have been in our department For the teaching resources stored and published on the platform, the system should be able to conveniently update the resource information according to the user's operation, and migrate to the resource integration platform according to the requirements, which will be included in the unified management of the platform; batch import function provides the function of batch processing for the same type of teaching resources, so as to reduce the workload of the submission [10–12]. The function of managing and submitting teaching resources is to delete, modify and update the submitted resources, and to obtain the information of resources' audit status, warehousing status and used status; the function of automatically auditing the legitimacy of resources' information is to automatically conduct preliminary audit on the resource description information entered by the submitted resources according to the rules, For those who do not meet the requirements, timely send a reminder message to ask for correction. The use case diagram of teaching resource submission participants is as follows (Fig. 5):

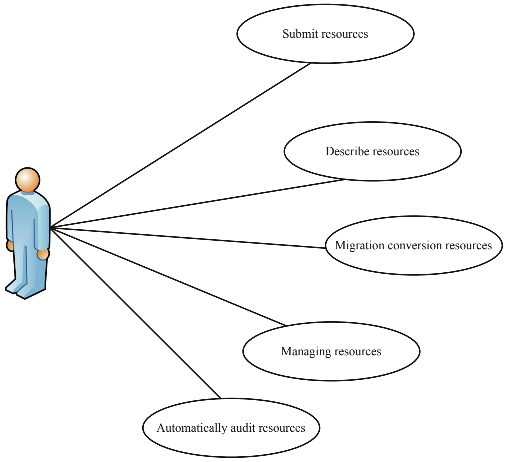


Fig. 5. Teaching resource submission participant use case

The participants of resource use mainly include teachers and students in various departments of the school, as well as researchers in the research room. These participants mainly obtain the online teaching resources they need through the system to help them complete related tasks. This kind of participants' requirements for system functions include: they hope that the system can provide personalized resource subscription and configuration functions, users can configure their own professional, interest and other information in the system, and they can obtain recommended teaching resources based on the system platform. At the same time, the system should also be targeted based on the basic information of users, as well as the historical records of query, browsing and download We hope that the system can provide a comprehensive query function, which can query all the resources in the platform according to the combination of multiple conditions, and can also realize the full-text retrieval function, which can not only query the teaching resources of the Department, but also query the education resources of other departments in the school. We hope that the system has teaching resources Evaluation function, the user should be able to achieve a detailed evaluation of the teaching resources based on the platform, can score the resources, on the one hand reflects the value of resources, on the other hand can also provide reference for other users; hope the system can provide feedback function, can provide the system administrator with relevant opinions on teaching resources through the platform. The use case diagram of resource usage participants is as follows (Fig. 6):

Resource management participants mainly refer to the personnel who organize and publish the teaching resources submitted by each node, mainly including the management personnel of school library and educational administration department. These participants hope to realize simple, efficient and intelligent teaching resource management operation through the system. The requirements of resource management participants for system functions mainly include: having the function of teaching resource audit, mainly including viewing and comparing the newly submitted teaching resources, automatically selecting the resources that may be the same from the database according to the

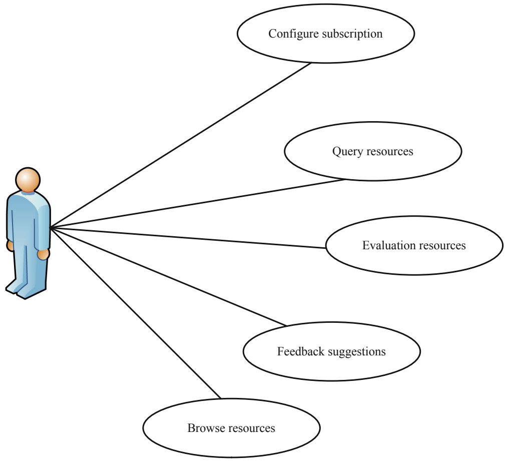


Fig. 6. Resource usage actor use case

name, type and size of the resources, so as to facilitate the comparison and de duplication of management personnel; resource information update and classification function, According to the definition of teaching resource description metadata, administrators can modify the description information of current resources, and classify teaching resources by multi label and multi-dimensional according to the information of resource submission unit, so as to facilitate the query and other operations of resource users; for the function of managing teaching resource storage, teaching resource integration system does not store all resources in the same place Database server, but based on the current network environment and storage structure, using distributed storage function, the teaching resources submitted by each department are still stored in its own database after being processed by the administrator; it has the function of interacting with resource users, and can answer the questions and suggestions of users based on the system, and transfer the relevant information Feedback to the resource providers of relevant departments. The use case diagram of resource management participants is as follows (Fig. 7):

According to the design objectives, functions and performance requirements of the teaching resource integration system, the logical bridging architecture of the system is designed in a hierarchical architecture. The specific design scheme is shown in the figure (Fig. 8).

2.3 The Realization of the Integration of Teaching Resources

Further optimize the data table of teaching resources. The data table of teaching resources is the most important data table in the most integrated system, recording the specific information of teaching resources. The fields in the data table can be customized according to the needs of users, providing the function of metadata scheme definition, and standardizing the data management information of teaching resources (Table 1).

The table records the basic information of teaching resources, including the name of resources, publishing time, affiliated institutions, etc. Because there are many attributes

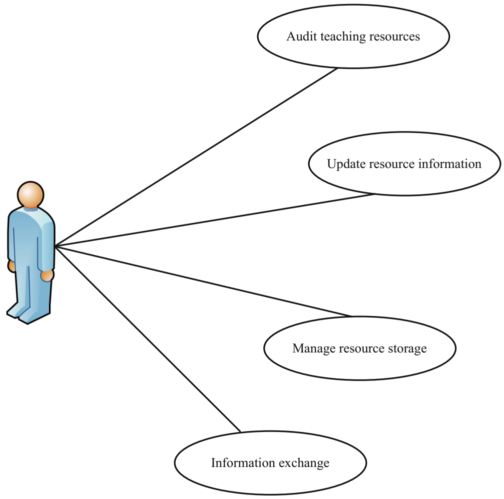


Fig. 7. Resource management actor use case

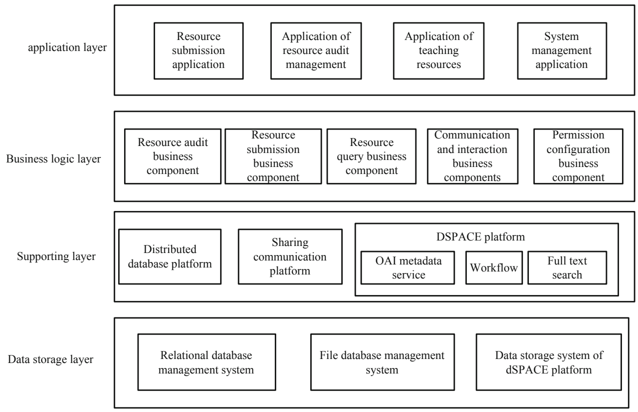


Fig. 8. System function structure framework optimization

of teaching resource entities, this table mainly records static information, and saves information such as resource download times in dynamic information table. According to the structure of resource integration platform, it is assumed that there are N total of information resources, and the subcarrier bandwidth of each resource integration is A. In the resource integration period, the channel gain is $P(B, \beta, \chi)$, and n_0 is the noise power density. The efficiency of information resource integration is as follows:

$$\eta_1 = A_0 \log\left(1 + \frac{q(n)|P(B, \beta, \chi)|^2}{e\mathrm{n}_0 A_0}\right) \tag{1}$$

Table 1. Teaching resource data management information

Serial number	Field name	Field type	Field length	Remarks
1	ID	Int	4	Resource number, primary key
2	ResTypeID	Int	4	Resource category, foreign key
3	ResName	Nchar	12	Resource name
4	UpDate	Datetime	8	Release time
5	OwnerID	Int	8	Resource organization ID
6	ResContent	text	8	Resource profile

Where $q(n)$ is the subcarrier power of information resource integration. Suppose $\mathrm{d}(B, \beta, \chi)$ represents the subcarrier allocation of resource integration configuration. After subcarrier allocation, the information resource integration efficiency is as follows:

$$\eta_2 = \sum_{\beta=1}^{N} \sum_{\chi=1}^{2} \mathrm{d}(B, \beta, \chi) P(B, \beta, \chi) \tag{2}$$

Furthermore, the course resource browsing service module is optimized to provide the function of browsing course teaching resource information according to the user's needs. The specific implementation method is: sending requests to remote servlets and using service data objects to return XML text data. The details are shown in the figure below (Fig. 9):

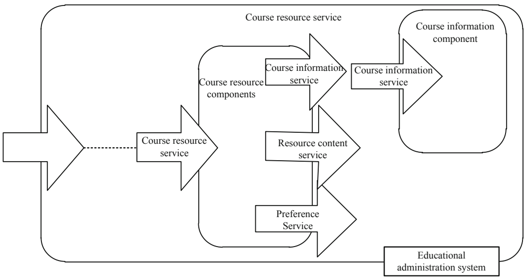


Fig. 9. Course resource browsing service module

As can be seen from the figure, the course resource browsing service module includes two aspects: course information browsing service component and course resource browsing service component. The course resource browsing service component realizes the business logic function through three service components: music, information content and hobby service. Among them, the course information service refers to the service provided by the course information service component, the preference service is based on the resources that users often browse, the collected services, and the better evaluated services; the course information browsing service component is the service to obtain the course information, which mainly provides data services for the course information service module in the course resource browsing service.

In the established resource table, the attributes of teaching resources are used as the names of the fields in the table. The attribute identification of teaching resources is divided into required data element P, optional data element Q and classified data element E. The required data element is the core element in the load balancing algorithm standard. The optional data element is the available field selected according to the teaching resources table. The classified data element is determined by certain data information. The expression of attribute identification of teaching resource is:

$$\eta_2 = \sum_{\beta=1}^{2} \eta_2(P, Q, E) \tag{3}$$

According to the classification data elements of the load balancing algorithm standard, combined with required fields and general optional data fields, a teaching resource data table is constructed. Here, taking the graph/image material data table as an example, the data table is constructed. Firstly, the fields that must be included in the data table are extracted according to the load balancing algorithm standard, and then the fields that can exist in the optional data set are selected. Finally, according to the data elements contained in the graph/image material in the classified data displayed in the table. The data object of teaching resource management in the system comes from the node of each department of our university, and the relevant personnel submit and describe the teaching resources. The design of this function mainly includes two aspects: one is to describe all kinds of teaching resources according to the requirements of resource metadata definition; the other is to submit teaching resources based on dSPACE framework. The flow chart of the collection and submission function of teaching resources is as follows (Fig. 10):

As shown in the figure above, after logging into the system, the user enters the workspace module to collect and submit teaching resources. First upload the teaching resources, and then input the metadata of the resources. The system will automatically audit the metadata. If it does not meet the requirements, it will return to the work area and ask the user to re-enter it. If it passes the initial step, it will enter the metadata editing process of the second step. After the editing, it will audit again. If it fails to pass the audit, it will go back to the work area and ask the user to re-enter it, Then it is submitted to the management personnel for manual review. After confirmation, it is added to the teaching resources document, and uploaded and saved, so as to realize the effective integration of massive teaching resources.

3 Analysis of Experimental Results

The effectiveness of the optimization method is verified through experiments. Select the types of information resources that the university can use and make statistics. The results are shown in the Table 2.

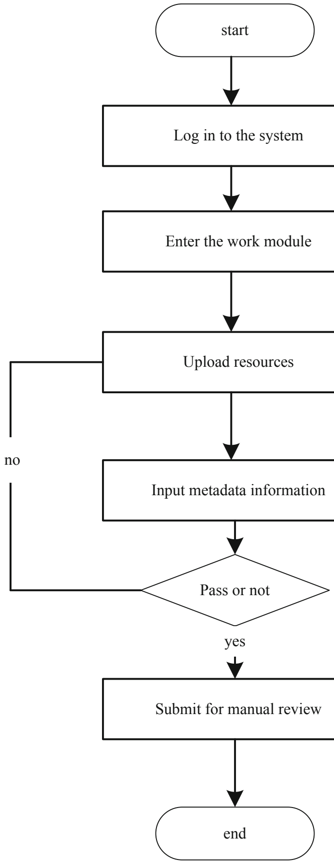


Fig. 10. System operation process optimization

Table 2. Information resources integration in Colleges and Universities

	Average value	Standard deviation	Variance
Unified distribution of periodicals in Colleges and Universities	4.20	0.845	0.812
Self access journals	3.25	1.004	1.020
Paper newspapers and periodicals	2.50	0.888	0.885
Supporting CD	1.80	1.005	1.221
Self access to CD	1.56	1.045	1.123
Electronic manuscript	1.58	0.845	0.765

It can be seen from the table that in the process of independent integration of information, the information resources obtained are relatively high. In order to verify the optimization performance of information resource integration based on optimized platform structure, the two methods are compared, as shown in the Table 3.

Table 3. Comparison of the two modes

	Traditional system	The system of this paper
Function	Resources construction, organization classification, sequence integration, using links to provide access, rapid positioning of resources	Provide references, information abstracts, automatic retrieval
Retrieval	Integrated into the search entrance, establish a one-stop resource navigation library	One stop to complete information query and get results
Basic feature	The system is easy to use and effective; the retrieval interface is friendly and the link is reasonable	The retrieval function is powerful, the knowledge system is complete, and it is convenient to obtain and transfer documents
Resource organization	Through the organization system, the information resources are integrated and the resources are revealed in depth	The distributed information resources are seamlessly connected in a conventional way to facilitate access
Integration technology	Using navigation to process the retrieval results, select reasonable results and pass them to users	Cross database integration, merging multi language search results

Based on the analysis of the test results, compared with the traditional teaching resource integration method, the design of teaching resource integration system based on load balancing algorithm proposed in this paper is relatively higher in the practical application process, and can achieve the research requirements of rapid and effective integration of massive teaching resources more quickly.

In order to verify the effectiveness of this system, a comparative analysis of the integration accuracy of teaching resources between this system and the traditional system is carried out. The comparison result is shown in Fig. 11.

According to Fig. 11, the integration accuracy of teaching resources in this system can reach up to 100%, which is higher than the integration accuracy of teaching resources in traditional systems.

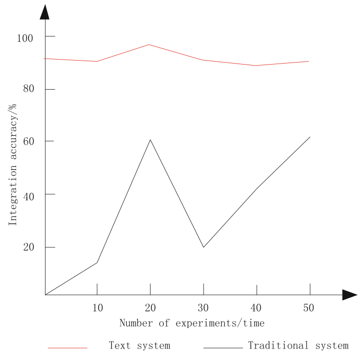


Fig. 11. Comparison of positioning accuracy of intrusion data in ship sensor network

4 Concluding Remarks

Through the design of the integration system of network resources, the sharing of teaching resources is realized. The integration of teaching resources is a relatively complex process, involving a wide range of content. Through the integration of network resources, teachers and students have a platform for mutual interaction, which effectively improves the utilization of resources, stimulates students' innovation ability, effectively links knowledge together, and improves teaching efficiency The successful design of learning resource integration system reduces the number of users switching in the Internet and meets the personalized needs of users. Give full play to the advantages of strong multimedia and network interaction and rich resources, create a relaxed and harmonious learning atmosphere, and consciously carry out horizontal comprehensive teaching related to information technology and disciplines. This has laid the foundation for the development of distance education.

References

1. Liu, Y., Wen, B., Zhou, J., et al.: Construction of a massive heterogeneous minority cultural resource integration model based on ontology. Int. J. Perform. Eng. **15**(3), 902–909 (2019)
2. Daniel, S., Stewart, K.: Open source project success: resource access, flow and integration. Oper. Res. **58**(5–6), 473–476 (2018)
3. Huang, H., Liu, C., Wang, X., et al.: Integration of multi-resource remotely sensed data and allometric models for forest aboveground biomass estimation in China. Remote Sens. Environ. **221**(5), 225–234 (2018)
4. Li, X., Zhu, M., Li, Y., et al.: Cascaded MVDC integration interface for multiple DERs with enhanced wide-range operation capability: concepts and small-signal analysis. IEEE Trans. Power Electron. **PP**(99), 1 (2019)
5. Graham, S.: Antecedents to environmental supply chain strategies: the role of internal integration and environmental learning. Int. J. Prod. Econ. **197**(MAR), 283–296 (2018)
6. Frantz, R.Z., Roos-Frantz, F., Corchuelo, R.: On the design of a maintainable software development kit to implement integration solutions. Oper. Res. **58**(1–2), 147–150 (2018)
7. Bütün, H., Kantor, I., Maréchal, F.: Incorporating location aspects in process integration methodology. Energies **12**(17), 3338 (2019). https://doi.org/10.3390/en12173338

8. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
10. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training, pp. 1–374. Springer, Heidelberg (2018)
11. Liu, J.: Research on integration of teaching resources for online open courses in higher vocational colleges under the background of information technology. J. Qiqihar Teach. Coll. (003), 17–18 (2019)
12. Jiang, T.: Discussion on optimization and integration of network teaching resources of college ideological and political courses in the era of big data. In: Journal of Physics Conference Series, vol. 1616, p. 012001 (2020)

A Data Mining Based Method for Identifying the Mismatch of Educational Resources in Regional Colleges and Universities

Yan Liu(✉), Sun Hui, and Sen-wei Wang

Dalian University of Science and Technology, Dalian 116052, China

Abstract. When identifying the mismatch of educational resources in regional colleges and universities, there is a certain mismatch between the elements of resource mismatch and the measurement, which leads to the problem that the actual recognition speed is too low. This paper constructs a data mining based method to identify the mismatch of educational resources in regional colleges and Universities. After determining the subject of collection, mining the data of educational resources in Colleges and universities, using all elements of resources to proxy variables, controlling the matching parameters between elements and measures, measuring the mismatch of educational resources, integrating similar teaching resources, establishing mismatch recognition rules, and finally completing the identification of educational resources mismatch. This paper simulates the regional university resource environment, selects the information science, information work, discipline field and related literature of CNKI as the mismatched educational resources. Experiments are used to verify the effectiveness of this method. The results show that the mismatch identification method designed in this paper can identify the mismatched resources quickly maximum.

Keywords: Data mining · Regional universities · Educational resources · Mismatch

1 Introduction

For a long time, University Library, as an academic, scientific research and service institution, has played an important role and accumulated a lot of information. With the development of science and technology, University Library urgently needs to use advanced technology and means to process all kinds of data information in order to improve service quality and resource allocation efficiency, and to promote university library to continuously improve its own business work and management level. Although the application of data mining technology in domestic library is still in the initial stage, with the development of information technology and the change of user demand, data mining technology will combine with the work of Library and play a great guiding role. The service object of university library is relatively fixed, mainly for the different needs of university teachers and students in learning, scientific research and work. From

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 291–302, 2021.
https://doi.org/10.1007/978-3-030-84386-1_24

the form of service, passive service is more than active service [1]. From the level of service, although the scope is relatively fixed, there are many levels, such as the level of undergraduate and graduate students, as well as the scope of research, the scope of interest and other aspects [2]. Therefore, the service of university library should be targeted and professional.

With the development of data mining technology, foreign countries began to study its application in the field of library, and applied the actual results to practice, and its application mode has become increasingly mature. By the end of 1990s, with the rapid development of the Internet, the construction of digital library, the construction of knowledge and information resources under the network environment, intelligent retrieval, interlibrary loan and other new topics have been emerging, and the development and research based on the application technology of digital library has become more detailed [3]. Foreign scholars have made some progress in the application of data mining technology. With the rapid application of the Internet, library digitization, knowledge and information resources construction, intelligent retrieval, interlibrary loan and so on have become research hotspots and made great achievements [4]. Digital library application technology has also made rapid development and wide application.

The innovation of this article is based on data mining technology. The elements in the resource are used to represent variables. Data mining technology is used to collect educational resources in colleges and universities. Resources are used for proxy variables. The adaptation parameters between the element and the measure are controlled. Similar teaching resources are integrated. The identification rules are established.

2 Identification Method of Regional University Education Resources Mismatch Based on Data Mining

2.1 Mining University Education Resource Data

Before collecting the data of university education resources, first determine the subject of collection, select the university resources of the same specialty as the collection object of behavior data, and collect the educational resources of colleges and universities according to the following processing process. The collection process is shown in Fig. 1 below:

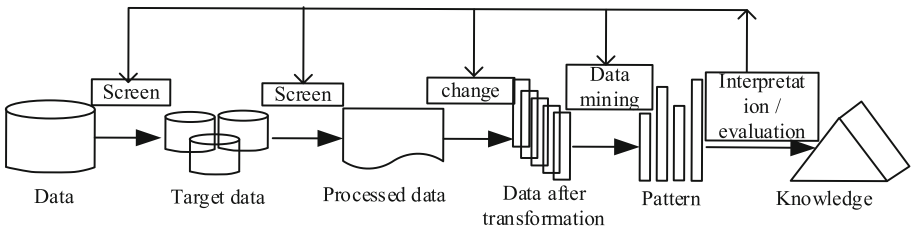


Fig. 1. Acquisition process

As shown in Fig. 1 above, firstly, according to the teaching management system of colleges and universities, collect and record the field of educational resources in Colleges and universities, formulate a data screening standard, sort out the data sets to be analyzed, and then select the data sets related to data mining to narrow the collected data range and enhance the mining quality of behavioral data [5]. Then this part of the data is preprocessed to remove the noise in the original collected data, filter the redundant and invalid data, and use the criterion function of K-average algorithm to fill in the missing data

$$E = \sum_{i=1}^{k} \sum_{q \in D_i} |q - n_i|^2 \tag{1}$$

In the above formula, E is the sum of the mean square deviation of all behavior data in the data set and the corresponding cluster center, q is the given data object, n_i is the mean value of clustering, q, n is multidimensional. The data filled with formula (1) is combined with the previous semi-structured data to be processed into structured data [6], and the naive Bayes classification method is used for classification. The classification process is as follows:

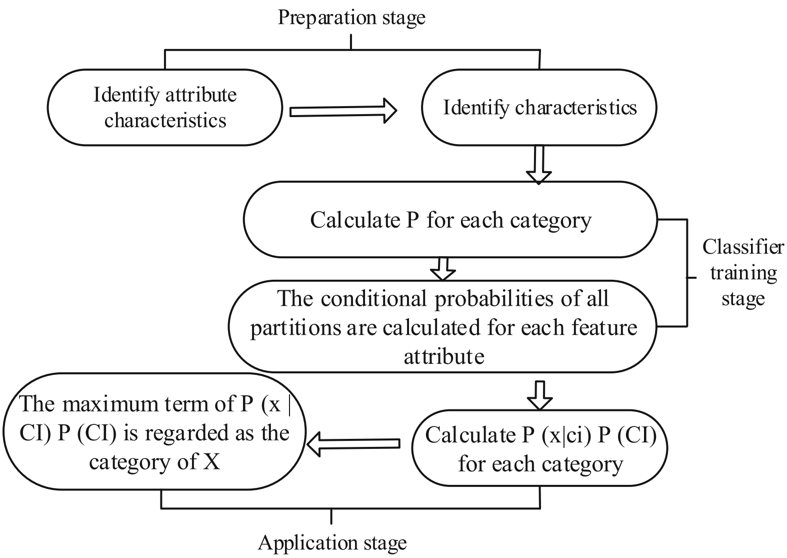


Fig. 2. Classification process

As shown in the above Fig. 2, first assume that each feature Y of the sample is uncorrelated and in an independent state C. Set it as the set of behavior data training tuples and corresponding class labels. Each tuple is represented by a dimensional vector $B_1, B_2, \ldots B_n$, in which the attributes of teaching resources measure the tuple C_i. Under one condition, the predicted tuple belongs to a class, so that the C_i has the highest posterior probability [7], and there is the following relationship:

$$P(C_i|Y) > P(C_j|Y) \quad 1 \leq j \leq m, j \neq i \tag{2}$$

From the above formula, $P(C_i|Y)$, the results can be obtained:

$$P(C_i|Y) = \frac{P(C_i)P(Y|C_i)}{P(Y)} \tag{3}$$

In the above formula, $P(Y)$ is the fixed value in the known data, the above collected and classified data are retained, and then the feature extraction processing of the collected and classified college education resources [8] is used to measure the mismatch of educational resources.

2.2 Measuring the Mismatch of Educational Resources

To measure the mismatch of educational resources, the total elements of resources [9] are used as surrogate variables to calculate the stock of educational resources in regional colleges and universities.

$$K_{it} = \frac{K_{it-1} + I_{it}}{D_{it}} \tag{4}$$

Among them, K_{it} represents the resource stock of regional colleges and universities in the region, I_{it} represents the introduction of educational resources by colleges and universities in the region, and D_{it} represents the configuration parameters. In order to eliminate the inconsistency of resource estimation among different university individuals, a resource update function is constructed

$$Y_{it} = \frac{A_{it}K_{it}^{\alpha}}{L_{it}^{\beta}} \tag{5}$$

Among them, Y_{it} refers to the number of resources replaced in Colleges and universities, A_{it} refers to the updating parameters of educational resources, L_{it}^{β} represents the number of types of educational resources, β and α respects represents the renewal elasticity of educational resources. In order to further estimate the elements of educational resources, the above calculation formulas (4) and (5) are combined to calculate the logarithm, which can be expressed as follows:

$$\ln Y_{it} = \frac{a_{it} + \alpha \ln K_{it}}{\beta \ln L_{it}} \tag{6}$$

Among them, the logarithm a_{it} of represents, and the meaning of other parameters A_{it} remains unchanged. The regional distribution of colleges and universities and the distribution of their educational resources have the characteristics of non degradation, and the relationship between the two in different regions or countries is not completely the same. A significant positive relationship between the mismatch rate and the size of regional colleges and universities was found, which shows that the universities in large regions tend to have higher mismatch rate of resources. OP covariance [10] can be a good measure of resource mismatch. Therefore, the size of the university area is used as a surrogate variable for the size, and use OP decomposition method to calculate the covariance difference between university education resources and mismatch. The op covariance is used as a measure of resource mismatch. To a large extent, it makes up for the possible defects in the mismatch method in the literature. The static OP decomposition method is adopted, which does not consider the dynamic changes of university education resources, that is, it does not take the new form of educational resources into consideration. This paper mainly decomposes the mismatch rate of each university in the same period

$$\Phi_t = \overline{\varphi_t} + \sum_i (S_{it} - \overline{S}) \tag{7}$$

Among them, $\overline{\varphi_t}$ represents the renewal rate of educational resources, S_{it} represents the share of educational resources in Colleges and universities, and $\overline{S}$ represents the average value of educational resources in Colleges and universities. Taking time as an independent variable, the change of university education resources mismatch is calculated, as shown in Fig. 3.

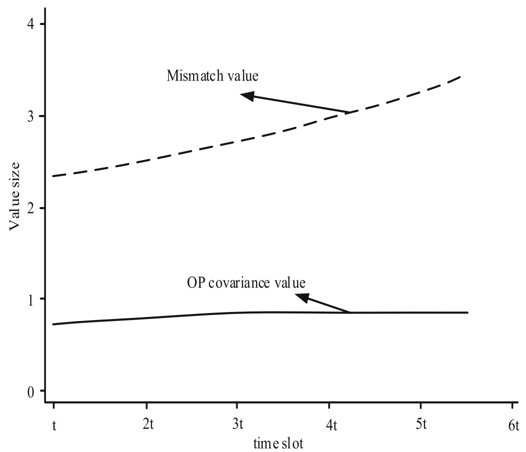


Fig. 3. The mismatch of educational resources in Colleges and Universities

As shown in Fig. 3, with the increase of OP covariance difference [11–13], the mismatch value of educational resources is also increasing, and the mismatch value almost reaches the value of 4 at the end of the statistical cycle. According to the numerical changes caused by the above mismatching process, the complexity of university education resources is defined.

2.3 Establish Mismatch Recognition Rules

Before establishing the recognition rules, the similarity teaching resources are integrated [14], and the similarity matrix is constructed by similarity evaluation method

$$S_D(d_i,d_j) = \begin{cases} v * SS_D(d_i, d_j), \mathit{if} d_i d_j \in DT \\ GS_D(d_i, d_j), \mathit{otherwise} \end{cases} \tag{8}$$

Among them, DT represents the set of mismatched information data and v is the weight parameter. Suppose the mismatched resource is g_i. The weights g_j between the two mismatched resources are calculated

$$LLS_N(g_i, g_j) = \frac{LLS(g_i, g_j) - LLS_{\min}}{LLS_{\max} - LLS_{\min}} \tag{9}$$

Where, $LLS(g_i, g_j)$ denotes the weight between mismatched resources, and represents the minimum $LLS_{\min}$ and $LLS_{\max}$ maximum log likelihood scores of mismatched resources, respectively. Then the functional similarity [15] between the two genes can be expressed as follows:

$$FS_G(g_i, g_j) = \begin{cases} 1, & g_i = g_j \\ 0, & e(g_i, g_j) \notin HumanNet \\ LLS_N(g_i, g_j) \in HumanNet \end{cases} \tag{10}$$

Among them, $e(g_i, g_j)$ represents the boundary value between the regional university education resources g_j and. using the similarity calculation results, the final mismatch identification results are for g_i mulated, and the module information recognition rules are finally calculated, as shown in Table 1.

Table 1. Identification rules established

Rule name	Resource name	Number
Recognition rule 1	Learning video	127
Recognition rule 2	Open class	48
Recognition rule 3	TV open class	145
Recognition rule 4	Video open class	40
Recognition rule 5	Excellent course	32
Recognition rule 6	Video conference system	11
Recognition rule 7	Electronic library resources	127
Recognition rule 8	Online teaching course	62
Recognition rule 9	Documentary of teaching resources	139
Recognition rule 10	Teaching materials	4

After establishing the recognition rules in the Table 1, the rules in Table 1 are used to realize the recognition of the mismatch of educational resources of regional universities [16, 17], and finally complete the research on the mismatch recognition.

3 Simulation Experiment

3.1 Experimental Preparation

The spider web system is prepared as the experimental environment of mismatch identification method. In the actual deployment, the system is refined into front-end processing, distributed storage and recognition display. In order to deal with the massive network traffic in large-scale network environment, the front-end processing part is further divided into: front-end packet capture machine and front-end processor. The front-end packet capturing machine is mainly responsible for capturing data packets in the network, and sending multiple packets with the same quintuple to the same front-end processor; The front-end processor is responsible for the processing of data packets, including flow table management, IP fragmentation reorganization, TCP reorganization, etc. at the same time, according to the traffic characteristics of complex applications, the statistical characteristics are extracted based on influenza knowledge model, and the complex application traffic is identified by saimmf method, and the logs are sent to the distributed storage subsystem.

Distributed storage uses multiple servers to build a distributed storage cluster based on Hadoop framework to ensure the storage reliability of data; at the same time, spark and shark are used to achieve efficient distributed computing. Analysis and display is divided into data analysis machine and data display machine. Among them, the data analysis machine is responsible for mining massive log data, modeling from multiple dimensions using network flow field method, and constructing private network. Data display machine is responsible for displaying the results after mining, and its display content mainly includes statistical information and real-time animation. The deployed verification experiment environment is shown in Fig. 4.

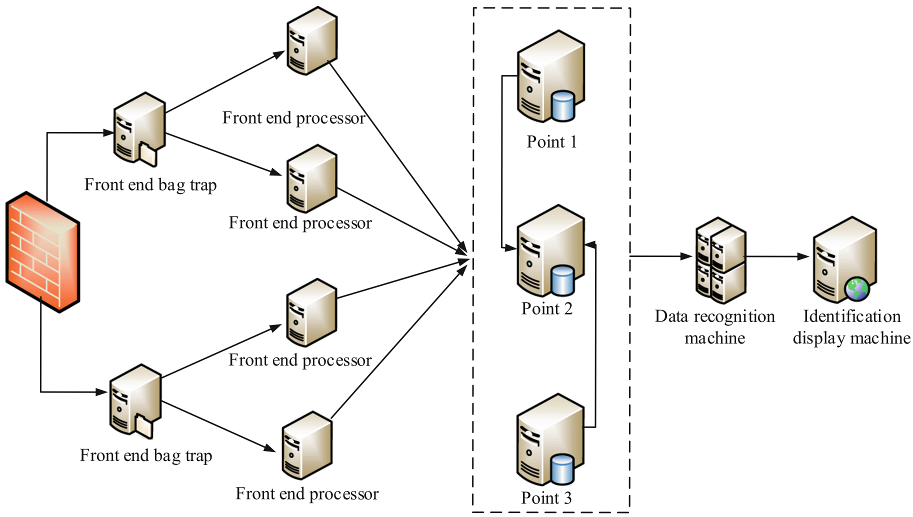


Fig. 4. Test environment of experimental deployment

In the test environment as shown in Fig. 4, the degree of association between knowledge nodes is the representation of resource aggregation, and the aggregation group is the collection of nodes with strong connection. The higher the unit requirements of the aggregation group, the higher the aggregation depth, and the more likely the knowledge nodes within the aggregation group will converge. The research sample of this paper is from CNKI database. The subject field of "information science and information work" subordinate to "library, information and digital library" in the database is selected, and the publication time of the sample is 2017–2019 (Due to the time lag of articles included in CNKI, the data was obtained in 2017. To ensure the accuracy of the data, the 2017 data was not selected as the research sample.). Based on the above conditions, a total of 12815 papers were retrieved, and 11288 papers were obtained after the critical reports and index articles were screened out. After the above resources are used as the educational resources of regional colleges and universities, the mismatch recognition methods in literature [4], the mismatch identification methods in literature [6] and the mismatch recognition methods designed in the paper are used to compare the performance of the three methods.

3.2 Results and Analysis

Based on the above experimental preparation, the size of educational resource packet is set to 64 bytes. Since it is impossible to manually label the complex application network traffic captured in the real network, it is difficult to accurately evaluate the identification performance of spider web system for specific complex applications. In order to solve this problem, manual access is used to generate network traffic for specific applications in the laboratory environment, and tcpdump tool is used to capture the corresponding application data packets. After that, the network traffic is injected into the spider web system by playback to identify and record the identification results. In the above experimental environment, control the wire speed of 100Mbps, 200Mbps, 500mbps and 800Mbps to send university education resources to the mismatch module. Finally, the number of data packets identified by the three mismatch identification methods is calculated and the recognition rate is calculated. The results are shown in Fig. 5.

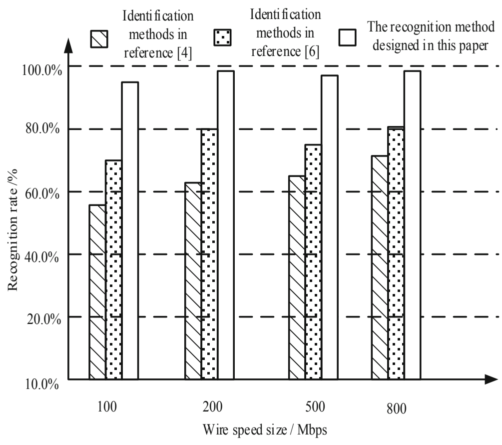


Fig. 5. Recognition rate results of three recognition methods

It can be seen from the experimental results shown in the above figure that under the same experimental environment, different recognition methods are controlled to identify educational resources with different linear speeds. According to the experimental results shown in the above figure, the average recognition rate of the recognition method in reference [4] is 60% on the left and right under four thread conditions, and the final average recognition rate of the identification method in reference [6] is about 70%, while the recognition rate designed in this paper is The average recognition rate of each method is about 97%. Compared with the mismatch recognition methods in the two literatures, the final recognition rate of the proposed method is the highest.

Keep the above experimental environment unchanged, set the data set of educational resources mismatch, take the number of TCP flows and UDP flows in the resources as the setting objects, and set the resource test data set as shown in Table 2.

Table 2. Set of test data sets

Data set	Number of TCP streams	Number of UDP streams
Resource dataset 1	176381	675531
Resource dataset 2	3194	547444
Resource dataset 3	83474	264107
Resource dataset 4	219474	1405242
Resource dataset 5	14425	1876533
Resource dataset 6	172291	451302

The test data set shown in the table above is taken as the processing object. Defining three mismatch methods to meet the storage requirements of resource log is a precise identification process. The number of accurate identification resources is obtained by counting the three identification methods, and the final accuracy rate of the three mismatch identification methods is calculated. The accuracy results are shown in Fig. 6.

From the accuracy results shown in the figure above, the three identification methods show different accuracy results after changing the resource allocation process with different line speeds. According to the precise value shown in the figure above, the average accuracy value obtained by the identification method in reference [4] is about 75%, and the accuracy value is the smallest. The average accuracy rate of the identification method in reference [6] is about 85%. The average accuracy of the proposed method is about 97%. Compared with the two methods in literature, the recognition method designed in this paper has the highest recognition accuracy, which meets the accuracy requirements of Library mismatch recognition.

Keep the above experimental environment unchanged, take the number of resources identified by the three mismatch identification methods in unit time as the comparison index, and the data in the test data set prepared in the above table as known. Count the final processing time of the three mismatch identification methods, and calculate the number of resources identified by different recognition methods in unit time. The experimental results are shown in Table 3.

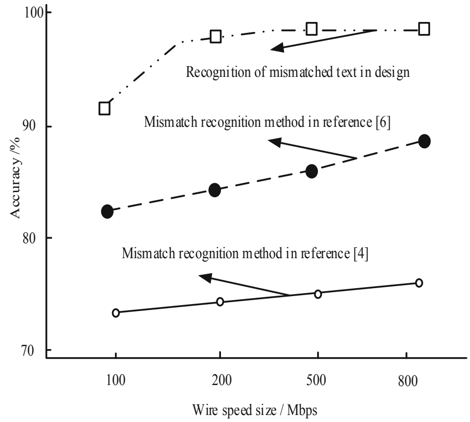


Fig. 6. Accuracy results of three identification methods

Table 3. Identification speed results of three resource mismatch methods

Data set Resource dataset 1	Recognition speed/(bar/sec)		
	Identification methods in reference [4]	Identification methods in reference [5]	Identification methods in reference [6]
Resource dataset 2	47.4	87.4	125.2
Resource dataset 3	49.5	86.5	158.7
Resource dataset 4	51.4	89.2	125.9
Resource dataset 5	51.1	93.9	134.6
Resource dataset 6	42.8	93.7	158.1
Data set	49.8	99.6	158.6

According to the results of recognition speed shown in Table 3, with the same resource test data set as the experimental object, under the control of the three identification methods, the recognition speed of the identification method in reference [4] is about 48 bars/second, and the speed of resource identification is relatively small. The recognition speed of the identification method in reference [6] is about 91 pieces/second, and the actual recognition speed is larger. The recognition speed is about 143. Compared with the two methods in literature, the recognition method designed in this paper has the fastest recognition speed. According to the above experimental results, the recognition method designed in this paper has the maximum recognition rate, the maximum accuracy rate of the recognition process, and the actual recognition speed, which is suitable for the application in the process of university education resources mismatch recognition.

4 Conclusion

With the advent of the era of big data, the amount of information is increasing rapidly. For the resource construction of digital library, resource aggregation has become an urgent problem. As an effective means of content aggregation, aggregation technology plays an important role in organizing massive resources and effectively establishing the connection between resources. With the support of data mining technology, the construction of a regional university education resources mismatch identification method can improve the lack of slow identification of resources in the literature, and provide certain theoretical basis for future research work.

References

1. Ding, G., Cheng, J.: Modeling of college students' academic performance based on educational' data mining. Heilongjiang Res. High. Educ. **38**(02), 76–81 (2020)
2. Wang, R., Wang, C., Li, J.: An intelligent divisional green tide detection of adaptive threshold for GF-1 image based on data mining. Acta Oceanol. Sin. **41**(04), 131–144 (2019)
3. Yin, Z.: Modeling and analysis of book borrowing flow in university library based on data mining. Microelectron. Comput. **35**(11), 95–99 (2018)
4. Zhong, R., Wang, H.: Data mining based specific data query technology for cloud computing management system in university. Mod. Electron. Tech. **41**(02), 130–132 (2018)
5. Liao, C., Bai, X., Xu, M.: Correction of space atmospheric model based on data mining method. J. Beijing Univ. Aeronaut. Astronaut. **44**(12), 2628–2636 (2018)
6. Liu, B.-P., Fan, T.-C., Yang, H.: Research on application of early warning of students'achievement based on data mining. J. Sichuan Univ. (Nat. Sci. Ed.) **56**(02), 267–272 (2019)
7. Chai, Y., Lei, C.: Survey of online learning behavior research applying data mining technology. Appl. Res. Comput. **35**(05), 1287–1293 (2018)
8. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
10. Liu, S., Lu, M., Li, H., et al.: Prediction of gene expression patterns with generalized linear regression model. Front. Genet. **10**, 120 (2019)
11. Lu, L., Zhou, J.: Research on mining of applied mathematics educational resources based on edge computing and data stream classification. Mob. Inf. Syst. **2021**(7), 1–8 (2021)
12. Bhat, M., Zaman, M., Butt, M.: An intelligent prediction system for educational data mining based on ensemble and filtering approaches. Procedia Comput. Sci. **2**(167), 1471–1483 (2020)
13. Prada, M.A., Dominguez, M., Vicario, J.L., et al.: Educational data mining for tutoring support in higher education: a web-based tool case study in engineering degrees. IEEE Access **8**, 212818–212836 (2020)
14. Ang, L.M., Ge, F.L., Seng, K.P.: Big educational data & analytics: survey, architecture and challenges. IEEE Access **PP**(99), 1 (2020)
15. Jung, I., Lee, J.: A cross-cultural approach to the adoption of open educational resources in higher education. Br. J. Educ. Technol. **51**(1), 263–280 (2020). https://doi.org/10.1111/bjet.12820

16. Nguyen, A., Gardner, L., Sheridan, D.P.: Data analytics in higher education: an integrated view. J. Inf. Syst. Educ. **31**(1), 61–71 (2020)
17. Karthikeyan, V.G., Thangaraj, P., Karthik, S.: Towards developing hybrid educational data mining model (HEDM) for efficient and accurate student performance evaluation. Soft Comput. **24**(5) (2020)

Optimization and Integration of Network Teaching Resources of Ideological and Political Course Based on Big Data

Ming-sheng Li(✉) and Li-jun Yun

Baotou Teachers College, Baotou 014030, Inner Mongolia, China

Abstract. In the current optimization and integration method of teaching resources, in the design of teaching resources integration method, the compatibility of the method framework is poor. When the constraint conditions are changed, the integration efficiency will be greatly affected. Therefore, this paper proposes the optimization and integration method design of network teaching resources of Ideological and Political Courses Based on big data. Firstly, according to the data mode of big data, the resource integration model is established. On this basis, CFI generalization framework is used as the resource integration framework, and the calculation method of data classification is added in the framework. Finally, computer technologies such as DOI and crossref are added to the framework to realize the integration of network teaching resources. In order to verify the feasibility of the integrated method. Taking the network teaching resource data of Ideological and political course of a university as the carrier, Experiments are used to verify the data optimization and integration effect of the designed integration method. The experimental results show that the design method is less affected by constraints, and the integration efficiency is high, which meets the design requirements.

Keywords: Teaching resources · CFI generalization framework · Big data · Resource integration

1 Introduction

The traditional information carrier system is dominated by paper-based carrier, and a stable system structure is formed by the mutual compatibility of paper-based carrier with microfilm carrier, magnetic carrier and laser carrier [1–3]. With the popularization of network digital technology application, all kinds of information begin to transform in digital form, and digital information will continue to grow, and the speed will be accelerated [4, 5]. Digital information has become the mainstream information resources, the Internet has become an important channel for people to obtain information knowledge, and people's behavior of obtaining information has also changed. For colleges and universities, digital resources can be convenient for the allocation of teaching resources. However, the growing number of complex digital resources, such as overlapping content, redundant information and low knowledge relevance, have formed "digital resource

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 303–312, 2021.
https://doi.org/10.1007/978-3-030-84386-1_25

island" and "digital resource overload". Digital resource island is the diversity and heterogeneity of storage digital resource system, which leads to digital resource It is an information environment state that is difficult to obtain and share. Digital resource overload is due to the large number of digital resources, which makes it difficult for people to accurately obtain information resources. These two dilemmas have brought a serious burden on people's utilization and access [6, 7]. Researchers at home and abroad have established a variety of resource integration systems, such as encompass with linkfinder plus and Millennium access plus map. However, in the actual use of the system, it is found that the system lacks the consideration of different constraints in the application. When different constraints are added to the resource integration, the integration running time will be significantly increased, and one-step optimization is needed in actual use.

2 Optimization and Integration of Network Teaching Resources of Ideological and Political Courses in Colleges and Universities Based on Big Data

2.1 Teaching Resource Database Model Based on Big Data

Big data is bound to play an extremely important role in resource bank project monitoring and education informatization work [8, 9]. In this paper, the establishment of teaching resource database, according to the ecological method, let the resource library achieve the growth of resource content, the increase of resource volume, the improvement of resource quality, and the realization of resource update in the continuous revision. Only by realizing ecological development can a virtuous circle be realized. The powerful functions of the resource bank in learning and teaching have been brought into full play. In this paper, the BDD model [10] is mainly used to reveal the problems existing in various aspects of the current resource library through the analysis of big data, and then formulate and implement the rectification plan for each sub project, and then accept the results. If it fails, it will be circulated once, and it will be iterated until the expert comments and passes. In order to better express this process,It is transformed into a mathematical model of sustainable development.

$$D = F(B, P1, P2, A, E, R) \tag{1}$$

Among them, D represents the effect of sustainable development of teaching resource library, F is a process function, B represents the output of big data, $P1$ represents the formulation and $P2$ represents plan of professional database. A refers to the rectification plan of the designated sub project, E indicates the assistant's assistance in the rectification, R represents the expert's evaluation and indicates the rectification result. And $P2$, A, E is a small iterative process. B, $P1$, $P2$, A, E, R is a large iterative process. In the model D, from small iteration to large iteration, the ecological development effect of the model is ensured, and the resource pool enters into a virtuous cycle and ecological development. The workflow of BDD ecological development model, first of all, through the resource system background, the professional teaching resource database and determine the active analysis $b1$, login ranking $b2$, behavior analysis $b3$, itinerary analysis $b4$, course analysis $b5$, classroom teaching $b6$, performance analysis $b7$ to generate reports.

To analyze the use of the whole resource database, and to generate a detailed table of the use of the resource database by the Ministry of education.

2.2 Framework of Teaching Resources Integration

This paper uses CFI generalization framework [11] as the resource integration framework. From CFI generalization to more extensive scenarios, it can be found that in the context of service ecosystem, the fundamental task of service resource integration is to select parts optimally according to the personalized needs of users or applications, and individuals form virtual resources. The framework includes three parts: input, output and resource integration. The input includes service resource pool, application requirement description and service resource quality. Service resource pool is the collection of service resources. The same large class of resources can be in different sub categories in different classification standards, and has different evaluation criteria; application requirements description is to describe and express the personalized needs of users in a standardized form. To be able to describe and understand user requirements is the premise of personalized service resource integration; the quality of service resources includes the quality attributes of all aspects of each resource, which can be examined from two aspects: the quality records of historical use of resources and the quality declared by service resource providers. The output is the result of the integration of service resources, that is, a set of resources obtained by matching and selecting resources. At the same time, these resources may be in different positions in the organizational structure of the collection. These common points and internal relations make these resources together form a resource set which can better meet the user's personalized application needs. When generating multiple result sets, they can be divided into different priorities according to the different evaluation results. The resource integration engine implements the service resource integration method. According to the personalized constraints of user requirements, the category and quality characteristics of resources, a set of resources is selected from the resource pool to form a virtual service resource that can meet the needs of users. The description of resource integration needs to conform to the description of service resources. In reality, the resources in a certain field are often classified according to different standards, which are reflected in the multi-dimensional classification of service resources. In addition, domain resources also have a certain number of general attributes and domain attributes, which are reflected in the multi-attribute of service resources, as shown in Fig. 1.

In CFI, developers and testers will be classified by age, technology, experience and available time per week, and have many attributes such as gender, occupation, education, interest, etc.

Multi dimensional and multi-attribute service resources can be represented as four tuples $R = (RB, RU, RA, RC)$, where RB is the basic information of service resources. RU informate related to the function or use of a service resource. RA represents a collection of service resource attributes. RC represents a collection of classification tags for service resources $|RC| = |F|$. The forest is composed of domain related service resource F classification tree. The number of classifications per service resource can be expressed as $F = \{T_1, T_2, \ldots, T_m\}$, where $T = (TN, ST)$ represents the name

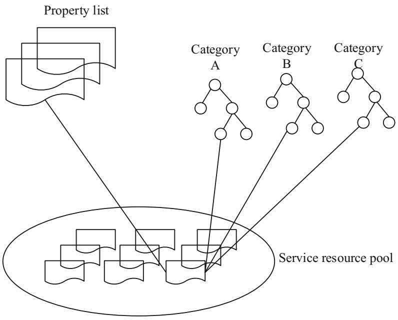


Fig. 1. Framework resource description

of the classification tree node. *TN* represents the set of sub classification trees of the classification tree, *ST* representing the classification leaf node, $|ST| = \varnothing$.

2.3 Classification of Teaching Resources

Most of the original features have little effect on the classification results [12]. The purpose of feature selection is to select the feature with the strongest distinguishing ability from these massive original feature items, so as to achieve the purpose of dimensionality reduction of high-dimensional feature vector space, reduce the amount of calculation in the subsequent classification process, and avoid "dimension disaster". Firstly, the document frequency in teaching resources is determined. The document frequency refers to the proportion of the documents with a certain feature item in the total number of documents in the corpus. The calculation formula is as follows:

$$DF(T_i) = \frac{\text{Number of documents with feature items}}{\text{Total number of documents}} \tag{2}$$

Firstly, a threshold value is set M and the document frequency value DF of all feature items is calculated. If the feature T_i of the item is removed $DF(T_i) > M$, the feature of the item T_i is retained. At the same time, $DF(T_i) < M$, to determine the statistical characteristics, this paper uses the method of mutual information [13] to extract statistical features, and calculates the statistical correlation between feature items and text categories to measure the degree of correlation. The calculation formula is as follows:

$$MI\left(T_i, C_j\right) = P\left(C_j\right) \sum\nolimits_{i=1}^{n} \log \frac{P\left(T_i \middle| C_j\right)}{P(T_i)} \tag{3}$$

In (3), $MI\left(T_i, C_j\right)$ represents the mutual information between the feature and the text, n represents the probability of the category for the text with one category in the corpus, $P\left(C_j\right)$ represents the frequency of the document with the feature item in the category, and $P\left(T_i \middle| C_j\right)$ represents the frequency of the document containing the feature item T_i. The larger the value MI, the greater the correlation between the feature and the category, the stronger the distinguishing ability of the feature item. At the same time, the feature gain of machine learning is determined, and the text importance of features can be determined by calculating the information content of feature items. The feature item contains more information, and the more important the feature item is [14]; the less information it contains, the less important the feature item is. The amount of information contained in a feature is calculated by subtracting the information difference of the corpus without the feature from the information contained in the whole corpus. The amount of information here is expressed in terms of entropy, and its calculation formula is as follows:

$$IG(T_i) = -\sum_{j=1}^{m} P(C_j)\log_2 P(C_j) + P(T)\sum_{j=1}^{m} P(C_j|T_i)\log_2 P(C_j|T_i) + P(\overline{T}_i)\sum\nolimits_{j=1}^{m} P(C_j|\overline{T}_i)\log_2 P(C_j|\overline{T}_i) \quad (4)$$

In formula (4), $P(C_j)$ represents the probability of similar texts in teaching resources in corpus. $P(T_i)$ represents the text probability of the feature item, $P(C_j|T_i)$ represents the text probability with the feature item in the class, and $P(\overline{T}_i)$ represents the text probability without the feature item. Then $P(C_j|\overline{T}_i)$ represents the text probability that does not contain feature items and does not belong to. Using the above operations, the characteristics of teaching resources are confirmed and classified according to the characteristics.

2.4 Resource Matching and Integration Technology

The integration of digital resources is not only to gather digital resources together, but also to describe, organize, process, sort, search, service and other aspects of information, which need to be supported by certain technologies [15]. At present, there are several digital resource integration technologies that attract people's attention. Using DOI technology, the unique identification code is established in the data. Its function is to assign permanent displacement identification code to digital objects. DOI provides users with permanent access to digital resources by parsing DOI. When users click DOI to ask for information, their requests are sent to the central server. The server parses DOI into URL and returns it to the end user, which enables users to access the resources. Cross ref is used to develop the reference link, and through this link, users can retrieve the metadata database and address database of crossref in different teaching resources, so as to obtain the corresponding DOI, URL and metadata. At the same time, SFX technology is added to it, which is actually a context sensitive reference link based on the open unified resource locator standard. This technology is actually a third-party service component between the link service provider and the information resources providing the link source. After receiving an OpenURL, the component obtains the metadata through parsing, and obtains the metadata through the identifier provided by the OpenURL to the relevant server, and then through the metadata, SFX can transfer the metadata to the relevant server Thus, there is no barrier between heterogeneous information sources and heterogeneous communication protocols. The overall integration process is as follows (Fig. 2):

Add the resource integration mode in the framework above, add the method of resource classification into the retrieval portal, and establish the database metadata. And

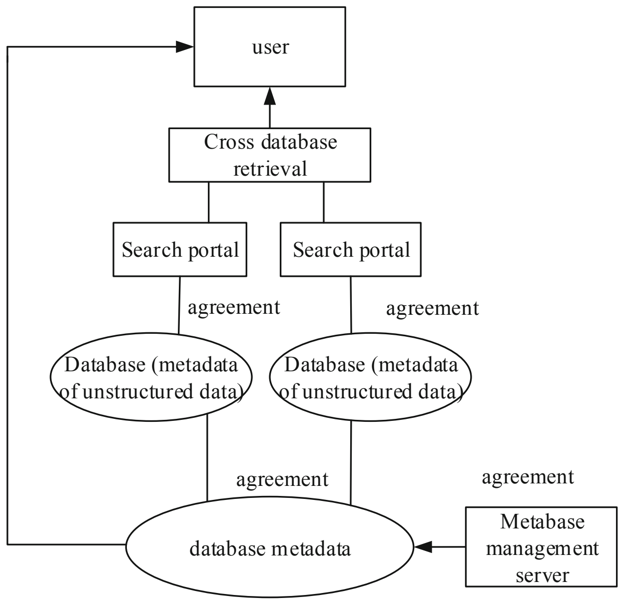


Fig. 2. Digital resource integration process

add Web services technology as a whole, and combine the advantages of distributed object technology and web technology, adopt service-oriented architecture. At the same time, through the HTTP protocol and XML data format to communicate, overcome the resources and services disordered, heterogeneous and encapsulation problems. At the same time, the XML data format is used to describe digital resources between different languages in this method. The soap protocol is used to make Wed Service eliminate the association with other heterogeneous platforms. The WSDL protocol is used to provide a unified access interface. Finally, UDDI is used for unified description, discovery and integration, so as to realize the release and sharing of digital resources, and realize the integration of resources and services. It has good applicability and flexibility. At the same time, in order to expand the data of distributed computing technology, and as a node to connect with the teaching resources users' equipment, and form a logical peer node, so that the network node has a high stability and reliability, and has the functions of client and server to complete the task cooperatively. Through direct interconnection, digital information resources can be fully shared and people can interact directly through the Internet, which makes network communication easier and resource sharing more direct. After calculation, and through various kinds of computer technology, to achieve the optimization and integration of teaching resources.

3 Experimental Demonstration and Analysis

In order to verify the effectiveness of the proposed method. In this experiment, the teaching resources of Ideological and political course in a university are used as the resource information of the experiment integration.

3.1 Experimental Environment

The experimental test environment includes one primary server and ten secondary servers, and two load generators are connected to generate the request load. The network connection structure of the server is as follows (Fig. 3):

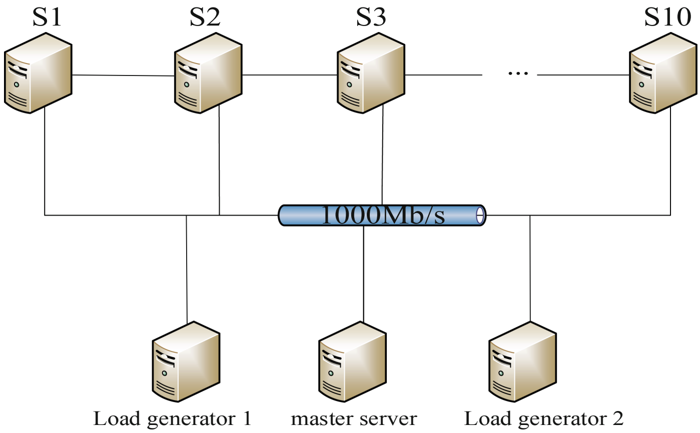


Fig. 3. Experimental server configuration

The configuration of the server is as follows (Table 1):

Table 1. Experimental server configuration

The server	Hardware configuration	Operating system	Software configuration
Load generator 1	Intel quad core 2.83 GHz, 4 GB memory, 1 GB/S	WinXP SP3	LoadRumner
Load generator 2	Intel quad core 2.83 GHz, 4 GB memory, 1 GB/S	WinXP SP3	LoadRummer
Master server	Intel quad core 2.83 GHz, 4 GB memory, 1 GB/S	Win2003 Server	Jvm1.6Master
Secondary server	Intel quad core 2.83 GHz, 4 GB memory, 1 GB/S	CentOS 5.3	JVM1.6NodeAgent

3.2 Experimental Methods

In this paper, the following experiments are carried out to verify the idle server merging and the bottleneck server splitting. Firstly, five application clusters are deployed in the system. They all have one load distributor and one web application server instance. The five application server instances are evenly distributed among the five servers. There are 1 master server and 10 slave servers, of which 5 application server instances are deployed on 5 different slave servers. In this paper, the experimental application is CPU intensive, each visit will do 100000 floating-point operations, the weight of CPU and memory is 9:1. Due to the limited network transmission data and diskless read/write operations, the resource consumption of network read/write and disk read/write is not considered. Then turn on the global adjustment operation switch to allow the platform to integrate resources. At this time, since the application has not been loaded, the resource utilization of each application is negligible. In this paper, the methods in literature [1], literature [2] and literature [4] are used and compared with the design method in this paper.

3.3 Experimental Results

Through the five application server instances, the platform will merge them into one secondary server. After the generation merging, each application will add the corresponding load, as shown in Fig. 4.

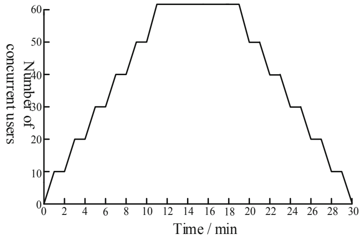


Fig. 4. Load curve of experimental application

With the gradient increase of each application load, the server load increases, and the resource usage of each application server instance increases, resulting in the bottleneck state of the only host server at present. At this time, the server splitting operation will be triggered, which will cause the platform to gradually split some cluster nodes into other servers, increasing the number of working servers. In this paper, under the condition of big data, the similar optimization effect is calculated. Four methods are used to integrate the experimental teaching resource data of Ideological and political courses in Colleges and universities. The operation efficiency in the integration process is shown in Fig. 5.

In Fig. 4, method 1 is the teaching resource integration method designed in this paper, method 2 is the teaching resource integration method in literature [1], method 3 is the teaching resource integration method in literature [2], and method 4 is the teaching resource integration method in literature [4]. In Fig. 4, it can be found that in the 200MB teaching resources integration, the running time is relatively small, but with the increase of the scale of resources, the running time has a big difference, while the first method has a shorter running time compared with other methods.In this paper, the operational constraints in actual use are simulated. And different numbers of constraints were added to the operation, and the result shown in Fig. 6 was obtained.

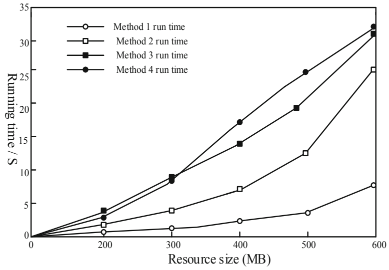


Fig. 5. Resource integration operation efficiency

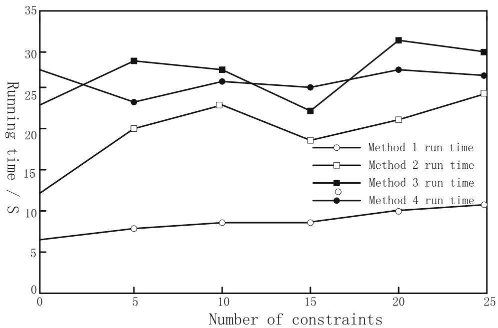


Fig. 6. Operation time under different requirements and constraints

In Fig. 6, it is found that the optimization and integration method of teaching resources designed in this paper is less affected under different constraints, while other methods are obviously affected, and the operation time changes under different constraints. Under the same number of constraints, the transportation speed of the teaching resources operation method designed in this paper is faster, which proves the feasibility of the teaching resources operation method.

4 Conclusion

In this paper, the big data model is used to establish the optimization model of teaching resources. At the same time, through the optimization of the framework, the operation efficiency of the integration method is higher. However, in this paper, due to the use of big data model to build the integration model, so the integration needs to be connected to the network, and through multiple servers, so there are still limitations.

References

1. Wan, L.: The development and integration of network-based teaching resources in universities' ideological and political courses. Jiaoyu Jiaoxue Luntan **12**(21), 56–57 (2018)
2. Huang, X.: Resource integration: reconstruction of teaching content based on learner needs. Theory Pract. Educ. **38**(22), 61–64 (2018)

3. Zhou, Q., Gao, J.: Practice and experience of clinical education and teaching resource integration and optimization configuration. Mod. Hosp. Manag. **16**(3), 74–76 (2018)
4. Sun, W.: Strategic research on the integration of primary school English story teaching and primary school English curriculum resources. Guide Sci. Educ. **1**(26), 130–131 (2018)
5. Lan, L.: Research on the integration and optimization of teaching resources of vocational service professional group based on the perspective of quality diagnosis and improvement. Commun. Vocat. Educ. **12**(6), 39–43 (2018)
6. Zheng, K.: The resource integration of foreign languages teaching from the perspective of "One Belt and One Road." J. Sichuan Univ. Arts Sci. **28**(2), 139–142 (2018)
7. He, F.: Research on the integration and application of micro-curriculum resources in high school physics teaching. Guide Sci. Educ. **6**(32), 141–142 (2018)
8. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
10. Liu, S., Lu, M., Li, H., et al.: Prediction of gene expression patterns with generalized linear regression model. Front. Genet. **10**, 120 (2019)
11. Zhao, H., Guo, L.: Design of intelligent computer aided network teaching system based on web. Comput.-Aided Des. Appl. **19**(S1), 12–23 (2021)
12. Ting, X.: Chemistry course network teaching based on key information search and big data cloud platform. J. Intell. Fuzzy Syst. **3**, 1–12 (2020)
13. Shen, Y., Yu, H.: Multimedia network teaching platform and its application in mechanical design. Int. J. Electr. Eng. Educ. 002072092098355 (2021)
14. Jian, W.: Application of blending learning based on network learning space in teaching design of digital art. Int. J. Emerg. Technol. Learn. (iJET) **14**(3), 177 (2019)
15. Chen, L., Feng, T., Fan, D.: Construction of a sharing model for network digital teaching resources oriented to big data. Int. J. Continuing Eng. Educ. Life-Long Learn. **30**(2), 190 (2020)

Research on Hybrid Recommendation Algorithm of Educational Courseware Resources Based on Heterogeneous Information Fusion

Sheng-bin Wu[1](✉) and Ying Yang[2]

[1] College of Information Engineering, Changsha Medical University, Changsha 410219, China
[2] School of Computer, Guangdong AIB Polytechnic College, Guangzhou 510507, China

Abstract. Aiming at the poor recommendation effect of the traditional hybrid recommendation algorithm for educational courseware resources, a hybrid recommendation algorithm based on heterogeneous information fusion is proposed. Through the description of the characteristics of educational courseware resources, the attributes are mapped into the rating matrix, and the average values of the attributes of all the evaluated educational courseware resources are calculated. After the similar items are merged, the double attribute rating matrix is obtained. The modular matrix is used to process the sub factor sequence, and the mean value of the correlation coefficient corresponding to each sub factor sequence is calculated. This paper studies the coupling relationship between educational courseware resources, completes the modular processing of educational courseware resources, and realizes the recommendation of network hybrid information combined with the design of network hybrid information recommendation algorithm. The experimental results show that the hybrid recommendation algorithm based on heterogeneous information fusion can better solve the problem of low recommendation efficiency caused by sparse score matrix and "cold start". The recommendation effect is better than the traditional collaborative recommendation algorithm, and the quality is higher.

Keywords: Heterogeneous information fusion · Educational courseware resources · Hybrid recommendation · Recommendation algorithm

1 Introduction

With the continuous development of the Internet and information technology, the popularity of intelligent terminals, and the large-scale coverage of 4G network and wireless network, people's life and work have undergone great changes. People take the network as the medium, and the learning mode of distance learning course resources is also developing continuously. Learners can learn through network courseware or other learning resources, and are no longer limited by time and space [1]. However, if the online education platform simply presents the offline course content and teaching resources,

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 313–324, 2021.
https://doi.org/10.1007/978-3-030-84386-1_26

it will lead to the poor interaction between teachers and students and the learning efficiency of students due to the time and space barrier of distance education; at the same time, there is no difference in one-way teaching for all students, which leads to poor personalization. The explosive growth in the number and scale of educational resources makes it difficult for ordinary learners to choose learning resources [2]. The resources obtained through traditional search engines are usually complex and inaccurate, which can not satisfy them. At the same time, although the current organizational structure of learning resources can meet the requirements of online learning, due to the proposal of personalized learning, learning resources also need to meet the needs of learners for the structural, dynamic and retrievable resources [3].

The study of learning resources in online education has a long history abroad. As early as 1998, the United States Department of education and the National Library of Education launched the gem project, which proposed to use metadata coding to describe, organize and manage network resources, so as to facilitate people to retrieve and obtain learning resources. Luo J et al. [4] because the traditional keyword search method is difficult for learners to find and obtain the most appropriate resources from the vast amount of educational resources, context aware resource recommendation service has become an important part of pervasive learning environment. To solve this problem, a context aware resource recommendation model and related recommendation algorithm are proposed in this paper The first part combines the content-based and collaboration based recommendation mechanism, and introduces the individual preference tree to consider the multi-dimensional attributes of resources, the rating matrix of learners and the energy of access preferences In the second part, in order to enhance the effectiveness of the recommendation, the connection type correlation and time satisfaction are calculated according to other relevant contexts. Then, the candidate resources can be filtered and sorted by combining the two parts to generate the recommendation results. The simulation results show that the proposed method is effective It is better than other most advanced algorithms in traditional and newly proposed metrics, and may be more suitable for pervasive learning environment H et al. [5] in view of the fact that the existing course video recommendation system is generally limited to one course and ignores the knowledge correlation between courses, in this work, a two-stage cross course video recommendation algorithm is proposed. The algorithm considers both the implicit feedback of learners and the knowledge association between course videos. Firstly, collaborative filtering is used to generate video seed set, which seeds Secondly, a cross course video association knowledge map is constructed, and the random walk algorithm is used to measure the relevance of the course video. The relevance is based on each video seed as the starting node, and is extended to the video subgraph. Then, several cross course video oriented subgraphs are recommended to the learners. The experimental results show that the cross course video association knowledge map can be used to measure the relevance of the course video. The recommendation algorithm is superior to the traditional recommendation algorithm based on collaborative filtering in accuracy, recall rate and knowledge relevance.

Scholars in the field of educational technology in China have also carried out a lot of research on learning resources in online education. Ren Lei [6] aimed at the problem of excessive granularity of user interest descriptions in traditional collaborative filtering algorithms, and the problem of inaccurate calculation of similarity caused by sparse score matrix., A hybrid recommendation algorithm based on incremental learning WHHR is proposed. This algorithm constructs a content-based user model through Widrow-Hoff incremental learning, and combines the collaborative filtering recommendation mechanism to achieve score prediction. The experiment verifies that the WHHR algorithm is in convergence speed and Compared with similar recommendation algorithms, the accuracy of recommendation has been greatly improved; Yangfengrui et al. [7] has relatively low accuracy and reliability for the traditional recommendation algorithm. In view of the problem of cold start of users and projects, this paper proposes a hybrid recommendation algorithm based on probability matrix decomposition. Firstly, the trust relationship of users is mined from the perspective of user rating, and then the relevance between items is measured by label context according to user characteristics, and then integrated into probability matrix model for recommendation. The experiment shows that, the proposed algorithm has achieved good results in the accuracy of recommendation compared with the conventional method.

2 The Design of Algorithms for Mixed Recommendation of Educational Courseware Resources

2.1 Build a Dual Attribute Score Matrix

All features of educational courseware resources are represented by a set, such as a. $c = \{c_1, c_2, c_3, \ldots, c_n\}$ vector composed of features of educational courseware resources is used to represent an educational courseware resource

$$p = \left[p_1, p_2, p_3, p_4, \ldots, p_n\right] \tag{1}$$

Among them, p_j describes a certain attribute characteristic of the educational courseware resource. When the educational courseware resource has this attribute characteristic, its value is 1; when it does not have this characteristic, its value is 0.

First, map the attributes of the educational courseware resources in the scoring matrix through the characteristic description of the educational courseware resources. Assuming that a_{ij} represents user u's rating of the j-th educational courseware resource attribute of the educational courseware resource i, then user u's rating of the j-th educational courseware resource attribute the score $R(u, j)$ is expressed as the average value of the j th educational courseware resource attribute of all the evaluated educational courseware resources by user u:

$$R(u, j) = \frac{\sum_{i=1}^{N} a_{ij}}{N} = \frac{\sum_{i=1}^{N} p_j \times R(u, i)}{N} \tag{2}$$

Among them, $R(u, i)$ is the score of user u on educational courseware resources i, and N is the total number of educational courseware resources evaluated by N.

Similarly, all features of a user can be represented by a set, such as $b = \{b_1, b_2, b_3, \ldots, b_n\}$. A user can be represented by a vector composed of user features

$$q = \left[q_1, q_2, q_3, q_4, \ldots, q_n\right] \tag{3}$$

Among them, q_k is used to describe a certain user attribute characteristic of the user. When the user has this attribute characteristic, its value is 1; when it does not have this characteristic, its value is 0.

Map the user's attribute characteristics to the newly established user-education courseware resource attribute scoring matrix. The score of user attribute k on the j-th education courseware resource attribute of $R(k,j)$ is expressed as the mean value of user u's evaluation of the j-th education courseware resource attribute:

$$R(k,j) = \frac{q_k}{H} \times R(u,j) = \frac{\sum_{i=1}^{N} q_k \times p_j \times R(u,i)}{N \times H} \tag{4}$$

Where H is the number of user attributes owned by user u.

After the same category items are merged, the double attribute score matrix is obtained as follows:

$$\text{Two attribute scoring matrix} = \begin{pmatrix} R(1,1), R(1,2), R(1,3), \ldots, R(1,j) \\ R(2,1), R(2,2), R(2,3), \ldots, R(2,j) \\ R(3,1), R(3,2), R(3,3), \ldots, R(3,j) \\ \ldots\ldots \\ R(k,1), R(k,2), R(k,3), \ldots, R(k,j) \end{pmatrix} \tag{5}$$

In the above description, the attributes of the educational courseware resources are mapped in the scoring matrix, and the average value of the attributes of all the evaluated educational courseware resources by the user is calculated. After the similar items are combined, a dual-attribute scoring matrix is obtained.

2.2 Modular Processing of Educational Courseware Resources

If the recommendation of educational courseware resources is taken as a system, modular processing refers to distinguishing the key factors of the recommendation of educational courseware resources, and rationally analyzing the sub-factors in the module [8]. Suppose u_{ij} represents the j-th factor in Educational Courseware Resource Module i, and its influence is recorded as x_{ij}.

When using the sequence of n sub-factors to deal with the influencing factors of educational courseware resource recommendation, a modular matrix based on personalized adaptive learning will be formed, namely:

$$\left(X_1', X_2' \cdots, X_n'\right) = \begin{pmatrix} x_1'(1) & x_2'(1) & \cdots & x_{nt}'(1) \\ x_1'(2) & x_2'(2) & \cdots & x_{n-1}'(2) \\ \vdots & \vdots & \vdots & \vdots \\ x_1'(m) & x_2'(m) & \cdots & x_n'(m) \end{pmatrix} \tag{6}$$

Using personalized adaptive learning to modularize the sequence of sub-factors, you can get:

$$(X_0, X_1, \cdots, X_n) = \begin{pmatrix} x_0(1) & x_1(1) & \cdots & x_n(1) \\ x_0(2) & x_1(2) & \cdots & x_n(2) \\ \vdots & \vdots & \vdots & \vdots \\ x_0(m) & x_1(m) & \cdots & x_n(m) \end{pmatrix} \tag{7}$$

The mean value of the correlation coefficient corresponding to each sub-factor sequence is calculated separately to reflect the correlation between the educational courseware resources and the sub-factor sequence [9], which is called the correlation sequence, which is recorded as:

$$r_{i0} = \frac{1}{m}\sum_{k=1}^{m} \zeta_i(k) \tag{8}$$

Then the educational resources of u_{ij} can be recommended as follows:

$$\lceil u_{ij} \rceil = \begin{cases} \frac{(\text{arcmax}\, \zeta_i(j) - r_{i0})}{\zeta_i(j)}, u_{ij} \text{ The recommendation effect was negative} \\ \frac{(r_{i0} - arc\max \zeta_i(j))}{\zeta_i(j)}, u_{ij} \text{ The recommended effect is positive} \end{cases} \tag{9}$$

The coupling degree function is used to study the coupling relationship between educational courseware resources. The coupling degree between different educational courseware resources can be expressed as:

$$T_m = \left\{ \frac{(u_1 \times u_2 \times \ldots u_m)}{\left[\prod \left(u_i + u_j\right)\right]} \right\}^{\frac{1}{m}}, i \neq j \tag{10}$$

Among them, the value of T_m is between 0 and 1, and u_i represents the total recommendation effect of educational courseware resources. The calculation formula is:

$$u_i = \sum^{m} \lambda_{ij} u_{ij} \tag{11}$$

Although formula (11) can be used to calculate the coupling degree between educational courseware resources, it can not reflect the status of personalized adaptive level to recommend educational courseware resources. Therefore, a coupling coordination function is constructed to calculate the coupling degree between educational courseware resources

$$\begin{cases} F = \alpha u_1 + \ldots + \beta u_m \\ A = \sqrt{T_m} \cdot F \end{cases} \tag{12}$$

Among them, A represents the coupling coordination degree function, T_m represents the coupling degree of the education courseware resources, F represents the coordination index, and α and β represent the overall recommendation weight of the education courseware resources.

Modularization of the sub-factor sequence is carried out using the modular matrix, and the mean value of the correlation coefficient corresponding to each sub-factor sequence is calculated. The coupling relationship between the educational courseware resources is studied using the coupling degree function, and the modular processing of the educational courseware resources is completed. Next, by calculating the similarity of educational courseware resources, to simplify the recommendation process of educational courseware resources.

2.3 Design a Hybrid Recommendation Algorithm for Educational Courseware Resources

Every piece of information released by users will involve a topic or multiple topics, and the characteristics of user information release match the topic model of educational courseware resources [10–12]. Therefore, the topic model is used to determine the topic distribution of the information posted by the user, so as to initially determine the user's interest orientation. The flow of the hybrid recommendation algorithm for educational courseware resources is shown in Fig. 1.

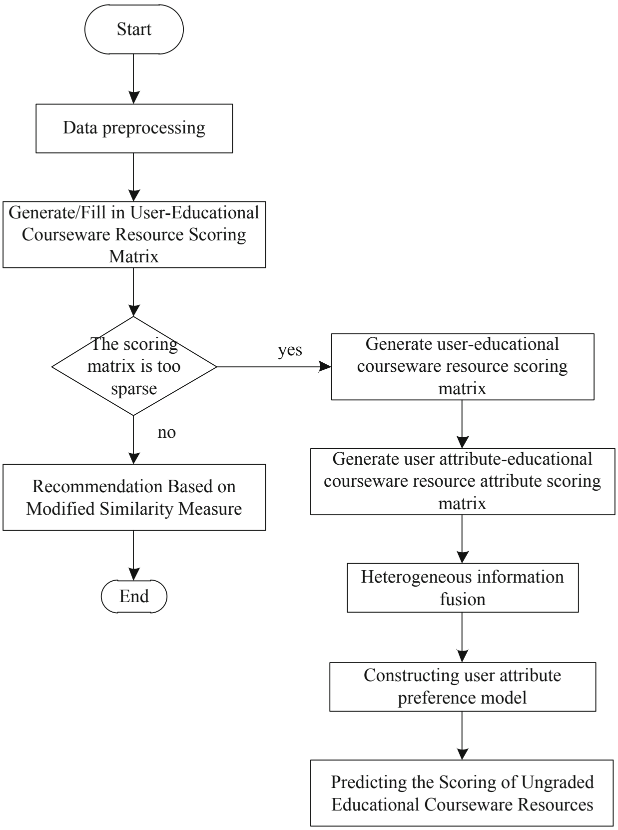


Fig. 1. Flow chart of hybrid recommendation algorithm for educational courseware resources

For the topic distribution of educational courseware resources, definition $C = \{C_1, C_2, \cdots, C_T\}$ represents the theme set of educational courseware resources. For a piece of educational courseware resource t, the posterior probability is $p(C_i \mid t)$. Therefore, the main part vector of the education courseware resource composed of posterior probability is $(p(C_1 \mid t), p(C_2 \mid t), \ldots, p(C_T \mid t))$, T Represents the number of subject collections of educational courseware resources. For the user's interest orientation, suppose $\{t_1, t_2, \cdots, t_d\}$ represents the set of educational courseware resources released by the user, then the T dimensional vector $(v_1, v_2, \cdots, v_T)$ represents the user's interest orientation in the educational courseware resources, and the calculation formula is:

$$v_i = \frac{1}{d}\sum_{j=1}^{d} p(C_i \mid t_j) \tag{13}$$

According to the user's interest weight, v_i is improved by using personalized adaptive learning

$$v_i = \frac{1}{d}\sum_{j=1}^{d} \alpha_j p(C_i \mid t_j) \tag{14}$$

Among them, $\sum_{j=1}^{d} \alpha_j = 1$ and α_j represent the user's interest weight value for educational courseware resources, which can reflect the user's preference set for educational courseware resources. The larger the value of α_j, the higher the user's preference for educational courseware resources.

Assuming that the education courseware resource t is composed of n words, the n-th word is recorded as w_n, and the topic of w_n is defined as z_{w_n}, then the probability of z_{w_n} is calculated as:

$$P\left(z_{u_i} = j \mid Z_{t,\neg i}, t, \varphi, \alpha\right) \propto \frac{P\left(z_{w_i} = j, Z_{t,\neg i}, t \mid \varphi, \alpha\right)}{P\left(Z_{t,\neg i}, t \mid \varphi, \alpha\right)} \tag{15}$$

On the basis of formula (15), if the topic distribution of word w_n is $V_{w_n} = (v_1, v_2, \cdots, v_T)$, then the standardization probability of v_i is:

$$v_j = \frac{P\left(z_{x_i} = j \mid Z_{t,\neg i}, t, \varphi, \alpha\right)}{\sum_{j=1}^{T} P\left(z_{u_i} = j \mid Z_{t,\neg i}, t, \varphi, \alpha\right)} \tag{16}$$

The probability that educational courseware resource t belongs to topic j is as follows:

$$\theta_{t,j} = \frac{n(j,t) + \alpha}{n(t) + T\alpha} \tag{17}$$

According to $\theta_{t,j}$, the average preference similarity of users in M cycles can be defined:

$$\mathrm{sim}_M = \frac{\sum_{\frac{1}{2}}^{M} \mathrm{sim}(u_{k-1}, u_k)}{M - 1} \tag{18}$$

In order to facilitate the comparison, the average preference similarity of users can be processed by personalized adaptive learning, and the user preference similarity can be calculated

$$\mathrm{sim}(U_{k-1}, U_k) = \cos\theta = \frac{\overrightarrow{u_{k-1} \cdot \overrightarrow{u_k}}}{|\mu_{k-1}\|\cdot|\mu_k\|} \tag{19}$$

In conclusion, heterogeneous information fusion is used to improve the recommendation method of educational courseware resources. Through modular processing of educational courseware resources, a network hybrid information recommendation algorithm is designed to realize the recommendation of network hybrid information.

3 Experimental Comparative Analysis

By comparing the difference in recommendation accuracy and the number of recommended educational courseware resources between the education courseware resource hybrid recommendation algorithm based on heterogeneous information fusion and the traditional user-based collaborative recommendation algorithm, it is verified that the recommendation algorithm in this paper can solve the sparse score matrix and cold start. And other issues.

3.1 Experimental Environment and Experimental Data Set

The experimental environment is inter (R) core (TM) i7–4790 CPU @ 3.60 GHz, the memory is 8.0 GB, and the operating system is Windows 7. Pychar 2017.1 and MATLAB are used to implement the data preprocessing and recommendation algorithm_R2017b.

The experimental data set is movielens data set, which is collected and founded by the group lens educational courseware resource group of Minnesota University in the United States. It can receive users' ratings on movies and provide personalized movie recommendation to them.

Among them, each evaluation score ranges from 1 to 5. Each user provides his / her age, gender, occupation and other attribute information when registering, and each movie provides feature information such as film title, release date, theme type, etc.

In this paper, the movielens LM data set is selected and divided into five subsets, which are disjoint. Each subset contains 80000 scoring base data sets and 20000 scoring test data sets. The base data set and the test data set are complementary.

The sparsity of base data set is 95%, which is a typical sparse matrix, which can help to verify the improvement of the algorithm in solving the problem of sparse score matrix.

3.2 Experimental Methods and Evaluation Indicators

Use offline experiments to verify the correctness of the improved algorithm. Each experiment selects a subset, uses the improved algorithm to predict the user ratings on the base data set, and then uses the true score of the test to calculate the error of the predicted score to verify The effectiveness of the algorithm.

Use evaluation indicators based on prediction accuracy to calculate the accuracy of the recommendation algorithm, and use MAE to measure its error:

$$MAE = \frac{\sum_{s \in S} \left| R_S - \hat{R}_s \right|}{|S|} \tag{20}$$

Among them, S represents the collection of all products, R_S represents the real score of products, and $\hat{R}_s$ represents the predicted score of product s by the current user calculated by the recommendation system.

Mae calculates the average error between the predicted score and the real score. The smaller the value, the higher the quality of the recommendation algorithm.

3.3 Experimental Results and Analysis

3.3.1 Experimental Results Recommended by the Algorithm

Select the number of neighbor user sets to be 10, 20, 30, 40, 50, and use the user-based collaborative recommendation algorithm (User-based C) and the hybrid recommendation algorithm of educational courseware resources based on heterogeneous information fusion to conduct comparative experiments, and predict the scoring result is compared with the average absolute error of the test data set, and the result is shown in Fig. 2.

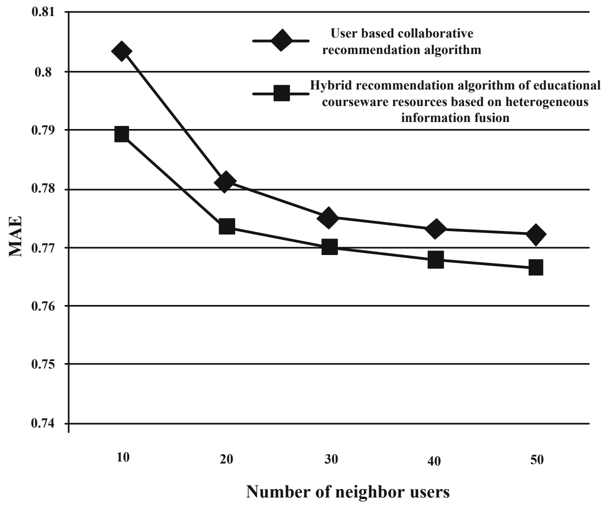


Fig. 2. Comparison of average absolute error of recommended algorithms

As shown in the figure above, the hybrid recommendation algorithm based on heterogeneous information fusion has smaller average absolute error and better recommendation effect than collaborative recommendation algorithm. Based on the double attribute rating matrix, the improved algorithm uses heterogeneous information fusion to simulate the user's attribute preference model, and makes reasonable rating prediction for the non rated items, which alleviates the inaccurate recommendation problem caused by the sparse rating data of traditional algorithms.

3.3.2 Algorithm Cold Start Recommended Experimental Results

(1) Make recommendations for new users
Twenty users were randomly selected and their rating data was set to zero to simulate the situation of new users entering the recommendation system. The number of neighbor user sets are 20, 40, 60, 80, 100, 120, 140, and the user-based collaborative recommendation algorithm (User-based CF) and the hybrid recommendation algorithm of educational courseware resources based on heterogeneous information fusion Users make recommendations and compare the number of items recommended by the two for new users. The experimental results are shown in Fig. 3.

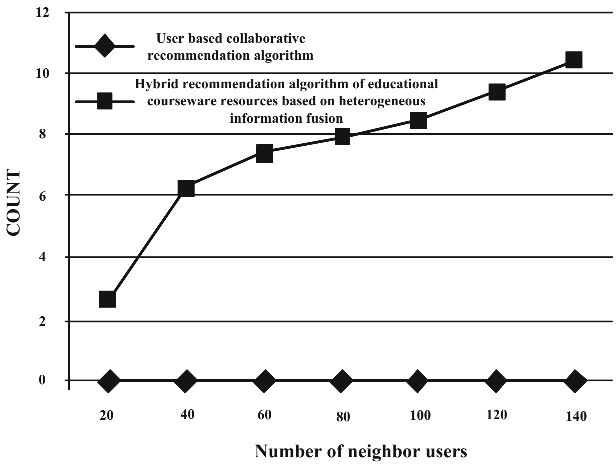


Fig. 3. Comparison of recommendation algorithms for solving user's "cold start" problem

As shown in Fig. 3, when new users enter, the hybrid recommendation algorithm based on heterogeneous information fusion can recommend more items for new users than the collaborative recommendation algorithm. With the increase of the number of neighbor users, the recommended items also increase, which effectively alleviates the impact of user cold start on the recommendation quality.

(2) Recommend new projects
Ten items were randomly selected and their score data were set to zero to simulate the situation of new items entering the recommendation system. The number of neighbor users is 20, 40, 60, 80, 100, 120, 140, respectively. The user based CF algorithm and the hybrid recommendation algorithm based on heterogeneous information fusion are used to recommend new projects. The number of potential users is compared. The experimental results are shown in Fig. 4.
As shown in the figure above, when a new project enters the system, the hybrid recommendation algorithm of educational courseware resources based on heterogeneous information fusion can recommend this new project to more users

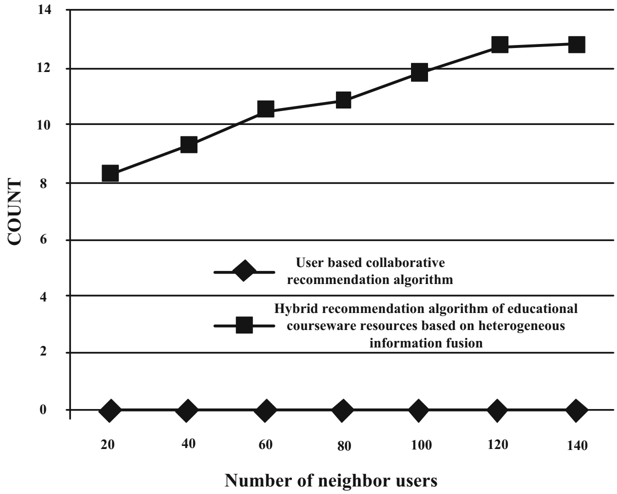


Fig. 4. Comparison of recommended algorithms for solving the "cold start" problem of items

than the collaborative recommendation algorithm, and as the number of neighbor projects increases, Recommending new items to more potential preference users has alleviated the impact of the cold start of items on the recommendation quality.

4 Conclusion

This paper proposes a hybrid recommendation algorithm for educational courseware resources based on heterogeneous information fusion. Heterogeneous information fusion is used to improve the recommendation method of educational courseware resources. Through modular processing of educational courseware resources, a network hybrid information recommendation algorithm is designed to realize the recommendation of network mixed information. The results show that the algorithm has better recommendation effect. Online education platform can not only help students learn knowledge more effectively, but also can obtain feedback information from users and collect diverse learning behavior data. The mining and analysis of learning behavior data is beneficial to the development of educational resources, and can help educators improve curriculum design and teaching methods, make effective evaluation on learners and promote them to improve their learning methods and improve learning efficiency. This paper mining the association between knowledge points in a course according to the user learning behavior data, and then provide the user with knowledge point recommendation service according to the association between knowledge points, which helps to consolidate the students' knowledge mastery and improve the learning efficiency.

Fund Projects. This paper is a scientific research fund project of Hunan Provincial Department of Education (project number: 20c0218).

References

1. Huayue, C.: The study on interesting mining based on topic model for web educational resource recommendation. Adv. Inf. Sci. Serv. Sci. **4**(2), 275–281 (2012)
2. Manouselis, N., Vuorikari, R., Assche, F.V.: Collaborative recommendation of e-learning resources: an experimental investigation. J. Comput. Assist. Learn. **26**(4), 227–242 (2010)
3. Lau, B.Y., Lee, C.S., Singh, Y.P.: A folksonomy-based lightweight resource annotation metadata schema for personalized hypermedia learning resource delivery. Interact. Learn. Environ. **23**(1), 79–105 (2015)
4. Luo, J., Dong, F., Cao, J., et al.: A context-aware personalized resource recommendation forpervasive learning. Clust. Comput. **13**(2), 213–239 (2010)
5. Zhu, H., Liu, Y., Tian, F., et al.: A cross-curriculum video recommendation algorithm based on a video-associated knowledge map. IEEE Access 1 (2018)
6. Liu, S., Lu, M., Li, H., et al.: Prediction of gene expression patterns with generalized linear regression model. Front. Genet. **10**, 120 (2019)
7. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
8. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training, pp. 1–374. Springer, Heidelberg (2018)
9. Corbellini, A., Mateos, C., Godoy, D., et al.: An architecture and platform for developing distributed recommendation algorithms on large-scale social networks. J. Inf. Sci. **41**(5), 686–704 (2015)
10. Mahboob, V.A., Jalali, M., Jahan, M.V., et al.: Swallow: resource and tag recommender system based on heat diffusion algorithm in social annotation systems. Comput. Intell. **33**(1), 99–118 (2017)
11. Ferreira, L.G., Barbosa, J., Gluz, J.C., et al.: Using learner group profiles for content recommendation in ubiquitous environments. Int. J. Inf. Commun. Technol. Educ. Official Publ. Inf. Resour. Manag. Assoc. **16**(4), 1–19 (2020)
12. Chen, H., Yin, C., Li, R., et al.: Enhanced learning resource recommendation based on online learning style model. Tsinghua Sci. Technol. **25**(3), 348–356 (2020)

Research on Resource Integration Method of Civil Engineering Construction Course Based on Big Data Mining

Hong-wei Tian(✉)

School of Road Bridge and Architecture, Chongqing Vocational College of Transportation, Chongqing 400021, China

Abstract. Due to the characteristics of large amount of data, scattered storage, and complex data media in civil engineering construction course resources, the application of traditional resource integration methods has problems of poor integration effect and application performance. Therefore, civil engineering construction based on big data mining is proposed. Curriculum resource integration method. Set up association rules, and use big data mining technology to get the initial data results of civil engineering construction course resources. Respectively through the standardization, word segmentation and other steps to achieve the pre-processing of the civil engineering construction course resources. Extract the characteristics of civil engineering construction curriculum resource data, calculate the feature weights and get the comprehensive feature fusion result. According to the feature extraction results, the resource types are divided, and the curriculum resources of the same type are integrated to obtain the final integration result. Through comparison with traditional resource integration methods, it is found that the designed curriculum resource integration optimization method can reduce the packet loss rate of the integration result. The application of the resource integration method effectively improves the retrieval speed of construction curriculum resources, so it has application and promotion value.

Keywords: Civil engineering · Curriculum integration · Construction resources · Big data mining technology · Feature weight

1 Introduction

Civil engineering is the general term of science and technology for the construction of various engineering facilities. It refers to the applied materials, equipment, survey, design, construction, maintenance, repair and other technical activities, and also refers to the object of engineering construction. In order to provide sufficient application-oriented talents for civil engineering construction industry, major universities have established civil engineering specialty [1]. The major of civil engineering cultivates senior engineering and technical personnel who master the basic theory and knowledge of various civil engineering disciplines, and can engage in planning, design, construction, management

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 325–337, 2021.
https://doi.org/10.1007/978-3-030-84386-1_27

and research in the fields of housing construction, underground building, road, tunnel, bridge construction, hydropower station, port and offshore structure and facilities, water supply and drainage and foundation treatment.

Civil engineering teaching is a synthesis of traditional and modern technical knowledge. The content of traditional construction technology is still being followed, but modern new technologies, new materials, new techniques, and new methods have greatly changed the construction technology, making it a collection of modern high-tech A compulsory course for applied undergraduate students closely integrated with traditional technology, construction technology and construction management, theory and practice. The characteristics of the civil engineering construction course are strong practicality, strong comprehensiveness, wide range of knowledge involved, rapid development, etc., in the application-oriented undergraduate professional courses, the status of this course is second only to reinforced concrete courses. The reason for this is that the applied undergraduate program focuses on application. The future goal of cultivated college students is to become engineers. The biggest feature of engineers is to make engineering. The goal of professional course teaching is to train students in practical engineering. Therefore, civil engineering construction occupies a relatively important position in similar courses. In the teaching process of civil engineering, architectural teaching needs to be combined with engineering examples to cultivate students' practical ability.

In order to maximize the application of civil engineering construction curriculum resources, the integration and sharing of construction curriculum resources are realized under the network environment. At present, the commonly used integration methods include metadata based integration method, cloud computing based integration method and structured P2P network based resource integration method. However, the traditional integration methods have the problems of low application performance and high packet loss rate. Therefore, data mining technology is used to optimize the design of traditional integration methods. Data mining generally refers to the process of automatically searching hidden information with special relationship from a large number of data. Firstly, the real-time data of the actual civil engineering construction site are collected and stored in the data warehouse. Then, using data mining technology, combined with the curriculum needs to develop association rules, we get the mining results of civil engineering construction curriculum resources, and preprocess the mining data of civil engineering construction curriculum resources. According to the preprocessing results, we extract the data characteristics of civil engineering construction curriculum resources, and calculate the feature weight of civil engineering construction curriculum resources. This paper divides the types of civil engineering construction curriculum resources and realizes the integration of civil engineering construction curriculum resources. The application of this technology provides basic data guarantee for the integration of resources, so as to improve the integration effect of curriculum resources.

2 Design of Resource Integration Method for Civil Engineering Construction Course

The integration of civil engineering construction curriculum resources is a systematic work, which needs to be orderly characterized by the characteristics and content characteristics of civil engineering construction curriculum resources in accordance with fixed steps and procedures under certain principles, so as to achieve the purpose of resource orderly processing, so as to realize the co construction and sharing of civil engineering construction curriculum resources. The integration of civil engineering construction curriculum resources can be divided into four steps: unified planning of resources, collection of resources, processing and management of resources, and integration and release of resources.

2.1 Mining Resource Data of Civil Engineering Construction Courses

The mining of civil engineering construction course resources is mainly divided into two steps. The first step is to collect real-time data in the actual civil engineering construction site and store it in the data warehouse [2]. Then, using the data mining technology, combined with the needs of the course, the association rules are established, and the mining results of civil engineering construction course resources are obtained.

The timeliness, reliability and completeness of data collection at the construction site are necessary for the dynamic management of the project. The specific construction process is shown in Fig. 1.

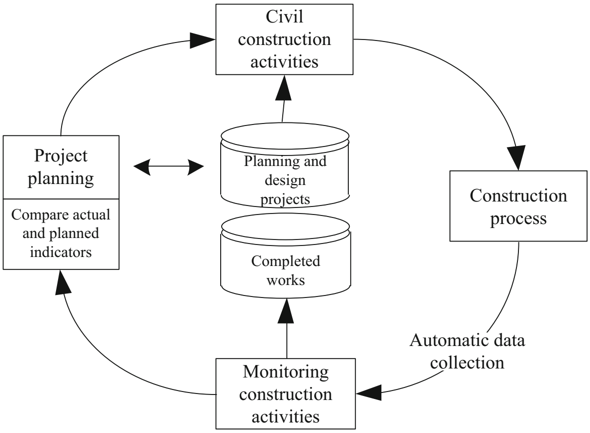


Fig. 1. Civil engineering construction flow chart

The data collected in the construction stage provides a good information platform for the safety monitoring and operation maintenance of the project. According to different uses, the automatic data acquisition technology of construction site can be divided into the following categories: automatic identification technology, positioning and tracking technology, image acquisition technology and sensor and intelligent monitoring technology.

On this basis, data mining technology is used to mine and collect the initial data of civil engineering construction course resources. The corresponding data mining model is shown in Fig. 2.

In the actual data mining process of civil engineering construction course resources, the mining model shown in Fig. 2 is used, and the association rules between the course

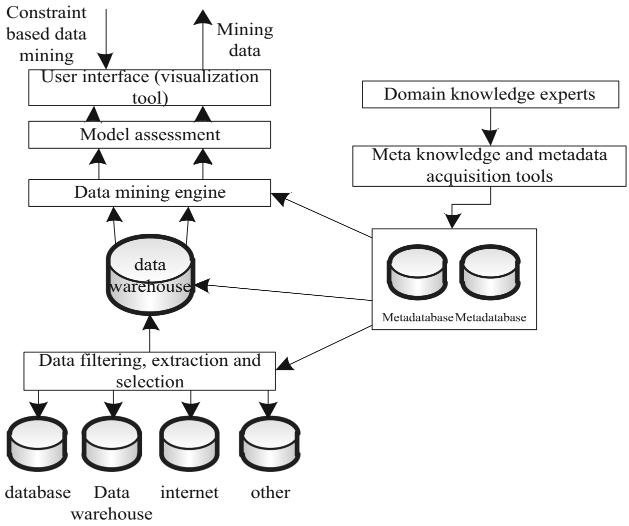


Fig. 2. Data mining model structure diagram

resources are used for specific data mining processing. Association rules are also called association patterns, which are logically implied expressions of the form X → Y, where X and Y are judgments about the value of attributes in the database [3]. Let I be a collection of m different projects, D is a civil engineering construction database, and each transaction T is a collection of a group of projects in I. Each transaction or transaction T is associated with a unique identifier TID. For item set X, if X belongs to transaction T, then transaction or transaction T supports X. If there are k items in X, then X is also called k-items set, or the length of X is k. Association rules refer to an implicit data relationship in the following form. The specific relationship expressions and constraints are as follows:

$$\begin{cases} X \to Y \\ X \subseteq I, Y \subseteq I \\ X \cap Y \neq \varphi \end{cases} \tag{1}$$

In order to mine meaningful association rules, two thresholds should be given: minimum support and minimum confidence. The former represents the minimum requirement of a group of data sets in statistical sense, while the latter reflects the lowest confidence of users on association rules. In a given item set, the user support level is greater than or equal to the minimum support level of the item set. The task of association rule mining is to find all frequent association rules in D in a given transaction or transaction database D. Frequent association rules refer to those rules whose support is greater than or equal to the minimum support threshold given by users, and the confidence level is also greater than or equal to the minimum confidence threshold given by users.

Follow the set association rules to realize the mining of civil engineering construction course resource data. A complete data mining process includes the establishment of mining object data mart, the statistical work of small data samples, online analysis, the establishment of data mining model and model optimization [4]. Each step is completed in a certain order, of course, there will be feedback between steps throughout the process. The process of data mining is not automatic, and many tasks need to be done manually. The business object studied in data mining is the foundation of the entire process, it drives the entire data mining process, and is also the basis for testing the final results and guiding analysts to complete data mining. The output result of the final data mining model is the final mining result of the civil engineering construction course resource data.

2.2 Data Preprocessing of Civil Engineering Construction Course Resources

The pre-processing of civil engineering construction curriculum resources mainly aims at the processing of resources with different formats, including data resources, text resources, image resources and image resources. The preprocessing operation can not only remove a large number of noise data in the text, but also provide the required corpus for the subsequent classification process [5]. Taking the text resources of civil engineering construction course resources as an example, because the text is edited and sorted by different users, in order to avoid garbled code in the process of word segmentation, it is necessary to standardize the coding method before word segmentation. The conversion principle of unstructured data is shown in Fig. 3.

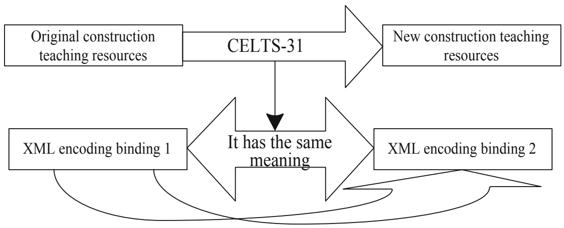


Fig. 3. Schematic diagram of unstructured data conversion

On this basis, Chinese word segmentation is carried out. The operation is to segment the whole text according to certain special rules, and form feature items with words, words or phrases as the basic unit. In the process of processing, the string is matched with the entries in a large enough machine dictionary according to certain rules. If the match is successful, the string is saved as a word segmentation result. In addition, stop words refer to meaningless features generated after word segmentation. The purpose of removing stop words is to reduce the spatial dimension of feature items to be processed in the process of text classification and improve the classification efficiency [6]. After word segmentation of the text, the obtained characters and words form a feature set, and then each feature item in the feature set is matched with the stop word in the stop word list. If the matching is successful, the feature is removed from the feature set; if the matching fails, the feature is retained.

Finally, the processed civil engineering construction course resource data is standardized, so that the processed data becomes data conforming to the standard normal distribution, that is, the average value is 0 and the standard deviation is 1. The standardization process is shown in formula 2.

$$x = \frac{X - \mu}{\sigma} \tag{2}$$

Where X is the original course resource data sample, μ and σ represent the mean value and standard deviation of all sample data respectively. After using the standardized method to process the data, the new training set data due to the square difference is standardized, each dimension of the feature vector value is equivalent processing, each dimension features are subject to the mean value of 0, variance 1 normal distribution, avoid the weight imbalance caused by the difference of each feature vector value.

2.3 Extracting Data Characteristics of Civil Engineering Construction Course Resources

Among the massive original feature items, most of them have little effect on the classification results. The purpose of feature selection is to filter out the most powerful feature items from these massive original feature items for retention, so as to achieve the purpose of reducing the dimension of the high-dimensional feature vector space, reduce the amount of calculation in the subsequent classification process, and avoid occurrences. "Dimensional disaster". The relevant knowledge of statistics and machine learning provides a good theoretical basis for the construction of feature selection methods [7]. The specific features that need to be extracted include document frequency, mutual information, and information contribution rate of the resource. The document frequency refers to the proportion of documents with a certain feature item in the total number of documents in the corpus. The calculation formula is as follows:

$$DF(T_i) = \frac{N_{T_i}}{N_{total}} \tag{3}$$

Where N_{T_i} and N_{total} represent the number of documents with feature T_i and the total number of documents respectively. Set a threshold M in advance, and calculate the document frequency value DF of all feature items. The relationship between the feature T_i and the document frequency threshold is judged. If it is greater than the threshold value, the feature term will be retained, otherwise the feature item will be eliminated. Mutual information is an index to measure the degree of correlation between resource data:

$$MI(T_i, C_i) = P(C_i) \sum_{i=1}^{n} \lg \frac{P(T_i|C_i)}{P(T_i)} \tag{4}$$

Among them, $MI(T_i, C_i)$ represents the mutual information between the feature item T_i and the text, n represents the text of n categories in the corpus, $P(C_i)$ represents the probability of belonging to category j, $P(T_i|C_i)$ represents the frequency of the document that the feature item appears in the category, and $P(T_i)$ represents the feature The document frequency of the item.

2.4 Calculating the Characteristic Weight of Civil Engineering Construction Course Resources

The feature extraction of civil engineering construction curriculum resources is related to its feature weight, so it is necessary to calculate its weight value. The weight calculation function based on feature contribution considers that the clustering of resources is mainly based on the similarity between resources, and the similarity calculation of resources mainly depends on the characteristics of resources. Therefore, the importance of the feature can be characterized by examining the contribution of features to document similarity calculation [8]. Generally, the point product of resource feature matrix is used to calculate the similarity of resources, as shown in formula 5.

$$sim\left(d_i, d_j\right) = \sum_t f(t, d_i) \times f\left(t, d_j\right) \tag{5}$$

In the formula, $f(t, d_i)$ is the weight value of feature item t in document d_i. Then the contribution of a certain feature item to the document collection is calculated by the following formula:

$$TC = \sum_{i,j \cap i \neq j} f(t, d_i) \times f\left(t, d_j\right) \tag{6}$$

All the features in the text set are arranged in descending order according to their contribution degree, and their contribution degree is used to represent the feature weight, and the comprehensive feature extraction results of civil engineering construction curriculum resources are obtained.

2.5 Classification of Civil Engineering Construction Course Resources

According to the CELTS-31 standard, the material types of this course are classified, as shown in Table 1.

In addition to the resource format of the civil engineering construction course, it can also be classified according to the content of the resource. The selected classification algorithm is the naive Bayes classification algorithm, which is a statistical classification algorithm based on Bayes' theorem [9]. The core idea is to calculate the posterior probability of each category of the text to be classified according to the known conditional probability and prior probability, and divide it into the category with the largest posterior probability. At the same time, we assume that the occurrence probability of all texts and the occurrence probability of each feature item are independent of each other. The calculation formula is as follows.

$$P\left(D \middle| C_j\right) = \prod_{11} P\left(W_k \middle| C_j\right) \tag{7}$$

Suppose that there are N category of texts in the corpus as C_n, and assume that D is arbitrary text, which is expressed as vector W_k and recorded as comprehensive

Table 1. Types of course resources and materials

Primary classification	Secondary classification	Classification description
Media resources	Text resources	Used to store basic information, including text, numbers and symbols
	Image resources	The image is stored in the form of vector graphics file; the image is stored in bitmap format after being digitized by scanning, digital camera, camera and other input devices
	Video resources	Store in video format
	Animation resources	Make animation of civil engineering construction and store it in the form of animation or video
Network courseware		Network version of teaching software, which is a detailed explanation of one or more knowledge points in the course, can run in the network operating platform through the browser, and can realize resource sharing in the network environment. The courseware can also be a stand-alone version, which can be downloaded and used through the network
Test paper materials		It includes the collection of test questions, analysis and analysis
Question bank		The teaching measurement of mathematical model is established to realize the collection of test questions in each learning stage of the course in the teaching resource platform
Case		The representative content of one or more civil engineering projects

feature vector. According to Bayes theorem, the posterior probability of class C_i can be expressed as follows:

$$P\left(C_j|D\right) = \frac{P\left(C_j\right)P\left(\mathrm{D}\middle|C_j\right)}{P(\mathrm{D})} \tag{8}$$

According to the calculated posterior probability result, the category of text D can be judged, and the text D can be classified into the category with the highest posterior probability.

2.6 Realize the Integration of Civil Engineering Construction Course Resources

Curriculum integration does not have a fixed mode, it is a diversified curriculum design mode, which emphasizes the teaching process. We believe that the integration of engineering basic courses should mainly meet the following integration principles: the overall principle of achieving the curriculum goal, the principle of multi-dimensional curriculum content optimization and integration, the principle of basing on the characteristics of the profession and the principle of effective integration of resources [10–12]. The classification results and feature extraction results of comprehensive curriculum resources are integrated, and all the civil engineering construction curriculum resources excavated are integrated, and the text curriculum resources and video curriculum resources integration results are obtained respectively.

The storage methods of civil engineering construction course resources can be divided into directory storage mode and database storage mode. The file directory storage mode mainly stores the resources in different directories of the server according to the classification results of civil engineering construction course resources, and operates and manages the resources through the operating system of computer and network platform.

3 Comparative Experiment Analysis

In order to test the integration effect and application performance of the civil engineering construction curriculum resource integration method based on big data mining, a comparative experiment was designed and the quantitative comparison results were obtained.

3.1 Experimental Environment Construction

This experiment takes the civil engineering construction teaching platform as the experimental environment, and configures the experimental environment. The specific configuration is shown in Table 2.

In this experimental environment, the integration method of civil engineering construction course resources based on big data mining is transformed into program code that can be read directly by computer and put into the experimental environment. When the plug-in installation and operation successful interface pops up in the civil engineering construction teaching platform, it proves that the integrated design method runs successfully in the experimental environment.

3.2 Experimental Data Set

Collect civil engineering construction data and build a corpus as an experimental data set. The specific resource data are shown in Table 3.

3.3 Experimental Process

In order to form an experimental comparison, the traditional resource integration method and the cloud computing-based integration method were set as the two comparison methods of the experiment, and they were imported into the experimental environment in the same way. Because the designed integration method uses data mining technology, it is necessary to set up data mining association rules in the experimental environment. Through the integration of three kinds of civil engineering construction course resources, the final integration result is obtained.

Table 2. Platform configuration environment table

Hardware environment	Application server	Database server	Client
Hardware configuration	CPU: Intel (R) Celeron (R) CPU 2.40 GHZ stepping01 Memory 1048256k ID: ST380817AS 80G SATA	CPU: Intel (R) Celeron (R) CPU 2.40 GHZ stepping01 Memory 1048256k ID: ST380817AS 80G SATA	CPU: Intel (R) Celeron (R) CPU 2.40 GHZ stepping01 Memory 1048256k ID: ST380817AS 80G SATA
Software configuration	OS: Microsoft Windows Server 2003. Standard JDK 1.5.0_06 Tomcat	OS: Microsoft Windows Server 2003. Standard JDK 1.5.0_06 Oracle10g	Window 2000 Professional (SP2) IE6. 0.2900 2180. xpsp_sp2
Web environment	10MLAN Huawei routers and switches	10MLAN Huawei routers and switches	10MLAN Huawei routers and switches

Table 3. Experimental data set

Numbering	Name	Source	Platform language database
1	Education resource library in e-era	APBABI	UNIX/JSP/ORACLE
2	Educational Digital Library	development by mandate	WIN2000/ASP/MSSQL
3	Teaching synchronization resource package	Self development	WIN2000/ASP/MSSQL
4	City civil engineering construction data management system	CNKI	WIN2000/ASP.net/MSSQL
5	Educational electronic journals	K12	WIN2000/ASP.net/
6	Intelligent question bank system	Tongfang	WIN2000/JSP/MYSQL
7	District a education resource library	Entrusted development, central audio visual education center	WIN2000/ASP/MSSQL

(*continued*)

Table 3. (*continued*)

Numbering	Name	Source	Platform language database
8	District B education resource library	Self development	WIN2000/ASP.net/MSSQL
9	District C education resource library	Self development	WIN2000/ASP.net/MSSQL
10	District D education resource library	Self development	LINUX/JSP/ORACLE
11	E District Education Resource Library	Self development	LINUX/JSP/ORACLE

3.4 Analysis of Experimental Results

The experimental test indicators are set to integrate packet loss rate and retrieval speed. The integrated packet loss rate is mainly used to test the integration effect of the design method, and the retrieval speed is used to reflect the application performance of the integration method in the civil engineering construction teaching platform.

Comparison Results of Integrated Packet Loss Rate
Through the statistics of the integration result data of the three resources, the test results about the integrated packet loss rate are obtained, as shown in Table 4.

Table 4. Comparative data of integration effect of construction curriculum resources

Input course resource data/GB	Data loss of traditional teaching resources integration method/GB	Data loss of integration method based on cloud computing/GB	Data loss of civil engineering construction course resource integration method based on big data mining/GB
10	1.14	0.85	0.21
20	2.02	1.23	0.34
30	3.11	1.66	0.64
60	5.62	2.04	0.89
80	10.51	4.28	1.34

It can be seen from Table 4 that the packet loss rates of the three integration methods are 11.9%, 5.79%, and 1.82%, respectively. It can be seen that the designed integration method has a lower packet loss rate, that is, the integration effect is better.

Retrieval Speed Comparison Results

The retrieval speed is mainly obtained by obtaining the background operation data of the civil engineering construction teaching platform. Collecting the background data before and after the application of the integration method can obtain the resource retrieval time. The statistical results of retrieval time-consuming are obtained through multiple experiments, as shown in Table 5.

Table 5. Statistical comparison results of retrieval time

Experiment number	Search content input time	Output time of retrieval results without application of integration method	Output time of search results using integration method
1	08:00:00	08:00:39	08:00:06
2	08:05:00	08:05:44	08:05:05
3	08:10:00	08:10:23	08:10:07
4	08:15:00	08:15:38	08:15:04
5	08:20:00	08:20:36	08:20:06

Through the calculation of the data in Table 5, it can be found that the average retrieval time of civil engineering construction curriculum resources before application is longer than that after application, which shows that the retrieval speed of curriculum resources has been improved after the application of integration method.

4 Concluding Remarks

The network teaching platform of civil engineering course design is the result of teaching reform in major colleges and universities combining the needs of engineering education development and learning from advanced educational concepts. Through the application of big data mining technology, a resource integration method for civil engineering construction courses is designed and implemented, which provides effective auxiliary tools for the teaching of civil engineering. However, in the process of research, the data of civil engineering construction curriculum resources are not compressed, so the integration time of civil engineering construction curriculum resources is still long. In order to improve the integration efficiency, the following research will further preprocess the data of civil engineering construction curriculum resources, so as to shorten the integration time of civil engineering construction curriculum resources.

References

1. Roure, B., Anand, C., Bisaillon, V., et al.: Systematic curriculum integration of sustainable development using life cycle approaches: the case of the civil engineering department at the Université de Sherbrooke. Int. J. Sustain. High. Educ. **19**(3), 589–607 (2018)

2. Kuzucuoglu, D., Ayhan, B.U., Tokdemir, O.B.: Integrating lean construction into the civil engineering curriculum*. Int. J. Eng. Educ. **35**(6), 1787–1802 (2019)
3. Kordi, N.E., Zainuddin, N.I., Taruddin, N.F., et al.: A study on integration of building information modelling (BIM) in civil engineering curricular. In: IOP Conference Series: Materials Science and Engineering, vol. 849, no. 1, p. 012018 (8pp) (2020)
4. Al-Harthy, A., Waris, M., Sana, A.: Assessments of the civil engineering program using the new abet accreditation criteria. Luis Gómez Chova, pp. 861–867 (2019)
5. Pan, C., Chen, K., Shen, X.: Research on teaching reform of civil engineering construction course under the background of new engineering. In: IOP Conference Series: Earth and Environmental Science, vol. 510, no. 6, p. 062011 (6pp) (2020)
6. Bae, Y., Woo, S.: Study of satisfaction levels on construction engineering education in cyber university and its improvements. KSCE J. Civ. Eng. **23**(2), 499–506 (2018)
7. Arashpour, M., Wakefield, R., Abbasi, B., et al.: Optimal process integration architectures in off-site construction: theorizing the use of multi-skilled resources. Archit. Eng. Des. Manag. **14**(1–2), 46–59 (2018)
8. Liu, S., Lu, M., Li, H., et al.: Prediction of gene expression patterns with generalized linear regression model. Front. Genet. **10**, 120 (2019)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
10. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training, pp. 1–374. Springer, Heidelberg (2018)
11. Sethi, A., Khan, R.A.: Curriculum integration: from Ladder to Ludo. Med. Teach. **42**(12), 1–3 (2019)
12. Waterman, K.P., Goldsmith, L., Pasquale, M.: Integrating computational thinking into elementary science curriculum: an examination of activities that support students' computational thinking in the service of disciplinary learning. J. Sci. Educ. Technol. **29**(1), 53–64 (2020)

Research on Teaching Evaluation Method

Teaching Quality Evaluation Method of Human Resource Management Based on Big Data

Liu Li(✉) and Cai-ming Zhang

China University of Labor Relations, Beijing 100048, China

Abstract. In view of the current teaching quality evaluation method of human resource management major, in the process of index weight calculation, the index hierarchy is less divided into grades, which leads to the low reliability of the selected indicators. This paper proposes a teaching quality evaluation method of human resource management specialty based on big data. Using big data technology, the information data of teaching quality evaluation is collected, and the evaluation indicators are obtained after screening. The evaluation index system of human resource management professional course teaching quality is constructed, and the index weight value is calculated to obtain the comprehensive evaluation set and corresponding evaluation value, determine the teaching quality grade, and realize the teaching quality evaluation of human resource management specialty. The experimental results show that the design method improves the reliability and extraction ability of index data, the index reliability is higher, and the evaluation results are more accurate.

Keywords: Big data · Teaching quality · Evaluation index · Human resources

1 Introduction

At present, domestic higher education is developing from popularization to popularization, and colleges and universities are also transforming from scale expansion to connotative development, and the further improvement of teaching quality in Colleges and universities has attracted more and more attention from all walks of life [1]. These changes have injected new impetus into the human resource management specialty, and increased the employment, innovation and entrepreneurship opportunities of human resource management graduates. Therefore, it is necessary to cultivate management talents with rich knowledge, good quality and skilled skills in human resource management major of colleges and universities, so as to lay a good foundation for students' employment and entrepreneurship [2]. Therefore, it is of great significance to evaluate the teaching quality of human resource management courses, find out the problems existing in the evaluation and analyze their causes, so as to improve the teaching quality of human resource management courses. Foreign curriculum teaching quality evaluation has a long history. The education departments of the United States, Britain, Germany, France and Japan evaluate the teaching quality on the basis of not violating the principles. The quality of the evaluation results is directly related to the amount of government

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 341–353, 2021.
https://doi.org/10.1007/978-3-030-84386-1_28

funding [3]. The domestic curriculum teaching quality evaluation has also made great progress. By using the methods of interview, investigation and quantitative analysis, this paper constructs the evaluation index system of teaching quality of human resource management major. The index system is established according to the common and basic quality standards of colleges and universities, and the weight is determined according to the hierarchical and classified standards, which reflects the unity of the teaching quality evaluation index system of various colleges and universities and differences, to achieve the classification of teaching quality evaluation. On the basis of the above theories, this paper puts forward the teaching quality evaluation method of human resource management specialty based on big data. By using big data technology, the information data of teaching quality evaluation is collected, and the evaluation index is obtained. The teaching quality evaluation index system of human resource management specialty is constructed, which improves the reliability and extraction ability of index data. Calculate the index weight value, get the comprehensive evaluation set and the corresponding evaluation value, determine the teaching quality level, realize the teaching quality evaluation of human resource management professional courses, make the evaluation results more accurate.

2 Design of Teaching Quality Evaluation Method for Human Resource Management Major Based on Big Data

2.1 Obtaining Teaching Quality Evaluation Indicators for Human Resource Management Professional Courses Based on Big Data

Obtaining Evaluation Indicators

When evaluating the teaching quality of human resource management courses, we should first construct the evaluation index system, and its construction principles are as follows: first, the goal. The designed teaching quality evaluation index system must strive to reflect the national education policy, as well as the requirements for the teaching work and personnel training of human resource management specialty, follow the education law, comprehensively and fully reflect the teaching objectives of colleges and universities, and the quality standard should conform to the school running orientation [4]. At the same time, it should also reflect the modern education concept which adapts to the requirements of education facing the world, informatization, socialization and lifelong learning and development. The second is orientation. The standard of teaching quality should be suitable for the situation of the school, and highlight the guidance. The so-called guidance is to make the teachers' teaching ideas, teaching methods and teaching effects close to the evaluation standards through evaluation. Therefore, we should pay special attention to the determination of the index weight. The third is scientific. The design of the index system should be scientific, the evaluation standard should be reasonable and conform to the teaching rules. Each index should have a clear connotation and pertinence, and the indicators should form an organic whole which is not only related, but also not inclusive or contradictory [5]. The fourth is feasibility. It is expected that there will be enough information in the process of implementation of the evaluation, and the specified contents can be concluded through actual observation and measurement, so as to collect information objectively, analyze and statistic data objectively. The fifth is effectiveness. An important change in methodology of curriculum teaching quality evaluation is to pursue the effectiveness of evaluation. The sixth is the combination of quantitative and qualitative evaluation to improve the fairness, rationality and objectivity of the evaluation.

On the basis of the above principles, the teaching quality evaluation indicators are obtained through big data technology. Firstly, on Ckni and Internet, search keywords of teaching quality evaluation of human resource management specialty are set up to obtain the relevant literature of teaching quality evaluation, construct the web database of curriculum teaching quality evaluation, and classify and store the relevant literature. Then, by using big data technology and web application, the hidden semantic information of evaluation factors in the database is searched, and the relevant factors affecting the teaching quality of human resource management course are mined. Finally, through data mining technology and data-based literature information, we can collect hidden information that can assist course teaching quality evaluation, merge and classify similar literature, and collect and sort out the feature description of curriculum teaching quality evaluation in all mining literature [6]. Remove the similar or repetitive features of concepts, and take the remaining relevant elements as the index community of capability evaluation. The process of obtaining index community is as Fig. 1.

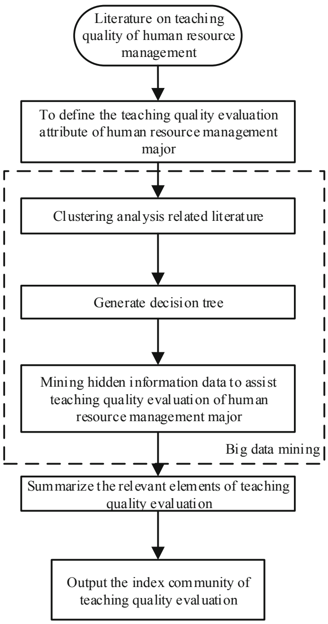


Fig. 1. Acquisition process of teaching quality evaluation indicators based on big data

Considering the development process of human resource management course teaching, the guiding ideology, teaching conditions, teachers, talent training mode and training plan, teaching reform, management system and teaching effect are taken as the evaluation criteria of factor indicators. The remaining teaching quality evaluation elements of human resource management specialty are counted frequently, and the index community is screened for the first time, set the mining frequency of the screening index to 4, and take the index greater than the mining frequency as the alternative index [7]. So far, the acquisition of teaching quality evaluation indicators of human resource management major has been completed.

Construction of Evaluation System

Then, the expert scoring method was used to screen the candidate indexes twice. First of all, according to the index system, the department carries out self-evaluation item by item and writes the self-evaluation report. Then, an expert group composed of senior professors in teaching was set up. On the basis of carefully reading the self-evaluation reports submitted by various departments, understanding and analyzing the basic situation of teaching work in each department, the expert group went to each department to listen to the work reports made by the main leaders. It includes the basic information of the Department, the characteristics and achievements in the teaching work of human resources major courses, as well as the existing problems and solutions. The expert group goes deep into the Department to investigate the laboratory, teaching and research section, carefully consult the relevant Annex materials, check the graduation thesis, examination papers and other teaching materials, and communicate and discuss with the relevant responsible person [8]. Finally, according to the actual teaching situation of human resource management courses, the expert group scored item by item with a serious and responsible attitude, discussed the diagnosis results and evaluation opinions, formed the summary materials of the expert group on the teaching work evaluation of the Department, and fed back the diagnosis results and evaluation opinions to the departments and colleges of human resource management specialty.

According to the "quantitative evaluation index system of teaching quality in Colleges and departments", the evaluation indicators are scored, and the specific scores are as follows: high quality courses refer to excellent courses of the University and above, and excellent courses above the provincial level, one course is calculated as two courses. When the core courses of human resource management major fail to meet the excellent course index of the University, this item is calculated as zero. The total number of courses refers to the sum of compulsory courses and limited optional courses offered by human resource management major. One national educational reform project is equal to five, one provincial project is equal to three, and one school key project is equal to two. One excellent textbook is equal to three, and one textbook published by national and ministerial publishing houses is equal to two. The score of teaching achievement award of human resource management specialty is calculated. The national first prize is 30 points, the national second prize and provincial first prize are 20 points, the provincial and ministerial level second prize and school level first prize are 10 points, the provincial and ministerial level third prize, school level second prize and school level third prize are 8 points and 6 points respectively. Repeated awards are calculated as the highest award. 1 provincial excellent graduation thesis, calculated as 2 excellent graduation theses at school level. Students' scientific and technological achievements and competitions are awarded 25 points at the international level, 15 and 10 points are added to the first, second and third prizes of the national level, 12, 10 and 8 points of the first, second and third prizes of the provincial level, 10, 8 and 6 points of the first, second and third prize of the municipal level, 6, 4 and 2 points of the first, second and third prize of the university level, 10 points of the national patent and 10 points of the publication of a thesis. The first three places in each level of competition will get the same second and third prize, and the next place will be reduced by 1 point, and repeated awards will be calculated as the highest prize. The final evaluation index is as Table 1.

Table 1. Teaching quality evaluation index of human resource management major

Primary indicators	Secondary indicators	Level three indicators
Teaching staff	Overall structure of the team	Teachers' age, educational background and degree
	Lecturer	Teacher's title, curriculum reform willingness, teaching quality
	Young teachers	Training system, teachers' level and teaching effect
Curriculum reform	Discipline construction	Construction planning and practice conditions
	Cultivation calculation	Characteristics of professional courses and cultivation of practical ability
	Curriculum system	Modern curriculum, basic teaching materials and teaching materials
Teaching effectiveness	Practical teaching	Core curriculum, laboratory, scientific research training
	Course features	Teaching reform projects, teaching resources and school running characteristics
	Course management	Management team structure, management system and teaching quality monitoring

Taking the content shown in Table 1 as the final evaluation index, the construction of the teaching quality evaluation index system of human resource management major has been completed.

2.2 Calculate the Weight of Teaching Quality Evaluation Index of Human Resource Management Major

Judge the importance of different evaluation indicators, and calculate the weight of teaching quality evaluation index of human resource management major. First of all, according to the hierarchy of evaluation indicators, the hierarchy of evaluation indicators is established. The first level indicators are used as the target level, the second level indicators are used as the criteria layer, and the third level indicators are used as the decision-making level. The 1–9 scale method is used to compare the evaluation indicators in the three levels to judge the importance of one index relative to another index [9]. Suppose any two indicators in a certain level are *i, j*, then the scale judgment standard of *i* indicator relative to *j* indicator is as Table 2.

Table 2. Criteria of index scale

Scale	requirement	Scale	requirement
1	*i* and *j* have the same importance	3	*i* is slightly more important than *j*
5	*i* is more important than *j*	7	*i* is obviously more important than *j*
9	*i* is more important than *j*	Reciprocal	Contrary to the above

When the importance of two indicators is between adjacent levels, 2, 4, 6, 8 are selected as the scale of the *i* indicator. Suppose the scale of *i* index relative to *j* index is a_{ij}, then the scale a_{ij} of *j* index relative to *i* index is:

$$a_{ji} = \frac{1}{a_{ij}} \tag{1}$$

Construct the weight judgment matrix of the *i* index, use the geometric average method to calculate the geometric average value w_i of all elements in each row of the matrix, and set the total number of level evaluation indicators as *n*, then the formula is:

$$w_i = n\sqrt{\prod_{i=1}^{n} a_{ij} i} = (1, 2, ..., n) \tag{2}$$

The judgment matrix is normalized to obtain the eigenvector corresponding to the maximum eigenvalue, which is used as the weight vector of the hierarchy evaluation index to obtain the weight value of each index [10]. Using fuzzy comparison method, using closeness to measure the similarity of any two indicators, set the geometric mean of *j* indicator as w_j, then the feature vector *w* of the level indicator is:

$$w = \frac{w_i}{\sum_{j=1}^{n} w_j} \tag{3}$$

Select the eigenvalues other than the maximum eigenvalue of the judgment matrix, process the eigenvector unit, calculate the negative average value of the eigenvalue, and realize the consistency test of the matrix [11]. Suppose the maximum characteristic value of the judgment matrix is δ, then the consistency index *C* is:

$$C = \frac{\delta - n}{n - 1} \tag{4}$$

Table 3. Average random consistency index values

Average matrix order	S value	Average matrix order	S value
1	0.00	5	1.24
2	0.58	6	1.32
3	0.90	7	1.41
4	1.12	8	1.45

Combined with the average random consistency index S, the value range of S is judged according to the order of the judgment matrix. The details are as Table 3.

The ratio of consistency index to S is calculated to get the random consistency ratio. When the ratio is less than 0.1, it can ensure that the judgment matrix meets the consistency index, and recognizes the eigenvector w. when the ratio is greater than 0.1 or equal to 0.1, the judgment matrix is adjusted and the weight set is recalculated. So far, we have completed the calculation of the weight of teaching quality evaluation index of human resource management major.

2.3 Evaluate the Teaching Quality of Human Resource Management

Establish the evaluation factor set $D = (M, N, P)$ of the teaching quality of human resource management professional courses, where M, N,, and P are respectively the faculty, curriculum reform, and teaching effect [12]. Construct an evaluation set, divide the teaching quality evaluation grades of human resource management professional courses, classify them into very good, good, average, poor, and very poor, and use the evaluation set to fuzzy evaluation factors. Suppose the fuzzy evaluation matrix of the three-level index to the second-level index is respectively R_M, R_N, R_P, and the weight of the third-level index is respectively L_M, L_N, L_P, calculate the index evaluation vector of the decision-making layer to the criterion layer, and then obtain the evaluation matrix K of the second-level index to the first-level index as:

$$K = \begin{pmatrix} L_M \cdot R_M \\ L_N \cdot R_N \\ L_P \cdot R_P \end{pmatrix} \tag{5}$$

Supposing the evaluation weights of the first-level indicators are respectively O_M, O_N, O_P, then the comprehensive evaluation set H of the teaching quality of human resource management professional courses is:

$$H = (O_M,\ O_N,\ O_P) \cdot K \tag{6}$$

To obtain the evaluation vector H_M, H_N, H_P, of M, N, P in the evaluation set, the final evaluation value of the teaching quality of human resource management professional courses is:

$$\begin{cases} M = H_M \cdot V^T \\ N = H_N \cdot V^T \\ P = H_P \cdot V^T \end{cases} \tag{7}$$

In the formula, V is the set evaluation set, and the value is $\{96, 86, 76, 66, 56\}$, which are expressed as very good, good, fair, poor, and very bad respectively, and T is matrix transpose [13]. Calculate the average of the evaluation values of the three indicators to obtain the comprehensive evaluation value D. The evaluation level of the teaching quality of human resource management professional courses is divided into 5 sections, A, B, C, D, and E as Table 4.

Table 4. Evaluation grade of teaching quality of human resource management major

Evaluation level	D value interval	Meaning
A	(0,55]	Difference
B	(55,65]	Commonly
C	(65,75]	Preferably
D	(75,85]	Good
E	(85,100]	Excellent

According to the comprehensive evaluation value, determine the teaching quality of human resource management courses in Colleges and universities. So far, we have completed the design of teaching quality evaluation method of human resource management major based on big data.

3 Experimental Analysis

In order to verify the effectiveness of the big data based teaching quality evaluation method for human resource management major, the design method is recorded as experimental group A, and two traditional teaching quality evaluation methods of human resource management major are respectively recorded as experimental group B and experimental group C. the reliability of the evaluation indexes of the three groups of methods is compared.

3.1 Experimental Process

Taking the human resource management major of a university as an example, three methods are used to evaluate the teaching quality of the major. Experimental group A establishes different levels of evaluation index sets: the target level is $U = \{U_1, U_2, U_3\}$; the criterion level is $U_1 = \{U_{11}, U_{12}, U_{13}\}$, $U_2 = \{U_{21}, U_{22}, U_{23}\}$, $U_3 = \{U_{31}, U_{32}, U_{33}\}$; the decision level is $U_{11} = \{U_{111}, U_{112}, U_{113}\}$, $U_{12} = \{U_{121}, U_{122}, U_{123}\}$, $U_{13} = \{U_{131}, U_{132}, U_{133}\}$, $U_{21} = \{U_{211}, U_{212}\}$, $U_{22} = \{U_{221}, U_{222}\}$,, $U_{23} = \{U_{231}, U_{232}, U_{233}, U_{234}\}$, $U_{31} = \{U_{311}, U_{312}, U_{313}\}$, $U_{32} = \{U_{321}, U_{322}, U_{323}\}$, $U_{33} = \{U_{331}, U_{332}, U_{333}\}$ and the specific meanings are as Table 1.

The importance of the course teaching quality factors of this major is judged, and the three-level index weight vector is calculated: the index weight of the teacher team is $\{U_{111}, U_{112}, U_{113}\} = [0.319, 0.407, 0.274]$, $\{U_{121}, U_{122}, U_{123}\} = [0.324, 0.287, 0.389]$, $\{U_{131}, U_{132}, U_{133}\} = [0.417, 0.307, 0.276]$, and the index weight of the curriculum reform is $\{U_{211}, U_{212}\} = [0.623, 0.377]$, $\{U_{221}, U_{222}\} = [0.461, 0.539]$, $\{U_{231}, U_{232}, U_{233}, U_{234}\} = [0.219, 0.278, 0.207, 0.296]$, the index of teaching effect the weight values are $\{U_{311}, U_{312}, U_{313}\} = [0.209, 0.342, 0.449]$, $\{U_{321}, U_{322}, U_{323}\} = [0.317, 0.483, 0.200]$, $\{U_{331}, U_{332}, U_{333}\} = [0.417, 0.231, 0.352]$. According to the weight value of the three-level matrix, the judgment matrix of the criterion layer index can be obtained as Table 5.

Table 5. Secondary index judgment matrix

	U_{11}	U_{12}	U_{13}	U_{21}	U_{22}	U_{23}	U_{21}	U_{22}	U_{23}
U_{11}	1	3/4	6/5	1	5/6	4/3	3/4	1	4/3
U_{12}	4/3	1/2	5/6	6/7	3/4	1	4/3	4/3	1/2
U_{13}	1	5/6	3/4	1	1	4/3	4/3	3/4	6/5
U_{21}	5/6	3/4	1	1	4/3	4/3	3/4	6/5	1
U_{22}	3/4	1	1	4/3	4/3	3/4	1	1	3/2
U_{23}	1	3/2	3/4	1	1	4/3	4/3	1/2	5/6
U_{21}	1	4/3	4/3	1/2	5/6	6/7	3/4	1	4/3
U_{22}	4/7	1	4/3	4/3	3/4	3/2	1	4/3	4/3
U_{23}	1	4/3	4/3	3/4	6/5	1/2	4/3	1	4/3

From Table 5, we can get the weight vector of the secondary index of curriculum teaching quality for this human resource management major: the index weight of the faculty is $\{U_{11}, U_{12}, U_{13}\} = [0.328, 0.207, 0.302]$, the index weight of curriculum reform is $\{U_{31}, U_{32}, U_{33}\} = [0.198, 0.389, 0.413]$, and the index weight of teaching effect is $\{U_{21}, U_{22}, U_{23}\} = [0.411, 0.402, 0.187]$. According to the index weight of the criterion layer, the judgment matrix of the first level index of the index set can be obtained as Table 6.

The fuzzy comprehensive evaluation of the teaching quality of human resource management professional courses is performed, and the comprehensive evaluation results of the teaching quality can be obtained as Table 7.

Table 6. First level index judgment matrix

	U_1	U_2	U_3	Weight
U_1	1	3/4	2/3	0.327
U_2	4/3	1	5/2	0.470
U_3	2/3	2/5	1	0.203

Table 7. Comprehensive evaluation results of teaching quality

	Teachers	Curriculum reform	Teaching effectiveness	Comprehensive
V_1 well	0.072	0.075	0.077	0.075
V_2 preferably	0.089	0.313	0.314	0.239
V_3 commonly	0.307	0.289	0.229	0.275
V_4 Poor	0.281	0.233	0.083	0.597
V_5 Very bad	0.250	0.089	0.314	0.218
Evaluation value	80.2	87.6	79.4	82.4
Grade	Good	Excellent	Good	Good

3.2 Experimental Results

Results of the First Group of Experiments

In order to improve the persuasion of the experimental results, 10 experiments were carried out respectively, and the average value of 10 experiments was taken to ensure that the environment of the control group and the experimental group was consistent. The statistical software spss23.0 was used to analyze the test indicators of the three groups of systems to test the reliability coefficient of the indicator set. Reliability is reliability, which refers to the consistency of the results obtained when the same object is measured repeatedly by the same method. The reliability index is usually expressed by correlation coefficient, that is, the correlation coefficient of two groups of data obtained from the same sample is used as the index of measurement consistency, which is called reliability coefficient. The reliability coefficient refers to the proportion of the real score which can be attributed to the change of the real score of the tested person, and can also be defined as the correlation between two parallel tests. The higher the reliability coefficient, the higher the data reliability of the indicator. The calculation formula of the reliability coefficient α is:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_{i-1}^{k} \sigma_i^2}{\sigma^2}\right) \tag{8}$$

In the formula, k is the total number of indicators, σ_i is the value variance of the σ^2 indicator data, and k is the value variance of all indicator data. The coefficient α is between 0.80 and 0.90, the effect is the best, between 0.70 and 0.80, the effect is quite good, between 0.65 and 0.70, the effect is only acceptable, between 0.60 and 0.65, the effect is the worst. Record and sort out the index data of the three groups of experiments, change the total amount of the evaluation index data, that is, change the number of students to get the reliability coefficient of the index data. The comparison results are as Fig. 2.

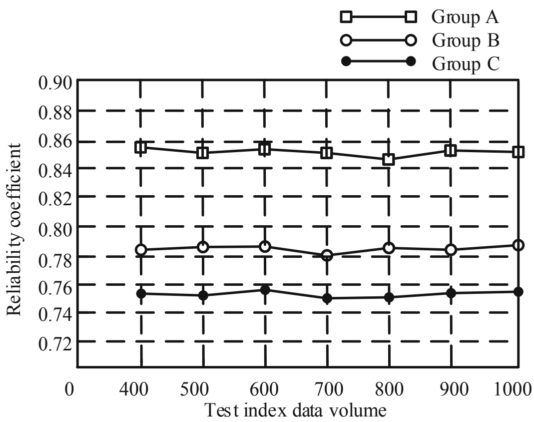


Fig. 2. Comparison results of reliability coefficient

According to 2, the reliability coefficient of the index coefficient of group A is always higher than that of group B and group C. The average reliability coefficient of group A is 0.857, which is the best. The average reliability coefficient of group B is 0.786, and the effect is quite good. Compared with group B and group C, the reliability coefficient of group A is 0.071 and 0.103 respectively.

Results of the Second Group of Experiments

Then use the statistical software spss23.0 to test the validity of the three sets of system test index data. Validity is validity, which refers to the degree to which measurement tools or means can accurately measure the things that need to be measured. Validity refers to the extent to which the measured results reflect the content to be investigated. The higher the validity value, the higher the information extraction level of the test index. The validity value calculation formula β is:

$$\beta = \frac{\upsilon^2}{\tau^2+\rho^2+\gamma^2} \tag{9}$$

In the formula, υ is the variance of the index data value with errors, and τ, ρ, and γ are the value variances of the index data of the first, second and third levels respectively. The result value is greater than 0.8, the index data validity is high, ranging from 0.7 to 0.8, the validity is good, the validity is between 0.6 and 0.7, the validity is acceptable, less than 0.6, the validity is poor. The comparison results of validity values of the three groups of experimental index data are as Fig. 3.

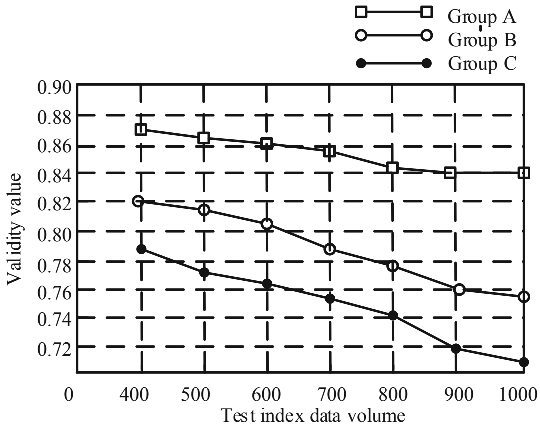


Fig. 3. Comparison results of validity values

According to Fig. 3, when the amount of index data increases, the validity value of the three groups of experimental index data decreases, but the validity value of experimental group A is also higher than that of group B and group C. The average validity value of group A is 0.853, and the index data validity is high. The average validity value of group B and group C is 0.784 and 0.749, respectively. The validity of index data is good, and the validity value of group A is increased by 0.069 and 0.104 respectively. To sum up, this design method improves the reliability and extraction ability of index data, and the reliability of evaluation index is better than the traditional method, which improves the teaching quality and accuracy of evaluation grade of human resource management major.

4 Conclusion

The design method gives full play to the advantages of big data technology, the comprehensive evaluation results of teaching quality are better, the reliability coefficient and validity value are higher, the reliability of evaluation index is improved, and the evaluation results are more accurate. However, there are still some deficiencies in this study. In the future research, new network technology and modern information technology are used to further improve the efficiency and quality of evaluation.

References

1. Lin, G.U.: Multimedia teaching quality assessment based on grey relational analysis and neural network. Modern Electron. Tech. **43**(9), 183–186 (2020)

2. Xu, X.: Research on teaching quality evaluation of online courses in higher vocational colleges based on fuzzy analytic hierarchy process. J. Wuxi Inst. Technol. **20**(4), 90–93+112 (2020)
3. Wei, L.I., Ying, X.U., Shuhai, C.H.E.N.: Research on teaching quality assurance and evaluation system based on college students' learning achievements. Theor. Pract. Contemp. Educ. **12**(2), 71–77 (2020)
4. Zhenyuan, Q.U.: Normalization construction of review and evaluation on the undergraduate teaching. ChongQing High. Educ. Res. **8**(3), 5–10 (2020)
5. Wang, J.: Analysis of teaching quality assurance system from the perspective of auditing and evaluation——taking the college of economics and management, Shihezi University as an example. J. Bingtuan Educ. Inst. **29**(1), 43–46+59 (2019)
6. Zhongkui, W.A.N.G., Jing, G.U.O., Xiaotian, H.U.: An analysis of performance-oriented undergraduate teaching quality evaluation model——based on technical analysis of british teaching excellence framework. Stud. Foreign Educ. **46**(3), 58–74 (2019)
7. Yihui, S.H.E.N.: Evaluation and analysis of junior college education quality based on deep belief network. Fujian Comput. **35**(11), 81–83 (2019)
8. Li, M., Zhong, S., Li, Q., et al.: Exploration and practice of course teaching quality assessment. J. Hubei Polytech. Univ. (Humanit. Soc. Sci.), **35**(2), 79–82:88 (2018)
9. Yu, L.I., Lan, H.U.: On practice of vocational schools to construct teaching quality evaluation system in shanghai. Vocat. Tech. Educ. **39**(27), 64–68 (2018)
10. Hou, R., Li, J.: Multi-dimensional big data intelligent classificati simulation under multi-layer perception learning. Comput. Simula Retrievaltion, **37**(5), 345–348+447 (2020)
11. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
12. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mobile Networks Appl. **24**(1), 1–4 (2019)
13. Liu, S., Glowatz, M., Zappatore, M., et al. (Eds.): E-Learning, E-Education, and Online Training. Springer International Publishing, 1–374 (2018). https://doi.org/10.1007/978-3-030-63952-5

Evaluation Model of English Continuous Pronunciation Teaching Quality Based on Cloud Computing

Dan Zhao[1](✉) and Guang-min Jiang[2]

[1] Business School, Wuhan Institute of Design and Sciences, Wuhan 430205, China
[2] Teng Zhou Vocational Education Centre, Tengzhou 277500, China

Abstract. In the conventional continuous speech evaluation system, the accuracy of the analysis is low when the speech information is evaluated. Therefore, a continuous pronunciation teaching quality evaluation system based on cloud computing platform is proposed. After analyzing the whole design of the evaluation model of English continuous pronunciation teaching quality, cloud computing technology is introduced to set up the evaluation framework of English continuous pronunciation teaching quality; Relying on the determination of the evaluation algorithm of English continuous pronunciation teaching quality, the maximum likelihood parameter is calculated and the evaluation model of English continuous pronunciation teaching quality is embedded to realize the construction of English continuous pronunciation teaching quality evaluation model. The experimental study shows that evaluation model of english continuous pronunciation teaching quality based on cloud computing designed in cloud computing can improve the teaching quality and students' performance.

Keywords: Cloud computing analysis · Continuous pronunciation teaching · Pronunciation quality assessment · Modeling · Maximum likelihood parameter

1 Introduction

Language is the most convenient way for people to communicate. With the deepening of economic globalization, people are communicating more and more closely, but it is difficult for people from different countries and regions to communicate with each other. Therefore, how to enable people to carry out efficient language learning is an important part of modern education. We know that the complete language learning includes four aspects: listening, speaking, reading and writing, among which the teaching of "speaking" is the teaching of spoken language one by one, which has been the weakness of teaching all over the world [1]. In addition, for oral tests, whether traditional interviews or the recent rise of the machine test, there are heavy scoring tasks, boring, subjective differences between the evaluators [2]. Therefore, it is urgent to improve the evaluation of pronunciation quality. In this paper, an evaluation model of English continuous speech teaching based on cloud computing platform is proposed. This paper introduces cloud

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 354–364, 2021.
https://doi.org/10.1007/978-3-030-84386-1_29

computing technology, constructs cloud computing system, sets up cloud computing evaluation framework of English continuous pronunciation teaching quality, and realizes the evaluation model of English continuous pronunciation teaching quality under cloud computing.

2 Related Work

Relevant scholars have done a lot of research. In reference [3], a holographic mobile phone based application for Spanish speaking children's basic English vocabulary pronunciation practice is proposed, and a holographic mobile application is introduced, which aims to help Spanish speaking children practice basic English vocabulary pronunciation. In order to stimulate students' learning motivation and improve their practical experience, multi-channel stimulation (sound, image and interaction) is used in the application of mobile hologram. One experimental group used mobile applications without holographic games, and the other used applications with holographic games. Performance evaluation, satisfaction survey and emotion analysis were conducted before and after the test. The results show that the use of holographic mobile applications has a significant impact on children's motivation. It also improves their performance compared to the traditional methods used in the classroom. In reference [4] proposed that the differences of vowel duration should be considered from the perspective of phonetic evaluation and stress. According to the evaluation of stress and pronunciation, the generation of vocabulary and phrase stress and the differences of vowel length of Korean primary school students were investigated. This paper analyzes the stress of words and phrases from the perspective of vowel length. Compared with the low level group, the pronunciation of stressed syllables in the high level group was significantly longer than that in the non stressed group. According to the comparison of stress position, it is found that the stress vowel in the second syllable takes much longer to pronounce in all pronunciation evaluation groups. In the evaluation, the duration of the people who produce the stressed syllables is much longer than that of the non stressed syllables. The results show that in the process of teaching, segmented teaching and extraordinary teaching should be carried out at the same time.

3 Overall Design and Research of Teaching Quality Evaluation Model for Continuous Pronunciation

The English continuous pronunciation teaching quality evaluation system mainly divides into the automatic speech recognition part and the pronunciation quality evaluation part.

3.1 Design of Automatic Continuous Speech Recognition Technology

Automatic recognition of continuous speech is a process in which the computer converts speech into transcribed text, and it is an important means for the computer to "understand" speech. Although the continuous speech recognition with large vocabulary has not reached the practical level yet, it is relatively easy for the computer to read the text aloud in the task of speech quality evaluation. The main task of speech recognition is to align students' pronunciation with the target text. At the same time, some CALL systems use speech recognition to judge abnormal reading such as addition, omission and readback. As shown in Fig. 1, the system first generates recognition information based on a given text, then decodes it through Viterbi based on a pre-trained acoustic model, and finally outputs the recognition results.

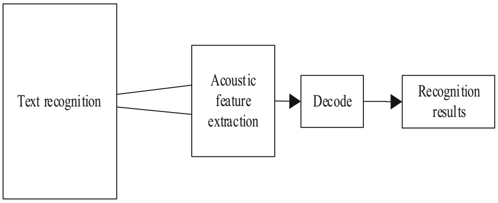


Fig. 1. Automatic speech recognition model

The main characteristics of speech signal are short-time average energy. Short time average energy E: refers to the sum of squares of all sample values in a frame speech signal.

$$E = \sum_{n=1}^{N} x(n)^2 \tag{1}$$

$$E(\varepsilon_i) = 0 \tag{2}$$

$x(n)$: A sample point of the signal.
N: Total number of samples in voice.

3.2 Design of English Continuous Pronunciation Teaching Quality Evaluation

After getting the result of speech recognition, we can extract the corresponding scoring features that can describe the quality of students' pronunciation, and then compute the machine scores, as shown in Fig. 2. The scoring model is trained on a dataset with manual scores.

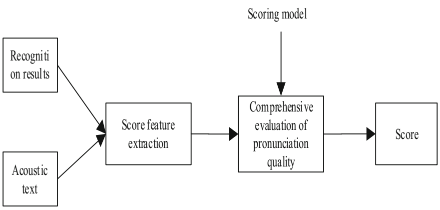


Fig. 2. Pronunciation quality evaluation model

Teachers' evaluation of pronunciation quality includes the examination of pronunciation standard degree, fluency degree and completeness. Therefore, the computer shall, like the teacher, calculate the measures of the standard degree of description pronunciation, fluency degree and completeness (i.e. the scoring characteristics) respectively according to the input speech and text, and then give the machine scores after a comprehensive examination based on the prior knowledge (scoring model). In the current research on evaluation, the posterior probability of integer logarithms of frames is commonly used to describe the students' pronunciation standard measure, while the speed of speech and the score of time length are commonly used to describe the students' pronunciation fluency measure. If the recognition results obtained by using the recognition network or language model need to be compared with the reference text, and the scoring characteristics describing the students' pronunciation fluency or completeness such as addition, omission and readback are extracted [5].

3.3 Construction of English Continuous Speech Teaching Quality Evaluation Model Under Cloud Computing

In order to construct the evaluation model of English continuous pronunciation teaching under cloud computing, cloud computing technology is introduced to change the traditional statistical method and set up the evaluation framework.

3.3.1 Introduction of Cloud Computing

The English continuous pronunciation teaching quality evaluation model based on cloud computing is a computing system to evaluate the English continuous pronunciation teaching quality. In order to improve the accuracy of the computational data, cloud computing technology is introduced, through obtaining the initial parameters of continuous speech evaluation, a set of interrelated data is constructed, and cloud computing technology is used to perform data processing tasks and output computational conclusions according to the quality evaluation algorithm of continuous speech teaching under cloud computing.

The evaluation model of English continuous pronunciation teaching is mainly based on cloud computing technology platform. Cloud computing is a product of traditional computer and network technologies such as utility computing, parallel computing, distributed computing, virtualization, network storage, load balancing, etc. [6]. The goal of cloud computing is to use "computing power" as a common infrastructure, just like power, water, and financial systems. Cloud computing is divided into three main categories: infrastructure services (JaaS), platform services (PaaS) and software services (SaaS). Infrastructure services mainly refer to that users acquire computer infrastructure through network, and deploy and run various software, such as operating system, application program and so on. Platform services consider the platform to include the operating system, programming language environment, database and web server [7]. Users deploy their applications on the platform, which provides hosting services for them. Users cannot manage the platform's infrastructure, but can set the amount of some of the underlying resources being used. A software service is a model for providing software over a network. Users do not need to develop their own, but instead apply to the service provider to rent Web-based software. Cloud providers install and run applications on the cloud, and users use the software through cloud clients (often browsers). Users cannot manage the underlying infrastructure, but can set up applications in a limited way [8, 9]. Its cloud computing architecture is shown in Fig. 3.

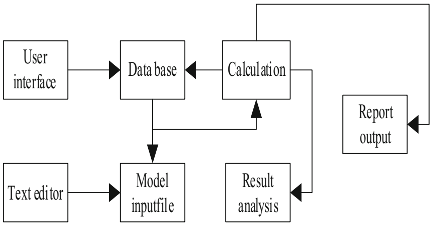


Fig. 3. Cloud computing architecture

3.3.2 Framework of the Evaluation Model

Figure 4 illustrates the basic structure of English continuous speech teaching quality evaluation system: the original speech is converted into digital signal through the microphone, and then sent to the recognition module through the speech processing module to get the recognized text output.

In its natural state, speech recognition is made difficult by the consideration that speakers may not rigorously adhere to grammatical structures, and that word reversals and redundancies may occur [10, 11]. Therefore, it is necessary to establish a blank model of some non-phonetic units in continuous speech, and discard them in recognition to improve the accuracy.

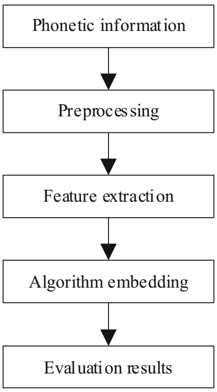


Fig. 4. Assessment Model Framework Diagram

3.3.3 Determination of Evaluation Algorithm

English continuous pronunciation teaching quality evaluation algorithm is the core program of English continuous pronunciation teaching quality evaluation and analysis under cloud computing background. The evaluation algorithm of English continuous pronunciation teaching quality is established, and the evaluation model of English continuous pronunciation teaching quality is embedded.

Firstly, the acoustic features are extracted from the speech of the students, then the basic model of standard speech is assembled into a forced linear matching network according to the speech script that the students need to learn, and the feature sequence is input into the network for forced alignment. The output is the time segmentation information of the real speech and the logarithmic likelihood probability of each phoneme. The segmentation result X is matched with the standard pronunciation model and the model in this paper. The log likelihood ratio score based on cloud computing for defining the feature sequence X is as follows:

$$V(X) = \log p\left(X/\lambda_m\right) - \log\left(X/\lambda_n\right) \tag{4}$$

In this formula, λ_m is the standard pronunciation model of the speech to be graded and λ_n is the model of this paper. The larger the log likelihood ratio $V(X)$ is, the closer the X is to the λ_m.

The introduction of cloud computing model into speech scoring calculation can reduce the influence of various factors, which is of great importance to speech quality evaluation. Cloud computing models can be targeted to represent incorrect recognition results that can be easily confused with the standard pronunciation model [12, 13]. This is because the English continuous pronunciation teaching quality evaluation model under cloud computing represents a large spatial distribution. When the model evaluates a feature vector, only a small number of mixed members contribute to the final likelihood value [14, 15]. These few members are the mixture components that are easily confused with the standard pronunciation model.

3.3.4 Determination of Maximum Likelihood Parameter

The purpose of maximum likelihood estimation is to find the appropriate model parameter P to maximize the likelihood function of the model given the training vector set [16, 17]. Assuming that the available training vector set is $Y = \{Y_1, Y_2, Y_3, \cdots, Y_n\}$, the likelihood function is as follows:

$$P\left(Y/\lambda\right) = \sum_{y=1}^{n} p\left(y_1/\lambda\right) \tag{4}$$

An important feature of MLE is that only when there are enough training eigenvectors can the model estimate converge to the real model parameters [18]. However, the expression of the model does not have a closed form solution, so an iterative method is needed to solve the parameters of the model, which is the expectation maximization algorithm [19]. The W is solved by introducing the maximum likelihood function.

$$W = \sum_{y=1}^{Y} p(Y/\lambda) \log p(y/\lambda) \tag{5}$$

Finally, the maximum likelihood parameter P_n is solved:

$$P_n = \sum_{y=1}^{Y} W(X_n Y_n) \tag{6}$$

Using the above method to get the parameter model of each phoneme can not only reduce the number of training corpus, but also reduce the amount of computation when calculating the log likelihood ratio. Therefore, in practical calculation, this method is often used to obtain the maximum likelihood parameters.

3.3.5 Evaluation Model Embedding

Obviously, it is impossible to evaluate a student's pronunciation quality comprehensively and objectively by using a measurement method. The results obtained through the scoring mechanism are more abstract to the student and inconsistent with human perception,

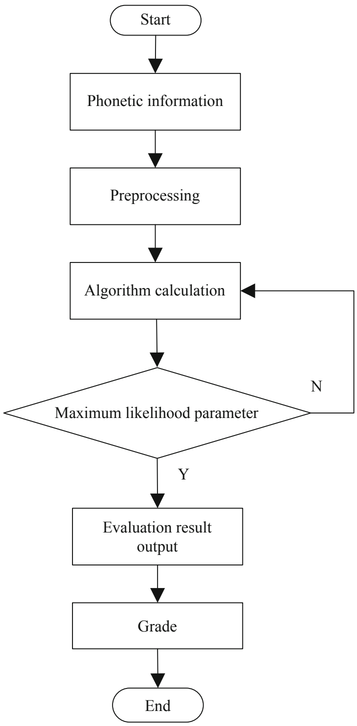


Fig. 5. Evaluation model embedding process

and therefore this machine scoring is mapped to a more vague classification based on pronunciation expertise [20]. In this system, the score is set to different levels, which is more in line with human perceptual habits, but also has a certain stability.

The model of English continuous speech teaching quality evaluation based on cloud computing is based on the evaluation algorithm, which generates files from the results of the calculation. The embedding process is shown in Fig. 5.

Based on the introduction of cloud computing platform, the model of English continuous pronunciation teaching quality evaluation system under cloud computing is established by the determination of English continuous pronunciation teaching quality evaluation algorithm and the embedding of English continuous pronunciation teaching quality evaluation model.

4 Analysis of Experimental Results

In order to verify the validity and feasibility of the evaluation model of English continuous pronunciation teaching under cloud computing, English courses are selected for experimental analysis.

4.1 Experiment Object

The subjects were randomly selected from five classes of English Majors in a university, 120 students in each class, a total of 600 students. Taking the English course of each class as a reference, the teaching quality of English Continuous pronunciation was evaluated.

Through the evaluation model of English continuous pronunciation teaching quality, the network course of college English is established, and the evaluation of pronunciation teaching quality is carried out.

The selected 600 students were randomly divided into three groups, and three students a, B and C were selected as the leaders of the three groups. Each group leader is mainly responsible for supervising the students' overall learning situation. When teachers answer questions, they will judge the students' learning situation in real time according to the learning situation of each group. Because the students in different teaching stages have different teaching tasks, the students will encounter various difficulties in learning, and each student's learning ability and learning basis are different, so the students' ability to solve problems in learning is not the same.

4.2 Case Results and Analysis

In order to verify the effectiveness of the evaluation model of English continuous pronunciation teaching under cloud computing, a comprehensive survey of English majors was conducted. According to the survey results, the group led by A is set as Group A, the group led by B is set as Group B, and the group led by C is set as Group C. The results of the survey include monthly examination, mid-term examination and final examination. Different groups of students have different perceptions of the four independent factors: ideological orientation, interactive education, public opinion rendering, and effect

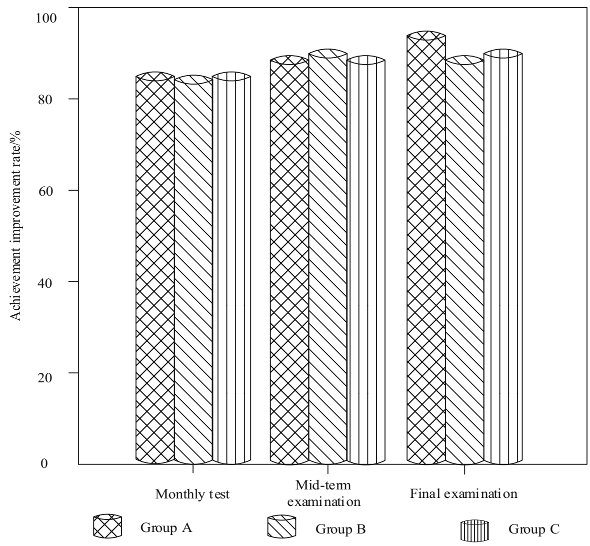


Fig. 6. Comparison of improvement rate of continuous pronunciation teaching in three groups

monitoring. The comparison of the improvement rates of the continuous pronunciation teaching in the three groups is shown in Fig. 6:

As can be seen from Fig. 6, the survey covers freshmen in Class 1 of English majors. The results of the survey show that students' scores in continuous pronunciation teaching have improved. Among the different exams, group A students led by group A showed the most significant improvement in English scores.

On the basis of cloud computing, the survey data show that the undergraduates of the school have a high level of awareness of the four factors of self-media platform. Through training English majors in continuous phonetic pronunciation, the operation of the four factors of self-media platform on English education is studied. The result of the improvement of the teaching quality of continuous phonetic pronunciation by the talent training path platform is shown in Fig. 7:

As can be seen from Fig. 7, with the change of the running time of English major talent training path, the overall performance improvement shows an upward trend. With the increase of the running time of the we media platform, the change of the independent variables of the platform can significantly improve the running efficiency of English majors, and the independent variables are positively correlated with the operating efficiency. It is proved that the teaching quality of English Continuous pronunciation can improve the efficiency of performance improvement through the English professional knowledge orientation of college students. On the whole, it has a positive correlation with the dependent variables, but the influence degree is weaker than the independent variables.

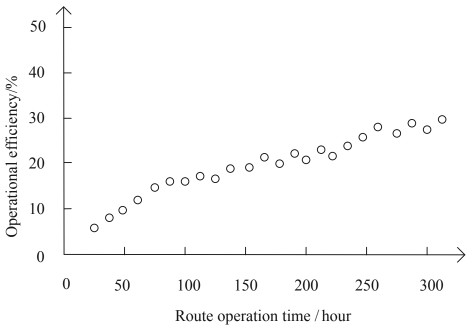


Fig. 7. The effect of teaching quality of English Continuous pronunciation on the efficiency of performance improvement

5 Conclusion

In this paper, a cloud -based assessment model of English continuous speech teaching is proposed. English continuous speech teaching quality evaluation system is mainly divided into automatic speech recognition part and pronunciation quality evaluation part. Based on the analysis and discussion of the two parts, this paper constructs the framework of English continuous pronunciation teaching quality evaluation model, determines the evaluation algorithm and maximum likelihood parameter, and realizes the establishment of English continuous pronunciation teaching quality evaluation model based on cloud computing through the embedding of evaluation algorithm, the teaching quality of English Continuous pronunciation can be improved. It is hoped that this study can provide a theoretical basis for the systematic analysis of English continuous pronunciation teaching quality assessment.

Fund Projects

1. A Study on the Development and Utilization of Student-centered College English Curriculum Resources in the 12th Five-Year Plan of the Chinese Institute of Education (0106129-DX21).
2. A Study on the Construction of College English Microcourse Resources and the Flipping Classroom Teaching Practice in the Construction of Digital Foreign Language Teaching Resources by Higher Education Press in 2017.
3. A Book on College English Application Ability Cultivation and Special training in the Textbook Construction Project of Wuhan Institute of Design and Sciences (JC201801).

References

1. Cheesman, M.J., Alcorn, S., Grant, G., et al.: ‘DrugSpeak’: increasing pharmacy students’ drug pronunciation proficiency. Med. Educ. **54**(10), 23–28 (2020)

2. Wielgat, R., Jędryka, R., Lorenc, A., et al.: POLEMAD - a database for the multimodal analysis of Polish pronunciation – science direct. Speech Commun. **11**(12), 12–20 (2020)
3. Cerezo, R., Calderón, V., Romero, C.: A holographic mobile-based application for practicing pronunciation of basic English vocabulary for Spanish speaking children. Int. J. Hum.-Comput. Stud. **124**(4), 13–25 (2019)
4. Park, K., Lee, S.C.: A study of the difference vowel duration according to pronunciation assessment and the stress. J. Acoustical Soc. Am. **144**(3), 1869 (2018)
5. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
6. Nijveld, A., Bosch, L.T., Ernestus, M.: Non-native but not native listeners rely on exemplars for comprehending reduced pronunciation variants. J. Acoustical Soc. America **144**(3), 1723–1728 (2018)
7. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
8. Arora, V., Lahiri, A., et al.: Phonological feature-based speech recognition system for pronunciation training in non-native language learning. J. Acoustical Soc. America **15**(12), 59–62 (2018)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mobile Networks Appl. **24**(1), 1–4 (2019)
10. Fen, Y., Biying, W.: The establishment of the teaching quality evaluation system for diversified courses in higher vocational colleges. Equipment Manuf. Educ. **15**(12), 32–38 (2019)
11. Yuelu, M., Ping, W., Si, X., et al.: Construction of teaching quality evaluation system for mobile information-based flipped classroom. Sci. Educ. Article Collects **59**(1), 1–8 (2019)
12. Al Ansari, A., Rushdi Arekat, M., Salem, A.H.: Validating the modified system for evaluation of teaching qualities: a teaching quality assessment instrument. Adv. Med. Educ. Pract. **9**, 881–886 (2018)
13. Sozer, E.M., Zeybekoglu, Z., Kaya, M.: Using mid-semester course evaluation as a feedback tool for improving learning and teaching in higher education. Assess. Eval. High. Educ. **12**(6), 1–84 (2019)
14. Peng, X., Dai, J.: Research on the assessment of classroom teaching quality with q-rung orthopair fuzzy information based on multiparametric similarity measure and combinative distance-based assessment. Int. J. Intell. Syst. **34**(7), 1–43 (2019)
15. Alexander, O., Grasso, T.F., Florian, T., et al.: Secure cloud computing: reference architecture for measuring instrument under legal control. Security Privacy **18**(5), 14–17 (2018)
16. Nazia, A., Huifang, D.: Elastic scheduling of scientific workflows under deadline constraints in cloud computing environments. Future Internet **10**(1), 5–10 (2018)
17. Meshram, C., Lee, C.-C., Ranadive, A.S., et al.: A subtree-based transformation model for cryptosystem using chaotic maps under cloud computing environment for fuzzy user data sharing. Int. J. Commun. Syst. **33**(7), 95–99 (2020)
18. Xia, Z., Chen, W., Li, Q., Yuan, F., Tian, C., Tang, L.: Prediction of mobile image saliency and quality under cloud computing environment. Digit. Signal Process. **91**, 66–76 (2019)
19. Zhai, L., Shen, S., Cheng, S.: Balanced distribution and optimization of electronic information resources under cloud computing platform. Comput. Simulation, **036**(007), 397–400, 440 (2019)
20. Teruel, K.P.: A framework for selecting cloud computing services based on consensus under single valued neutrosophic numbers. Neutrosophic Sets Syst. **22**(1), 4–10 (2018)

Design of Intelligent Evaluation System for Application Effect of Internet Financial Sharing Course

Hui-ying Yan(✉) and Ling Cheng

NanChang JiaoTong Institute Business School, Nanchang 330000, China

Abstract. The traditional Internet course application effect evaluation system has the problem of slow convergence speed when scheduling network resources, resulting in small load energy on each node. In response to this problem, this research designed a new intelligent evaluation system for the application effect of Internet financial sharing courses. Focus on the design of the collector, memory and transmitter of the hardware part of the system, and ensure the efficient operation of the system through VPG configuration and 6 bus connections; then design the system software flow, which is divided into unified standards, information transmission, information storage, path selection, and documentation Six steps of conversion, resource sharing, and information evaluation. The experimental results show that the intelligent evaluation system designed in this study can effectively improve the convergence speed and increase the load energy on each node, making the resource nodes more balanced, and fundamentally improving the evaluation performance.

Keywords: Financial sharing course · Application effect evaluation · Resource node · Information evaluation

1 Introduction

With the rapid development of Internet technology, the proportion of paper resources in people's lives has become smaller and smaller, while the proportion of Internet resources has become larger and larger. Universities all over the country are reducing subscriptions to paper resources. Internet courses Resources are more supported and loved by people [1].

While sharing courses bring great convenience to learners, it also brings some problems. The first is the security issue. Resource sharing allows a large amount of data to be stored in the cloud, and users can access it without administrative rights, making it easier for hackers to attack. The second is the issue of resource usage. Many saved resources have a high repetition rate. Resources are wasted, and resource managers rarely buy and introduce new resources. The original resources are difficult to be fully utilized, and operating costs continue to increase. Finally, there is the issue of charging.

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 365–378, 2021.
https://doi.org/10.1007/978-3-030-84386-1_30

Resource management requires a lot of operating costs. How to charge it has always been a problem [2, 3].

At the same time, in order to improve the application effect of Internet sharing courses, the construction of an effective intelligent evaluation system for the application effect of Internet sharing courses and improving the efficiency of information transmission is a hot topic in related fields. For the Internet Financial Sharing course, the current course application effect intelligent evaluation system is still in the past management mode, lack of pertinence, and management technology has not made great progress. The development trend of big data era makes information communication more and more digital. Therefore, this paper designs a new intelligent evaluation system for the application effect of Internet Financial Sharing course. Design ideas of the system are as follows: first of all, through the design of the collector, storage and transmission to build the system hardware environment, and through the VPG configuration and 6 bus connection to ensure the system run efficiently, and then in accordance with the unified standards, information transmission, information storage, path selection, document conversion, resource sharing, information evaluation six steps, and complete the system design of the software process.

2 System Hardware Design

Establish an intelligent evaluation system for the application effect of Internet financial sharing courses, guide the allocation and application of course resources according to the evaluation results, and realize the allocation of resources according to user needs, so that users can obtain the best means of obtaining the most abundant resources when allowed. The currently designed evaluation system has poor unification capabilities, and it is difficult to achieve resource sharing in a true sense, and the level still remains at paid sharing. Therefore, this article optimizes the hardware part of the shared system in view of the above problems.

The hardware structure of the intelligent evaluation system for the application effect of Internet financial sharing courses is shown in Fig. 1.

The system hardware shown in Fig. 1 applies cloud resource technology to enable shared course resources to be shared. A large number of embedded products are added to the system hardware to support various cloud classroom systems, improve the quality of financial courses, and ensure learning efficiency. At the same time, the use of embedded design in the evaluation process can improve the integration of information and make the evaluation process easier to operate.

On this basis, design collectors, memories and transmitters, and realize the storage, analysis and transmission of information on the basis of collecting information on the application effects of Internet financial sharing courses, thereby improving the effectiveness of the evaluation results.

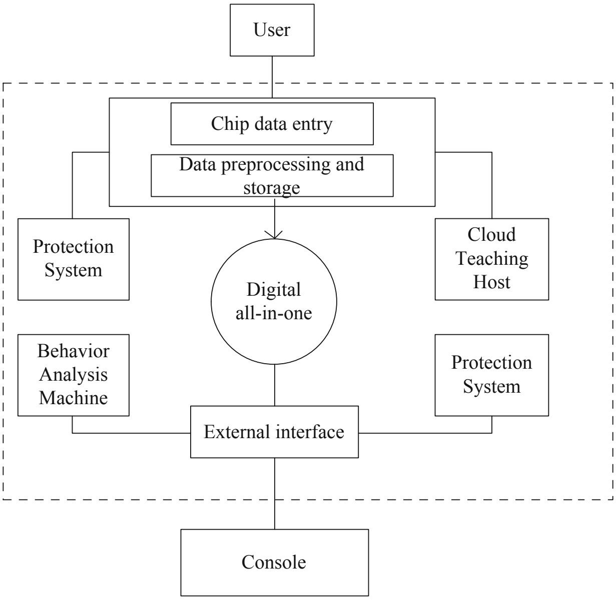


Fig. 1. System hardware structure diagram

2.1 Collector Design

The digital literature resource collector designed in this paper can achieve high-quality positioning acquisition, and compress the collected audio and video to achieve the low-power requirements of the system. The internal chip of the collector is Cawdsz6852, which is introduced by TI company and has the characteristics of multi-functional multimedia application [4, 5]. The collector is automatically connected with the wireless network, and the signal code is synthesized and transmitted to the wireless network data terminal, which is stored in the terminal and uniformly recorded in the hard disk. The collector structure is shown in Fig. 2.

When collecting video signals, the collector in Fig. 2 selects SCLK as the clock to record all signals. The VPO configuration mode of the collector is rawd mode, and the input video is one channel video. The collected nbsl signal is converted into PAL Color difference signal and output in the form of uraw-312.52.

When collecting audio signals, use BCLK as the clock to support synchronous input and synchronous output of each frame rate. The encoding device supports microphone and stereo input and output. The collected signal is an 8K signal with 19-bit quantization. The data exchange mode is DSP mode [6, 7]. The result frame of the signal acquisition process of the collector is shown in Fig. 3.

The signal collector in Fig. 3 is connected with PCI and HPI, the bus interface is Ethernet interface, and the data path is connected with B3 and B19 through PCI bus. The transceiver can receive and receive 10 m~100 m physical layer data. In order to realize simultaneous transmission of three kinds of data networks, ap685 is connected

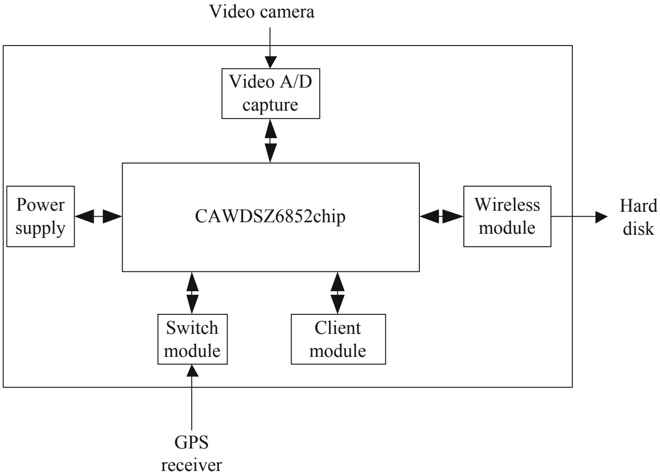


Fig. 2. Structure diagram of collector

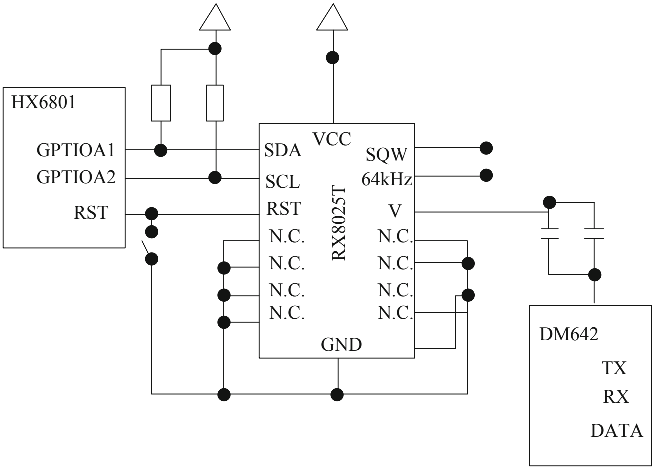


Fig. 3. Block diagram of the signal acquisition process

inside the system. The upstream rate and downlink rate of the collector are 3.5 mbit/s and 6.7 mbit/s respectively.

2.2 Memory Design

In order to improve the storage efficiency of the memory and increase the amount of information that can be analyzed by the evaluation system, this article selects a flash memory with a large storage range and low manufacturing cost, which is widely used in the transmission and communication of library digital literature resources, Adding a single-chip microcomputer in the memory greatly increases the storage capacity and continuously reduces the area occupied. The memory structure is shown in Fig. 4.

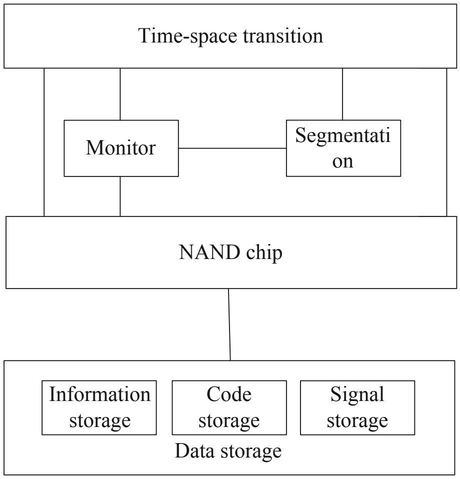


Fig. 4. Memory structure

There are six buses outside the memory, each bus is connected with an FPGA interface, and different interfaces are connected with different signals [8, 9]. The main design is as follows:

(a) Bus 1 connects signals in I/O mode with 52 bit width. It can input and output in two-way mode to realize bidirectional exchange of data. The mode of remark is I/O.
(b) Bus 2 connects the signal in out mode with 84 bit width, and outputs the signal in one way to control the signal entering.
(c) Bus 3 connects signals in BSC mode with 16 bit width and outputs chip selection signal in one way.
(d) Bus 4 connects signals in clas mode with link bit width of 6. It can input signals in one-way way to realize the board selection of signals. Different types of signal input modes are different.
(e) Bus 5 connects signals in bus mode with 81 bit width and busy signal input mode.
(f) Bus 6 connects signals in add mode, with link bit width of 27, and outputs address signal in one-way mode [10, 11].

The working intensity of the memory is very high, up to 10 h a day. Each memory must correspond to a microprocessor, connect FPGA and abus at the same time, complete the data exchange at the upper computer, so that the human-computer interaction can be completed smoothly. The memory circuit diagram is shown in Fig. 5.

The memory circuit diagram in Fig. 5 controls the work of different resistors through flash chip and SRAM chip. The CPU dominates the whole system and tests the read-write of the memory chip. When communicating with the upper computer and the lower

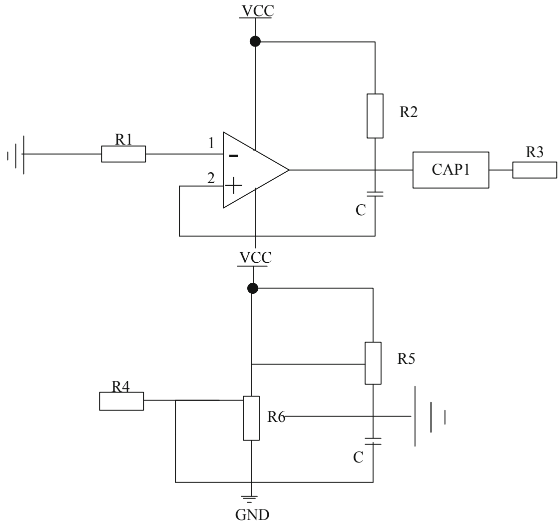


Fig. 5. Schematic diagram of memory circuit structure

computer, the system software should be automatically debugged to read the program loaded by flash, so as to provide a better running environment for the CPU [12].

2.3 Transmitter Design

The transmitter is responsible for transmitting the information from the collector and memory to the central evaluation program. The transport chip used in this paper is maux8996 chip, which can correspond with external bus interface and other module interfaces and connect with specific timing logic.

There are 160 pins in the transmitter, each pin is connected with different expansion interface and interface bus. The structure of the transmitter is shown in Fig. 6.

In Fig. 6, the memory can transmit audio data and video data of Internet Financial Sharing course to more than 300 m. It can support the transmission of VGA, SVGA, XGA, SXGA, WXGA and other signals. The maximum resolution can reach 1823 × 1532p/80/120 Hz, with ultra high definition resolution. It does not need to install drivers or reset the network when installing. It is very simple and convenient. The most important point is that the designed transmitter can support synchronous transmission and analysis of video and audio, effectively avoiding the phenomenon of delay and asynchronous. The transmitter circuit diagram is shown in Fig. 7.

CAT5e / 6 network cable is selected by the transmitter, and VGA signal can be used in the transmission process. Different processing methods are adopted for the transmission signal of different paths. The over-voltage circuit protection is selected at the power supply, and the flow protection mode of the transmission port is level 3 protection mode, which provides a good guarantee for the safe operation of the system. Compared with the traditional transmitter, the transmitter designed in this paper not only has a strong

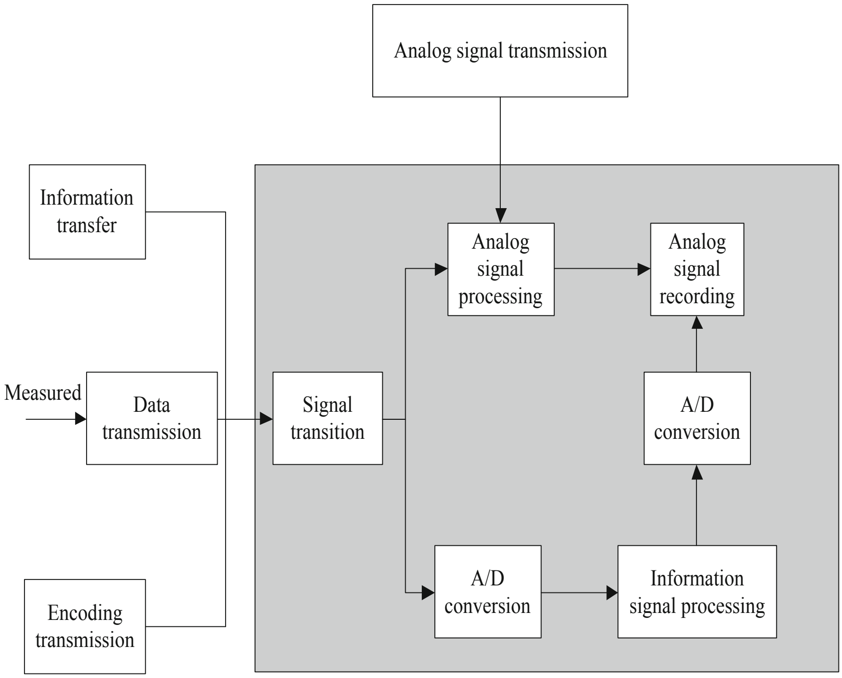


Fig. 6. Schematic diagram of the transmitter structure

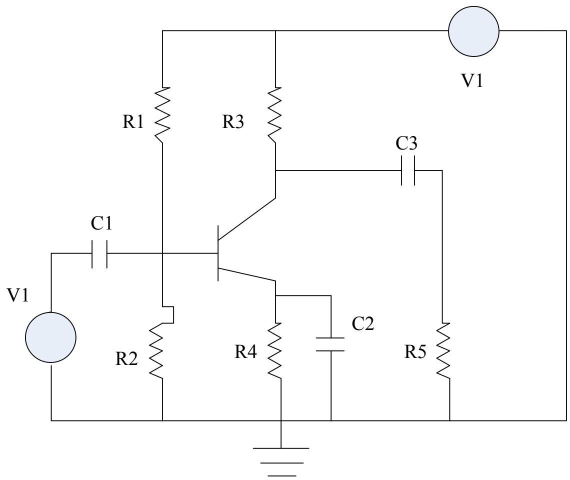


Fig. 7. Transmitter circuit structure diagram

driving ability, but also has excellent lightning protection characteristics, which makes the system more stable and cost-effective.

3 System Software Flow Design

Based on the design of the collector, memory and transmitter and the construction of the system hardware environment, the software flow of the intelligent evaluation system for the application effect of Internet Financial Sharing course is designed. Figure 8 is the flow chart of system software.

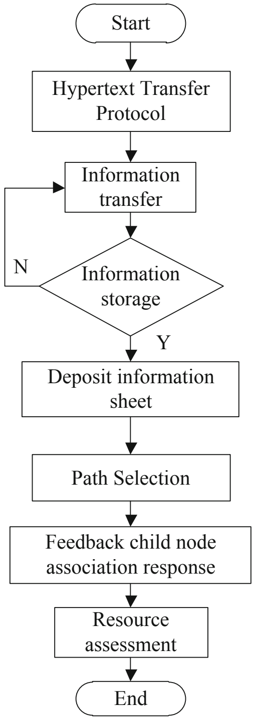


Fig. 8. System software flow diagram

The main working steps of the software flow chart shown in Fig. 8 are 6 steps. Since resource sharing can only be realized in a unified platform, it is necessary to make clear the transmission of information. There are four forms of transmission information. Online cataloging has its own coding rules. Each user can encode the new books and upload the encoded data to ensure that the information resources used are more standardized. The consulting services provided by virtual reference services are not subject to any time and space To solve the problem for users through page push, web browsing and other ways; then transfer the obtained information through the transmitter, and transmit the above Internet Financial Sharing course application information to the central evaluation module; the central evaluation module stores and processes the uploaded signals, and selects different paths to send them to the users; and then converts the documents again to make the data correct Finally, the evaluation of course application information is completed.

The software network model designed in this paper is divided into input layer, hidden layer and output layer. When evaluating, we should focus on how to reduce the complexity of data. The theoretical basis of the model design is: find the sample probability of the random variable distribution in the space, use experimental simulation to calculate the probability of an event in the sample, find the attribute average, analyze the probability of change, and determine the cost of the evaluation process. So as to find out the best evaluation plan. The software model of the intelligent evaluation system for the application effect of Internet financial sharing courses is shown in Fig. 9.

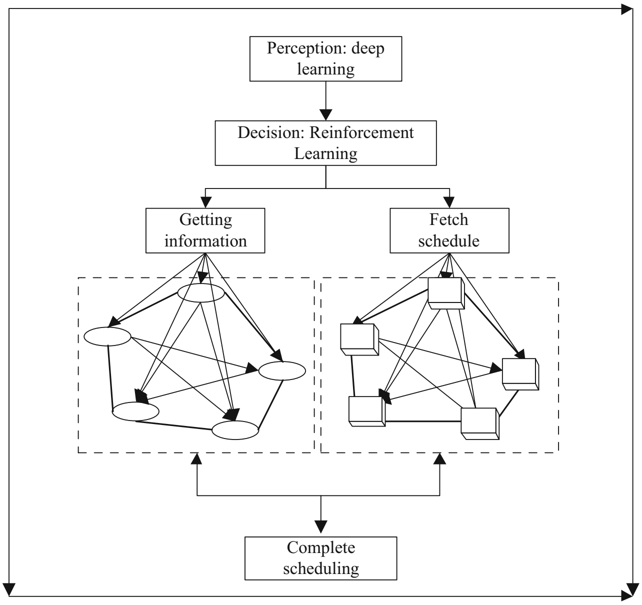


Fig. 9. Software model of intelligent evaluation system for application effect of Internet Financial Sharing course

The intelligent evaluation system for the application effect of Internet financial sharing courses assigns multiple weights to the samples, uses non-uniform discrete methods to resample the samples, and re-schedule them uniformly. This can be regarded as a discrete uniform distribution, and the weight samples can also be reduced. The sampling process is shown in formula (1):

$$E_{pv}(f(x)) = \int_a^b f(x)p(x)dx \tag{1}$$

In formula (1), $E_{pv}(f(x))$ is the density value obtained by random sampling verification, x is the sample value, a is the weight of the total data, and b is the weight of the sample. After sampling, weighting is performed to estimate the state value. Sampling results are displayed as values and processed recursively. Recursive processing such as formula (2):

$$V_k = \frac{f(x_1) + f(x_2) + \ldots\ldots + f(x_n)}{n} \tag{2}$$

In formula (2), V_k is the recursive value of the sample, $f(x_1), f(x_2)$ and $f(x_n)$ are the weighted values corresponding to the network shared resources, and n is the number of network shared resources. The sample equations are recorded as $P(v_k|v_{k-1})$ and $P(v_0|v_k)$, and the probability density is verified by Monte Carlo method. In the verification, it is assumed that the state of the system is always distributed, and the predicted values are independent of each other without interference. The expression of probability density function of system samples is as follows:

$$P(v_k|v_{k-1}) = K_I \int_0^t e(t)dt \tag{3}$$

In formula (3), K_I represents the nonlinear system parameter, $e(t)$ is the importance function, and t is the recording time. The above formula is ideal for non-linear systems, but it is very difficult to estimate for linear systems. The system state is not stable enough and it is very difficult to schedule. Therefore, correction processing is required. The network shared resource data scheduling obtained after linear system correction The function density is:

$$P(V_{0K}|V_k) = K_D \frac{de(t)}{dt} \tag{4}$$

In formula (4), K_D is the parameter of linear system. In order to normalize the above functions, change the weight value, and conduct random sampling, so that each value presents a recursive state and tends to the same sample for evaluation. The assessment process is as follows:

$$k_x v + k_y v = \sqrt{(x, y)[I_x, I_y][u, v]} \tag{5}$$

In formula (5), $k_x v + k_y v$ is the evaluation result, v is the evaluation speed, u is the scheduling distance, and I_x, I_y is the increased horizontal and vertical resources. According to the above calculation process, the intelligent evaluation of the application effect of the Internet financial sharing course is completed.

4 Experimental Study

In order to test the application effect of the intelligent evaluation system for the application effect of Internet financial sharing courses designed in this paper, the traditional evaluation system is selected to carry out comparative experiments with this system, and the evaluation speed of different systems and the energy load of each node are recorded.

4.1 Experimental Parameter Design

Design experimental parameter nodes on the Internet platform, and the node allocation of each network resource is shown in Table 1.

Table 1. Network shared resource node allocation list

Number	Communication capability	Sharing capabilities
1	0.25	230
2	0.26	196
3	0.25	235
4	0.32	245
5	0.28	210

4.2 Experimental Results and Analysis

(1) Comparison of convergence rates.

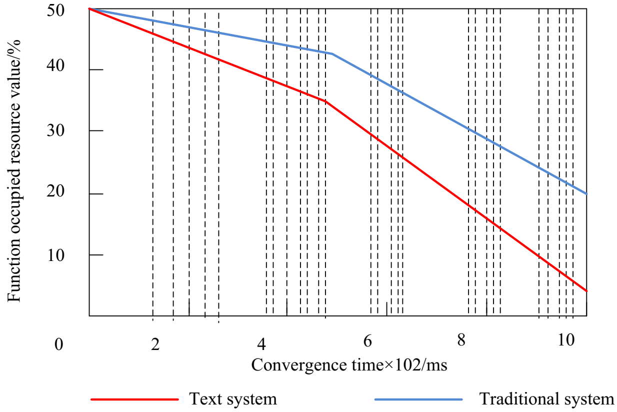


Fig. 10. Experimental results of convergence rate comparison

In order to improve the verification effect, the DVFS strategy and MVDS measurement are unified and simulated. Observing Fig. 10, it can be seen that compared to the traditional system, the system of this paper has great advantages. When the convergence time reaches 300ms, the evaluation system of this paper can find the optimal scheduling plan, while the traditional evaluation system can only find the optimal scheduling plan when the convergence time is 700 ms. Find the best evaluation method. It can be seen that the evaluation system in this paper has the advantages of fast working speed, high accuracy and strong predictive ability.

(2) Analysis of network node load energy.

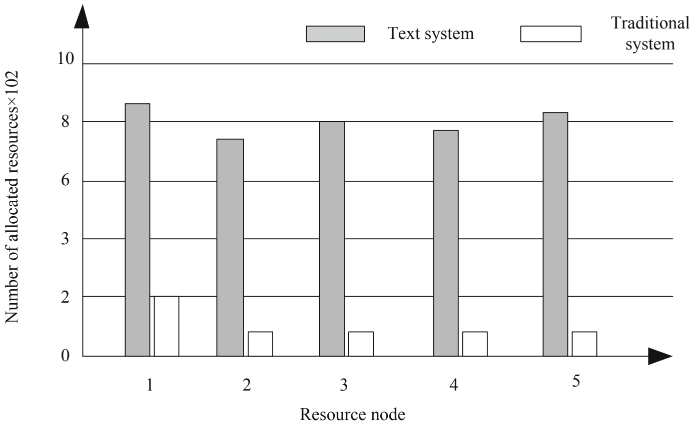


Fig. 11. Comparison results of network node load energy

As can be seen from Fig. 11, the computing power ranking of network nodes is node 1 > node 5 > node 3 > node 4 > node 2. When the resource scheduling is reasonable, each node completes the scheduling according to its own computing power. The traditional system can only allocate less data resources, which leads to the imbalance of resource nodes. This system can allocate the network node resources well and improve the balance of resource nodes.

Based on the above experimental results, the following experimental conclusions are drawn: the traditional intelligent evaluation system has a non-uniform layout of hardware facilities, lack of connections between various hardware, independent work, and poor overall planning. When the literature is introduced, a unified investigation cannot be made, a large amount of human and material resources are wasted, and it is difficult to guarantee sustainable development for shared development. At the same time, the sharing system and the retrieval system are not related, and it is difficult for the central evaluation module to control the evaluation service process. In addition, traditional systems have a variety of ways to evaluate resources. Metadata, carrier format, and storage formats can record resources. It is difficult to share documents, and there are no corresponding protection measures in the system, and the education resource evaluation process is lacking. protection mechanism.

And this system can layout from a macro point of view, establish database collaborative development, and achieve a compatible, complementary collaborative relationship.

Through the virtual management center unified revision management literature organization, the integration of information, all the literature resources planning into a unified format, so as to better complete the application performance evaluation.

5 Conclusion

The Internet provides a good platform for the sharing of information resources. Every resource user can use the Internet resources on an equal and voluntary basis. At the same time, different institutions can cooperate with each other to expand the resource reserve through different technical means. At present, there are many ways to share the resources of Financial Sharing courses in Colleges and universities, including online cataloging, document delivery, Cooperative procurement and virtual reference. Various forms of data dissemination make the management of shared resources more complex. Therefore, this paper designs the application effect intelligent evaluation system of Internet Financial Sharing course, which provides strong support for the further development of Internet Financial Sharing course in the future.

Although the system in this paper has achieved a certain degree of application effect, it still has room for improvement due to the limitation of research time. In the future research, the system will be further optimized from the aspects of improving the evaluation efficiency.

References

1. Jianmin, L., Linhui, W., Xingang, C., et al.: The planning, simulating and executing for the surgery of bilateral renal masses used the three-dimensional intelligent qualitative and quantitative analysis system(IQQA). Chinese J. Urology **40**(05), 356–360 (2019)
2. Qinglin, Z., Jian, T., Yuansheng, Z., et al.: Design of dispatching operation risk assessment and auxiliary decision-making system based on multi-source data fusion. Adv. Power Syst. Hydroelectric Eng. **34**(03), 42–49 (2018)
3. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
4. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mobile Networks Appl. **24**(01), 1–4 (2019)
5. Dong, B., Cui, J., Xu, W.: Intelligent evaluation method for power system stability with demand response resources. Power Demand Side Manage. **21**(04), 67–71+82 (2019)
6. Guanxiu, T., Jun, L., Chunli, Y., et al.: Development and evaluation of intelligent system for assessing mild cognitive impairment. Nursing J. Chinese People's Liberation Army **35**(18), 39–42 (2018)
7. Gang, X., Xiaobo, H., Xiaohua, W., et al.: Design and quantitative evaluation of simulation training system for aviation missile detection operations. Mil. Oper. Res. Syst. Eng. **32**(04), 58–64 (2018)
8. Yifu, M., Linhao, Y., Yongjun, Z.: Complexity evaluation of smart grid information management system based on multi-dimensional structure entropy. Electric Power Autom. Equipment **038**(005), 117–122 (2018)
9. Jiafeng, P., Hejian, Z., Jie, G., et al.: Research and application of fuzzy comprehensive judgment in dispatching anti-misuse platform. Power Syst. Prot. Control **46**(20), 158–163 (2018)

10. Liu, S., Glowatz, M., Zappatore, M., et al. (Eds.): E-Learning, E-Education, and Online Training. Springer International Publishing, pp. 1–374 (2018). https://doi.org/10.1007/978-3-030-63952-5
11. Zhao, J.: Research on the model of teaching evaluation system based on internet. Tech. Autom. Appl. **39**(05), 43–45+58 (2020)
12. Wei, N., Bingru, Z., Hang, Z.: Performance evaluation system design of financial shared service center under new environment – based on analytic hierarchy process. Friends Acc. **05**, 135–140 (2019)

Comprehensive Evaluation Model of MOOC Teaching Quality of Accounting Major Based on Rete Algorithm

Li-min Zhang(✉)

School of Economics and Management, Shenyang Institute of Technology, Shenfu Demonstration Zone, Shenyang 113112, China

Abstract. In order to provide auxiliary tools for MOOC teaching of accounting major and improve the application effect of traditional teaching quality evaluation model, a comprehensive evaluation model of MOOC teaching quality of accounting major based on Rete algorithm is designed. This paper analyzes the MOOC teaching mode of accounting major and uses Rete algorithm to match teaching data. On this basis, the evaluation standard of teaching quality grade is determined, the comprehensive evaluation index of teaching quality is set and the weight of evaluation index is calculated. Through the comprehensive solution of quantitative index and weight value, the comprehensive evaluation of teaching quality of accounting specialty is realized. Through the practical application of the model designed in this paper, it is found that the model can restrict the MOOC teaching quality of accounting major and indirectly improve the MOOC teaching effect of accounting major.

Keywords: Rete algorithm · Accounting teaching · MOOC teaching · Teaching quality · Comprehensive evaluation model

1 Introduction

Accounting major is the knowledge of how to recognize income and assets in a certain business cycle. In addition to preparing financial statements and recording business transactions, accountants are more important to be able to participate in the merger between enterprises, quality management, the application of information technology in finance, tax strategy and management decision-making activities of many enterprises. Accounting major involves a wide range of fields, including assurance, audit, taxation, company accounting, management accounting, financial management, bankruptcy liquidation, forensic accounting, budgeting, business consulting, etc. In order to break the limitation of time and space, improve the teaching level of accounting major, and provide high-quality accounting talents for enterprises in the society, the teaching course of accounting major is set up on the MOOC platform [1]. MOOC platform, namely large-scale open online courses, is the product of “Internet plus education”. The teaching of accounting major under MOOC platform focuses on the cultivation of accounting practical skills

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 379–391, 2021.
https://doi.org/10.1007/978-3-030-84386-1_31

and literacy. MOOC teaching mode is used in accounting major of higher vocational colleges to make students' professional knowledge points and contents different from the traditional teaching mode. It is not based on students' one-time achievements, but generated many times according to students' learning situation. MOOC teaching mode not only emphasizes the teaching and learning of knowledge content, but also pays attention to the cultivation of accounting practical skills and literacy, which makes students have a more profound and direct understanding of practical skills and theoretical professional knowledge, and effectively solves the problem of accounting major's emphasis on theoretical knowledge teaching in Higher Vocational Colleges. Students are easy to produce new thinking and views in network learning, which is more meaningful it is conducive to students' personalized learning.

Due to the special performance of MOOC teaching platform, it is necessary to evaluate the teaching quality on the basis of MOOC. Teaching quality is the reflection of teaching activity and teaching effect, and it is the interrelated concept of the need and expectation of teaching activity. Teaching quality evaluation refers to the evaluation of teachers' academic professional level, teaching methods and teaching attitude. One of the basic contents of educational measurement is how to evaluate the teaching quality, but so far there is no unified standard. The teaching quality of a course is closely related to many factors, such as the teaching quality of each course in the early stage, the cooperation of each teaching link, the teaching effect of teachers, the quality of students and learning attitude.

Foreign MOOC started earlier, and the research on MOOC quality evaluation is more mature than that in China. Combing the existing MOOC quality evaluation abroad, its related research can be divided into macro level, meso level and micro level, that is, the evaluation standard with the state as the main body, the evaluation standard with institutions and universities as the main body, and the evaluation standard proposed by experts and scholars [2]. With the development of MOOC in China, there are more and more researches on MOOC quality evaluation, which can be divided into three categories according to the main body of the evaluation standard: the evaluation standard of online teaching quality issued by government agencies; the evaluation standard independently developed by the MOOC platform construction team; and the evaluation standard of MOOC teaching quality developed by scholars.

However, the current MOOC quality evaluation methods mostly use analytic hierarchy process (AHP) to build the MOOC teaching quality evaluation system of accounting major, and design the MOOC teaching quality evaluation model based on it. Due to the lag of AHP so far, this method has the problems of low evaluation reference value and application performance, Therefore, Rete algorithm is applied to teaching quality evaluation. Rete algorithm is a fast forward rule matching algorithm, and its matching speed has nothing to do with the number of rules. On this basis, by analyzing the teaching mode of MOOC in accounting major, Rete algorithm is used to match teaching data, determine the evaluation standard of teaching quality grade, set comprehensive evaluation index of teaching quality and calculate the weight of evaluation index, and solve the problem through the comprehensive solution of quantitative index and weight value, To realize the comprehensive evaluation of accounting teaching quality. This paper aims to improve the application value of the comprehensive evaluation model of MOOC teaching quality of accounting major through the application of Rete algorithm, and indirectly improve the teaching quality of MOOC of accounting major.

2 Design of Comprehensive Evaluation Model for MOOC Teaching Quality

Teaching quality is an important cornerstone of a university. It is related to the future and development of the University. It is the core starting point of carrying out a series of other work, and determines the academic ability of the University. The objective and detailed evaluation of teachers' teaching level can provide effective reference for improving the teaching mode and building a more sound teaching team, so as to improve the quality of education and teaching.

2.1 MOOC Teaching Mode of Analytical Accounting

MOOC teaching of accounting major is divided into three steps: online activity, in class activity and after class activity. Online activity is the beginning stage of a course and the most important stage. The smooth implementation of this stage will lay a solid foundation for the improvement of the final teaching results. Therefore, this link is divided into three steps, as shown in Fig. 1.

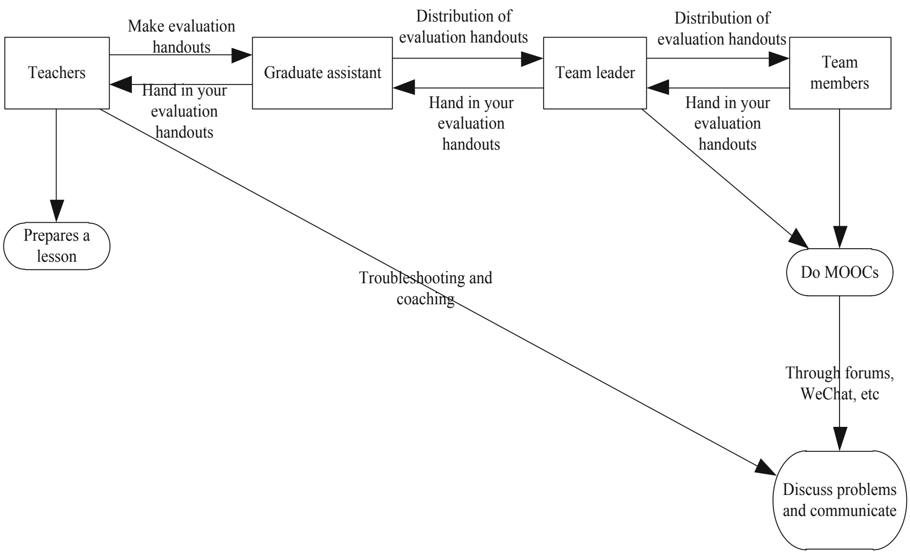


Fig. 1. Flow chart of online activities

In the MOOC learning stage, students can use a variety of mobile devices or PC terminals to learn MOOC courses anytime and anywhere. According to the teaching resources and teaching guidance provided by teachers, they can plan their own learning rhythm, watch MOOC videos and self-study course materials independently, and complete small tests interspersed in the course. Before the face-to-face course, we should guide the students to study independently to deepen their understanding of knowledge. In the classroom activities, the teacher's activities mainly include: according to the requirements of teaching objectives, combined with the sorting results of evaluation handouts, classroom analysis of the key points and difficulties encountered by students in MOOC learning; teachers organize students to carry out classroom activities in groups in an orderly manner, and organize interaction between groups at the same time. In this process, teachers provide personalized guidance and listen and record the difficulties of learning, observe the overall performance of students, judge whether the teaching objectives achieve the teaching focus [3]. After the discussion, the teachers evaluate the quality of learning task completion and interactive discussion, and complete the teaching activities in class. After class teaching mainly uses the linkage of online consultation system, message board, email, forum, microblog, QQ group and wechat group with mobile phones, so that students can ask questions, answer and discuss at any time and any place [4]. This can not only solve the problems left in the classroom, but also extend the classroom discussion to after class. Through online conversation, students' information expression ability and thinking ability can be further enhanced; students can more freely mine information, put forward more problems, and realize the consolidation and deepening of knowledge.

2.2 Using Rete Algorithm to Match Teaching Data

Figure 2 shows the basic structure of MOOC teaching.

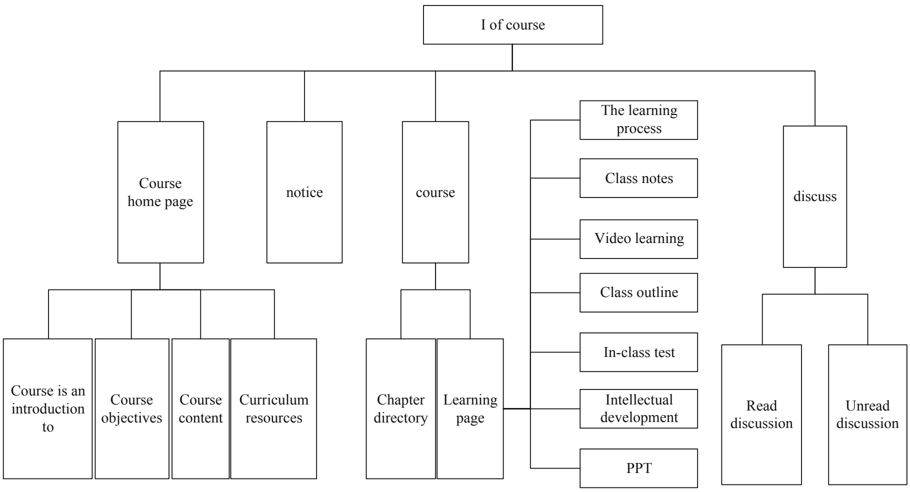


Fig. 2. MOOC teaching structure of accounting major

In the teaching structure shown in Fig. 2, the real-time teaching data is collected, and on this basis, the Rete algorithm is used for data matching. Rete algorithm needs a state memory and a rule memory. The elements stored in the state memory are represented as WME, each WME represents a state of the system, and the state memory can be a global database, which represents the whole state of the system [5]. WME can be used as the input of one-input node or the right input of two-input node. Token refers to the WME binding list that has been matched in the rule. The list contains one or more wmes, which can be used for the left input of the two-input node. If the WME is passed to the left end of the two-input node, the WME is encapsulated as a token with only one WME as the left input of the two-input node. The process of pattern matching between WME or token and node is shown in Fig. 3.

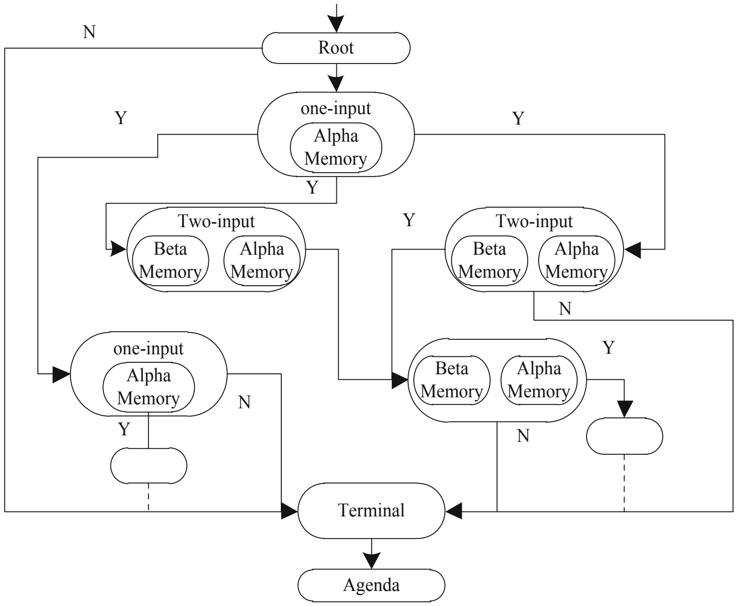


Fig. 3. Rete algorithm pattern matching flow chart

WME and the successor node of root are matched by type. If the matching is successful, the WME is transferred to the successor node to continue matching, otherwise the matching ends. If the WME is transferred to the one-input node, the pattern corresponding to the node is matched. If the matching is successful, the fact will be saved in the alpha storage area corresponding to the one-input node, and the WME is transferred to the successor node to continue matching, no then end the matching [6]. If WME is passed to the right end of the two-input node, it will be added to the alpha storage area of the node and matched with the token in the beta storage area of the node. If the match is successful, WME will be added to the token, and then the token will be passed to the next node. Otherwise, the match ends. If the token is passed to the left end of the two-input node, it will be added to the beta storage area of the two input node and matched with the WME in the alpha storage area. If the match is successful, the token will encapsulate the matched WME to form a new token and pass it to the next node. Otherwise, the match ends [7]. If the token is passed to the end node, the rule corresponding to the root node is activated, and the action corresponding to the rule is put into the agenda for execution [8].

2.3 Determine the Evaluation Standard of Teaching Quality Grade

The MOOC teaching quality comprehensive evaluation grade standard of accounting major is set as the comparison standard of comprehensive evaluation model, and the teaching quality is divided into five grades. The corresponding standards and quantitative evaluation scores of each grade are shown in Table 1.

Table 1. Comprehensive evaluation grade standard of teaching quality

Teaching quality grade	Quantitative scoring	Teaching standards
Excellent	90–100	The concept of accounting major is clear, the teaching framework is clear, the teaching mode is in line with the practical operation mode of accounting major, and there is no teaching error
Good	80–89	The concept of accounting major is relatively clear, the teaching framework is relatively clear, and the teaching mode is relatively in line with the practical operation mode of accounting major
Secondary	70–79	The concept of accounting major is basically clear, the teaching framework is basically clear, and the teaching mode is basically in line with the practical mode of accounting major. There are 1–2 teaching errors
Pass	60–69	The concept of accounting major is fuzzy, the teaching framework is fuzzy, but there is a certain degree of organization, the teaching mode and the practical operation mode of accounting major are partially overlapped, and there are 2–3 teaching errors
Fail	<60	There are more than three teaching errors, such as inaccurate explanation of accounting professional proper nouns, unable to build a complete and clear teaching framework independently, teaching mode not in line with accounting practice mode

2.4 Setting up Comprehensive Evaluation Index of Teaching Quality

The evaluation of teaching quality is a complex problem, which is not only restricted by the evaluation object and the evaluation goal, but also influenced by the evaluation subject's values. Therefore, the construction of evaluation model must be carried out according to some principles [9]. Among them, the comprehensive principle requires that the main factors affecting the teaching quality of accounting major should be taken into account when constructing the evaluation index system, which can reflect the effect of theoretical teaching and the quality of practice, and provide necessary data; the systematic principle requires that these elements of the index system should not be simply arranged and piled up without regularity, but must be considered The inner connection and mutual influence between them. The principle of scientificity refers to the establishment of the index items, the formulation of the evaluation criteria, the establishment of the index weight, the implementation of the evaluation process and the evaluation results, which should not only conform to the reality of the evaluation object, but also conform to the objective law of teaching activities. In order to make the MOOC teaching quality evaluation of accounting major scientific, the evaluators should grasp the situation of the evaluation object thoroughly, carefully, comprehensively and objectively, make realistic and fair judgment, seek and explore the way of improvement for the evaluation object from the perspective of the evaluation object, and put forward pertinent, targeted and feasible opinions. When constructing the evaluation system, the selected indicators should not only be collectable and quantifiable, but also be able to carry out effective measurement or measurement, that is, when collecting data, whether qualitative or quantitative, they should be easy to obtain, and they can be processed by certain statistical methods to get the required data [10].

According to the design principles of the teaching quality evaluation system and on the basis of the existing research results in the theoretical circle, the specific indicators are selected from the aspects of teaching objectives, teaching conditions, teaching links, teaching management and teaching results, some of which are shown in Table 2.

In the evaluation index system of teaching quality, teaching content is the main information intentionally transmitted in the process of interaction between teaching and learning. In the MOOC teaching quality evaluation of accounting major, the evaluation of "teaching content" mainly includes course overview, teaching design and teaching resources. First of all, the course page should provide teachers and teaching team introduction, course content introduction, and clearly explain the assessment method, credit and certification requirements of the course. At the same time, considering the universality of learners and the difference of knowledge background, it should explain to learners the basic physics knowledge and operation skills they should have when learning the physics course. Secondly, the teaching team should pay attention to the three links of "pre teaching test", "curriculum framework and key and difficult points" and "class hour design" in the teaching design. Before the formal teaching, the basic information of learners should be collected by means of questionnaires and so on. On this basis, the teaching steps and contents should be appropriately adjusted, and personalized guidance should be given [11]. MOOC teaching resources of accounting major are rich, which usually include "teaching video resources", "video auxiliary resources" and "teaching practice resources". According to the needs of the course, the teaching resources should be used reasonably to ensure the teaching quality of MOOC of accounting major. In the process of quality evaluation, the indicators of course access are the number of times of course platform access and the number of applicants, the course learning situation is

Table 2. MOOC teaching quality evaluation index of accounting major

First level indicators	Secondary indicators	Third level indicators
Teaching conditions	Teaching purpose	Definition
		Recognition
		Completion
Teaching conditions	Teaching team	Title of speaker
		Quality and ability of teaching staff
	Teaching environment	Teaching facilities
		Financial support
Teaching methods and means	Teaching content integrity and richness	
	Teaching method	Diversity of methods
	Teaching devices	Demonstration experiment, multimedia teaching, etc
	Proportion of theoretical and practical hours	
Teaching activities	Teacher activities	Knowledge explanation, classroom organization, question and answer interaction, etc
	Student activities	Course access, course learning, online interaction, etc
Teaching achievements	Homework evaluation	Job qualification rate, job completion rate, job design, job feedback
	Classroom assessment	Course qualification rate and course completion rate
	Proportion of students' awards and certificates	
	Rate of employment	

the length of course learning and video viewing. These quantitative indicators can be directly obtained by reading the background data of MOOC platform, while the quantitative processing of the proportion of theoretical and practical class hours, the qualified rate of homework, the proportion of students' awards and qualification certificates can be improved expressed as:

$$\begin{cases} \eta_T = \frac{T_L}{T_S} \\ \eta_h = \frac{n_h}{n_h + n_b} = \frac{n_h}{n_{tol}} \\ \eta_j = \frac{n_m}{N} + \frac{n_z}{N} \end{cases} \tag{1}$$

In formula (1), T_L and T_S are the number of class hours of theory and practice courses in MOOC courses of accounting major, respectively. n_h, n_b and n_{tol} correspond to the number of qualified assignments, the number of unqualified assignments and the total number of assignments. In addition, n_m and n_z represent the number of students who have obtained awards and accounting professional qualification certificates, and N is the total number of students who have participated in teaching. Similarly, we can get the quantitative processing results of other indicators in the constructed teaching quality evaluation index system.

2.5 Calculate the Weight of Comprehensive Quality Evaluation Index

Different indicators have different effects on MOOC quality. According to the importance of the indicators, weight is given. The calculation formula of comprehensive index weight is as follows:

$$\begin{cases} M = (0.2Q_1, 0.3Q_2, 0.2Q_3, 0.1Q_4, 0.2Q_5) \\ Q_i = \left(a_i^1 A_{i1}, a_i^2 A_{i2}, \ldots, a_i^n A_{in}\right) \end{cases} \tag{2}$$

Among them, Q_i is the weight set of the bottom indicators under the i first level indicators, a_i^n is the weight set of the n second level indicators under the i first level indicators, and A_{in} is the weight set of the third level indicators under the n second level indicators under the i first level indicators [12, 13].

2.6 To Realize the Comprehensive Evaluation of Accounting Teaching Quality

After calculating the weight value, we can get the weight matrix M of MOOC teaching quality comprehensive evaluation model based on Rete algorithm.

$$P = \sum_{i=1}^{n} D_i \times M_i \tag{3}$$

Where: D_i and M_i are the quantitative results and weight values of the indicators respectively [14, 15]. By comparing the evaluation results in formula (3) with the teaching quality grade standards set in Table 1, the final comprehensive evaluation results of MOOC teaching quality of accounting major can be obtained.

3 Comparative Experimental Analysis

The comprehensive evaluation model of MOOC teaching quality of accounting major based on Rete algorithm is developed by using ASP and SQL Server technology and B/S three-tier architecture. It aims to provide users with online teaching evaluation, real-time view, statistics, analysis, background maintenance and other functions. The major of accounting and finance in three schools is selected as the research object. The MOOC of the three universities is mainly responsible for associate professor or above. The division of curriculum team is clear. The three universities have specialized teachers responsible for courseware production, video photography and answering questions, and professional personnel responsible for post production, curriculum development, platform maintenance and data statistics.

Under the MOOC teaching platform of accounting major, the personnel participating in the comparative experiment can be divided into five types: teachers, students, experts, system administrators and teaching administrators. Among them, teachers can log in this system to evaluate the teaching performance of colleagues, and can view the specific situation of participating in the evaluation, and can also conduct self-evaluation and query the evaluation results and ranking. Students log in to the system to grade the teachers and query the evaluation details. Expert: log in the system to evaluate the accounting professional teachers, give the corresponding score, and query the specific situation of personal evaluation. The system administrator can set the questionnaire, indicators and other related data through the system login, manage the evaluation objects and the evaluated objects, query, analyze and count the final scoring results, control the evaluation process and manage users at all levels. Teaching administrator: view the situation of department personnel participating in the evaluation, view the final results, and uniformly manage the evaluation data of relevant departments.

Due to the application of Rete algorithm in the evaluation model, it is necessary to build rete network in the experimental environment, as shown in Fig. 4.

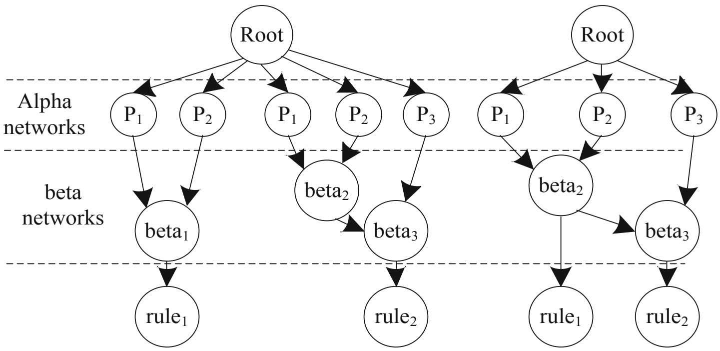


Fig. 4. Rete network structure

The purpose of this experiment is to verify the application effect of the designed teaching quality evaluation model in MOOC teaching of accounting major. Therefore, taking the students' performance of the research school as the quantitative comparative data, the change of accounting major students' professional performance before and after the application of the teaching quality evaluation model is obtained. Using the comprehensive evaluation model of MOOC teaching quality of accounting major based on Rete algorithm to evaluate the current teaching work, the results are shown in Fig. 5.

According to the evaluation results in Fig. 5, the optimization method of teaching quality is formulated and implemented. After a period of time, the changes of accounting students' scores before and after the application of the evaluation model are obtained. Several students are randomly selected, and the comparison results are shown in Table 3.

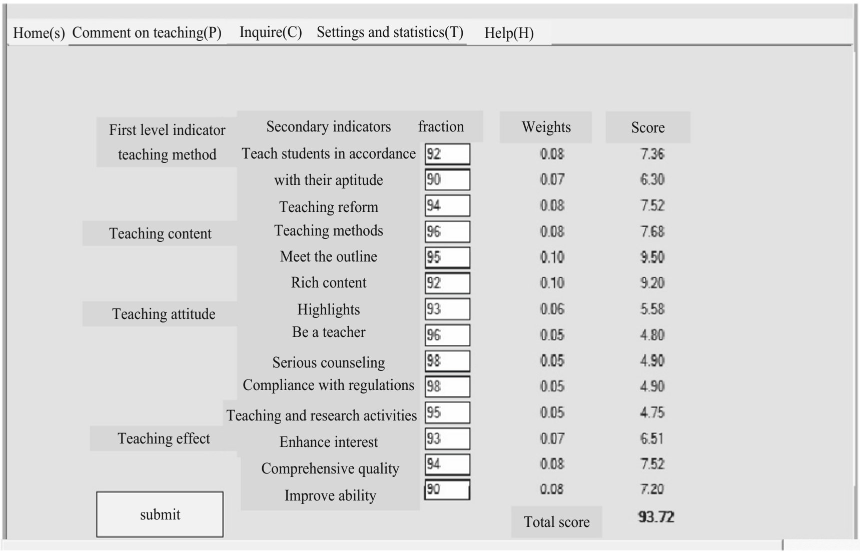


Fig. 5. MOOC teaching quality evaluation results of accounting major

Table 3. Application test results of teaching quality evaluation model

Accounting student number	Score/score of accounting major before applying teaching quality evaluation model	The score/score of accounting major after applying teaching quality evaluation model
01	82.3	91.5
02	88.6	96.7
03	79.4	90.4
04	75.5	91.2
05	80.2	93.3
06	81.4	92.8
07	66.7	89.7
08	90.3	95.6
Total score	644.4	741.2

It can be seen from the data in Table 3 that through the application of the MOOC teaching quality comprehensive evaluation model of accounting major based on Rete algorithm, the scores of accounting major students have been improved to varying degrees, and the average comprehensive scores of students have been improved by about 12.1 points, which proves that the designed teaching quality comprehensive evaluation model has a positive effect on students' professional learning.

4 Concluding Remarks

By using Rete algorithm to evaluate the MOOC teaching quality of accounting major, we can get a better comprehensive evaluation index of MOOC teaching quality of accounting major, and provide a scientific basis for the comprehensive evaluation of MOOC platform. Although the model can be very close to the teaching characteristics of MOOC course and reasonably evaluate the quality of the course, the teaching quality of the course is not only reflected in the selected evaluation index, but also affected by the characteristics of learners and the comprehensive management of the platform. Therefore, the evaluation of MOOC teaching quality of accounting major should consider the overall situation, comprehensively consider various factors, and make a scientific and correct judgment. Only good teaching quality evaluation of MOOC can make MOOC platform develop better.

References

1. Liu, H., Zhu, Y.: Research on the construction of teaching quality evaluation system. J. Phys: Conf. Ser. **73**(1), 25–27 (2020)
2. Zhang, M., Yu, X.: The construction of teaching quality evaluation system of modern apprenticeship based on big data. J. Phys: Conf. Ser. **78**(5), 28–30 (2020)
3. Dong, Q.W., Wang, S.M., Han, F.J., et al.: Innovative research and practice of teachers' teaching quality evaluation under the guidance of 'innovation and entrepreneurship.' Procedia Comput. Sci. **154**(1), 770–776 (2019)
4. Li, Z.: Evaluation of teaching effectiveness based on Gray Markov chain in the context of MOOC. IOP Conf. Ser.: Mater. Sci. Eng. **56**(9), 42–52 (2019)
5. Liu, G., Cai, Q., Ren, H.: A novel fuzzy evaluation method on teaching quality of college English based on preference selection index. IOP Conf. Ser.: Mater. Sci. Eng. **80**(1), 12–27 (2020)
6. Wang, Z., Tian, Q., Duan, X.: Research on the evaluation index system of college students' class teaching quality based on association algorithm. Cluster Comput. **22**(6), 13797–13803 (2019). https://doi.org/10.1007/s10586-018-2100-8
7. Ma, W., Yang, Z.: Evaluation of teaching quality in higher vocational colleges based on quantum behaviour particle swarm optimization. J. Phys: Conf. Ser. **29**(1), 32–42 (2020)
8. Abdelhadi, A., Nurunnabi, M.: Engineering student evaluation of teaching quality in Saudi Arabia. Int. J. Eng. Educ. **35**(1), 262–272 (2019)
9. He, M., Wu, L., Sun, Y., et al.: study on the integrative practice of university teaching space and information platform——taking Xi'an Eurasia University as an example. J. Phys: Conf. Ser. **21**(1), 69–77 (2020)
10. Li, X., Mo, X.: Application of AHP based on mathematical operational research in teaching evaluation system. J. Phys: Conf. Ser. **50**(3), 15–26 (2020)
11. Fen, Y., Biying, W.: The establishment of the teaching quality evaluation system for diversified courses in higher vocational colleges. Equipment Manufact. Educ. **33**(2), 39–41 (2019)
12. Debroy, A., Ingole, A., Mudey, A.: Teachers' perceptions on student evaluation of teaching as a tool for faculty development and quality assurance in medical education. J. Educ. Health Promot. **8**(1), 218–225 (2019)
13. Trskan, D.: Quality indicators, a new method for evaluation of teaching practice in teacher education programmes in Slovenia: example of quality indicators for school mentors – external mentors. Rev. Electrónica Interuniversitaria De Formación Del Profesorado **20**(2), 63–77 (2017)

14. Meng, Q.X., Xie, Y.H., Zhou, S.T.: Research on the comprehensive evaluation of MOOC teaching quality based on the improved hierarchical model. Educ. Modernization **7**(16), 62–64 (2020)
15. Guo, X., Zhang, M.H., Wu, L., et al.: Research and implementation of comprehensive evaluation algorithms for teaching quality in colleges and Universities. Comput. Modernization **18**(06), 121–126 (2019)

Evaluation Method of Teaching Effect of Applied Logistics Management Course Based on Deep Learning

Lin He[1], Qi-xiang Wu[1](✉), and Qian Jiang[2]

[1] College of Information Engineering, Fuyang Normal University, Fuyang 236041, China
[2] International Cooperation Exchange Center, Chongqing Vocational College of Transportation, Jiangjin 402260, China

Abstract. In order to improve the teaching quality of applied logistics management course, a model of teaching effect evaluation based on deep learning is designed. The evaluation system of teaching effect of applied logistics management course is constructed, and the evaluation model of teaching effect is established by using the method of deep learning according to the evaluation system, and the evaluation level analysis is carried out on the evaluation value. The experimental results show that the design evaluation model is more accurate and the error value is smaller than the traditional model. Therefore, the evaluation model of teaching effect based on deep learning is more in line with the teaching effect requirements of applied logistics management course.

Keywords: Deep learning · Applied logistics management · Teaching effect evaluation · Artificial neural network

1 Introduction

Course teaching effect is the basic standard of college teaching. With the arrival of the popularization of higher education in China, how to ensure the teaching quality of applied logistics management course while expanding the enrollment scale has become an important task for higher education in the new era [1, 2]. In order to meet the needs of the future development of the logistics industry, and to train senior technical personnel with solid basic theoretical knowledge of logistics and proficient in the core competence of the major, applied undergraduate majors have emerged. How to ensure the quality of application-oriented talent training while adapting to the needs of society is an urgent problem that needs to be solved in this profession. High quality teaching effect evaluation is the basis and premise of verifying teaching quality. The formulation and implementation of professional teaching effect evaluation method can make the logistics professional teaching quality management from illusory, free and changeable to the track of standardization, systematization and institutionalization.

At this stage, the traditional teaching effect evaluation method of logistics management course can not meet the development needs of the professional application-oriented

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 392–402, 2021.
https://doi.org/10.1007/978-3-030-84386-1_32

talents. There is no scientific and standardized teaching quality assurance system in the traditional teaching effect evaluation mode, so the teaching quality standard can only stay in words and oral, and can not be truly implemented. Therefore, this paper uses the artificial neural network technology in deep learning to optimize the traditional teaching effect evaluation method of logistics management course. Artificial neural network is a complex machine learning algorithm. Aiming at the current teaching effect of applied logistics management, this paper designs the evaluation method of teaching effect by using artificial neural network model, further improves the evaluation method of course teaching effect, and promotes the improvement of teaching effect of applied logistics management course.

2 Design of Teaching Effect Evaluation Method for Applied Logistics Management Course Based on Deep Learning

Based on the deep learning background, the teaching effect model of application-oriented logistics management course is set, and through the analysis and Research on the system process of the set teaching effect evaluation model, the teaching effect evaluation

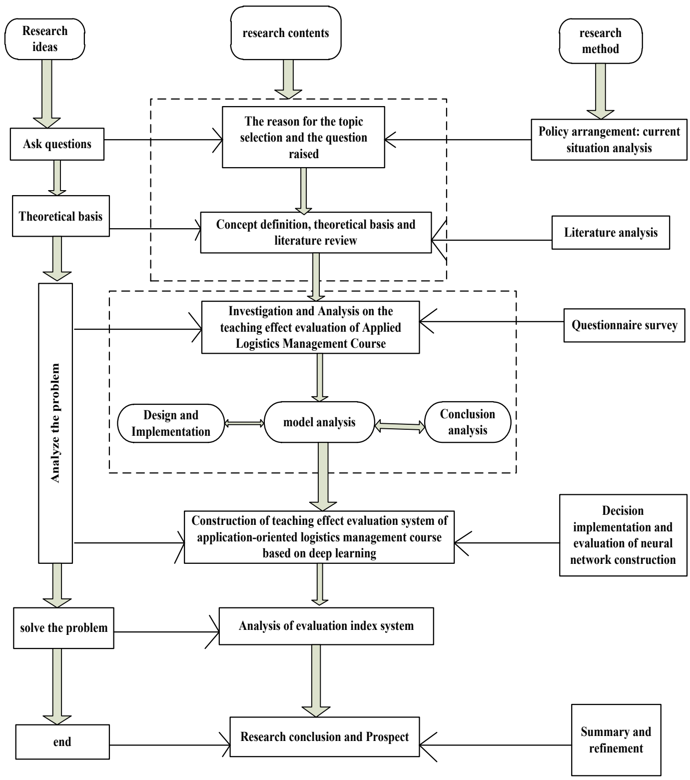


Fig. 1. Flow chart of the evaluation method of applied logistics management course teaching effect

model of application-oriented logistics management course is completed according to the following system process.

According to the process of effect evaluation model set in Fig. 1, the teaching effect evaluation model of application-oriented logistics management course based on deep learning is designed. According to the model setting experiment, the feasibility of the design effect model in this paper is tested.

2.1 Teaching Effect Evaluation System of Applied Logistics Management Course

Before establishing the teaching effect evaluation model of application-oriented logistics management course based on deep learning, we should first determine the evaluation index system. Based on the principles of scientificity, comprehensiveness, accuracy and operability [3, 4], taking the application-oriented logistics management course teaching effect evaluation index as the research object, the evaluation index system based on deep learning should be designed The network structure of teaching quality evaluation model (Fig. 2).

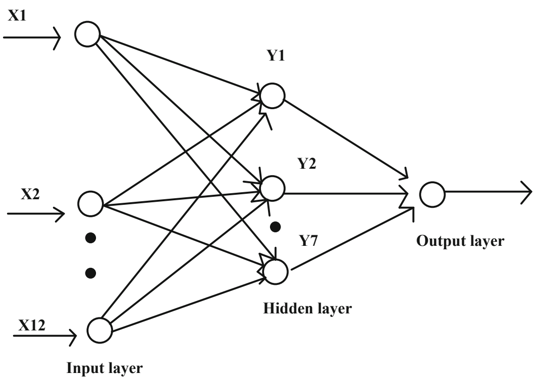


Fig. 2. Deep learning model diagram of teaching effect of applied logistics management course

The teaching effect evaluation index system is designed by using the above model as shown in the table below (Table 1).

The course schedule of applied logistics management is divided in detail, such as the main idea of each chapter, course schedule, teaching attitude and so on. The neural network model is constructed by using its index system, and the evaluation method designed in this paper is deeply studied by constructing the teaching effect evaluation model.

2.2 Construction of Evaluation Model Based on Deep Learning

Because the evaluation of the teaching effect of applied logistics management courses requires comprehensive and multi-level analysis and research on the problem, which contains too many uncertain factors. In order to solve the problems of weight determination and data dispersion in the process of experiment, a teaching effect evaluation model

Table 1. The teaching effect evaluation system of applied logistics management courses based on deep learning

Primary indicators	Serial number	Secondary indicators
Teaching attitude	1	Abide by laws and regulations, no lateness, early leave, absence from class
	2	Love students and care about their growth
	3	Be rigorous in academic research, prepare lessons, correct homework seriously, answer questions and solve puzzles seriously and responsibly
Content of courses	4	Clear teaching objectives, highlight the key points of teaching, and be good at teaching students in accordance with their aptitude
	5	The language is concise and accurate, and the advanced teaching methods are used to teach courses
	6	Good at combining theory and practice to develop students' sense of innovation
Teaching method	7	High professional theoretical level and strong practical ability
	8	Follow the outline closely and connect with reality
	9	The classroom atmosphere is enthusiastic, encouraging students to actively participate in the teaching process
Teaching effectiveness	10	Through teaching, students master the theoretical knowledge of the course
	11	Through teaching, improve students' self-study ability in relevant courses
	12	Through learning, help students find problems in the course

is designed. Using the experimental target value under the condition of reducing the speed is most suitable for the variance problem of the numerical evaluation model. The article uses the artificial neural network [5, 6] in the deep learning mode to evaluate the teaching effect of applied logistics management courses. Through the in-depth study of the model, the accuracy of the data processing of the obtained indicators is ensured, and the feasibility of the course teaching model is improved. In this paper, we introduce the set of evaluation elements as the set of factors that affect the evaluation objectives, that is, "A" is used to represent, and $A = \{A1, A2, ..., An\}$, where $Ai(i = 1, 2, ..., n)$ represents each element in the set, which constitutes the elements of the teaching effect evaluation target set. The information contained in the set is fuzzy. According to the hierarchical structure of the teaching effect evaluation index of the applied logistics management course, four first-level evaluation indexes can be expressed as $A = \{A1, A2, A3, A4\}$.

In the set of teaching effect evaluation targets, A_1 is the teaching method, A_2 is the teaching effect, A_3 is the teaching content, and A_4 is the teaching attitude. Each first-level indicator is divided into several second-level indicators that affect the higher-level indicators. For example, the teaching methods in the first-level indicators are divided into guided teaching, flexible teaching methods, teaching integration with practice, and teaching method innovation, which can be expressed as $A = \{A11, A12, A13, A14\}$. The same way can be used to establish the teaching effect evaluation element set. The teaching effect evaluation index of application-oriented logistics management course designed above is simplified. Under the determined evaluation target, it is divided into four first level indicators and sixteen second level indicators, and α is the weight value. The importance of different teaching effect evaluation elements is not the same, and the evaluation results of teaching effect are also different. In order to reflect the importance of teaching effect evaluation elements more scientifically, the weight value of objective element $\alpha i(i = 1, 2, ..., n)$ is constructed for evaluation element $ai(i = 1, 2, ..., n)$, that is, the teaching effect evaluation weight set $\alpha = \{\alpha 1, \alpha 2, ..., \alpha n\}$; the weight value $\alpha i(i = 1, 2, ..., n)$, with the normalization and non negative, the factor set is as follows:

$$\sum_{i=1}^{n} b_i = 1, bi \geq 0 \ _{(i=1,2,...,n)} \tag{1}$$

The teaching effect evaluation element set $ai(i = 1, 2, ..., n)$ can be regarded as the degree of membership under the teaching effect evaluation result set, and the weight value set is a subset of the element set. In order to avoid the artificial subjectivity in the setting of the weight value, the fuzzy consistent judgment matrix is used to obtain the corresponding weight value. According to the constructed secondary factor set [7] $A = \{A11, A12, A13, A14\}$, the fuzzy description of the factor set is judged by the quantitative scale., Construct a judgment matrix with the same ambiguity, as follows:

$$R = \begin{pmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \end{pmatrix} \tag{2}$$

Among them: *rij* is a factor, *ai* and *aj* are relatively important membership relations, and the weight meets the following conditions:

$$ui = \frac{1}{n} - \frac{1}{2r} + \frac{1}{nr}\sum_{j=1}^{n} r_{ij}, i = 1, 2, ..., n \tag{3}$$

It can be seen from formula (3) that r can:

$$r \geq \frac{n-1}{2} \tag{4}$$

In the above formula, the larger the selected value r, the smaller the weight difference; the smaller the r, the larger the weight difference. Therefore, the larger the value of r, the more it shows that the teaching effect model ignores the factor of the importance of elements. In practice, $r = \frac{n-1}{2}$ is generally adopted. This is the way to ignore the importance of elements.

Because the teaching effect evaluation set model is a set of quantitative evaluation of the evaluation objects by the participants. If it is marked as V, then $V = \{v1, v2, ..., vm\}$, where $vi(i = 1, 2, ..., n)$ in set V represents the total evaluation result of teaching effect. By considering all the influencing factors in the teaching effect model, the best result is selected.

Fuzzy comprehensive evaluation [8, 9], as an evaluation method in the artificial neural network model, is to evaluate all the fuzzy vector element sets, and obtain the scientific evaluation results that best reflect the characteristics of things through the comprehensive evaluation of the impact evaluation target, Fuzzy comprehensive evaluation considers the influencing factors involved in the evaluation objective more comprehensively, and can be expressed in the results with the characteristics that are most in line with the actual situation. In the fuzzy evaluation of the teaching effect evaluation target element, suppose that when the i element Ai in the teaching effect evaluation target fuzzy vector set is evaluated, the membership degree of the j element vj of the effect evaluation set is Oij, then the i element A_i a single evaluation set $Oi = (oi1, oi2, ..., oin)$ derived from the evaluation result.

Since the evaluation of a single element can only reflect the influence of a single element on the evaluation goal, the evaluation of the teaching goal can only reflect the scientificity and correctness of the evaluation goal result only when the overall fuzzy evaluation is carried out. If the weight set R is a fuzzy matrix with one row and n columns, combine the weight set with a single-element matrix to obtain a fuzzy set Ci;

$$Ci = Ai \bullet Ri = (a1, a2, ..., am) \begin{pmatrix} r_1 & ri12 \ldots ri1m \\ ri21 & ri22 \ldots ri2m \\ \vdots & \vdots \quad \ddots \vdots \\ rim1 & rin2 \cdots rinm \end{pmatrix} \tag{5}$$

In the above formula, $cj(j = 1, 2, ..., m)$ is the evaluation index. The first level evaluation judgment matrix can be obtained from the fuzzy vector element set of the second level evaluation.

2.3 Grading of Evaluation Results

Through the evaluation value obtained from the deep learning-based applied logistics management course teaching effect evaluation model set above, the evaluation level is analyzed, and the first-level index weight and the first-level index fuzzy relationship matrix W obtained by the design are used, thus, The intermediate variable S is obtained, and the formula is shown below.

$$W = S \circ R = S \circ \begin{pmatrix} C_1 \circ R_1 \\ C_2 \circ R_2 \\ Ck \circ R_k \end{pmatrix} = (b1, b2, ..., bp) \tag{6}$$

Among them, $bk(k = 1, 2, ...P)$ refers to the comprehensive evaluation value of each evaluation index, that is, the final value in the teaching process of the application-oriented logistics management course; by normalizing bk [10–12], the evaluation value can be calculated, that is, the w value, then the evaluation level of the application-oriented logistics management course can be obtained.

$$w = bk \times v^T \tag{7}$$

As a result, the evaluation grade w of the teaching effect evaluation of the applied logistics management course is obtained. If the value of w is in which level of the teaching effect evaluation grade, the overall comprehensive evaluation is at which evaluation grade.

Through the evaluation of the teaching effect of application-oriented logistics management, the teaching effect evaluation model based on deep learning is set on the basis of the traditional evaluation model. Through the deep division of the first level index into the second level index, combined with the secondary index weight obtained, the weight values of the first and second level indicators are obtained, and the relationship moments are obtained by different weight values Array.

R obtains the intermediate value B, and then normalizes the obtained B to obtain the evaluation value, that is, the shape value, which can obtain the grade level, which is the comprehensive evaluation result of the teaching effect of the applied logistics management course designed in the article.

3 Experimental Demonstration Analysis

3.1 Experimental Environment Setting

In order to better verify the feasibility of the optimization design of the effect evaluation model of the application-oriented logistics management course teaching based on deep learning, the experimental link is constructed, and the advantages of the design system in this paper are verified by comparing the design model and the traditional model.

This experiment uses the BP neural network evaluation model to collect data for the experiment. Because the BP algorithm is very sensitive to the network structure, different network structures have different ability to solve problems. The more complex the structure of the neural network, the stronger its ability to handle complex nonlinear problems, but the longer the training time; if the neural network structure is too simple, the network training will be difficult to converge or even if it can converge, the time will be too long. Studies have shown that increasing the number of hidden layers can improve the nonlinear mapping ability of neural networks and enhance the network's ability to deal with complex nonlinear problems, but too many hidden layers will prolong the learning time of the network. Therefore, the number of neurons in the input layer is set to n = 4, the number of neurons in the hidden layer is s = 4, the activation function of the BP neural network neurons is a combination of the rectified linear unit and the Maxout function, and the learning rate is set It is set at 0.05, the coefficient of inertia is 0.9%, and the maximum number of training sessions is 15,000. Introduce the matlab programming to the set experiment and use the LMBP algorithm to make each iteration no longer follow a single negative gradient direction, but allow the error to search along the direction of deterioration, and use the different accuracy error values obtained as a comparison Parameters to verify the feasibility of the teaching effect evaluation model of the design course in the article.

3.2 Experimental Process

The design teaching effect evaluation model in the text is compared with the traditional model under the experimental environment set above, and the two models are subjected to 5 repeated experiments at the same time with the same experimental process, and the experimental results are extracted. The experimental steps are as follows:

First of all, the traditional model and the teaching effect model designed in this paper are initialized with network and parameters, and random values between $[-2/n,\ 2/n]$ are given to each connection weight coefficient βij, βj and threshold value δj, δ, where $i = 1, 2, ..., n, j = 1, 2, ..., s$.

Secondly, in each of the two models, a pair of sample training data $Ep = [e1, e2, ..., e16]$ is selected as the input layer and yp is the expected output. Use the data Xp obtained in the input layer to connect the weight coefficient βij and the threshold βj to calculate the output of each hidden layer neuron.

Finally, through the iterative calculation of the experimental process, the error values of the two models are obtained, and then a second pair of samples is selected for training, and the above algorithm is repeated until the end of the five experimental runs of the two models.

3.3 Analysis of Experimental Results

Use the above experimental process to extract the error data obtained from the traditional model and the teaching effect evaluation model set in the article. Under the condition of three different precision target values, draw two model error numerical curves, as shown in the following figure (Figs. 3, 4, 5).

From the above experimental results, we can see that when the set target value is constantly shrinking, and the data is processed through the interaction between independent neurons and hidden neurons, the error value of the course teaching effect evaluation model designed in this paper is the smallest, the result is the best, and it is easier to get the accurate value in a short time than the traditional model. Because the teaching quality

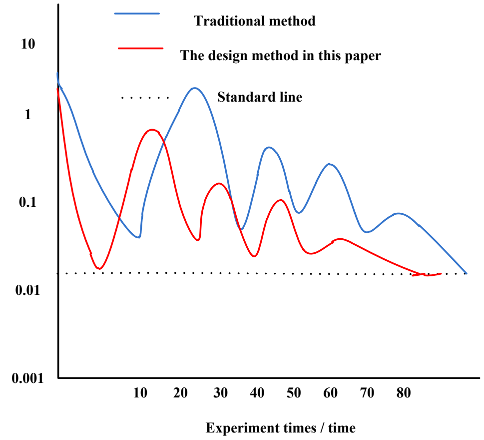


Fig. 3. Error curve of the traditional model and the design model in the text when the target is 0.01

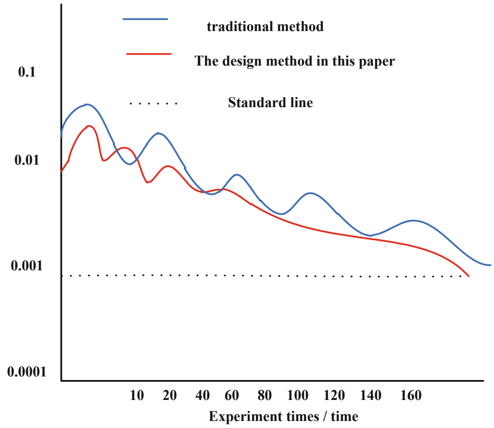


Fig. 4. Error curve of traditional model and design model in this paper when the target is 0.001

evaluation system in Colleges and universities is a complex nonlinear system, there are many uncertain factors between input and output. Neural network model, with its highly nonlinear function mapping function, self-adaptive and self-learning ability, can effectively overcome the defects of traditional evaluation methods and weaken the artificial influence factors of index weight determination in traditional evaluation methods when the structure of the network and its algorithm are determined, the output accuracy of the network depends on the quantity and quality of the input samples. The more the number and the better the quality of the samples, the closer the output evaluation value of teaching effect is to the actual evaluation value, and the more accurate the effect of teaching quality can be described. Therefore, the teaching effect evaluation model designed in this paper is better than the traditional system model.

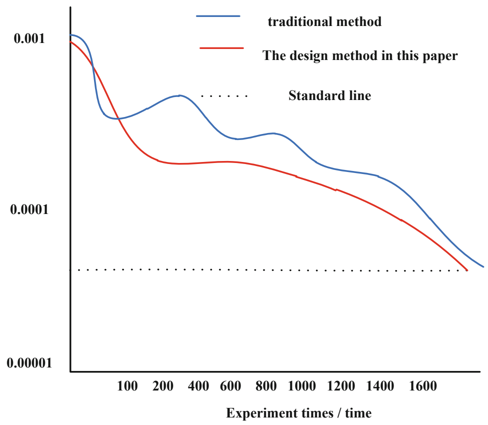


Fig. 5. Error curve of the traditional model and the design model in the text when the target is 0.0001

4 Concluding Remarks

Improving applied logistics management talents has become an urgent problem in the current logistics industry. The basis of solving this problem is to improve the evaluation method of applied logistics management course. With the deepening of teaching reform in Colleges and universities, how to improve the teaching quality and train more applied talents has become the core of the teaching reform in Colleges and universities. The establishment of a course teaching effect evaluation method that focuses on improving teaching quality also highlights its importance. significance. Through the study of the teaching effect evaluation method of applied logistics management courses based on deep learning, artificial neural network technology is added to the traditional teaching evaluation model to comprehensively collect, organize and analyze the teaching status, and make value judgments on it to improve teaching Activities, the process of improving teaching quality, and comparing the teaching effect evaluation of the set courses in the article with traditional models through setting experiments, proves the use of neural network algorithms to optimize traditional effect evaluation methods. However, it is a very complex task to improve a teaching effect evaluation model. Due to the various and complex factors affecting teaching, this paper can not cover a wide range of situations. It is hoped that in the future, the evaluation model can be further optimized to make it more in line with the needs of application-oriented Logistics management course teaching effect evaluation method.

References

1. Chen, J.,Wang, Z.,Chen, J. , et al.: Design and research on intelligent teaching system based on deep learning.Comput. Sci. **46**(S1), 550–554+576 (2019)
2. Liu, C., Lin, L., Yu, C., et al.: Research on peanut hyperspectral image classification method based on deep learning. Comput. Simul. **37**(03), 189–192+283 (2020)

3. Luo, H., Jiang, W., Fan, X., et al.: A survey on deep learning based person re-identification. Acta Autom. Sinica **45**(11), 2032–2049 (2019)
4. Wang, R., Zhang, W.: implicit evaluation object recognition method based on deep learning. Comput. Eng. **45**(11), 2032–2049 (2019)
5. Wang, X., Zhang, H., Zhang, R., et al.: Big data pipeline network risk assessment method based on deep learning. Fire Sci. Technol. **38**(06), 902–905 (2019)
6. Liu, S., Lu, M., Li, H., et al.: Prediction of gene expression patterns with generalized linear regression model. Front. Genet. **10**, 120 (2019)
7. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mobile Networks Appl. **24**(1), 1–4 (2019)
8. Liu, S., Glowatz, M., Zappatore, M., et al. (Eds.). E-Learning, e-Education, and Online Training, pp. 1–374. Springer International Publishing, Berlin, Heidelberg (2018). https://doi.org/10.1007/978-3-030-63952-5
9. Qi, Y.U.E., Xin, W.E.N.: Application of improved GA-BP neural network in teaching quality evaluation. J. Natural Sci. Heilongjiang Univ. **36**(03), 353–358 (2019)
10. Xu, F., Chen, Y., Huang, Z., et al.: An empirical study on teaching quality evaluation of pharmaceutical administration. J. Shenyang Pharm. Univ. 36(12), 1119–1126 (2019)
11. Liang, H.: Role of artificial intelligence algorithm for taekwondo teaching effect evaluation model. J. Intell. Fuzzy Syst. **40**(2), 3239–3250 (2021)
12. Luyten, H., Bazo, M.: Transformational leadership, professional learning communities, teacher learning and learner centred teaching practices; evidence on their interrelations in Mozambican primary education. Stud. Educ. Eval. **60**, 14–31 (2019)

Evaluation Method of Online Learning Process Under the Background of Educational Big Data

Yi- huo Jiang[1(✉)] and Yi Jiang[2]

[1] City College of Dongguan University of Technology, Dongguan 523419, China
[2] Department of General Knowledge, Fujian Chuanzheng Communications College, Fuzhou 350202, China

Abstract. In the actual evaluation of learning process, affected by online non process data, the evaluation index system is confused, resulting in the problem of low confidence of the final evaluation results. This paper designs an online learning process evaluation method under the background of educational big data. Set up the online learning process acquisition network, collect online learning process data, divide the collected learning process data according to the technical direction and teaching design direction, construct the index type system, regard the same level of indicators as a whole to distribute the weight, according to the weight value, build the evaluation process, and complete the design of process evaluation method. After setting the experimental parameters and delimiting the experimental samples, the evaluation method in reference [3], the evaluation method in reference [6] and the evaluation method designed in the paper are used to carry out the experiment. The results show that the confidence result of the evaluation method designed in this paper is the largest.

Keywords: Education big data · Online learning · Process · Non process data

1 Introduction

With the successful application of computer technology and network technology in the field of education, network learning has gradually become one of the important learning methods in modern society. It extends learning from walled campus to virtual network, making full use of the advantages of network technology to make up for the shortcomings of traditional education. Network learning has changed the traditional teaching mode. The teaching center has changed from teachers to students, and students have become active knowledge constructors. E-learning has many advantages, such as rich learning resources, various interaction types and autonomous learning methods, but it faces new problems in the process of practice.

Due to the separation of teachers and students in e-learning, teachers can not supervise students face to face. Students mainly rely on self-awareness and self-control for autonomous learning, which makes students' online learning efficiency low and the effect of online learning poor. The process evaluation of web-based learning has become an

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 403–414, 2021.
https://doi.org/10.1007/978-3-030-84386-1_33

effective method to ensure the quality of online learning. Online learning process evaluation can help teachers master the learning progress and learning effect of students. However, there are some problems in the current online learning process evaluation, such as unified evaluation scheme, unable to make teachers flexibly adjust according to the needs of the curriculum, simple way to transform evaluation data into performance, and less feedback information of evaluation. How to evaluate the process of e-learning effectively is still in constant exploration.

The research on online learning process evaluation at home and abroad is mainly reflected in three aspects: evaluation theory research, evaluation technology research and application research. Considering the uniqueness of e-learning, foreign researchers have established an E-learning Evaluation System from four aspects of students' curriculum resources, learning attitude, communication and cooperation, and knowledge effect based on the analysis of students' learning behavior. Some scholars propose to use the hybrid algorithm of Bayesian and neural network to evaluate [3]; Some scholars propose to model and analyze big data [4]; Some scholars put forward structured analysis based on social network data for evaluation [5];Some scholars propose to use cloud computing for data mining, association and retrieval of key features to achieve evaluation [6].From the application of online learning process evaluation at home and abroad, it can be found that the current online learning evaluation has gradually paid attention to the students' learning process and learning results, but there are still some problems, such as the evaluation content is not comprehensive enough, the evaluation scheme can not be flexibly adjusted according to the curriculum requirements, and the evaluation data transformation method is simple.

2 Evaluation Method of Online Learning Process Under the Background of Educational Big Data

2.1 Collect Online Learning Process Data

Online learning has a wide range of knowledge sources, so we should analyze its knowledge sources and web access process when collecting. The knowledge involved in the online learning process is divided into internal knowledge organization level and external knowledge organization service level, and the online learning knowledge sources are integrated into a large collection network, as shown in Fig. 1.

The source of online knowledge base in Fig. 1 is divided into four parts: intelligence knowledge base, online learning data collection, comprehensive knowledge base and knowledge consultation. According to these four parts, the correlation strength between

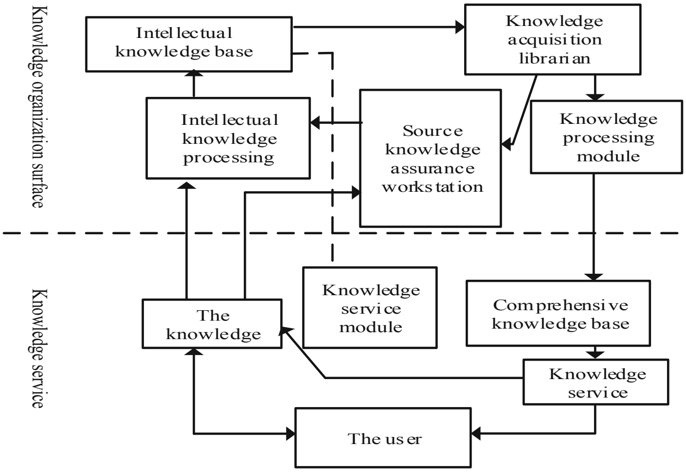


Fig. 1. Knowledge source network of online learning

the knowledge nodes of the whole network is calculated:

$$\begin{cases} C_A = \frac{1}{2}\sum_{k \in Z} CA_k h_{k-m} \\ C_V = \frac{1}{2}\sum_{k \in Z} CV_k h_{k-m} \\ C_H = \frac{1}{2}\sum_{k \in Z} CH_k h_{k-m} \\ C_D = \frac{1}{2}\sum_{k \in Z} CD_k h_{k-m} \end{cases} \tag{1}$$

Where, C stands for correlation degree, A represents intelligence knowledge base, V represents data collection set, H represents comprehensive knowledge base, D represents knowledge point inquiry, Z represents node number of knowledge points, k represents a real number set, and m represents the number of knowledge nodes with intersection. Web access process is mainly aimed at the learning interface often used by online students, that is, the access records left on the server, including frequent access paths, frequent access page groups and user clustering. Data purification processing access record, set the access record data group as, data purification processing formula

$$I = \sqrt{\sum_{n=1} (X_n - X_{n-1})^2} \tag{2}$$

Where, I represents the access data record data combination. Identify users, sessions and events in the data record, and constantly supplement path data to form the final user dialog file [1–4]. The data collection clustering algorithm is used to process the final user dialogue file p, and the correlation coefficient is calculated:

$$\rho = \frac{\sum_{p \in S} (I(p) - \bar{I})}{\sqrt{\sum_{p \in W} (I(p) - \bar{I})^2}} \tag{3}$$

Where, $\bar{I} = \frac{1}{M \times N} \sum_{p \in W} I(p)$, W and p represent the number of clustering processing, $\bar{I}$ represent the user dialog file, and represent the path data of data ρ combination. At that time, $\rho > 1$, the web access data is the knowledge of online learning. After collecting online learning data, the evaluation index of learning process is set.

2.2 Setting Evaluation Index

When setting the evaluation index, take the online learning data obtained as the processing object, divide the collected learning process data according to the technical direction and teaching design direction, and the classification types are shown in Fig. 2.

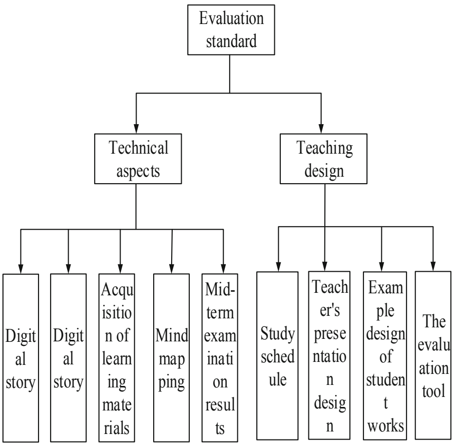


Fig. 2. Index types obtained by Division

Under the index type divided in Fig. 2, when determining the evaluation index, the appropriate value of the positive treatment index type is selected as the evaluation value of each index. In order to prevent the dimensionless value in the evaluation index from interfering with the evaluation result [5], the extreme value of the evaluation value is defined as the dimensionless value, and the extreme value calculation formula is as follows:

$$\begin{cases} x_{i\,\max} = \frac{\max\ k_i - x_i}{\max\ x_i} \\ x_{i\,\min} = \frac{x_i - \min\ k_i}{\max\ x_i - \min\ x_i} \end{cases} \tag{4}$$

Where, k represents the evaluation value of the index. After removing the interference of dimensionless values, the relevant parameters of the index are calculated by assuming that the random variable samples $(X_1, Y_1),\ (X_2, Y_2),\ \ldots,\ (X_n, Y_n)$ of two indexes are

$$r(X, Y) = \frac{\sum_{i=1}^{n} (X_i - \overline{X})(Y_i - \overline{Y})}{\sqrt{\sum_{i=1}^{n} (X_i - \overline{X})^2 (Y_i - \overline{Y})^2}} \tag{5}$$

$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n}$, $\overline{Y} = \frac{\sum_{i=1}^{n} Y_i}{n}$ According to the above calculation formula, the linear parameters of the evaluation index are calculated, and the correlation between the evaluation indexes is controlled [6], and the statistical quantity t of the partial linear parameters is calculated

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \tag{6}$$

The meaning of each parameter in the above calculation formula remains unchanged. When the statistics of linear parameters conform to the relationship $|t| > t(n-2)$, there is an over significance level parameter β in the linear parameter. Referring to the statistical relationship of linear parameters, the significance level parameter is calculated

$$\beta = \frac{|t|}{t(n-2)} \tag{7}$$

When the significance level parameter value β is greater than 1, it indicates that the selected evaluation parameters have strong correlation; when the significance level parameter value is greater than 0 and less than 1, it indicates that the correlation of the determination evaluation parameters is not strong [7]. When the correlation coefficient is not strong, the nonlinear parameters between the indicators are calculated. By using the Spearman correlation coefficient, the sample position $(R_i,\ L_i)$ of the evaluation index is marked, and then the nonlinear parameters can be calculated

$$\tau(R, L) = \frac{\sum_{i=1}^{n} (R_i - \overline{R})(L_i - \overline{L})}{\sqrt{\sum_{i=1}^{n} (R_i - \overline{R})^2 (L_i - \overline{L})^2}} \tag{8}$$

Where, τ is the Spearman correlation coefficient. Similarly, the position parameters conform to the quantitative relationship $\overline{R} = \frac{\sum_{i=1}^{n} R_i}{n}$, $\overline{L} = \frac{\sum_{i=1}^{n} L_i}{n}$, The statistical value of position parameter is calculated, and the significance level coefficient is obtained when the statistic formula obeys normal distribution. The index with large significance level coefficient is selected as the processing index of evaluation method, and the evaluation method is constructed by using this part of processing index.

2.3 Complete the Construction of Evaluation Method

Using the above-mentioned evaluation index as the processing object of the evaluation index, the evaluation index is divided into different evaluation systems [8], and the same grade index is regarded as a whole to allocate the weight, and the weight value can be calculated

$$\sum_{i=1}^{n} a_i = 1 \tag{9}$$

a_i represents the set of grade indicators, and the weight distribution of evaluation indicators is shown in the Fig. 3:

As shown by the numerical distribution of index weight shown in Fig. 3, the evaluation results are quantified by using fuzzy mathematics algorithm with the progressive line r of each evaluation index as the standard. It is proposed for the non-linear point of view of the evaluation process. The evaluator obtains the evaluation data of the evaluation subject from the evaluation factors affecting the evaluation subject, uses the fuzzy operation in fuzzy mathematics and other methods to quantitatively display the complex non quantitative data [9], and then makes different degrees of non quantitative fuzzy evaluation to obtain a comparable quantitative evaluation result The process and the final design of the evaluation process are shown in Fig. 4.

According to the evaluation process shown in Fig. 4, according to the evaluation objectives, the evaluation factors of the evaluation object are selected and determined, and the measurable evaluation system is established. Determine the weight of each evaluation index. Based on the importance of each evaluation factor in the whole evaluation system,

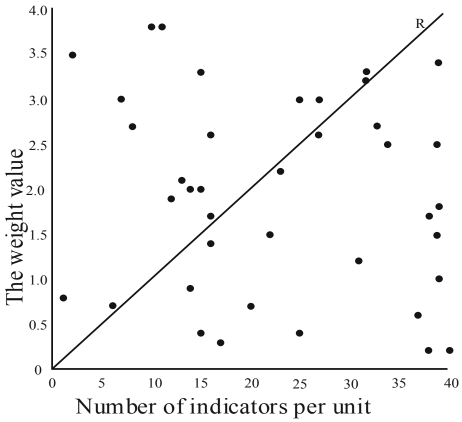


Fig. 3. Numerical distribution of index weight

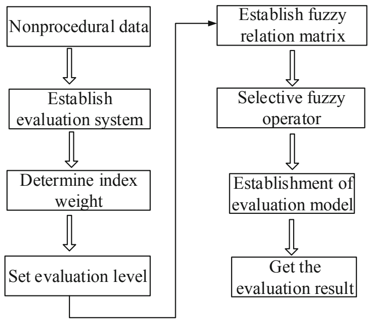


Fig. 4. Evaluation process of construction

the weight of each evaluation factor is set. Set the comment set [10]. The membership degree of each evaluation grade is determined, and the evaluation set is established, which serves as a reference and basis for the transformation of evaluation results into qualitative evaluation. The fuzzy operator is selected, the operation formula is determined, the relevant evaluation data are collected and processed, and the comprehensive evaluation results are obtained.

3 Simulation Experiment

3.1 Experimental Preparation

In the process of this experiment, the comprehensiveness of the evaluation index is taken as the experimental contrast object. The original method and the design method are applied to the experimental platform to analyze the experimental samples set in advance, and the comprehensive value of the analysis index is obtained. In order to ensure that the experimental platform has no influence on the experimental results, the parameters of the experimental platform are set as follows (Table 1).

Table 1. Experimental environment parameters

Parameter properties	Name	Parameter
Server side	Processor	Pentium 1GHz or higher
	Memory	256MB or above
	Hard disk space	40Gb or above
	Operating system	Windows 2000/Serve2003/XP
	database	MysQL 5.1
	Web server	Tomcat 5.5
	Development Kit	JDK 1.6
	Operating system	Windows 2000/Serve2003/XP
Client side	Processor	1GHz or higher
	Memory	128MB or above
	Hard disk space	10GB or above
	Operating system	Windows 2000/Serve2003/XP
	Operating system	Windows 2000/Serve2003/XP

The above parameters are used to complete the establishment of the experimental platform, and the education effect of a university is evaluated. By comparing the comprehensiveness of the two evaluation indexes, the evaluation indexes are set in the form of radar chart, as shown in Fig. 5.

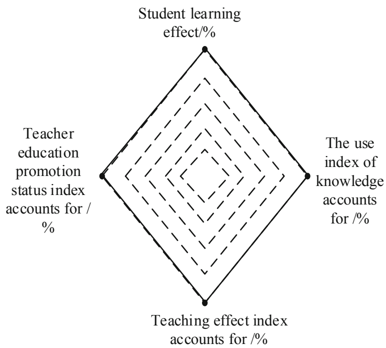


Fig. 5. Experimental sample

The experimental sample indicators are divided into four directions, namely, students' learning effect, teachers' education promotion status, knowledge use and teaching effect. In this paper, a comprehensive evaluation of the experimental results in the literature [3] was completed.

3.2 Results and Analysis

Using the above settings, the experiment was completed. The experimental results of the evaluation method in reference [3], the evaluation method in reference [6] and the experimental comparison results of the design method in the paper are as follows (Fig. 6):

According to the above experimental results, compared with the design method in this paper, the index selection range of the evaluation method in the two literatures is smaller, and the difference between the evaluation index method and the experimental sample is large. The index selection results of this design method have high similarity with experimental samples, which can effectively ensure the comprehensiveness and accuracy of the evaluation of experimental objects. The index of the evaluation method in the literature is not comprehensive, which is easy to lead to one-sided evaluation. This evaluation method can effectively avoid the problem of poor reliability of evaluation results. To sum up, the process evaluation method designed in this paper is better than the learning process evaluation method in the two literatures.

Under the above experimental environment, the multiple parameters of evaluation index in the learning process can be calculated as follows:

$$c = \varepsilon \frac{X}{r} \tag{10}$$

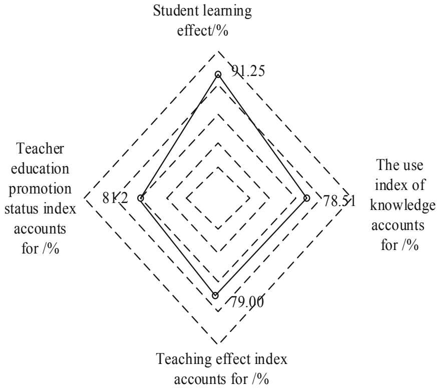
Where, represents the evaluation parameters, represents the set of evaluation factors, and represents the dimension parameters of indicators. The larger the diversity parameters obtained by defining the evaluation method, the more comprehensive the evaluation method is. Finally, the changes of diversification parameters of the three process evaluation methods are shown in Fig. 7.

It can be seen from the results of the diversification parameters shown in the above figure that with the increasing number of evaluation index sets, the three process evaluation methods show different sizes of diversified parameters. According to the size of diversification parameters obtained from the above figure, the evaluation method in reference [3] with the increasing number of sets, the value of diversification parameters obtained by this method is about 0.4 The indexes involved in the method are poor in comprehensiveness. The evaluation method in reference [6] gets about 0.7 diversification parameters, and the corresponding evaluation methods have strong comprehensiveness. However, the evaluation method designed in this paper finally obtains the diversified parameters of about 1.1, and the comprehensive index obtained by the evaluation method is the strongest.

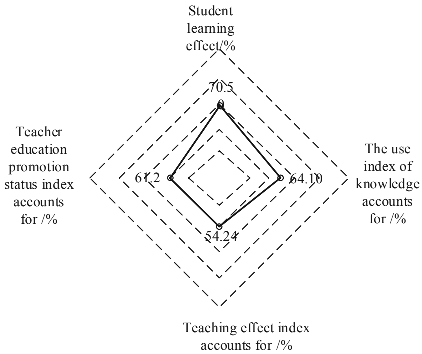
In the above experimental environment, based on the multiple parameters obtained by the evaluation method, the confidence calculation formula of the evaluation method is set, which can be expressed as follows:

$$t_r = \frac{c}{\sum_{i=1}^{k} X_i} \tag{11}$$

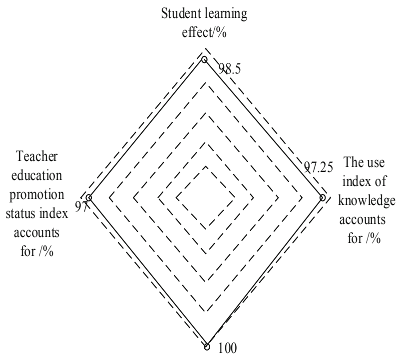
Among them, X_i represents the set of evaluation elements, k represents the total number of evaluation indicators, and the meaning of other parameters remains unchanged.



(a) Comprehensive results of evaluation methods and indicators in reference [3]



(b) Comprehensive results of evaluation methods and indicators in reference [6]



(c) The evaluation method designed in this paper has comprehensive results

Fig. 6. Comprehensive comparison results of three evaluation methods

The confidence levels of the three evaluation methods of learning process are summarized and calculated. The final confidence results are shown in Table 2.

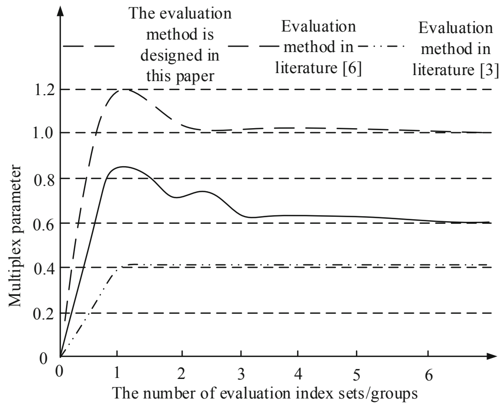


Fig. 7. Diversity results of three evaluation methods

Table 2. Confidence results of three evaluation methods

Number of indicator sets	Confidence value		
	Methods in the literature [3]	Methods in the literature [6]	The evaluation method is designed in this paper
1	4.02	7.14	9.06
2	4.09	7.35	9.23
3	4.17	7.43	9.44
4	4.28	7.62	9.48
5	4.44	7.72	9.72
6	4.62	7.74	9.87

From the confidence results shown in Table 2, the three evaluation methods show different confidence values. The larger the defined confidence value, the more accurate the evaluation results of the evaluation method. According to the values in the table, the confidence value obtained by the evaluation method in reference [3] is the smallest, and the credibility of this evaluation method is poor. The confidence value obtained by the evaluation method in reference [6] is relatively poor The evaluation method designed in this paper has the largest confidence value and the strongest credibility.

To sum up the experimental results, we can find that the designed evaluation method has a more comprehensive learning effect, up to 100%, the diversity of evaluation parameters up to 1.1, the highest confidence level up to 9.87, which has a better performance.

4 Conclusion

E-learning, born in the environment of educational informatization, has changed the traditional learning methods and learning evaluation methods. The dual process of process evaluation plays an important role in enhancing the monitoring and feedback of learners' learning process, guiding learners to maintain long-term learning motivation and improving their autonomous learning ability. Integrating process evaluation into e-learning environment and constructing e-learning platform for process evaluation is of great significance to comprehensively evaluate the learning effect and improve the quality of e-learning.However, due to the limited conditions, this paper only conducted an experiment on one university, which is not representative. In the future research, it will be further promoted, and experiments will be carried out in Colleges and universities all over the country to verify the practicability of this method.

References

1. Lemen, C., Haojing, L., Jiayu, J.: An analysis of data object traceability guarantee method in big data environment. Inf. Documentation Serv. **41**(02), 83–92 (2020)
2. Fang, L.U., Li-ting, W.E.I.: New research methods of college students' learning states under background of big data. Heilongjiang Res. High. Educ. **37**(12), 143–148 (2019)
3. Zhang, C., Liu, J., Ran, H.: Research on e-commerce credit evaluation method based on Bayesian and neural network hybrid algorithms. Inf. Sci. **38**(02), 81–87 (2020)
4. Liu, W., Ji, W., Zhang, C.: Big Data Modeling Analysis Method for Intelligent Production Maintenance. China Mech. Eng. **30**(02), 159–166 (2019)
5. Liang, Y.: Simulation research on big data unstructured stability detection in social networks. Comput. Simul. **36**(05), 325–328+336 (2019)
6. Yu, B., Zhang, Z., Liu, R.: Efficient retrieval of key features of big data based on cloud computing. Sci. Technol. Eng. **18**(19), 244–249 (2018)
7. Chen, D., Zhan, Y., Yang, B.: Analysis of applications of deep learning in educational big data mining. E-education Res. **40**(02), 68–76 (2019)
8. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training[J]. Mobile Networks and Applications **24**(1), 1–4 (2019)
10. Liu, S., Lu, M., Li, H., et al.: Prediction of gene expression patterns with generalized linear regression model. Front. Genet. **10**, 120 (2019)

Research on Online Course Teaching Quality Evaluation Method Based on Internet of Things Technology

Guang Tao[1(✉)], Jie He[1], and Rou-jia Ji[2]

[1] Wuhan University of Bioengineering, Wuhan 430415, China
[2] School of Science, Hubei University of Technology, Wuhan 430068, China

Abstract. Network teaching is a new modern teaching mode. Network teaching evaluation is a key link in the whole network teaching process and an effective method to ensure the quality of network teaching. Therefore, this paper puts forward the online course teaching quality evaluation method under the Internet of things technology. By analyzing the influencing factors of online course teaching quality, it constructs the online course teaching quality evaluation system, determines the online classroom teaching evaluation index of colleges and universities, and calculates the final teaching quality evaluation result according to the evaluation proportion by using the Internet of things technology. The simulation results show that the proposed method is effective in online course teaching quality evaluation.

Keywords: Internet of things technology · Online course · Quality evaluation

1 Introduction

With the vigorous development of computer, multimedia, network and other technologies, the network teaching mode has provided an excellent opportunity for the leap forward development of China's education. The so-called network teaching refers to a kind of teaching activity that students with certain self-learning and self-discipline ability use network technology and multimedia technology to realize in different places through the interaction with computer network, which is mainly based on active learning, supplemented by teacher guidance and computer intelligent coordination [1]. As a new type of teaching form, network teaching emphasizes students and self-learning as the center, which is more open, flexible and diverse than traditional teaching. To ensure the quality of network teaching, we must build a reasonable and perfect network teaching quality evaluation and monitoring system. Teaching evaluation is a key link in the whole teaching process, which refers to the process of making value judgment on students' behavior changes through teaching according to teaching objectives, so as to provide basis for improving and optimizing teaching [2]. Network teaching evaluation belongs to the sub category of teaching evaluation, which has three meanings of teaching evaluation, namely value judgment, evaluation development and reference standard. However,

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 415–429, 2021.
https://doi.org/10.1007/978-3-030-84386-1_34

compared with traditional teaching, network teaching has its own unique characteristics, such as the separation of teaching and learning activities in time and space, the need for reliable and safe network transmission system for the realization of teaching, learners' learning is mainly autonomous learning, etc., which makes network teaching evaluation often show its unique characteristics [3]. How to establish an effective network teaching evaluation system has become an important issue for modern educators. Because the traditional online course teaching quality evaluation method has the problem that the evaluation effect is not ideal, the online course teaching quality evaluation method is proposed under the Internet of things technology. This paper discusses the network teaching mode and characteristics, analyzes the remarkable characteristics of network teaching evaluation, expounds the system structure of network teaching quality evaluation, and focuses on the design and implementation of network teaching evaluation system. The simulation results show that the online course teaching quality evaluation effect of this method is good, which lays the foundation for online course teaching.

2 Evaluation Method of Online Course Teaching Quality

2.1 Factors Influencing the Teaching Quality of Online Courses

In China, the practice and theoretical research of teaching quality evaluation in Colleges and universities started late, only a few decades of development. Compared with the western developed countries with more than 100 years of history, the theoretical research is not deep enough, and the practice is still in the exploratory stage. However, under the guidance of national policies and school exploration, the theory and practice of teaching quality evaluation in Colleges and universities have also been greatly developed [4]. The teaching quality of university teachers is an important part of teaching quality. At present, the domestic factors affecting the teaching quality of university teachers can be summarized into the following six aspects: the quality of teachers, the way of knowledge accumulation, classroom practice, teaching auxiliary conditions, incentive mechanism and external environment. The specific influencing factors of online course teaching quality evaluation are shown in the Fig. 1.

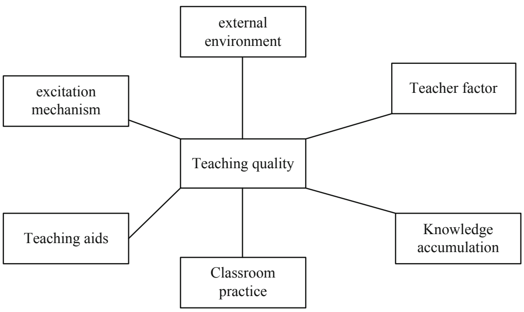


Fig. 1. Factors Influencing online course teaching quality evaluation

Among them, the elements included in each link can be determined according to the actual situation.

(1) The quality of university teachers includes educational background, knowledge structure and personal charm;
(2) The ways of knowledge accumulation include self-study, further study, training, academic exchange, expert guidance, etc.;
(3) Classroom practice includes classroom teaching hours, the number of different teaching objects and other elements;
(4) Auxiliary teaching conditions include computer, teaching projector, teaching software and other facilities;
(5) The incentive mechanism includes teaching and research awards, professional title recognition and other elements;
(6) The external environment includes the social respect for university teachers and the status of teachers;

The so-called influence factor refers to the most important component of the system. Without a certain basic element, the system cannot be formed. Teachers, teaching content, online classroom teaching environment and students are indispensable basic elements in the online classroom teaching process. Teachers are the main body of "teaching" in the online classroom teaching process, and they are the designers and implementers of online classroom teaching process [5]. The influence of teaching content on teaching quality mainly refers to the satisfaction degree of teaching content on teaching objectives and the influence of teaching content on online classroom teaching quality in form of expression. Online classroom teaching environment refers to the environment in which teachers and students carry out teaching activities, and students are the main body of "learning" in the process of online classroom teaching [6]. In the process of online classroom teaching, the relationship between the influencing factors is analyzed, as shown in the Fig. 2:

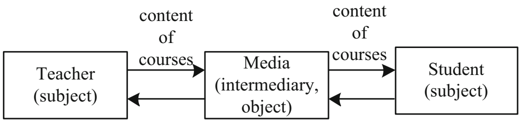


Fig. 2. Relationship between the influencing factors of teaching evaluation

At present, the classification of teaching quality evaluation content in Colleges and universities is relatively unified, as shown in the table below:

Table 1. Content optimization of online course teaching quality evaluation

Classification criteria	Evaluation type	Remarks
Evaluation criteria	Relative evaluation	To understand the differences between students and reflect the position of individuals in the group; the disadvantage is that the benchmark of different groups is different, and the relative evaluation should not be used as the basis to judge the distance between individual and mathematical target
	Absolute evaluation	It is difficult to distinguish the differences between the students and the students in learning
Evaluation function	Diagnostic evaluation	Through this kind of evaluation, we can understand the students' learning readiness, judge whether they have the conditions required to achieve the current teaching objectives, and provide the basis for teaching students in accordance with their aptitude
	Formative assessment	It can timely understand the results of stage teaching and the progress of students' learning, existing problems, and then timely adjust and improve teaching
	Summative evaluation	The purpose is to test whether the students' academic achievement has finally reached the requirements of teaching objectives, and to evaluate the effect of the whole teaching activity, which attaches importance to the results
Evaluation method	Qualitative evaluation	Using the logical analysis methods of analysis, synthesis, comparison, classification, deduction and induction, the data and data obtained from the evaluation are processed in thinking, and the analysis results are mainly descriptive data
	Quantitative evaluation	Using mathematical statistics, multivariate analysis and other teaching methods, regular conclusions are extracted from the complex evaluation data

The research on the evaluation index system of teaching quality in Colleges and universities is the focus of this paper. Now we choose the teaching evaluation index system of some colleges and universities in China and the United States for horizontal comparison [7]. Through the comparative analysis of this table, we can see that the teaching quality evaluation index of colleges and universities in China is relatively unified, and the teaching quality evaluation index of colleges and universities is relatively rich, including the objective evaluation of teaching and curriculum, the relationship between teachers and students, etc.

2.2 Improvement of Online Course Teaching Quality Evaluation System

From the meaning of online classroom teaching and the development mode of online classroom teaching, there are many factors that affect the quality of online classroom teaching in Colleges and universities, including subjective factors and objective factors, and the relationship between these factors is very complex. Their role in online classroom teaching in Colleges and universities is not played alone, but linked and restricted each other. The online classroom teaching process in Colleges and universities is an integral system composed of multiple elements [8]. The process of online classroom teaching in Colleges and universities consists of four basic elements: teachers, teaching content, online classroom teaching environment and learners. Further construct the model diagram of influencing factors of online classroom teaching quality in Colleges and universities, as shown in the figure, in order to get the online teaching quality evaluation system conveniently (Fig. 3).

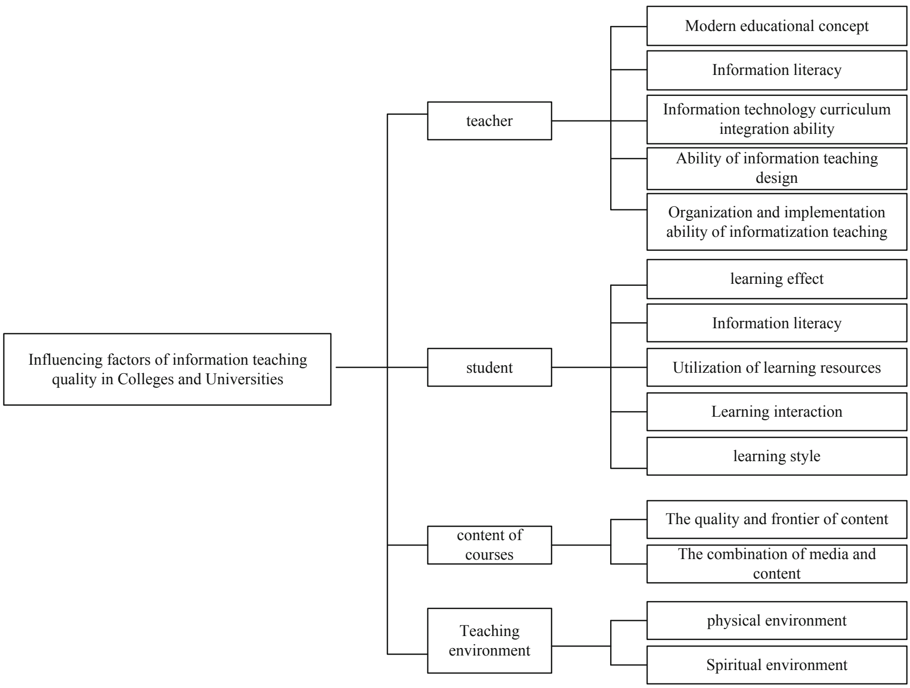


Fig. 3. Online teaching quality evaluation system

To determine the evaluation index of online classroom teaching in Colleges and universities, in addition to considering the factors that affect the quality of online classroom teaching in Colleges and universities, we must also have a certain theoretical basis and research as the basis, with the help of certain scientific procedures and methods, so as to ensure the scientificity, objectivity and effectiveness of the evaluation index [9]. On the basis of extracting the influencing factors of online classroom teaching quality in Colleges and universities, combined with the principles of online classroom teaching quality evaluation in Colleges and universities, this paper preliminarily formulates the online classroom teaching quality evaluation indicators, as shown in Table 1 (Table 2):

In the process of developing the evaluation index, if we classify the evaluation index from the process of preparation, implementation and feedback of online classroom teaching in Colleges and universities, there will be many factors that affect online classroom teaching in Colleges and universities. For example, the modern education concept, information quality and teaching environment of university teachers play a certain role in the process of teaching design, teaching activities and teaching feedback [10–12]. This paper classifies the evaluation indicators from the elements contained in the process of online classroom teaching in Colleges and universities. When determining the secondary indicators under the two primary indicators of teachers and students, it is determined according to the time sequence of teaching activities: teaching preparation, teaching implementation, and the main influencing factors in teaching feedback. Combined with experts' opinions, the index system was modified and improved. In the process of accepting experts' opinions, different experts put forward the problem of "teaching effect as the subordinate index of students' index", and pointed out that this is a problem that should be paid attention to in the development of evaluation system. The student evaluation model includes four major categories: teaching effect, teaching content, teaching method and teaching attitude. Then each category is subdivided, and different evaluation standards are set for each category. Thus, students can score various indicators based on the comprehensive teaching situation, so as to get the quantitative results of student evaluation, which is a part of the evaluation results. This paper sets up the student evaluation form from the actual situation, as shown in the table (Table 3).

Teacher evaluation also includes four major categories: teaching attitude, teaching content, teaching effect and teaching method. Then, we divide each category into sub categories, so that teachers can score by category, and take the quantitative results of teacher evaluation as part of the evaluation results. According to the actual situation, the teacher rating table is set up, as shown in the Table 4.

The evaluation index system not only ensures the scientificity and comprehensiveness of the evaluation index, but also has a general understanding of the importance of the evaluation index, which is helpful to grasp the relative weight of each index from a macro perspective.The expression for calculating the weight is:

$$W_j = \frac{E_j}{\sum_{i=1}^{m} d_j} \tag{1}$$

Among them, W_j represents the attribute weight coefficient, and d_j represents the consistency parameter of the evaluation index.

Table 2. Optimization of teaching quality evaluation index in Colleges and Universities

Primary indicators	Secondary indicators	Third level index	Remarks
Teacher	Teacher literacy	Teaching philosophy	The purpose, task, teachers and students view, talent view of modern education
		Awareness information	Information insight, enthusiasm for information utilization and information security
		Information capability	Ability of information acquisition, understanding, processing and expression
		It operation	Information technology equipment, teaching software use, courseware production resources processing
		Curriculum integration	The ability of using information technology to support subject teaching
	Instructional design	Teaching analysis	Analysis of teaching content and teaching object
		Strategy design	Teaching goal design, teaching strategy design, media use design, teaching practice design
		Teaching evaluation	Teaching process evaluation and teaching effect evaluation
	Teaching implementation	Target control	Knowledge goal, ability goal, emotion goal and their relationship
		Activity organization	The choice of teaching form and the distribution of effect, content and time
		Media application	Media application opportunity, standard operation and proficiency, maintenance

(*continued*)

Table 2. (*continued*)

Primary indicators	Secondary indicators	Third level index	Remarks
		Learning guidance	Learning content, method guidance, students' question answering, special task
Student	Student literacy	Learning philosophy	Cognition, understanding and application of modern learning concept
		Awareness information	Information curiosity, awareness of active use, information technology knowledge
		Information capability	Ability to acquire, screen and process
		It operation	The basic operation of information technology, follow the teacher's requirements
	Learning process	Emotional Participation	Learning attitude, enthusiasm and interest
		Resource utilization	The utilization of teaching resources and the frequency of inquiring materials
		Learning style	Understanding and choice of learning style

2.3 The Realization of Online Course Teaching Quality Evaluation

Based on the determination of the evaluation scheme, the teaching quality evaluation is started. The evaluation results come from the data of students, teachers and leaders. On the basis of all the data, the final teaching quality evaluation results are calculated according to the evaluation proportion, so as to sort and publicize. In teaching evaluation, its core functions are evaluation notification function and student evaluation function. In order to understand the implementation details, the workflow of the above functions is explained by using sequence diagram. As part of the evaluation, the workflow is as follows:

Using 360° evaluation method to evaluate the teaching quality of online courses, each user needs to fill in the evaluation data, so students need to fill in according to the student evaluation scheme, and the filling page is studentestimate.jsp. According to the student evaluation scheme, the students are scored one by one. After scoring, the evaluation results are submitted to the system.

Table 3. Student evaluation index

	Learning interaction	Students' cooperation and communication with teachers
Content features	Content quality	Enrichment, content and teaching objectives in accordance with the degree
	Content update	The cutting edge of content
Content organization	Hierarchy	The organization has different levels and takes care of individual differences
	Applicability	The teaching content is suitable for the form of presentation
Physical environment	Hardware environment	Multimedia teachers, network room, voice room, micro classroom and other normal use
	Software environment	Normal use of network teaching platform and teaching software
Spiritual environment	Organizational system	Teaching management standard, teacher standard, student discipline assessment
	Interpersonal psychology	Teacher student relationship, teaching atmosphere and study style
Subject knowledge	Basic knowledge	Basic contents of teaching objectives
	Expanding knowledge	Network resources development learning
Ability and quality	Quality	Learning habits, interest cultivation and learning methods
	Ability	Exploration and innovation, cooperation and practice ability

Check the values, including the value type check and the value range check. If the check fails, it will prompt the students the reason for failing. If the check passes, it is necessary to save the values in the student evaluation results for use. Thus, the sequence diagram of evaluation function can be obtained, as shown in the Fig. 4.

Before starting the evaluation process every semester, the academic affairs office needs to send the evaluation deadline and other information to the email or mobile phone of students, teachers and leaders in the form of SMS and e-mail, so that users can complete the evaluation in time. The workflow of the evaluation notification function is as follows:

After starting the teaching quality evaluation, the staff of the educational administration office need to send the evaluation notice information to remind users to complete the evaluation in time. The evaluation notice page is smsNotice.jsp Page. The staff of the educational administration office need to submit the evaluation information and the notice list, so as to batch notify according to the list, which can improve the efficiency.

Table 4. Teacher evaluation table

Evaluation items (full marks)	Breakdown item (full score)	Evaluation criterion
Teaching effect (20)	Clear learning purpose (5)	Excellent (5), good (3), qualified (2), poor (1)
	Pay attention to the cultivation of students' independent ability and enrich the knowledge system (5)	Excellent (5), good (3), qualified (2), poor (1)
	Pay attention to the cultivation of students' analytical ability (5)	Excellent (5), good (3), qualified (2), poor (1)
	Cultivate hands-on ability (5)	Excellent (5), good (3), qualified (2), poor (1)
Teaching content (30)	Comprehensive teaching content (4)	Excellent (4), good (3), qualified (2), poor (1)
	Challenging teaching content (8)	Excellent (8), good (6), qualified (4), poor (2)
	Pay attention to the teaching of basic courses (8)	Excellent (8), good (6), qualified (4), poor (2)
	Whether the amount of work is appropriate/the practice time is sufficient (5)	Excellent (5), good (3), qualified (2), poor (1)
	Whether the teaching content is substantial (5)	Excellent (5), good (3), qualified (2), poor (1)
Teaching methods (12)	Proper teaching methods (4)	Excellent (4), good (3), qualified (2), poor (1)
	Colorful explanations (4)	Excellent (4), good (3), qualified (2), poor (1)
	Integrating multiple teaching methods (4)	Excellent (4), good (3), qualified (2), poor (1)
Teaching attitude (38)	Have a strong sense of responsibility, do not hold classes, answer students' questions in time (4)	Excellent (4), good (3), qualified (2), poor (1)
	Reasonable and fair assessment method (4)	Excellent (4), good (3), qualified (2), poor (1)
	Strict discipline (4)	Excellent (4), good (3), qualified (2), poor (1)
	Good classroom atmosphere, frequent communication with students (4)	Excellent (4), good (3), qualified (2), poor (1)

(*continued*)

Table 4. (*continued*)

Evaluation items (full marks)	Breakdown item (full score)	Evaluation criterion
	Solve students' problems in time (4)	Excellent (4), good (3), qualified (2), poor (1)
	Being a teacher (4)	Excellent (4), good (3), qualified (2), poor (1)
	Have detailed record and know the teaching content well (8)	Excellent (8), good (6), qualified (4), poor (2)
	Whether the teaching process is normal (6)	Excellent (6), good (3), qualified (2), poor (1)

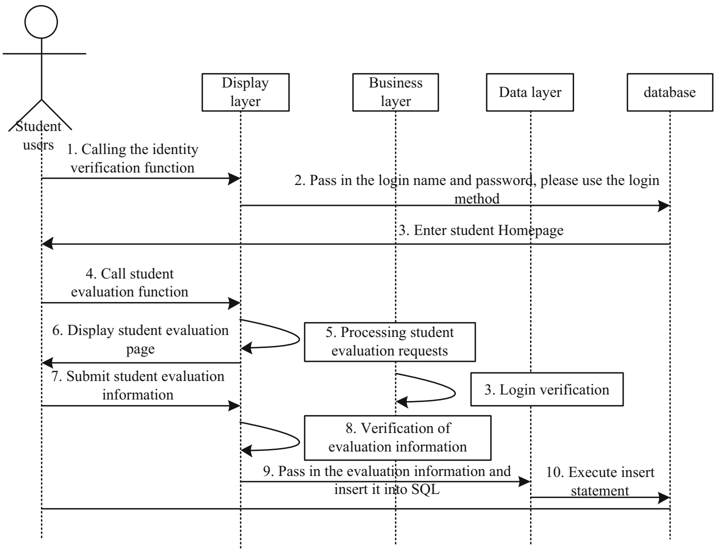


Fig. 4. Sequence diagram of teaching quality evaluation

To verify the content of the notification, we mainly check the format of the empty notification list and the notification list. On the basis of successful verification, we can send the content to the notification list.

Record the notification log, so as to display the list of notification failure and notification success, which is convenient for the staff of the educational administration office to view. In the online classroom teaching quality evaluation model, the online classroom teaching quality evaluation organization is responsible for organizing teachers, students and teaching quality management personnel to obtain the information of each index of online classroom teaching quality evaluation through certain evaluation means, fill in the online classroom teaching quality evaluation survey scale, and then the online classroom teaching quality evaluation organization processes the survey data to obtain the online classroom teaching quality According to the results of classroom teaching quality evaluation, we find the problems and experience in the process of online classroom teaching. Finally, the online classroom teaching quality evaluation organization is also responsible for the feedback of the evaluation results to the teachers, students and teaching managers of online classroom teaching, so that they can understand the problems existing in online classroom teaching, so as to improve the quality of online classroom teaching in time.

3 Analysis of Experimental Results

After the construction of teaching quality evaluation system is completed, it needs to be deployed to the school network environment. Therefore, the environment used in the implementation phase or test phase is not consistent with the actual environment, which may affect the final deployment of teaching quality evaluation system and cause losses to the school. Through the investigation of the actual environment, the environmental requirements of the system can be made clear, which are described below.

The client does not undertake the key task of the teaching quality evaluation system. It only needs the user to submit the business request through the browser, and the software and hardware can meet the basic application requirements without too high hardware configuration.

Software: support users to submit teaching quality evaluation request by using various types of browsers. Users can choose to install various browsers such as IE and Firefox.

Hardware: the memory is larger than 1 GB, at the same time, there are requirements for the network, must be connectable teaching quality evaluation.

The display of teaching evaluation results is the key of teaching evaluation. Through the progress display of the evaluation results, it is convenient to check the progress of teaching evaluation and receive the opinions or suggestions of teaching evaluation in time, which is conducive to the timely correction of teaching deficiencies and the improvement of education and teaching behavior. Teaching evaluation results can include teacher evaluation results and student evaluation results. By searching the corresponding class in the system, you can view the evaluation progress of class teachers, or view the evaluation progress and evaluation results of a teacher separately. The mutual evaluation results between teachers and students are located in different interfaces. Enter different teacher numbers to view the latest evaluation progress. At the same time, you can modify the corresponding evaluation results and delete the corresponding scores. Through the teaching evaluation results, we can analyze the teaching situation of different teaching and research departments. Histogram is used to reflect the status of teaching evaluation. It can be used to compare the evaluation results of teachers in different semesters or academic years. At the same time, according to the evaluation results, it is convenient for department or college leaders to view the evaluation results. Using the histogram display method, the evaluation results can be displayed more intuitively, and the display results are shown in the Fig. 5.

The function test process and performance test process of the system are described in detail, and the test results of the two are given. The test results are closely related to the deployment of the system. If any one of the results is not up to the standard,

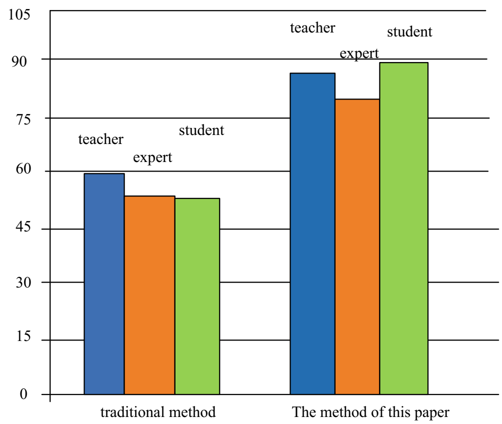


Fig. 5. Analysis of evaluation results

the teaching quality evaluation system can not be deployed to the school to deal with the teaching quality evaluation business. Through the comparative analysis of the test results and requirements, we can see that the teaching quality evaluation system has reached the deployment requirements and can be applied to schools. In order to test the feasibility of the online classroom teaching quality evaluation index constructed in this study. In order to complete the research, the online classroom teaching evaluation scale in Colleges and universities is transformed into the form of questionnaire, and the participants of the course are investigated. The secondary index score is obtained by multiplying each three-level index score by the corresponding weight and weighted sum: the method of obtaining the primary index score and the secondary index score is the same, that is, each secondary index under the primary index is multiplied by the corresponding weight the corresponding weights are obtained by weighted summation.

Based on this, the teaching quality evaluation results are recorded as follows (Table 5):

From the results of the evaluation, we can see that the scores of teachers' indicators, students' indicators and teaching content are relatively high, indicating that the situation of teachers and students participating in teaching activities is better. From a practical point of view, Professor Zhang Yichun is a doctoral supervisor of educational technology. He has a deep research on online classroom teaching, and his own information literacy, online classroom teaching design and implementation ability are very good; Most of the students have a good understanding of online classroom teaching and strong learning and research ability; the teaching content is more in line with the teaching objectives and has a certain cutting-edge, and its presentation form is also in line with the requirements of online classroom teaching. Compared with the other three indicators, the teaching environment indicators are slightly worse, which belongs to the good level. The main purpose of this evaluation is to test the feasibility of the online classroom teaching quality evaluation index constructed in this study. Through this application research, it can be fully illustrated that the evaluation index obtained in this study can comprehensively

Table 5. Teaching quality evaluation results

–	–	Content	Index
Content of courses	Content quality	The consistency of enrichment, content and teaching objectives	3.98
	Content update	Cutting edge of content	4.31
	Hierarchy	The organization has different levels and takes care of individual differences	4.03
	Applicability	The teaching content is suitable for the form of display	4.42
Teaching environment	Hardware environment	Multimedia classroom, network room, voice room, micro classroom, library	4.00
	Software environment	Network teaching platform, teaching software and teaching support system	3.92
	Organizational system	Teaching management standard, teacher standard and student discipline	4.03
	Interpersonal psychology	Teacher student relationship, teaching atmosphere and study style	3.96

and objectively evaluate the quality of online classroom teaching in Colleges and universities. Through the quantification of indicators, the examination data are summarized and analyzed, so that the whole evaluation is more scientific and reasonable, easy to operate, and the evaluation results are clear at a glance.

4 Concluding Remarks

Network teaching evaluation is one of the key links in the whole network teaching process. The network teaching evaluation system can not only evaluate each link of the network course, but also collect information of all stages and aspects according to the actual situation to carry out process evaluation and summary evaluation, so as to make up for the lack of information collection and process evaluation in the existing similar systems. With the improvement of system development and application performance, its application range can break through the limitations of the teaching evaluation field, and provide a basis for further research and development of similar systems. However, in the process of research, the running efficiency of the system is not considered, which leads to a long time for online course teaching quality evaluation. Therefore, in the next research, the running time of the system will be focused on, so as to improve the efficiency of online course teaching quality evaluation.

References

1. Shen, W., Zhang, S.: Emotional tendency dictionary construction for college teaching evaluation. Int. J. Emerg. Technol. Learn. (iJET) **13**(11), 117 (2018)
2. Zhang, X., Shi, W.: Research about the university teaching performance evaluation under the data envelopment method. Cogn. Syst. Res. **56**(AUG.), 108–115 (2019)
3. Ibrahim, Y.E.: Integrated evaluation of teaching effectiveness: a case study. Int. J. Eng. Educ. **34**(6), 1822–1828 (2018)
4. Qu, F.L., Chen, L., Jiang, Y.C.: The research and application of intelligence evaluation system in colleges and universities. J. Phys.: Conf. Ser. **1693**(1), 012027 (2020). (7pp)
5. Weltman, H.R., Timchenko, V., Sofios, H.E., et al.: Evaluation of an adaptive tutorial supporting the teaching of mathematics. Eur. J. Eng. Educ. **44**(5), 787–804 (2019)
6. He, Y., Li, T.: A lightweight CNN model and its application in intelligent practical teaching evaluation. MATEC Web Conf. **309**(4), 05016 (2020)
7. Jia, S., Pang, Y.: Teaching quality evaluation and scheme prediction model based on improved decision tree algorithm. Int. J. Emerg. Technol. Learn. (iJET) **13**(10), 146 (2018)
8. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
10. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training, pp. 1–374. Springer, Heidelberg (2018)
11. Guo, M., Xiong, X., Feng, G., et al.: A research on behavioral deviation and reform program of teaching quality evaluation in experiment and training of colleges. Lab. Res. Explor. **038**(005), 229–232, 274 (2019)
12. Zhao, H.: Research on the evaluation method of teaching quality of Chinese as a foreign language based on immersion teaching. Manage. Sci. Res.: Chin. Engl. Version **1**, 8–10 (2019)

Evaluation Model of Computer Education Reform Effect in Colleges and Universities Based on Improved Fuzzy Clustering Algorithm

Lu Guo, Ying Wei(✉), and Shan Jiang

School of Information and Control, Shenyang Institute of Technology, Shenyang 113112, China

Abstract. In order to test the effect of teaching reform methods, the evaluation model of computer education reform effect in Colleges and universities is constructed based on the improved fuzzy clustering algorithm. The traditional fuzzy clustering algorithm can not solve the problem of effect evaluation. Firstly, the fuzzy clustering algorithm is improved. Based on the two-dimensional missing data set, the geometric structure of the algorithm is analyzed, and the operation law of the algorithm is explored. Then, the evaluation index system of university computer education reform effect is established, which is divided into general goal, primary goal and secondary goal. The hierarchical weight and total weight of the scale are calculated by improved clustering fuzzy algorithm, and the model structure is evaluated based on the reality. Taking a university as an example, this paper analyzes the accuracy of the evaluation model after the reform of computer education.

Keywords: Improved fuzzy clustering algorithm · Computer · University teaching · Education reform · Effect evaluation model

1 Introduction

The development of computer engineering is very rapid. Computer science has been emerging in my country since the 1990s. It has only been more than 20 years, but it has already undergone earth-shaking changes. From the very beginning of computer hardware technology to today's various branches of software design, network technology, Internet of Things technology, artificial intelligence, computer principles, etc., the original education methods are no longer suitable for the disciplines they have developed. Computer education reform is imperative, but the effect of education reform needs further exploration [1].

Appropriate evaluation of the teaching effect of such colleges and universities that are undergoing education reforms can enable the functional departments of colleges and universities to more accurately grasp the teaching situation of teachers and the current situation of student learning, improve teachers' teaching attitudes, teaching methods, and cultivate high-quality talents. It is more suitable to carry out teacher team building and teaching reform in a planned way. In this process, the most important thing is to achieve

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 430–440, 2021.
https://doi.org/10.1007/978-3-030-84386-1_35

a fair, just, and uniform standard for evaluating teachers' teaching effects. Therefore, based on the improved fuzzy clustering algorithm, the evaluation model of the reform effect of computer education in universities is explored.

2 Research on Improved Fuzzy Clustering Algorithm

Fuzzy clustering algorithm can not be directly applied to the data set with missing data, so this paper proposes a completion algorithm which can be applied to the missing value filling.

Firstly, the geometric structure of the data set with missing values is analyzed. Taking a simple two-dimensional data set as an example, the two-dimensional data set can be reflected in the plane coordinate system [2]. For the two-dimensional data set X with missing values, for example, $x_k = (x_{k1}, NA)$ represents the missing point in the ordinate, which is represented by a line passing through point x_{k1} parallel to the ordinate in the plane, $x_k = (NA, x_{k2})$ represents the missing point in the abscissa, which is represented by a line passing through point x_{k1} parallel to the abscissa in the plane, and $x_k = (NA, NA)$ is meaningless in the clustering algorithm.

Therefore, the data set should not contain all attribute missing data groups. Therefore, as shown in Fig. 1, in two two two-dimensional data sets with missing values, the black dot represents the data point that is not missing, the straight line represents the data with missing attributes such as $x_k = (x_{k1}, NA)$, and the circle represents the clustering boundary of the corresponding complete data set [3]. If the cluster number $c = 2$ of each two-dimensional dataset with missing values is known, the missing values shown in 1 can be reasonably estimated. With the increase of data volume and dimension, missing data can be estimated more accurately.

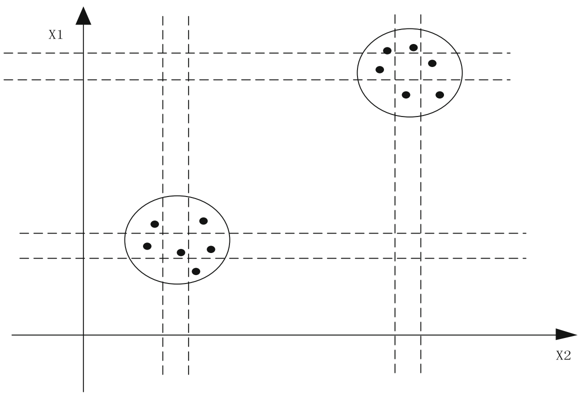


Fig. 1. Geometric structure of the two-dimensional missing data set

Therefore, four missing data filling methods based on the improved fuzzy clustering algorithm can be obtained, which are: complete data strategy, partial distance strategy, optimized completion strategy and optimal model strategy. Among them, the optimal complement strategy is the best way to fill in missing data. Assume that the data sample set is $X = \{x_1, x_2, \cdots, x_n\}$, where x_k is the k-th w-dimensional data vector in the data set X, and satisfies $1 \le k \le n$. Among them, x_{kj} is the j-th value in the x_k vector, and $1 \le j \le s$, $1 \le k \le n$. The data set X contains missing values, which can be expressed as NA, let:

$$X_M = \left\{x_{kj} = NA | 1 \le j \le s, 1 \le k \le n\right\} \tag{1}$$

The X_M in the formula is extremely missing data set. For example, when s = 3 and n = 4, the data set is set to:

$$X = \left\{\begin{bmatrix} 1 \\ NA \\ 2 \end{bmatrix}\begin{bmatrix} 3 \\ 5 \\ 8 \end{bmatrix}\begin{bmatrix} 3 \\ 14 \\ 15 \end{bmatrix}\begin{bmatrix} NA \\ 2 \\ NA \end{bmatrix}\right\} \tag{2}$$

At this moment $X_M = \{x_{12}, x_{41}, x_{43}\}$.

3 Establishment of Evaluation Model for the Reform of Computer Education in Universities

3.1 Establishment of the Evaluation Index System for the Reform of Computer Education

The evaluation of the effect of education reform is the process of making an objective measurement and value judgment on the process and effect of teaching and learning based on certain methods and standards based on the classroom teaching effect of teachers after the teaching reform. Classroom teaching is one of the core tasks of colleges and universities. As the focus of teaching work, teaching quality has always attracted the attention of colleges and various competent teaching departments [4]. The effectiveness of education reform is the core issue in the process of teaching reform in colleges and universities. Improving the quality of teaching after reform is the eternal theme of teaching reform in colleges and universities. After the teaching reform, the monitoring and evaluation of teacher's teaching quality refers to a series of tasks implemented by adjusting and controlling its influencing factors according to the requirements of talent training objectives to ensure the training of talent quality. It can be seen that the quality of school classroom teaching will affect the overall quality of students and the quality of school education reform. The teaching effect is mainly reflected in the result of the dynamic synthesis of quality in the process of teaching and learning between teachers and students.

Therefore, the evaluation of the effect of education reform should include several basic contents. One is the evaluation of the teaching and learning process, which is reflected in the determination of the teacher's classroom teaching goals, the arrangement of teaching content, the design of teaching structure, the choice of teaching methods, and the embodiment of teaching expansion ability; the other is Students' understanding and mastery of what they have learned, the enthusiasm of students' learning and the cultivation of students' skills, etc. are investigated [5]. If there is no more reasonable scientific evaluation standard, it will seriously dampen teachers' enthusiasm for teaching. Affect the teaching effect, affect students' performance and employability. Therefore, the establishment of a scientific evaluation system for the effects of educational reforms to standardize, rationalize, and quantify it has become an urgent requirement to improve the quality of college computer teaching reforms. The research of this subject discusses and analyzes the model of evaluating the effect of computer education reform from the goals and policies of college computer education reform and employment status.

The evaluation scale is one of the indispensable tools in the evaluation of the effect of computer education reform, and it is one of the main tasks in the process of the evaluation of the effect of teaching reform. In the classroom teaching evaluation of colleges and universities, the teaching evaluation scale is mainly used to evaluate the teaching quality of college teachers [6]. The teaching evaluation scale is compiled according to the characteristics of classroom teaching, which is composed of evaluation index, evaluation standard and evaluation grade. Evaluation index refers to the goal of teaching, which is the concrete induction of teaching goal. The evaluation indexes of computer education reform are mainly about teaching means and methods, teaching situation, teaching attitude, teaching management, teaching quality and so on. Evaluation standard refers to the scale and criterion of value judgment in quality and quantity of each evaluation index in classroom teaching. It is also the criterion that the evaluation subject students should follow to evaluate college teachers' classroom teaching. Evaluation standard is often a more specific explanation and explanation of evaluation index. Evaluation grade refers to the evaluation standard as the criterion to measure the degree of the evaluation index reaching the standard, expressed with a certain level or score [7].

The effect evaluation of computer education reform is to use some mathematical modeling methods to explain data or information on the basis of quantitative, or to carry out empirical evaluation on the basis of quantitative, so as to distinguish the high and low levels. Generally speaking, the rating scale is a standardized scale to evaluate classroom teaching behavior, as shown in Table 1.

In the teaching evaluation of computer education reform in colleges and universities, the expert index weight calculation model can refer to the calculation process of the student and teacher evaluation model. The evaluation indicators of experts are $U_1, U_2, \cdots, U_n$, and the corresponding weights of these classroom evaluation indicators are $C_1, C_2, \cdots, C_n$. For each first-level indicator, there are different numbers of second-level indicators. The number of corresponding second-level indicators under the n first-level indicators in the teaching evaluation of computer education reform in colleges and universities can be expressed as $K_1, K_2, \cdots, K_n$ respectively. In this way, the secondary index weights corresponding to the teaching evaluation indexes of the computer education reform in colleges and universities are: $C_{11}, C_{12}, C_{13}, \cdots, C_{1k}$ and $C_{21}, C_{22}, C_{23}, \cdots, C_{2k}, \cdots, C_{n1}, C_{n2}, C_{n3}, \cdots, C_{nk}$ respectively. If there are n first-level indicators among the above weights, the sum of the weights of the first-level indicators in the entire target is 1 [8]. The sum of the weights of the students and teachers in the whole goal is 1, as shown in the following formula:

$$C_1 + C_2 + \cdots + C_n = 1 \tag{3}$$

Table 1. Computer education reform effect evaluation standard scale

General objective	First level indicators	Secondary indicators
Evaluation on the effect of computer education reform in colleges and universities	Teaching methods and means	The teaching method is vivid and intuitive B1
		Method innovation is flexible and diverse B2
		Combining theory with practice B3
		Heuristic interaction B4
		Knowledge development B5
	Teaching situation A2	Vivid and concise language B6
		Natural and generous B7
		Moderate theoretical depth B8
		Focus on B9
		Clear and accurate concept B10
		Lesson preparation B11
	Teaching attitude A3	Lesson preparation B12
		Clear teaching purpose B13
		Moral cultivation B14
	Teaching management A4	Good classroom discipline B15
		Strict requirements for teaching and educating B16
		Correct homework B17 carefully
	Teaching quality A5	Student achievement B18
		Student ability training B19
		Students learn B20

Formula (3) can also be expressed as:

$$\begin{cases} C_1 = C_{11} + C_{12} + \cdots + C_{1k_1} \\ C_2 = C_{21} + C_{22} + \cdots + C_{2k_2} \\ \qquad\qquad \cdots \\ C_n = C_{n1} + C_{n2} + \cdots + C_{nk_n} \end{cases} \tag{4}$$

Through the above calculation process of expert weight in the teaching evaluation of computer education reform in colleges and universities. First, calculate the total score

F of the expert's secondary index, then calculate the weight of the secondary indicator evaluated by the expert, and finally calculate the weight of the primary indicator evaluated by the expert. In addition, students and teachers can also refer to this calculation process to obtain the corresponding second-level evaluation index scores, first-level index weights, and second-level index weights.

3.2 Improved Fuzzy Clustering Algorithm to Calculate the Judgment Matrix

After the hierarchical structure is established, the affiliation of elements between the upper and lower levels is determined. Assume that element C_k of the previous level is used as a criterion for element $A_1, A_2, \cdots, A_n$ of the next level. There is a dominant relationship, our aim is to assign $A_1, A_2, \cdots, A_n$ according to their relative importance under criterion C_k. The corresponding weight. The Analytic Hierarchy Process uses the method of pairwise comparison. In the process of pairwise comparison, decision-makers have to answer questions repeatedly: For criterion C_k, the two elements A_i and A_j, which one is more important and how important, it is necessary to assign a certain value to how important it is [9, 10]. Each expert makes a pairwise comparison of the evaluation indicators independently. One is denoted as $\frac{X_i}{X_j}$, and its value is a_{ij}, where $i, j = 1, 2, 3, \cdots, 21$, $\mathrm{m} = 10$. In the process of calculating the geometric square $a_{ij} \underset{=}{\Delta} \sqrt{\prod_{k=1}^{m} a_{ijk}}$, the inverse symmetric matrix $A = (a_{ij})n \times n$ can be listed.

Using the comprehensive evaluation in the improved fuzzy clustering algorithm, the comprehensive score of the object is the highest level node, and the lowest level is a number of evaluation indexes. There are 21 evaluation indexes in this paper, which are x1, X2, X3, x4, X5, X6 X20, X21, the weight coefficients of the highest level are B1, B2, B3, B4, B5, the comprehensive evaluation formula is $\sum_{i=1}^{21} b_i x_i$, and the total ranking of the levels is calculated. The calculation results are shown in Table 2.

In the above table, the effect evaluation weight of computer education reform in colleges and universities can be obtained. When the weight value is larger, it indicates that the criterion has a higher effect in the effect. Therefore, if you want to increase the results of computer education reform in colleges and universities, you need to pay more attention. Items with higher weight values.

3.3 Structure Analysis of Evaluation Model

First of all, the evaluation of teachers' teaching effect will have an impact on students' academic performance. Examination results are not only an important indicator to measure the solid degree of students' knowledge at this stage, but also a standard to reflect the teaching effect of teachers. Therefore, they can be used as a standard value to evaluate the effect of computer education reform in Colleges and universities. In the above study, through the students' evaluation of teachers (including professional course teachers, basic course teachers, professional training and experimental teachers, professional basic course teachers, etc.), the teaching results of this course at this stage are obtained. In other words, the final or mid-term examination results are directly proportional to the

Table 2. Weight level sorting

Target layer	Weights	Criterion layer	Weights	Combination weight
A1	0.1236	B1	0.1230	0.0145
		B2	0.1274	0.0364
		B3	0.2143	0.0154
		B4	0.1246	0.0234
		B5	0.1547	0.0124
A2	0.1361	B6	0.1647	0.0244
		B7	0.2365	0.0265
		B8	0.4236	0.0635
		B9	0.4632	0.0144
		B10	0.3456	0.0144
		B11	0.2465	0.0355
A3	0.1428	B12	0.4456	0.0247
		B13	0.2348	0.0745
		B14	0.3445	0.0244
A4	0.1556	B15	0.1545	0.0234
		B16	0.1765	0.0147
		B17	0.3445	0.0164
A5	0.1834	B18	0.1446	0.0452
		B19	0.6452	0.0140
		B20	0.3414	0.0423

teaching effect evaluation, which is in line with the teaching effect evaluation theory. As for the evaluation of students' academic performance and the teaching effect of each teacher, the differences may be different from the attributes of these courses.

The courses are offered in different ways. Most of the basic courses such as advanced mathematics are offered in large classes, and the teaching effect is obviously not as good as that in small classes. In addition, the students in two pilot classes of teaching reform have higher scores, and the evaluation of teachers' teaching effect is obviously on the high side, In addition, the experimental course has been set up, which greatly improves the students' interest in learning. This is not in the ordinary class, which leads to the difference of performance. Therefore, for the basic course of mathematics, the students' performance is low, the evaluation of teachers' teaching effect is low, and the difference of teaching evaluation in our college is still improving. For the basic course of mathematics, higher mathematics provides the necessary mathematical knowledge basis, thinking method basis and mathematical ability basis for the study and practical work of subsequent professional courses. Cultivate and improve students' consciousness and ability of analyzing and solving problems, and further cultivate students' innovative consciousness and ability.

In this way, computer teachers should not only have solid computer related theoretical knowledge, but also have the expansion and practical ability of Internet and computer hardware. So that students can better combine basic theory with scientific practice and professional practical problems. This teaching method also makes students have higher requirements on the breadth and depth of computer teachers' basic knowledge, professional knowledge and teaching related professional courses. The teachers of other basic courses only need to learn relative to the theoretical knowledge of the course and the expanded knowledge associated with the course, which will not involve interdisciplinary teaching. For the teachers of professional courses, they only need to learn the knowledge of professional courses. Moreover, professional courses are arranged with practical training courses, so that students can study in the specific working environment personally, which is more direct, more intuitive, and the effect is better, so students like it more. Naturally, they have high evaluation of teachers and good academic performance [11–13].

From the above analysis, it can be seen that due to the different requirements of the nature of the curriculum types, the teaching methods, requirements and results will not be the same. Therefore, the ultimate purpose of the evaluation of teachers' teaching effect is to improve the teaching methods and teaching contents according to the obtained teaching effect evaluation conclusions and different courses. Teachers in teaching, according to the nature of different courses, take different teaching methods, the design of teaching content in accordance with the specific characteristics of the school rectification. So as to improve students' academic performance.

4 Practice of Evaluation Model for Computer Education Reform in Universities

4.1 Practice Environment

In order to better serve the reform of computer education in colleges and universities, when the evaluation model is implemented, a certain school is used as the research object to participate in the classroom teaching evaluation practice. Three teachers with certain English teaching experience were used as experts, and they listened to each other and evaluated themselves as teacher representatives. After the lecture, the students were asked about the results of the lessons and obtained experimental data. In order to test the accuracy of the evaluation model based on the improved fuzzy clustering algorithm and whether it has practical significance in practical applications, the conclusions obtained from the evaluation model based on the algorithm are compared with traditional evaluation methods.

4.2 Practice Process

The weight hierarchical ranking in Table 2 is used as the data index basis of the experiment. After experts, teachers and students score respectively, the index score is obtained by combining the above calculation method. According to the investigation results of the suitability of expert evaluation, we can know the value of the investigation results of the suitability of the secondary evaluation index, and then calculate the evaluation matrix R of the teaching plan, teaching attitude, teaching means and classroom performance of the primary evaluation index.

$$R = \begin{bmatrix} 0.8\ 0.1\ 0.1\ 0.0 \\ 0.9\ 0.1\ 0.0\ 0.0 \end{bmatrix} \tag{5}$$

Among them, the teaching evaluation indicators at each stage can determine that the teaching reform method has different teaching effects. Combining the above evaluation value and evaluation relationship matrix, the evaluation formula can be obtained as follows:

$$B_1 = (B_{11}, B_{12}, B_{13}, B_{14}) \tag{6}$$

The first-level fuzzy comprehensive matrix of teacher evaluation is R: including teaching plans, teaching attitudes, teaching methods, classroom settings, and classroom performance. Through the evaluation result B_1, B_2, B_3, B_4, B_5, the first-level improved fuzzy clustering algorithm comprehensive matrix R1 is obtained according to the above formula.

$$R_1 = \begin{bmatrix} B_1 \\ B_2 \\ B_3 \\ B_4 \\ B_5 \end{bmatrix} = \begin{bmatrix} 0.0423\ 0.0912\ 0.0329\ 0.0 \\ 0.0436\ 0.0928\ 0.0367\ 0.0 \\ 0.0459\ 0.0915\ 0.0347\ 0.0 \\ 0.0448\ 0.0942\ 0.0346\ 0.0 \\ 0.0471\ 0.0936\ 0.0325\ 0.1 \end{bmatrix} \tag{7}$$

According to the first level fuzzy clustering comprehensive matrix R1 of education reform evaluation and the weight U of the first level index, the second level evaluation value B can be obtained. After normalization, the comprehensive evaluation value is obtained, and then the result is processed. The evaluation set is v = {very suitable, suitable, unsuitable and very unsuitable}, and the values are 3, 2, 1 and 0 respectively. According to formula (4), the total score of teacher evaluation is as follows:

$$\omega = (0.0471 + 0.0936 + 0.0325 + 0.1) \times \begin{pmatrix} 3 \\ 2 \\ 1 \\ 0 \end{pmatrix} \tag{8}$$

Finally, a quantitative result of 0.2345 was obtained, indicating that the teacher is suitable for the middle school English classroom teaching effect, which means satisfaction, and thus obtained a quantitative result. The number 2.0222 is between 2–3, indicating that the teacher evaluation rating is between satisfactory and very satisfied, indicating that the teacher evaluation is relatively satisfied with the evaluation of the teaching effect of this class.

In order to further verify the effectiveness of the evaluation model of improving the effect of computer education reform in the school, the accuracy of the evaluation of the

Table 3. Evaluation accuracy of educational reform effect (%)

Number of iterations/times	Methods of this paper	Traditional method
20	95	89
40	94	88
60	96	89
80	94	87
100	95	86

effect of the reform model on the education reform is analyzed experimentally. In order to highlight the experimental accuracy, the results obtained are shown in Table 3:

By analyzing the experimental data in Table 1, we can see that with the constant change of the number of experimental iterations, the evaluation accuracy of this method is always higher than the traditional method, and always higher than 90%, which verifies the effectiveness of the proposed method.

4.3 Practice Results

Through a comprehensive investigation of the influence of various factors on the scientific evaluation of English classroom teaching effect, this paper combines qualitative and quantitative methods to decompose some assumptions in the process of teaching reform, and fully reveals the essence of evaluation. Using the improved fuzzy clustering algorithm as the evaluation basis not only eliminates the shortcomings of qualitative evaluation, but also avoids unexpected human factors to a certain extent. For example, when students evaluate, it is not easy to find their own problems in the classroom, and teachers' attention may have a certain impact on the real evaluation [14, 15]. Different evaluation subjects have different research perspectives, which makes the evaluation results more accurate and reasonable. The disadvantage is the complex teaching evaluation model, the formula calculation is more troublesome, can use the modern computer mathematical formula editor, easy to edit, improve work efficiency. In this paper, from the perspective of expert evaluation, student evaluation and teacher evaluation, independent evaluation indicators are established to complete the research process for teachers, students and expert members, so as to obtain complete and real information sources. Experts, students and teachers evaluate the effect of middle school English classroom teaching, and the results are 2.0222, 2.2195 and 2.0188 respectively, which are very close to each other.

In summary, the conventional scoring method is not only simple, but also easier to implement, but the problem is not very comprehensive and the accuracy is not very high. The method used to improve the fuzzy clustering algorithm can avoid the intervention of many subjective factors. On the one hand, it converts the qualitative problems of experts, students, and teachers into quantitative problems, and more scientifically evaluates the effect of computer teaching reform in colleges and universities. Investigate the practical environment and gain a new understanding of the teaching evaluation of computer teaching reform in colleges and universities. The results obtained are more realistic, making the results more scientific and reasonable. Therefore, the improved fuzzy clustering algorithm is better than the traditional scoring method in the evaluation of the teaching effect of the computer teaching reform in colleges and universities.

5 Concluding

In summary, this article uses an improved fuzzy clustering algorithm to evaluate the effect of college computer reforms and builds an evaluation model. The algorithm used above is more complicated in actual calculation, but the actual evaluation effect is more accurate, so the evaluation method has reference value.

References

1. Li, X., Chang, Z.: Improved fuzzy clustering algorithm for data mining model in big data. Mod. Electron. Tech. **43**(3), 177–182 (2020)
2. Zhu, Z., Liu, Y.: A novel algorithm by incorporating chaos optimization and improved fuzzy C-means for image segmentation. Acta Electron. Sinica **48**(5), 975–984 (2020)
3. Li, Z.: Optimization analysis of temperature measurement points of spindle box with improved FCM fuzzy clustering algorithm. Mech. Eng. Autom. (3), 140–142 (2020)
4. Han, Z., Li, D., Zhao, J.: Image segmentation algorithm based on improved genetic fuzzy clustering and level set. Comput. Eng. Design **40**(5), 1390–1393, 1412 (2019)
5. Xu, B., Lin, H.: Selection method of typical daily load curve based on improved fuzzy clustering. Electr. Meas. Instr. **56**(4), 21–26 (2019)
6. Ni, B.: Exploration of the cooperative education mode of "ideological and political courses" and computer courses in police colleges. Theory Pract. Innov. Entrep. **3**(14), 112–113, 122 (2020)
7. Lin, H., Li, T., Zhang, Y., et al.: Construction and reform of Java programming course based on CDIO engineering education model. J. Yunnan Univ. Natl. (Nat. Sci. Edn.) **29**(2), 133–139 (2020)
8. Wang, Y.: Research on computer basic education based on internet. China Comput. Commun. **32**(2), 246–248 (2020)
9. Chen, H., Yang, Q., Zheng, F., et al.: Evaluation of the implementation results of essential medicines system in hospitals—by model construction and empirical study based on big data. Chin. J. Hospit. Pharmacy **40**(15), 1627–1633 (2020)
10. Peng, X., Tang, D.: The evaluation model and its application of the river chief system based on the combined weight-ideal interval method. J. Water Resour. Water Eng. **31**(2), 50–56 (2020)
11. Yang, G., Gao, M.: T evaluation model and effectiveness analysis of effect of student participation in curriculum reform based on core concept of "Sydney Accord." Vocat. Tech. Educ. **41**(23), 56–60 (2020)
12. Liu, S., Glowatz, M., Zappatore, M., et al.: e-Learning, e-Education, and Online Training, pp. 1–374. Springer, Heidelberg (2018)
13. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
14. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**(10), 62412–62420 (2019)
15. Wang, Y., Ma, Y., Yu, S.: Reform of computer course scoring model for sergeant cadet education and its effect on teaching quality. Comput. Eng. Sci. **41**(01), 229–233 (2019)

Evaluation Model of Electrical Control Teaching Mode Reform Effect Based on Deep Convolution Neural Network

Shan Jiang(✉), Quan-wen Chen, and Lu Guo

School of Information and Control, Shenyang Institute of Technology, Shenyang 113112, China

Abstract. In view of the results obtained by introducing neural network into the evaluation model of the reform effect of the existing teaching model, the paper proposes an evaluation model of the effect of the reform of the electrical control teaching mode based on the deep convolution neural network. The corresponding weight in the rating system is established, the weight is obtained by using the deep convolution neural network, and finally, the data is extracted by the multiple collinear regression method to complete the evaluation of the reform effect of the electrical control teaching mode. The experimental results show that the evaluation model of the teaching model reform effect evaluation model of the design method is more quality and feasible.

Keywords: Teaching mode · Evaluation model · Neural network · Multicollinearity

1 Introduction

The key problem faced by the reform of teaching mode at the teaching level is the low efficiency of the classroom, which will greatly affect the level of personnel training. Therefore, an important routine content of teaching management in Colleges and universities is to analyze and evaluate the teaching mode of teachers. The establishment of the evaluation model of teaching mode reform effect can not only provide reference for other universities to carry out course teaching effect evaluation, but also apply this kind of evaluation thinking to other types of evaluation [1–3]. Help teaching managers or teachers to identify whether a teaching reform achievement has achieved the purpose of improving quality through vertical and horizontal comparison, and provide data reference for determining whether to continue this reform practice [4–6].

In developed countries, the evaluation of the effect of teaching mode reform is divided into three stages, namely, preliminary formation, punitive evaluation and developmental evaluation, which focus on students and carry out teacher performance evaluation of students, but this kind of evaluation is controversial [7]. Most colleges and universities in China have established their own teaching effect evaluation index system, including teaching objectives, methods, effects and attitudes, etc. the evaluation contents and versions of colleges and universities have little difference. Some people understand that the

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 441–451, 2021.
https://doi.org/10.1007/978-3-030-84386-1_36

whole of teaching quality evaluation is to evaluate the quality of classroom teaching, which leads to the relatively single content of evaluation [8]. Subsequently, people began to study the effect evaluation of teaching mode reform towards the direction of operation model, but the quality of the evaluation results is not ideal.

2 Design of Evaluation Model for the Reform Effect of Electrical Control Teaching Mode Based on Deep Convolution Neural Network

2.1 Establishment of Evaluation System Weight

The importance of two indicators in the evaluation index system can not be reflected, and the weight analysis and calculation can express the relative importance of an indicator in the overall evaluation [9, 10]. A group of evaluation index system corresponding to the index weight constitutes the weight system. In this paper, the indicators of teaching evaluation are divided into different levels, such as target level, criterion level, indicator level, scheme level, etc. [11–13]. In this paper, all indicators have been divided into first level indicators, second level indicators and third level indicators, and their internal subordination has been determined. Based on this, the importance of corresponding evaluation indexes is analyzed, and the corresponding evaluation system indexes can be obtained, as shown in Table 1.

Table 1. Index allocation of evaluation index system

Evaluation criterion	Extremely important	Very important	Iimportant	Commonly	Unimportance
Inquiry activities	15	39	27	8	6
Explore knowledge	21	61	24	19	
Emotional attitude	29	30	25	11	9

In Table 1, the evaluation importance is assigned as follows: extremely important is 1, very important is 0.75, important is 0.5, general is 0.25, unimportant is 0. Then multiply and add the data of importance of each index with the corresponding assignment, and divide the result by the total number to calculate the average score. Finally, the average score of the two indicators is subtracted to form a matrix according to Saaty method. When the importance score of A_i and A_j of two indicators at the same level (i.e. average score), and construct the judgment matrix R, and stipulate that when $0.025 < A_i - A_j \leq 0.05$, A_i is slightly more important than A_j, and the value of satty is taken as 3. When $0.075 < A_i - A_j \leq 0.1$, A_i is more important than A_j, and satty is 5. When $0.125 < A_i - A_j \leq 0.15$ and A_i are more important than A_j, satty value is 7. When

$0.175 < A_i - A_j$, A_i is more important than A_j, satty is 9. Using the example in Table 1, the corresponding matrix of student evaluation index system is obtained as follows (Table 2):

Table 2. First level index matrix of student evaluation index system

First level indicators	Explore knowledge	Inquiry activities	Emotional attitude
Explore knowledge	1	1/5	1/2
Inquiry activities	5	1	5
Emotional attitude	2	1/5	1

Namely:

$$R = \begin{Bmatrix} 1 & \frac{1}{5} & \frac{1}{2} \\ 5 & 1 & 5 \\ 2 & \frac{1}{5} & 1 \end{Bmatrix} \tag{1}$$

At the same time, the indexes are sorted in a single hierarchy, and the weight value of the indexes is calculated, and the relative importance level and the relative importance level in matrix R are obtained, such as $V_1 = 1 + 1/5 + 1/2 = 1.7$, $V_2 = 5 + 1 + 5 = 11$, $V_3 = 2 + 1/5 + 1 = 3.2$, The sum of all levels is: $\sum_i^n V_i = V_1 + V_2 + ... + V_n$.

At the same time, the importance level and the ratio of the sum of the index weights are determined. The weight vector is calculated as follows:

$$W_i = \frac{V_i}{\sum V_I} \tag{2}$$

According to formula (2), the weight calculation in the matrix can be completed, and the corresponding ranking can be carried out to complete the establishment of index weight.

2.2 Weight Convergence of Deep Convolution Neural Network

In order to calculate the function form in the weight system of the rating index, this paper uses the deep convolution neural network to learn the meridional basis function and deal with the weight of the evaluation index. Radial basis function is usually defined as a monotone function of Euclidean distance between any point a and x center c in space, and its effect is local, that is, when c is far away from c, the value of the function is relatively small [14, 15], as shown in Fig. 1:

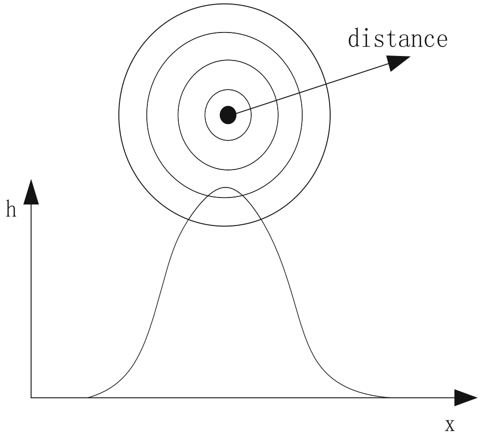


Fig. 1. Radial basis function diagram

The formula of radial basis function is as follows:

$$h(x) = \exp\left(-\frac{(x-c)^2}{r^2}\right) \tag{3}$$

In formula (3), r represents the corresponding radial basis function index. The birth of radial basis function is mainly to solve the problem of Multivariable Interpolation.

For the reform and evaluation of teaching mode, the evaluation index can be used as the basis function and processed by radial basis function. The RBF interpolation is to construct a function $F(x) = \sum_{i=1}^{N} w_i \varphi_i(\|x - x_i\|)$, and let the curve pass through the corresponding sample points, and keep the space dimension N, where the evaluation difference is φ. Given the sample points, the corresponding radial basis function matrix format is determined:

$$\begin{bmatrix} \varphi_{11}, & \varphi_{12}, & \cdots, & \varphi_{1N} \\ \varphi_{21}, & \varphi_{22}, & \cdots, & \varphi_{2N} \\ \cdots & \cdots & \cdots & \cdots \\ \varphi_{N1}, & \varphi_{N2}, & \cdots & \varphi_{NN} \end{bmatrix} \begin{bmatrix} w_1 \\ w_1 \\ \vdots \\ w_N \end{bmatrix} = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_N \end{bmatrix} \tag{4}$$

At the same time, deep convolution neural network is used to map the input of low dimensional space to high dimensional space by using hidden element RBF, and then the curve is fitted in this high dimensional space. It can be equivalent to finding an optimal surface in a certain hidden high-dimensional space, which can fit the training data. In the process of training, the network parameters are used as the weight value of the output layer, and the center is determined by clustering algorithm. The empirical formula $\sigma^2 = \frac{d\max}{\sqrt{h}}$ can be used for variance, where d max represents the maximum Euclidean distance in the center of the neural network, h represents the number of network centers, and the weight convergence of the output value can be directly given in the network without iteration. Let T represent the period in the training sample Expected output, Y represents the actual output of the sample. Φ represents the output value of RBF function in the hidden layer of neural network:

$$\begin{aligned} E &= \frac{1}{2}(T - Y)^T(T - Y) = \frac{1}{2}(T - \Phi V)^T(T - \Phi V) \\ &= \frac{1}{2}\left(T^T T - 2T^T \Phi V + V^T \Phi^T \Phi V\right) \end{aligned} \tag{5}$$

Formula (5) represents the linear equations of output layer weights. When the number of samples is large (more than the number of weights), the equations are contradictory equations without exact solutions. In this case, the least square method can be used to transform them into the following normal equations:

$$\begin{aligned} &\frac{\partial E}{\partial V} = 0 \Rightarrow -\Phi^T T + \Phi^T \Phi V = 0 \\ &\Rightarrow V = \left(\Phi^T \Phi\right)^{-1} \Phi^T T \end{aligned} \tag{6}$$

Formula (6) can be solved by Jacobi iterative method.

In the process of network training, the selection of training parameter μ directly affects the performance of the algorithm. If the value is too large, it is approximate to gradient descent method, and the convergence speed is slow. If the value is too small, it is approximate to Gauss Newton method, which easily leads to irreversible operation. In essence, neural network training problem can be attributed to optimization problem, which can be described as the problem of finding the extremum of multivariate function. As we all know, at the beginning of the optimization process, the search should take a big step, which is never conducive to the global search. At the end of the optimization process, the search should take a small step, so that the algorithm will not miss the global optimal solution. It is reflected in the deep convolution neural network. In the early stage of training, the value of μ should be relatively small to make the algorithm approximate the optimal solution with the second-order convergence rate of Gauss Newton, while in the later stage, the value of μ should be relatively large to make the algorithm approximate

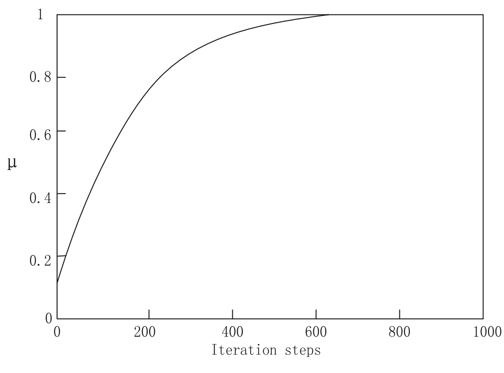


Fig. 2. Iterative change of deep convolution neural network

the optimal solution with the first-order convergence rate of approximate gradient descent method. As follows (Fig. 2):

After training, the data is imported into the deep convolution neural network to complete the weight convergence.

2.3 Multicollinearity Regression Method

By using the estimation method of multiple linear regression, the regression coefficients form the distribution characteristics of statistics. Use these methods to analyze the factors that affect students' learning efficiency and teachers' teaching level.

Assuming conditions, the least square estimator is set and the corresponding multiple linear regression model is established as follows:

$$y_t = \beta_0 + \beta_1 x_{t1} + \beta_2 x_{t2} + \ldots + \beta_{k-1} + u_t \tag{7}$$

In formula (7), y_t represents the explained variable, that is, the dependent variable. x_{tj} stands for explanatory variable, that is, independent variable. u_t is the random error term and β_k is the regression parameter.

Heteroscedasticity method was used for analysis. On the basis of the linear relationship between residual and explanatory variables, the square and cross terms of explanatory variables are added to get the auxiliary regression model. Testing the heteroscedasticity of the original model is equivalent to testing whether the regression parameters of the auxiliary regression model are significantly zero except for the constant. When H_0 holds, it is equivalent to the constant in $\hat{u}_t^2$. In multiple linear regression method, multicollinearity is common, and the consequences are complex, so the test of multicollinearity is particularly important. There are multiple explanatory variables in this method. One explanatory variable can be used for linear regression of all other explanatory variables, and goodness of fit can be calculated. The one with the largest goodness of fit and close to the one with the largest goodness of fit indicates that the linear relationship between the corresponding explanatory variable and all other explanatory variables is significant. This method has multicollinearity. At the same time, multicollinearity only affects the estimated values of the corresponding parameters of some unimportant explanatory variables, which can be omitted from the method. According to the front-end method, the modified Frisch method (stepwise regression method) was used in this method. There is a certain degree of linear correlation between $0 < \left| r_{xixj} \right| < 1$ explanatory variables. This situation is often encountered in practice. With the enhancement of collinearity, the accuracy and stability of parameter estimation are affected. When calculating, the goodness of fit of $\left(R^2\right)$ is very high, F is very high, and the variance $Var\left(\beta_j\right)$ of each regression parameter estimation is large, which indicates that the variable has multicollinearity. Extract the data with multiple collinearity, and take it as the final result of the evaluation factor index to complete the evaluation.

3 Experimental Analysis

In order to verify the feasibility of the designed teaching mode reform effect evaluation model. Using the class of electrical control major in a university to evaluate the teaching effect reform. The model designed in this paper and the model in literature [1], literature [3] and literature [4] are compared.

3.1 Experimental Class Information

The experimental results are based on the sophomore electrical class 3, class 4 and class 6 after the implementation of teaching reform in the University (Table 3).

Table 3. Participants

Class	Number of males	Number of women	Total number (person)
Electrical class 3	38	11	49
Electrical class 4	29	8	37
Electrical class 6	33	7	40
Involving teachers	8	6	14

3.2 Evaluation Index Weight Distribution

Before evaluating the effect of teaching mode reform in the University, the influencing factors of teaching mode reform in the university are determined and the weight is allocated (Table 4).

3.3 Experimental Calculation Basis

In order to verify the advantages and disadvantages of the design evaluation model, this paper tests the relative weight and consistency of the elements of the evaluation model. According to the sorting weight calculation formula:

$$w_i = \frac{\sqrt[n]{\prod_{j=1}^{n} a_{ij}}}{\sum_{j=1}^{n} \sqrt[n]{\prod_{j=1}^{n} a_{ij}}} \tag{8}$$

In formula (8), a_{ij} represents the weight value of the element in the model. After the relative weight is determined, the relative weight of all elements in the model is calculated by MATLAB software to obtain the maximum eigenvalue λ max. The higher the eigenvalue value is, the more obvious the characteristics of each element in the model are. After expert analysis, the maximum eigenvalue of the model should be $\lambda \max \leq 2.896$. At the same time, the consistency index $C.I$ is used to calculate the consistency:

$$C.I \triangleq \frac{\text{S-}c}{c-1} \tag{9}$$

Table 4. Experimental evaluation index weight distribution

Serial number	Evaluation factors	Key points of evaluation	Factor weight	Weight score
1	Instructional objective	Determine the teaching task	0.16	3
		Implementation of teaching objectives	0.3	1/2
		The feasibility of teaching purpose	0.21	1
2	Content of courses	Understand theory and master skills	0.41	1/5
		The content is primary and secondary, highlighting the key points	0.15	2
3	Teaching structure	The logic of teaching	0.22	1
		Combination of teaching links	0.36	1.5
		Scientific organization of teaching	0.27	2.5
4	Teaching method	Optimizing teaching methods	0.41	3
		Logic and appeal of teaching language	0.29	2
		Arousing students' enthusiasm	0.11	1

In formula (9), c represents the order of the evaluation model and S represents the maximum eigenvalue of the model. The lower the consistency of the model, the better the quality of the model. After expert analysis, the consistency of the model should be $C.I \geq 0.0192$.

3.4 Model Evaluation Results

According to the model, the teaching mode reform effect is evaluated, in which the largest eigenvalue λ max and consistency $C.I$ are used to judge the advantages and disadvantages. First of all, the evaluation results of teaching purpose factors of teaching mode are calculated:

In Table 5, evaluation model 1 is the evaluation model designed in this paper, evaluation model 2 is the evaluation model in literature [1], evaluation model 3 is the evaluation model in literature [3], and evaluation model 4 is the evaluation model in literature [4].

Table 5. Evaluation index of teaching purpose

Scoring index		Implementation of teaching tasks	The feasibility of teaching purpose
Evaluation model 1	λmax	3.786	3.857
	C.I	0.0116	0.0108
Evaluation model 2	λmax	3.127	3.542
	C.I	0.0186	0.0179
Evaluation model 3	λmax	3.127	3.542
	C.I	0.0191	0.0168
Evaluation model 4	λmax	3.364	3.172
	C.I	0.0183	0.0188

The maximum eigenvalue λ max and consistency $C.I$ of the four models meet the requirements of expert analysis, but the comparison shows that the model parameters in this paper are better. The evaluation results of teaching content are as follows (Table 6):

Table 6. Evaluation index of teaching content

Scoring index		Understanding theory	Highlight the key points
Evaluation model 1	λmax	3.892	3.846
	C.I	0.0126	0.0115
Evaluation model 2	λmax	3.077	3.174
	C.I	0.0158	0.0189
Evaluation model 3	λmax	3.117	3.012
	C.I	0.0132	0.0151
Evaluation model 4	λmax	3.222	3.187
	C.I	0.0126	0.0134

In order to ensure the reliability of data, the evaluation indexes are calculated in the same way. The evaluation indexes of teaching results are as follows (Table 7):

The model evaluation factors of teaching structure and teaching method are calculated as follows (Table 8):

In the above table, except that the maximum eigenvalue of evaluation model 2 is lower than the required value, the other results meet the requirements of the minimum evaluation model. However, according to the comparison of the values in the table, it can be found that in this experiment, the designed evaluation model is better than the other evaluation models in evaluating the same factors.

Table 7. Evaluation index of teaching structure

Scoring index		The logic of teaching	Combination of teaching links	Scientific teaching
Evaluation model 1	λmax	3.692	3.799	3.695
	C.I	0.0119	0.0104	0.0114
Evaluation model 2	λmax	2.961	3.045	3.015
	C.I	0.0162	0.0178	0.0144
Evaluation model 3	λmax	2.917	2.982	2.988
	C.I	0.0142	0.0151	0.0183
Evaluation model 4	λmax	3.041	3.211	3.115
	C.I	0.0158	0.0152	0.0187

Table 8. Evaluation index of teaching structure

Scoring index		Optimizing teaching methods	Logicality and appeal of language	Enthusiasm mobilization
Evaluation model 1	λmax	3.815	3.912	3.783
	C.I	0.0139	0.0115	0.0109
Evaluation model 2	λmax	2.876	3.014	3.115
	C.I	0.0172	0.0188	0.0184
Evaluation model 3	λmax	2.961	2.992	2.981
	C.I	0.0172	0.0165	0.0144
Evaluation model 4	λmax	3.061	3.041	2.915
	C.I	0.0168	0.0183	0.0187

4 Conclusion

This paper, the deep convolution neural network is used to design the evaluation model of teaching mode reform effect. Although the model can improve the efficiency of evaluation and the objectivity of evaluation results, there are some shortcomings, such as the poor universality of the model, and the well-trained model for one type of university is not suitable for other types of universities. Therefore, how to improve the universality of the evaluation model is the key problem to be solved in the next step.

References

1. Li, C., Wang, J., Yang, S.: Construction of psychiatric nursing skill teaching model based on blending-learning concept and its effect evaluation. Chin. J. Mod. Nurs. **24**(16), 1961–1965 (2018)

2. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
3. Jin, X., Qi, H.: Construction of quality evaluation index system in practical teaching based on quality stereoscopic model—a case study of internship program. J. Nanjing Radio Telev. Univ. (2), 55–58 (2019)
4. Feng, B.: Research on multi-evaluation mechanism of blended teaching based on CoI model. J. Guangdong Univ. Educ. **39**(4), 14–19 (2019)
5. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
6. Zhu, J., Chen, G., Xiang, H., et al.: Evaluation model of study behavior of blending teaching based on random forests. Comput. Knowl. Technol. **15**(29), 118–120 (2019)
7. Bai, C., Wang, F., Wang, B.: Construction of the practice teaching evaluation indicator system of electrical engineering based on the CIPP model. Comput. Knowl. Technol. **15**(27), 118–121 (2019)
8. Zhang, Y.: Research on teaching evaluation based on topic model. Comput. Knowl. Technol. **15**(7), 32–34 (2019)
9. Hu, Q., Su, B.: Evaluation of informatization teaching quality in higher vocational colleges based on dynamic CIM comprehensive model. J. Sci. Teach. Coll. Univ. **39**(3), 24–29 (2019)
10. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training, pp. 1–374. Springer, Heidelberg (2018)
11. Chen, X.Q., Zhao, W.T., He, F.J., Chen, Y.C., Song, Q.M.: Practice and exploration of mixed teaching reform of human anatomy based on rain classroom. Chin. J. Anat. **42**(1), 98–100 (2019)
12. Ouyang, G.H., Shen, X.Y.: Teaching quality assessment in higher education from the perspective of learning paradigm: a practical investigation based on the practice of teaching excellence framework in the United Kingdom. Univ. Educ. Sci. **6**(6), 81–88 (2019)
13. Li, F., Zhang, W., Lv, Z.: On theoretical construction and characteristic of higher engineering education system. Res. High. Educ. Eng. **14**(5), 180–186 (2019)
14. Lu, Y., Xue, T.Q., Chen, P.H., Yu, S.Q.: A study on the system design and key technologies of an ai-driven ed ucational robot: taking the "smart learning partner" as an example. Educ. Res. **26**(2), 83–91 (2020)
15. Lin, L.: Educational action forms in german systematic pedagogy: a study based on educational theories of Immanuel Kant, Johann Friedrich Herbart and Friedrich Schleiermacher. **16**(3), 149–159 (2019)

Evaluation Method of Interactive Quality of Road and Bridge Construction Course Teaching Based on Principal Component Analysis

Hong-wei Tian(✉)

School of Road Bridge and Architecture, Chongqing Vocational College of Transportation, Chongqing 400021, China

Abstract. In order to improve the teaching quality of road and bridge construction course, an interactive quality evaluation method based on principal component analysis is proposed. According to the hierarchical model of teaching interaction, the evaluation index of teaching interaction quality is selected, and the evaluation system of teaching interaction quality is preliminarily constructed. On this basis, the principal component and its quantity of evaluation index are determined based on principal component analysis method, and the evaluation system of teaching interaction quality is determined, which is transformed into NVivo analysis and evaluation framework, and the relationship between superior and subordinate is used to evaluate teaching interaction quality Price index node is used for classification and management, and the linear weighted value of each principal component is calculated. The final evaluation result is obtained by weighted summation, so as to realize the evaluation of teaching interaction quality of road and bridge construction course. The experimental results show that the evaluation result of this method is more in line with the actual value, and the evaluation effect is better.

Keywords: Principal component analysis · Road and bridge construction course · Teaching interaction quality · Evaluation

1 Introduction

In recent years, my country's highway construction has achieved great results, and highway construction has also developed rapidly. As of the end of 2019, my country's total highway mileage has reached 125,400 km, ranking first in the world. At present, due to factors such as my country's population, private car ownership, passenger traffic, freight volume, inter-provincial, and international trade, the market has great potential for road demand [1]. As an important part of highway construction, bridge construction has also undergone major developments in terms of materials, structural design, bridge type, span, and construction methods. The world's bridges are moving towards new, long-span, lightweight, sensitive and beautiful new bridges. Goal development.

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 452–464, 2021.
https://doi.org/10.1007/978-3-030-84386-1_37

The development of road and bridge engineering requires more high-level talents who are engaged in on-site construction technical work on the front line of production. How to train high skilled applied professional and technical personnel to meet the needs of highway development in China and meet the needs of road and bridge construction operators, organizers and managers, it is necessary for road and bridge construction teachers of civil engineering major in China to organize and carry out classroom teaching and practical teaching reasonably around the professional training objectives and combined with engineering practice.

Road and bridge construction is a professional course closely related to practice for civil engineering majors. It mainly includes two parts: road construction and bridge construction. The purpose and task of this course are: according to the latest development of the subject, through multimedia teaching with pictures and texts, practice Teaching and other teaching methods enable students to fully grasp modern road and bridge construction techniques after completing this course, and initially have the ability to design and guide construction of roads and bridges [2]. The teaching quality of this course directly affects the professional quality and engineering ability of civil engineering students. Therefore, in order to meet the current demand for the ability of road and bridge engineering professionals in our country, and improve the practical ability and engineering application ability of students, this paper puts forward the research on the interactive quality evaluation method of road and bridge construction course based on principal component analysis. The method of transforming a set of principal variables into a set of principal variables by principal component analysis is called orthogonal transformation. The paper obtains the evaluation index of teaching interaction quality, calculates the matrix of the evaluation indexes of teaching interaction quality by principal component analysis method, constructs the evaluation system of teaching interactive quality. Based on the above-mentioned evaluation system of interactive quality of road bridge construction course, it is transformed into NVivo analysis and evaluation framework, and the tree node is directly established, Through the relationship between the upper and lower levels, the paper classifies and manages the teaching interactive quality evaluation node, and completes the interactive quality evaluation of the road bridge construction course. Through the introduction of principal component analysis method, the evaluation index of teaching interaction quality is processed to obtain more accurate evaluation results of teaching interaction quality of road and bridge construction course [3].

2 Research on Interactive Quality Evaluation Method of Road and Bridge Construction Course Teaching

2.1 Preliminary Construction of Teaching Interactive Quality Evaluation System

Through the existing literature research, it can be seen that with the increasing attention to the factors of teaching interaction quality evaluation, the perspective of researchers has gradually shifted from the systematic perspective to the hierarchical research of various interaction quality, focusing on the level and depth of teaching interaction.

For the research on the level of teaching interaction, based on laurillard's conversation model of general learning process, Chen Li, a domestic scholar, has constructed a hierarchical model of teaching interaction as shown in Fig. 1.

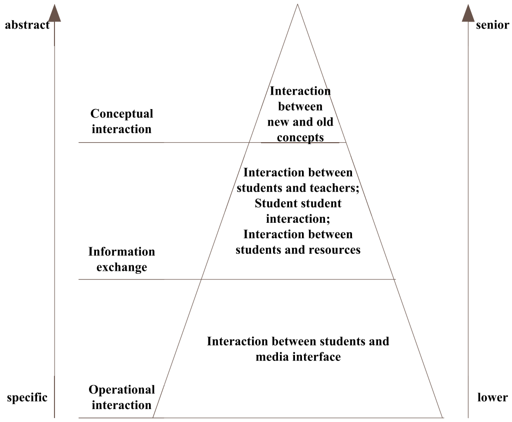


Fig. 1. Hierarchical model of teaching interaction

As shown in Fig. 1, the model divides the teaching interaction behavior in classroom teaching process from concrete to abstract and from low level to high level, which are operation interaction, information interaction and concept interaction. Among them, operational interaction refers to the interaction between teachers and students and media interface; information interaction refers to the information exchange behavior of learning between students and other teaching elements through various symbols, which is subdivided into the interaction between students and learning resources, between students and teachers, and between students and students; conceptual interaction refers to the relationship between the new and old concepts in students' minds Interaction [4].

Based on the content of the above-mentioned construction model, together with emotional interaction, it is used as the first-level indicator of the interactive quality evaluation of road and bridge construction courses, as shown in Table 1.

Table 1. The first-level index table of teaching interactive quality evaluation

First level indicator	Describe
Operational interaction	Interaction between teachers and students and media interface. It includes not only the non editing operations such as viewing and displaying resources by means of media, but also editorial operations such as annotating and changing resources by teachers and students through media
Information exchange	The act of transmitting information between teachers and students and between students
Emotional interaction	Teachers and students in the process of information exchange and classroom atmosphere related to a strong emotional attitude behavior
Cognitive interaction	The conceptual interaction between teachers and students in cognitive level based on information interaction

As shown in Table 1, interactive teaching behaviors may occur at the same time in the classroom teaching process, or may not occur at the same time, there is no strict hierarchical relationship [5].

After the above description, the interactive behaviors of road and bridge construction courses can be classified according to their respective attributes [6]. On this basis, combined with the first-level indicators established in Table 1 (operational interaction, information interaction, emotional interaction, cognitive interaction), some of the second-level indicators (the eight second-level indicators at the cognitive level are marked, understood, applied, and analyzed), Evaluation, creation, fascination, self-knowledge), as well as the specific teaching behaviors in the existing interactive teaching quality evaluation system, the interactive teaching quality evaluation system of road and bridge construction courses can be initially constructed, as shown in Table 2.

As shown in Table 2, the operational interaction level refers to the interaction behavior between teachers and students and media technology in the classroom environment of the road and bridge construction course. According to the different application activities carried out by teachers and students with the help of technology, summarized and sorted out from the 9 selected course teaching video examples. The simple "teacher operation technology" and "student operation technology" in the existing evaluation system are subdivided into "teacher and student simple operation technology" and "teacher and student editing resources", and the existing "technology acting on students" is changed into "real-time transfer of technology and technology".

At the information interaction level, it includes teacher's instruction, teacher's instruction, classroom management, peer discussion, students' practice and students' thinking. It mainly takes some speech and action behaviors without obvious emotional characteristics in the existing evaluation system as the secondary indicators of information interaction [7]. The teacher's control of classroom teaching tasks in the existing evaluation system, such as beginning, prompting, ending and other speech acts, are classified into teacher's instructions or instructions, because these behaviors have the function of expecting students to obey.

Emotional interaction specifically includes four aspects: positive feedback and negative feedback from teachers to students, positive responses from students to teachers, encouragement and assistance to students. Among them, the teacher's acceptance of emotions in the existing evaluation system, teachers' encouragement, and acceptance of opinions are combined into a behavior of positive feedback from teachers to students, because they all reflect the positive emotions between teachers and students Interactive. At the same time, through the coding analysis of nine cases, it is found that in addition to the emotional interaction of teachers' encouragement and praise to students, there are also students' emotional reactions to teachers. Therefore, students' positive responses to the teacher have been increased, such as students' positive actions. Hand, collective answer, etc. [8].

In this study, the interaction behavior at the cognitive interaction level mainly refers to the analysis of the content of teachers' and students' questions or responses in classroom teaching. In the existing evaluation system, "teachers raise open questions" and "teachers raise closed questions" are subdivided into eight dimensions of teachers' questions: memorization, comprehension, application, analysis, evaluation, creation, empathy and

Table 2. Teaching interaction quality evaluation system

Primary indicators	Secondary indicators	Encoded
Operational interaction	Teachers' operation technology	1
	Teacher editing resources	2
	Student operation technology	3
	Student editing resources	4
	Technology and technology sharing content	5
Information exchange	Teaching by teachers	6
	Teacher instruction	7
	Classroom management	8
	Student discussion	9
	Do exercises	10
	Students' thinking	11
Emotional interaction	Teachers' negative feedback	12
	Teachers' positive feedback	13
	Respond positively to teachers	14
	Encourage peers	15
Cognitive interaction—teacher questions	The level of memory	16
	Understanding level	17
	Application level	18
	Analysis level	19
	Evaluation level	20
	Creation level	21
	On the level of magic	22
	Insight level	23
Cognitive interaction—students answer or ask questions	The level of memory	24
	Understanding level	25
	Application level	26
	Analysis level	27
	Evaluation level	28
	Creation level	29
	On the level of magic	30
	Insight level	31

(*continued*)

Table 2. (*continued*)

Primary indicators	Secondary indicators	Encoded
Silence or silence confusion	Invalid language or behavior	32

self-knowledge. In the existing evaluation system, "students' active response" and "students' active questioning" are subdivided into eight dimensions of questions or answers in the following eight dimensions: recollection, comprehension, application, analysis, evaluation, creation, magic and insight [9]. Specific explanations are given at the end of each index to help researchers make behavior judgments.

The last one is the chaotic behavior or invalid language that may not help teaching in the course teaching, such as the problem behaviors shown by individual students in the classroom (weird, making faces, destroying things, etc.), or due to the out-of-control atmosphere of the activity And cause temporary confusion and other invalid behavior.

2.2 Determination of Teaching Interaction Quality Evaluation System

The above-mentioned preliminary construction of interactive quality evaluation system for curriculum teaching is a multi-index comprehensive evaluation method. At present, there are many comprehensive evaluation methods for multiple indicators at home and abroad. According to the different weight determination methods, these methods can be roughly divided into two categories: one is subjective weighting methods, such as analytic hierarchy process, Delphi method, etc., and most use comprehensive consulting scoring The qualitative method of this kind of method is influenced by human factors, which tends to exaggerate or reduce the effect of certain indicators, so that the result of the sorting cannot completely and truly reflect the actual relationship between things; the second is the objective weighting method, which is based on The correlation between indicators or the degree of variation of each indicator value is used to determine the weight, which avoids the deviation caused by human factors, such as principal component analysis and factor analysis. Because the principal component analysis method overcomes the influence of human factors, this research uses the principal component analysis method to determine the final teaching interactive quality evaluation system.

Principal component analysis is a very useful multivariate statistical analysis method. It is widely used in social economy, enterprise management, biochemistry, medicine, education and other fields. It is a statistical analysis method which transforms multiple indexes into a few comprehensive indexes. In the study of multi index (variable), because the number of variables is too many, and there is a certain correlation between them, so the collected data reflect the information to a certain extent, and when there are many variables, it is more difficult to study the distribution law of samples in high-dimensional space. Principal component analysis is to simplify this situation, that is to say, to adopt one method the method of dimensionality reduction is to find several comprehensive factors to represent the original variables, so that these comprehensive factors can reflect the information of the original variables as much as possible, and they are not related to each other. Almost all complex comprehensive evaluation problems will use this method to reduce the data dimension.

The basic steps of multi-index comprehensive evaluation with principal component analysis include:

Step 1: Standardization of the original indicator data, that is, dimensionless;
Step 2: Find the correlation coefficient matrix between index data;
Step 3: Find the characteristic root, characteristic vector and contribution rate of the matrix;
Step 4: Determine the number of principal components;
Step 5: Explain the meaning of the principal component in the network teaching system;
Step 6: Synthesize the determined principal components to obtain a comprehensive evaluation value.

Based on the principal component analysis method, the process of determining the teaching interaction quality evaluation system of road and bridge construction course is as follows:

Step 1: The original teaching interaction quality evaluation body index is dimensionless.

There are many methods for dimensionless processing, such as straight line type, fold line type and curve type. In this study, the linear dimensionless method is used for data processing, mainly because:

First, for the multi index comprehensive evaluation, the result of dimensionless evaluation is a relative description of the development level of the evaluated things, rather than an absolute scale;

Second, the non-linear dimensionless methods such as broken line and curve type are not more accurate than linear methods in any case;

Thirdly, from the case application experience of multi index comprehensive evaluation at home and abroad, the results of linear formula comprehensive evaluation are often similar to nonlinear method, but this method is easy to use and understand.

In the linear dimensionless formula, there are two commonly used methods: extreme value method and Z-Score method. Among them, the Z-Score method is more suitable for situations where there are a large number of evaluated objects. In view of the research needs, the Z-Score method is more suitable. In addition, taking into account the requirements of the multi-index comprehensive evaluation method used for the dimensionless method, the principal component analysis method requires the Z-Score method to be used for dimensionless processing.

Suppose there are n sample and p indexes, we can get the data matrix $X = \left(X_{ij}\right)_{nxp}$. Among them, $i = 1, 2, \cdots, n$ and n are the total number of samples; $j = 1, 2, \cdots, p$ and p are p indicators; X_{ij} is the j index value of the i th sample.

The Z-score method was used to standardize the data transformation

$$\begin{cases} Z_{ij} = \frac{X_{ij} - \overline{X}_j}{S_j} \\ \overline{X}_j = \frac{1}{n} \sum_{i=1}^{n} X_{ij} \\ S_j = \left[\frac{1}{n-1} \sum_{i=1}^{n} \left(X_{ij} - \overline{X}_j \right)^2 \right] \end{cases} \tag{1}$$

Step 2: The determination of index weight.

In order to make the comprehensive evaluation value synthesized by multiple indicators more accurately reflect the real situation of the interactive quality of road and bridge construction courses, so as to ensure the scientific nature of the comprehensive evaluation, it is necessary to assign different weights to the non-dimensionally transformed indicators. number.

When this study adopts the principal component analysis method for comprehensive evaluation, the weight of each indicator is automatically determined and guaranteed by the principal component analysis method, and no additional method is required to set the weight value for each indicator.

Step 3: Find the correlation matrix of the indicator data.

The expression of the correlation matrix between the evaluation indexes of teaching interaction quality is:

$$R = \left(r_{jk}\right)_{pxp} \tag{2}$$

In formula (2), r_{jk} represents the correlation coefficient between evaluation index j and evaluation index k, and the calculation formula is:

$$\begin{aligned} r_{jk} &= \frac{1}{n-1}\sum_{i=1}^{n}\left[\left(X_{ij}-\overline{X}_j\right)^2/S_j\right]\cdot\left[\left(X_{ik}-\overline{X}_k\right)^2/S_k\right] \\ &= \frac{1}{n-1}\sum_{i=1}^{n} Z_{ij}Z_{ik} \end{aligned} \tag{3}$$

Step 4: The eigenvalue and eigenvector of correlation matrix R are obtained to determine the principal component.

From the characteristic equation $|\lambda Ip - R| = 0$, one can obtain p characteristic roots $\lambda g(g = 1, 2, \cdots, p)$, and arrange them as $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p \geq 0$ in order of magnitude. It is the variance of the principal components, and its size describes the role of each principal component in describing the object being evaluated size. From the characteristic equation, each characteristic root corresponds to a characteristic vector Lg, the expression is

$$Lg = Lg_1, Lg_2, \cdots, Lg_p = 1, 2, \cdots, p \tag{4}$$

The standardized index variables were transformed into main components:

$$Fg = Lg_1Z_1 + Lg_2Z_2 + \cdots + Lg_pZ_p \tag{5}$$

In the result of formula (5), call $F1$ as the first principal component, $F2$ as the second principal component, and Fp as the p th principal component.

Step 5: The variance contribution rate was calculated to determine the number of principal components.

Generally, the number of principal components is equal to the number of original indicators. If the number of original indicators is large, it is difficult to conduct comprehensive evaluation. Principal component analysis is to select as few as possible k

principal component ($k < p$) for comprehensive evaluation, and at the same time make the loss of information as little as possible.

k value is determined by variance contribution rate $\sum_{g=1}^{k} \lambda g / \sum_{g=1}^{k} \lambda g \geq 85\%$.

Through the above process, the principal components and quantity of the interactive teaching quality evaluation index are determined, and the structure of the teaching interactive quality evaluation system is determined to prepare for the follow-up road and bridge construction course teaching interactive quality evaluation.

2.3 Realization of Teaching Interaction Quality Evaluation

Based on the above-identified road and bridge construction course teaching interactive quality evaluation system, it is converted to the NVivo analysis and evaluation framework, tree nodes are directly established, and the teaching interactive quality evaluation index nodes are classified and managed through the subordinate relationship [10–12]. Part of the tree node relationship diagram is shown in Fig. 2.

Tree node

name	Source of materials	Reference point
Operational interaction	0	0
Simple operation for teachers	0	0
Teacher editing resources	0	0
Simple operation for students	0	0
Student editing resources	0	0
Media and media real time sharing	0	0
Information exchange	0	0
Teaching by teachers	0	0
Teacher instruction	0	0
Student discussion	0	0
Do study	0	0
Learning and thinking	0	0

Fig. 2. Partial tree node graph

After the node is established, it is necessary to code the teaching interaction quality evaluation indicators one by one according to the node, combine the principal component analysis method to calculate the linear weighted value A Fg of each principal component, and then perform the weighted summation of the k principal components, that is, The final evaluation value, the weight is the variance contribution rate of each principal component, then the final evaluation value of teaching interaction quality is calculated as:

$$F = \sum_{g=1}^{k} \left(\lambda g / \sum_{g=1}^{p} \lambda g \right) Fg \tag{6}$$

The calculation result of formula (6) is the evaluation result of teaching interaction quality of road and bridge construction course, and its value range is [0, 100]. the larger the value, the better the teaching interaction quality.

Through the above process, the evaluation of interactive quality of road and bridge construction courses has been realized, which provides strong support for the cultivation of road and bridge construction talents in my country.

3 Experiment and Result Analysis

In order to verify the performance difference between the proposed method and the existing methods in teaching interaction quality evaluation, the MATLAB software platform is used to design the simulation contrast experiment.

3.1 Experimental Data Preparation and Processing

Because the dimensions, orders of magnitude and forms of each evaluation index in the evaluation index system of teaching interaction quality are different, it is difficult to compare and analyze them. Therefore, it is necessary to normalize the original data. In the linear dimensionless method, the threshold method has no strict requirements on the number and distribution of index data, and in the process of dimensionless processing, the original data is relatively less. Therefore, there is no need to process the data in the miniaturization experiment. Due to the limitation of space, it is not described in detail.

3.2 Determining the Weights of Teaching Interactive Quality Evaluation Index

According to the principal component analysis method to determine the weight of teaching interaction quality evaluation index of road and bridge construction course, to prepare for the follow-up experiment.

The weight values of teaching interaction quality evaluation index are shown in Table 3.

3.3 Analysis of Experimental Results

Based on the above-identified evaluation indicators, conduct interactive quality evaluation experiments of road and bridge construction courses, compare the experimental results with the given actual results, and judge the evaluation performance of the proposed method.

The evaluation data of teaching interaction quality obtained through experiments are shown in Table 4.

Table 3. Table of weights of evaluation indexes for teaching interactive quality

Primary indicators	Secondary indicators	Weights
Operational interaction	Teacher operation technology	0.0312
	Teacher editing resources	0.0420
	Student operation technology	0.0210
	Student editing resources	0.0203
	Technology and technology sharing content	0.0214
Information exchange	Teacher lecture	0.0201
	Teacher instruction	0.0259
	Management classroom	0.0219
	Student discussion	0.0228
	Do exercises	0.0227
	Student thinking	0.0214
Emotional interaction	Teacher negative feedback	0.0246
	Teacher positive feedback	0.0271
	Respond positively to teachers	0.0102
	Encourage companions	0.0328
Cognitive interaction—teacher questions	Memorization level	0.0412
	Understanding level	0.0321
	Application level	0.0128
	Analysis level	0.0415
	Evaluation level	0.0145
	Create level	0.0690
	Supernatural level	0.0548
	Self-knowledge level	0.0834
Cognitive interaction—students answer or ask questions	Memorization level	0.0124
	Understanding level	0.0525
	Application level	0.0301
	Analysis level	0.0567
	Evaluation level	0.0401
	Create level	0.0100
	Supernatural level	0.0300
	Self-knowledge level	0.0123

(*continued*)

Table 3. (*continued*)

Primary indicators	Secondary indicators	Weights
Silence or silence confusion	Invalid language or behavior	0.0412

Table 4. Teaching interaction quality evaluation data table

Number of experiments	Evaluation results (points)		
	Actual value	Proposed method	Comparison method
1	52.12	52.12	45.12
2	65.12	65.10	50.23
3	58.49	58.41	58.49
4	71.05	70.00	70.21
5	81.48	81.00	86.59
6	81.00	81.23	89.54
7	85.41	81.25	85.36
8	75.32	74.21	80.12

As shown in the data in Table 4, compared with the comparative method, the error between the teaching interactive quality evaluation result of the proposed method and the actual value is smaller, which fully proves that the proposed method has a better evaluation effect.

4 Conclusion

Aiming at the problem of inaccurate evaluation results in the traditional teaching interaction quality evaluation method of road and bridge construction course, this paper puts forward the evaluation method of teaching interaction quality of road and bridge construction course based on principal component analysis. This study determines the evaluation index of teaching interaction quality based on principal component analysis method, which greatly improves the evaluation effect and provides the teaching of road and bridge construction course help.

References

1. Reeves, T.D., Hake, L.E., Chen, X., et al.: Does context matter? Convergent and divergent findings in the cross-institutional evaluation of graduate teaching assistant professional development programs. CBE Life Sci. Educ. **17**(1), 8 (2018)
2. Wimmer, I., Tröscher, A.R., Brunner, F., et al.: Systematic evaluation of RNA quality, microarray data reliability and pathway analysis in fresh, fresh frozen and formalin-fixed paraffin-embedded tissue samples. Sci. Rep. **8**(1), 6351–6351 (2018)

3. Jin, J.C.: Student evaluation of teaching in higher education: evidence from Hong Kong. Int. J. High. Educ. **8**(5), 95 (2019)
4. Krzysztofik, M., Zbróg, P.: Proposing a workshop on art evaluation in university teaching. Respectus Philol. **37**(42), 195–204 (2020)
5. Alshammari, E.: Student evaluation of teaching. Is it valid? J. Adv. Pharm. Educ. Res. **10**(2), 96–103 (2020)
6. Ogbonnaya, U.I.: The reliability of students' evaluation of teaching at secondary school level. Probl. Educ. 21st Cent. **77**(1), 97–109 (2019)
7. Lora, C., Christine, B., Linnea, G., et al.: Teaching teachers onsite: using evaluation to develop effective professional development programs. J. Museum Educ. **43**(3), 274–282 (2018)
8. Liu, S., Lu, M., Li, H., et al.: Prediction of gene expression patterns with generalized linear regression model. Front. Genet. **10**, 120 (2019)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
10. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training, pp. 1–374. Springer, Heidelberg (2018).
11. Guo, M., Xiong, X., Feng, G., et al.: A research on behavioral deviation and reform program of teaching quality evaluation in experiment and training of colleges. Lab. Res. Explor. **038**(005), 229–232, 274 (2019)
12. Zhao, H.: Research on the evaluation method of teaching quality of Chinese as a foreign language based on immersion teaching. Manage. Sci. Res. Chin. Engl. Vers. (1), 8–10 (2019)

Research on Intelligent Correction of Abnormal Data in Online Education System Based on Big Data Technology

Yana Tang[1](✉) and Jing Zhao[2]

[1] South China Institute of Software Engineering GU, Guangzhou 510990, China
[2] Xi'an International Studies University, Xi'an 710128, China

Abstract. In the traditional correction method of abnormal data in online education system, the unreasonable selection of training samples by RBF neural network leads to a large error in the correction of abnormal data. Therefore, GA algorithm is used to improve RBF neural network, and a new intelligent correction method of abnormal data in online education system based on big data technology is proposed. The classification model of abnormal data in online education system is constructed by decision tree classification algorithm. The pretreatment of abnormal data is completed based on big data technology. The specific pre-processing steps include: data cleaning, data integration, data transformation, data reduction, dimension reduction, numerical reduction, data discretization and concept layering. GA-RBF neural network is used to correct abnormal data of online education system. By comparing the performance of this method with the traditional intelligent correction method of abnormal data in online education system, it can be seen that the prediction and filling accuracy of this method is higher than that of the traditional method, and the performance is improved.

Keywords: Big data technology · Online education system · Abnormal data · Smart correction

1 Introduction

For many years, there has never been a unified understanding of the definition of abnormal data. Researchers in different fields have given different definitions of abnormal data from different perspectives. Dixon regards abnormal data as "data that is suspected in data analysis". Grubbs considers abnormal data to be those data points that deviate significantly from other sampled data. Elashoff stated that abnormal data are some extreme data points to some extent [1]. It was not until the mid-1980s that the definition of abnormal data became more complicated.Guttman regards abnormal data as pseudo data that does not obey the law of data distribution; Rohlf believes that points not in the data cloud can be considered as potential abnormal data; Hawkins defines abnormal data as: far away from most of the data and the true distribution density may be low Some of the data; Campbell defines multivariate abnormal data as: data points in the form of

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 465–476, 2021.
https://doi.org/10.1007/978-3-030-84386-1_38

relationships that are significantly different from important data [2]. In the 1990s, some authors began to describe abnormal data from a statistical perspective. Anscombe and Tukey believe that abnormal data should have larger residuals; Portnoy pointed out that the residuals of abnormal data are greater than the residuals of most other data, and these residuals are obtained by linear regression methods. And he further pointed out: If the residual error of a data is greater than five times the standard deviation, then the data is considered abnormal data; in 1983, Beckman and Cook pointed out that the definition of abnormal data is still very vague.Barnett further pointed out that "the important thing is not whether any observation data is outside F, but whether the largest observation data under F is abnormally huge". Comrey believes that abnormal data is caused by incorrect measurement and data contamination [3]. There are also many abnormal data in online education systems. These abnormal data mainly refer to data that affect the operation of the online education system. For these abnormal data, it must be intelligently corrected to ensure the normal operation of the online education system.

At present, there are also some relevant research results, such as: Literature [4] is based on sliding basic Windows sampling (SBWB) and Gaussian process regression This paper presents a regression (GPR) model based on SBWS_GPR prediction model for anomaly detection of uncertain multi-data in online education systems. In the historical data set collected based on time series, index number is introduced to cluster the historical data set of online education system, the mapping relationship between data set and index number is analyzed, and the input data obtained in real time is distributed through the sliding window to match, so as to realize the abnormal point detection and correction of single data of online education system. Literature [5] used fuzzy C-means clustering to obtain the clustering center curve of online education system data, and corrected the abnormal data according to the identified abnormal data types of online education system by combining the clustering center curve and the correction algorithm. However, the above methods have the problem of low accuracy of abnormal data prediction and filling.

Therefore, big data technology is applied to the intelligent correction of abnormal data in the online education system, and an online education system abnormal data based on big data technology is proposed. Smart correction method. Decision-tree classification algorithm is introduced to construct the classification model of abnormal data in online education system. The pretreatment of abnormal data is completed based on big data technology. GA-RBF neural network is used to correct abnormal data of online education system. The experimental results show that the accuracy of this method is higher than that of the traditional method, and its application performance is better than the traditional method.

2 Design an Intelligent Correction Method for Abnormal Data in an Online Education System Based on Big Data Technology

2.1 Abnormal Data Detection

First, the abnormal data detection of the online education system is carried out, and the classification model of the abnormal data of the online education system is constructed through the decision tree classification algorithm, and the abnormal data of the online education system is detected through this model [4]. The steps to build an abnormal data classification model for the online education system are as follows:

The core part of the decision tree classification model construction is the split feature selection. The online education system abnormal data sample set is divided into different branches according to the abnormal data feature value of the online education system, so that each branch corresponds to the child node as "pure" as possible, that is, try to make The sample types in each subset are the same. The construction result of the decision tree is a tree model (binary or multi-branch). When the partition rule is Boolean logic or the classification target is binary classification, a binary tree model is generally generated [6]. The general flow of decision tree construction is shown in Fig. 1.

In the actual application scenarios of abnormal data detection in online education systems, the constructed decision tree classification model is often too "lush". Each segmentation point is fully used, and the leaf nodes are almost completely "pure". The model is too in line with the characteristics of the training sample, so the effect of classifying the training sample is excellent, but the effect of classifying the test data may be much worse, which is "overfitting". The versatility of the over-fitting model is not strong, so it needs to be pruned to make it more simplified. Combining pre-pruning and post-pruning methods to pruning the constructed decision tree classification model.

The pre-pruning method is as follows: Pre-pruning is the pruning performed during the construction of the decision tree. In order to avoid over-fitting when the number of nodes is too large, a condition to stop continuing to create branches can be set in advance. When samples of each category in a sample set of a node meet this condition, the splitting of the node will be stopped without waiting for all the splitting attributes All are used up, even if the node can be split more purely. Finally, use the category with the largest number of samples to mark the node category and use it as a leaf node. The pre-pruning algorithm is simple to use and suitable for use in scenarios where the decision tree model is relatively small.

The post-pruning method is as follows: Post-pruning is pruning after the construction of the decision tree is completed. The specific method is to merge all the node samples rooted at a certain node. If the increase in the amount of information of the sample set after the merging is less than a certain threshold, the subtree is replaced with a leaf node, and the category of the leaf node is subject to a "majority vote" Decision [7, 8]. Typical post-pruning algorithms include error rate reduction pruning and pessimistic pruning. The post-pruning operation is relatively complicated, which is suitable for use in scenes with large-scale models and high precision requirements.

2.2 Preprocessing of Abnormal Data

Then, based on big data technology, preprocess the abnormal data of the online education system. Specific preprocessing steps include: data cleaning, data integration, data transformation, data reduction, dimensionality reduction, numerical reduction, data discretization, and concept layering.

The purpose of the data cleaning routine is to fill in missing values, smooth noise and identify outliers, and correct inconsistencies in the data [8]. First fill in missing values with the mean of the attributes. Then smooth the noise data, the specific steps

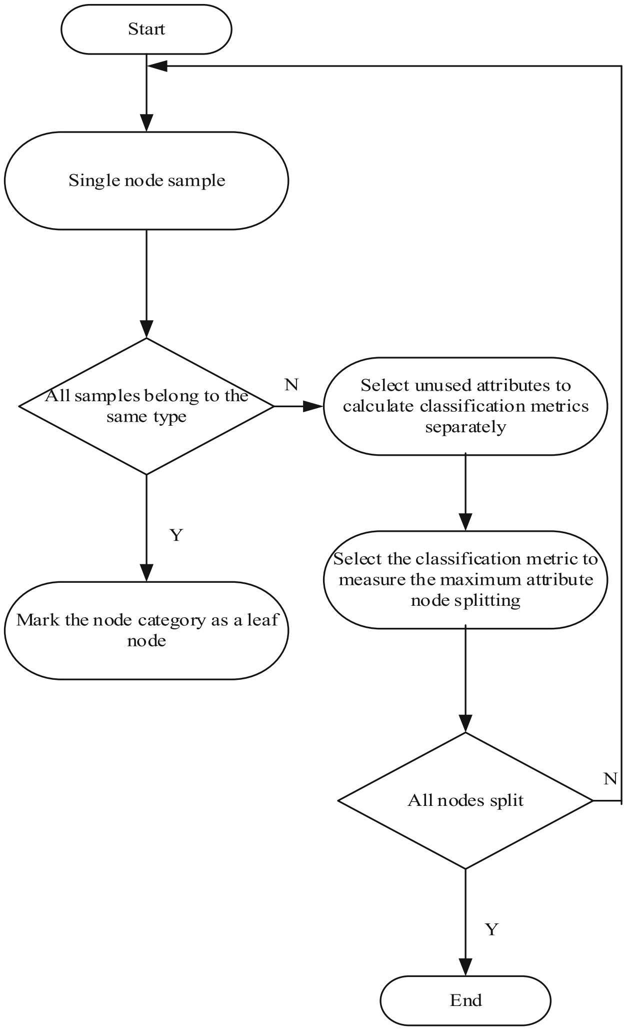


Fig. 1. The general flow of decision tree construction

are as follows: the outliers can be detected by clustering, and similar values can be organized into groups or "clusters". Intuitively, values that fall outside the cluster set are considered outliers. Then perform data cleaning, the first step is deviation detection. When discovering noise, outliers, and unusual values that need to be investigated, you can use existing knowledge about the nature of the data. This kind of knowledge or "data about data" is called metadata. Examine the domain and data type of each attribute, the acceptable value of each attribute, and a length range of the value; examine whether all values fall within the expected range and whether there are known dependencies between attributes; grasp the data Trends and recognition anomalies, such as values that are more than two standard deviations away from the mean of a given attribute may be marked as potential outliers. Another type of error is the inconsistency of the source code and the inconsistency of the data representation. Field overload is another source of error. Observing the data must follow the uniqueness rule, continuity rule and null value rule. Other external materials can be used to manually correct some data inconsistencies [9, 10]. For example, errors in data input can be corrected using paper records. But most errors require data transformation.

Step 2: Correct the deviation. That is, once deviations are found, it is usually necessary to define and use (a series of) transformations to correct them. Choose to write a customized program for this step of the data cleaning process. The two-step process of deviation detection and correction is performed iteratively. As the knowledge of the data increases, it is important to continuously update the metadata to reflect this knowledge. This helps speed up the data cleaning of future versions of the same data store.

In data integration, there are many problems to be solved. The first is the problem of pattern integration and object matching. The matching of real-world equivalent entities from multiple information sources involves entity recognition. Determine whether the customer id in one database is the same attribute as the cust number in another database. The metadata of each attribute can be used to help avoid schema integration errors. Metadata can also be used to help transform data.

Redundancy is another important issue. An attribute may be redundant if it can be "derived" by another or another set of attributes. Inconsistent attribute or dimension naming can also lead to redundancy in the result data set. Some redundancy can be detected by correlation analysis. Given two attributes, this analysis can measure the extent to which one attribute implies the other based on the available data. For numerical attributes, the correlation between attributes A and B is calculated to estimate the correlation between these two attributes.

In addition to detecting redundancies between attributes, duplicates should also be detected at the tuple level. The use of denormalized tables may also lead to data redundancy. Inconsistencies usually occur between different copies, due to incorrect data input, or due to part of the updated data, but not all occurrences.

The third important issue of data integration is the detection and processing of data value conflicts. For example, for the same entity, attribute values from different data sources may be different. This may be due to different representations, scales or encodings. When matching the attributes of one database with another during data integration, the structure of the data should be considered to ensure that the attribute functional dependencies and reference constraints in the original system match those in the target system. The heterogeneity and structure of data semantics pose a huge challenge to data integration. Careful integration of data from multiple data sources can help reduce and avoid redundancy and inconsistencies in the resulting data set.

The purpose of data transformation is to transform data into a unified form. Data transformation mainly involves the following contents:

(1) Smooth: Remove the noise in the data. This technique includes binning, regression, and clustering.
(2) Aggregation: aggregate or aggregate data.
(3) Data generalization: Use concept layering to replace low-level or "original" data with high-level concepts.

(4) Standardization: Scale the attribute data proportionally to make it fall into a small specific interval.
(5) Attribute construction (or feature construction): New attributes can be constructed and added to the attribute set. Attribute construction is the construction of given attributes and adding new attributes to help improve the understanding of high-dimensional data structures.

The data specification first requires data cube aggregation: the data cube stores multi-dimensional aggregation information. Each unit stores an aggregate value, which corresponds to a data point in a multi-dimensional space. Each attribute may have a conceptual hierarchy, allowing data analysis at multiple abstract layers. The data cube provides quick access to pre-calculated summary data, so it is suitable for intelligent correction of abnormal data in online education systems.

The cubes created at the lowest level of abstraction are called primitive cubes. The basic cube should correspond to the individual entity of interest. That is, the lowest level should be available or useful for analysis. The cube at the highest level of abstraction is called a vertex cube [11]. The data cubes created for different abstraction layers are called cubes, so the data cubes can be regarded as the grid of cubes. Each higher level of abstraction will further reduce the size of the resulting data. When performing intelligent correction of abnormal data in the online education system, the smallest available cube associated with a given task should be used.

Then proceed to attribute subset selection. The heuristic methods for attribute subset selection include the following:

(1) Step by step forward selection: The process starts with an empty attribute set as the reduction set, determines the best attribute in the original attribute set, and adds it to the reduction set. In each subsequent iteration, the best attribute in the remaining original attribute set is added to the set.
(2) Delete backward step by step: The process starts with the entire attribute set. At each step, delete the worst attribute still in the attribute set.
(3) Combination of forward selection and backward deletion: It is possible to combine the stepwise forward selection and backward deletion methods, each step selects a best attribute, and deletes a worst attribute from the remaining attributes [12].
(4) Decision tree induction: The decision tree algorithm was originally used for classification. Decision tree induction constructs a structure similar to a flowchart, in which each internal (non-leaf) node represents a test of an attribute, and each branch corresponds to an output of the test; each external (leaf) node represents a class prediction. At each node, the algorithm selects the "best" attribute and divides the data into categories. When decision tree induction is used for attribute subset selection, the decision tree is constructed from the given data. All attributes that do not appear in the tree are assumed to be irrelevant. The attributes appearing in the tree form a reduced attribute subset. The end criteria of the method can be different. The process can use a degree threshold to decide when to stop the attribute selection process.

Dimensional reduction uses data encoding or transformation to obtain a reduced or "compressed" representation of the original data. The method used is principal component analysis.

Principal component analysis is to search for k n-dimensional orthogonal vectors that best represent the data, where $k \leq n$. In this way, the original data is projected into a much smaller space, leading to dimensionality reduction. PCA works by creating a replacement, smaller set of basic elements of "combined" attributes. The original data can be projected into this smaller set. PCA often reveals previously undetected connections and therefore allows interpretation of unusual results. The basic process is as follows:

(5) Normalize the input data so that each attribute falls into the same interval. This step helps to ensure that attributes with larger domains do not dominate attributes with smaller domains [13].
(6) PCA calculates k orthonormal vectors as the basis of normalized input data. These are unit vectors, and each direction is perpendicular to the other. These vectors are called principal components. The input data is a linear combination of principal components.
(7) Arrange the principal components in descending order of "importance" or intensity. The principal components basically act as the new axis of the data, providing important information about the variance. In other words, sort the coordinate axes so that the first coordinate axis displays the largest variance of the data, the second displays the second largest variance, and so on.
(8) The principal components are arranged in descending order of "importance", and the size of the data can be reduced by removing the weaker components (that is, the variance is smaller). Using the strongest principal component should be able to reconstruct a good approximation of the original data [14].

PCA has low computational overhead, can be used for ordered and disordered attributes, and can handle sparse and skewed data. Multidimensional data with more than 2 dimensions can be handled by reducing the problem to a 2-dimensional problem. Principal components can be used as input for multiple regression and cluster analysis.

Numerical reduction technology refers to the selection of alternative, "smaller" data representations to reduce the amount of data. The method used is clustering: clustering technology treats data tuples as objects [15, 16]. It divides objects into groups or clusters, so that objects in one cluster are "similar" to each other, but "different" from objects in other clusters. Generally, similarity is based on a distance function, defined by the "closeness" of objects in space. The "mass" of a cluster can be expressed by its diameter, which is the maximum distance between any two objects in the cluster. Centroid distance is another measure of cluster quality, defined as the average distance from the cluster centroid (representing the "average object", or average point in the cluster space) to each cluster object [17].

In data reduction, the actual data is replaced with the cluster representation of the data. The effectiveness of this technique depends on the nature of the data. If the data can be organized into different clusters, this technique is much more effective. In the database system, the multidimensional index tree is mainly used for quick access to data. It can also be used to reduce hierarchical data and provide multi-dimensional clustering of data. This can be used to provide approximate answers to queries. For a given set of data objects, the index tree recursively divides the multidimensional space, and its root node represents the entire space. Usually, this kind of tree is balanced and consists of internal nodes and leaf nodes. Each parent node contains keywords and pointers to child nodes, and the child nodes together represent the space represented by the parent node [18]. Each leaf node contains a pointer (or actual tuple) to the data tuple it represents.

In this way, the index tree can store aggregate and detailed data at different resolutions or abstract layers. It provides hierarchical clustering of data sets, in which each cluster has a label to store the data contained in the cluster. If we regard each child of the parent node as a bucket, the index tree can be seen as a hierarchical histogram [19]. Similarly, each bucket is further divided into smaller buckets, allowing data to be aggregated at a finer level. The use of a multidimensional index tree as a form of data reduction depends on the order of attribute values on each dimension. Two-dimensional or multi-dimensional index trees include R-trees, quad-trees and variants of Chuangmen. They are very suitable for processing sparse data and skewed data [20, 21].

Data discretization and concept stratification: Among them, the method used for data discretization is as follows: Based on the discretization: The discretization is one of the most commonly used measures of discretization. Di-based discretization is a supervised, top-down splitting technique. It uses the class distribution information when calculating and determining the split point (the data value that divides the attribute interval) [22]. For discrete numerical attribute A, select the value of A with the smallest direct value as the split point, and divide the result interval recursively to obtain hierarchical discretization. This discretization forms a conceptual hierarchy of A.

The method used for concept hierarchy is as follows: The partial order of attributes is explicitly stated by the user or expert at the schema level: Generally, the conceptual hierarchy of classification attributes or dimensions involves a set of attributes. Users or experts can easily define the concept hierarchy by explaining the partial order or total order of attributes at the pattern level [23].

2.3 Intelligent Correction of Abnormal Data

The abnormal data detected in the online education system is corrected by GA-RBF neural network, and the specific process of correcting abnormal data is shown in Fig. 2.

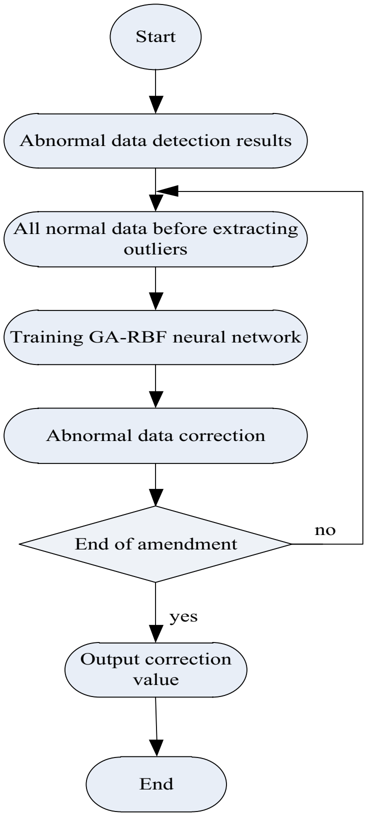


Fig. 2. Intelligent correction process of abnormal data

3 Experimental Verification

3.1 Experimental Design

The performance of the designed method of intelligent correction of abnormal data in the online education system based on big data technology is experimentally verified. Intelligent correction method of abnormal data of online education system based on big data technology is used to intelligently correct abnormal data of an online education system. The course data structure of the system is shown in Table 1.

Obtain the abnormal data prediction filling accuracy data of the online education system abnormal data intelligent correction method based on big data technology as the experimental data. In order to enhance the comparison of the experimental results, the original two online education system abnormal data intelligent correction methods were used as the comparison methods in the experiment to conduct comparative experiments. Including the intelligent correction method of online education system abnormal data based on AR model and the intelligent correction method of online education system abnormal data based on neural network algorithm. These two methods are also used to conduct intelligent correction experiments of abnormal data of experimental online

Table 1. Course data structure of the system

Type of data	Field	Type of data	Field interpretation	Is it empty	Data length
Course information data	Name	Varchar	Course title	No	20
	Summary	Varchar	Course summary	Yes	500
	Category	Int	Content classification	No	11
	Num	Int	Total number of videos	No	11
	Id	Number	Course id	No	10
	Id of teacher	Number	Teacher id	No	10
	Id of resouce	Number	Course resource id	No	10
	Time	Number	Duration	No	10
Teaching video data	Index	Int	Video sequence number	No	11
	Path	Varchar	Video path	No	100
Video associated data	Time	Varchar	Point in time	No	20
	Title	Varchar	Associate video title	No	100
	Summary	Varchar	Introduction to related courses	Yes	200
	Relatedid	Int	Associated video id	No	11

education system courses, and the abnormal data prediction filling accuracy data of these two methods are obtained as comparative experimental data.

3.2 Analysis of Experimental Results

There is an intelligent correction method of abnormal data in online education system based on big data technology, a method in literature [4] and a method in literature [5]. The comparison between the prediction accuracy of abnormal data and the filling accuracy of experimental data is shown in Table 2.

According to the comparison between the accuracy of the prediction and filling of abnormal data in Table 2 and the experimental data, it can be seen that the prediction and filling accuracy of the intelligent correction method of online education system based on big data technology is higher than that of the traditional method.

Table 2. Comparison of experimental data for prediction and filling accuracy of abnormal data

The number of abnormal data test samples (a)	Abnormal data prediction filling accuracy rate (%)		
	Method based on big data technology	Methods in literature [4]	Methods in literature [5]
500	99.35	94.20	95.80
600	99.32	94.18	95.74
700	98.65	94.15	95.64
800	98.28	94.13	95.58
900	98.17	94.08	95.47
1000	98.04	93.95	95.37
1100	97.98	93.85	95.24
1200	97.92	93.74	95.05
1300	97.81	93.28	95.01
1400	97.80	93.10	95.00

4 Concluding Remarks

The intelligent correction method of abnormal data in online education system based on big data technology realizes the improvement of abnormal data prediction and filling accuracy. This method is of great significance to the operation and promotion of online education system. In practical application, the application of this method can optimize the operating quality of the online education system, and the correction of abnormal data can improve the efficiency of the online education system.

References

1. Zou, X., Azam, M., Islam, T., et al.: Environment and air pollution like gun and bullet for low income countries: war for better health and wealth. Environ. Sci. Pollut. Res. **23**(4), 3641–3657 (2020)
2. Liu, F., Choi, D., Xie, L., et al.: Global spectral clustering in dynamic networks. Proc. Natl. Acad. Sci. U.S.A. **115**(5), 927–932 (2018)
3. Parisi, C.A., Ritchie, C., Petriz, N., et al.: Chronic urticaria in a health maintenance organization of Buenos Aires, Argentina - new data that increase global knowledge of this disease. An. Bras. Dermatol. **93**(1), 76–79 (2018)
4. Helma, C., Cramer, T., Kramer, S., et al.: Data mining and machine learning techniques for the identification of mutagenicity inducing substructures and structure activity relationships of noncongeneric compounds. J. Chem. Inf. Comput. **35**(4), 1402–1411 (2018)
5. Liu, Z., Liu, C., Ding, J., Zhang, H.: Characterization and modelling of high temperature flow behaviour of V modified 2.25Cr-1Mo heat resistant steel plate. J. Wuhan Univ. Technol.-Mater. Sci. Ed. **35**(1), 192–199 (2020). https://doi.org/10.1007/s11595-020-2243-3
6. Kenselyn, O., Boff, A.L., Rangel, B.R.: Verrucous hemangioma and histopathological differential diagnosis with angiokeratoma circumscriptum neviforme. An. Bras. Dermatol. **93**(5), 712–715 (2018)

7. Schuemie, M.J., Hripcsak, G., Ryan, P.B., et al.: Empirical confidence interval calibration for population-level effect estimation studies in observational healthcare data. Proc. Natl. Acad. Sci. U.S.A. **115**(11), 2571–2577 (2018)
8. Kwietniewski, L., Schreyögg, J.: Profit efficiency of physician practices: a stochastic frontier approach using panel data. Health Care Manag. Sci. **21**(1), 76–86 (2016). https://doi.org/10.1007/s10729-016-9378-y
9. Palumbo, J.R., et al.: Assessing associations between indoor environment and health symptoms in Romanian school children: an analysis of data from the SINPHONIE project. Environ. Sci. Pollut. Res. **25**(9), 9186–9193 (2018). https://doi.org/10.1007/s11356-018-1568-3
10. Ho, L.S., Wheeler, E.: Using program data to improve access to family planning and enhance the method mix in conflict-affected areas of the democratic Republic of the Congo. Glob. Health Pract. **6**(1), 161–177 (2018)
11. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training, pp 1–374. Springer, Heidelberg (2018)
12. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
13. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
14. Bag, S., Aich, P., Islam, M.A.: Behavioral intention of "digital natives" toward adapting the online education system in higher education. **45**(3), 158–166 (2020)
15. Jiang, Y., Li, X.: Intelligent online education system based on speech recognition with specialized analysis on quality of service. Int. J. Speech Technol. (1), 12–24 (2020)
16. Al-Odeh, M.: What universities in the Middle East can learn from the American online education system. Int. J. Inf. Commun. Technol. (IJ-ICT) **9**(1), 31–40 (2020)
17. Guan, Y., Wang, L., Meng, Z.M.: Accurate attitude determination based on adaptive UKF and RBF neural network using fusion methodology for Micro-IMU applied to rotating environment. Math. Probl. Eng. **20**(1), 20–31 (2020)
18. Chen, X., Chen, H., Xu, H.: Vehicle detection based on multifeature extraction and recognition adopting rbf neural network on ADAS System. Complexity **2020**(2), 1–11 (2020)
19. Yang, W., Guo, J., Liu, Y., et al.: Multi-objective optimization of contactor's characteristics based on RBF neural networks and hybrid method. IEEE Trans. Magn. 1–4 (2019)
20. Mohammadnezhad, M., Ghaffari, A.: Hybrid routing scheme using imperialist competitive algorithm and RBF neural networks for VANETs. Wirel. Netw. **25**(5), 2831–2849 (2019). https://doi.org/10.1007/s11276-019-01997-6
21. Ting, X.: Chemistry course network teaching based on key information search and big data cloud platform. J. Intell. Fuzzy Syst. (3), 1–12 (2020)
22. Ding, Y.: Performance analysis of public management teaching practice training based on artificial intelligence technology. J. Intell. Fuzzy Syst. **40**(5), 1–14 (2020)
23. Li, H.: Analysis of computer teaching pattern based on outlier data mining and machine learning. J. Intell. Fuzzy Syst. (2), 1–11 (2020)

Monitoring Method of students' Learning Behavior in Online Education Platform Based on Data Mining

Cheng-zhao Chen[1], Zheng Chen[1](✉), and You-xin Li[2]

[1] Wuhan College of Arts and Science, Wuhan 430345, China
[2] Department of Mechanical and Electrical Engineering, QingHai Higher Vocational and Technical Institute, Haidong 810799, China

Abstract. Education platform learning is a kind of autonomous learning, which is manifested as learners' autonomous control of learning behavior on their own education platform. In order to better improve the practical application effect of education platform, this paper proposes a monitoring method of students' learning behavior based on data mining technology, and uses data mining technology to collect and analyze students' learning behavior The process and results of the monitoring function to evaluate students' learning behavior. Based on the clear definition of learning behavior of educational platform, this paper studies the monitoring mechanism of learning behavior of educational platform from the visual angle, so as to improve the learning effect and quality of educational platform.

Keywords: Data mining · Online education · Online education · Teaching monitoring

1 Introduction

With the gradual popularization of the Internet in China and the arrival of learning society, the focus of online education platform has shifted from the initial provision of teaching resources to the organization of teaching activities. When organizing teaching activities, most schools tend to focus only on the organization of knowledge content, the design of online courses and the provision of learning resources, while ignoring the learning supervision of registered students, which is an important reason for the low learning quality of the current education platform [1]. The research status of learning behavior on education platform and learning behavior monitoring on education platform was investigated. The traditional method elaborated the connotation and significance of learning behavior monitoring on education platform, and proposed the data collection method of learning behavior monitoring on education platform. Through the research of data mining technology, the method of learning behavior characteristic log mining to realize intelligent feedback of learning behavior was proposed, Intelligent monitoring of learning behavior and application effect analysis are realized.

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 477–488, 2021.
https://doi.org/10.1007/978-3-030-84386-1_39

On the basis of the above research, some new ideas and methods are proposed to solve the problem of learning behavior monitoring on the education platform. Therefore, a monitoring method of students' learning behavior on the online education platform based on data mining is proposed. Using background database server log combined with online learning platform technology, collection of learning behavior data mining, using data mining technology to feedback of learning behavior, to achieve a certain comprehensive intelligent education platform learning behavior monitoring method, education platform for students learning behavior, rtvu teaching platform operation monitoring and data collection, Support data mining, get similar groups, related questions and other intelligent feedback, effectively realize the effective supervision of students' learning behavior. This study will effectively promote the management of the teaching process of the online education platform and provide a strong guarantee for the improvement of the teaching quality of the online education platform.

2 Online Education Platform Students' Learning Behavior Monitoring Method

2.1 Optimization of Feature Mining Method of Display Education Data

The operation of online education platform is usually based on a database management mode, which provides a safe, reliable and efficient running environment for data management, recording the time and times of students entering the mode, as well as all interactive behaviors. Online learning model collects various data in various ways to reflect students' learning behavior. How to analyze these large amounts of data, so as to provide guidance for students' learning evaluation and give scientific evaluation has become the focus of current research. Therefore, it is necessary to establish a large amount of knowledge behavior data model, and conduct learning behavior characteristics based on the above requirements combined with data mining After data preprocessing, the learning behavior information matrix of education platform is formed. Then, the algorithm of statistical analysis, path analysis, association rule mining and sequential pattern discovery are used to extract students' behavior orientation, so as to deeply mine students' learning state.

Data mining refers to the extraction of effective models hidden in a large number of, incomplete, noisy and random massive network data, and obtains the user's use characteristics according to this model. The object of data mining is massive, heterogeneous and distributed data mining documents. Data mining server log uses data mining as middleware to mine database and the data mining of log and user information on data mining server is no longer the category of traditional data mining [2]. Secondly, data mining is logically a graph composed of documents and hyperlinks. Therefore, data mining documents are semi-structured or unstructured, and lack of machine-readable implication. However, the objects of data mining are limited to structured data in database and use storage structures such as relational tables to mine knowledge. Therefore, some data mining technologies are not suitable for data mining Mining, preprocessing data mining documents to get the feature representation of documents, has become the research focus of data mining.

In online teaching platform, there are a lot of heterogeneous forms of massive resources, and each isomer only corresponds to a single attribute interface. In order to better realize the unified monitoring requirements of massive information, assembly language must be used as a tool to analyze different resource isomers abstractly, and select the rules that meet the most interface attribute requirements at the same time as the standard conditions of all interfaces. This process is the unification of heterogeneous interface specifications of massive resources. The specific content specification of monitoring learning feature mining is shown in Table 1.

Table 1. Content optimization of monitoring learning feature mining

Monitoring interface	Replacement method	Replacement function
Set up the interface	Monitoring data set	Get data sources and collect data source information
Set data	Set interface collection	
data mining	My clipboard data	Collect data destination information and decide whether to cancel the operation according to the anti monitoring rules
Get monitoring data	Real time monitoring information collection	
Settings view	–	Make sure that the monitor observation window is always at the top of the chain and that the site is first

Data mining is a process of extracting information or knowledge from data mining resources. It applies the traditional ideas and methods of data mining to data mining, and extracts interesting, potential, useful patterns and hidden information from data mining documents and data mining activities [3]. Log mining in the process of data mining is the direct source of data. Therefore, in the process of data mining, it is necessary to standardize the access logs: server logs, error logs, cookie logs to record the information about user access and interaction. In the process of data mining, there are two formats of server log: one is common, the other is extended. Therefore, the data mining common logs collected on the server can be used as the research object, and its format is shown in Table 2.

The learning behavior data acquisition module of online education platform is mainly responsible for collecting and quantifying the data of students' online learning behavior, and storing it in the behavior database to prepare for analyzing the characteristics of students and resources. Data collection module must ensure the comprehensiveness and accuracy of data collection. In order to dynamically track, collect, analyze, evaluate and feedback the learning behavior of students on the education platform, a data acquisition model of learning behavior based on the learning platform of education platform is further designed. The structure is shown in Fig. 1.

The main functions of the learning behavior data collection model are: first, tracking the learning process of students in the learning platform of education platform, collecting the data related to learning behavior in this process, and establishing the learning

Table 2. Data log mode of learning behavior monitoring

Name	Content	Parameter
Client IP	IP or/DNS entry of remote host	10.445.65
Date	The date the page was requested	19.02.4
Time	Request page time	10:00–12:00
Port	Server interface	80.22.401
Service name	The name of the service requested by the user	–
Page	User requested	5–12
Protocol version	Protocol version for transmission	–
State	Server status	Normal
Byte	Bytes transmitted (sent or received)	10.47.52

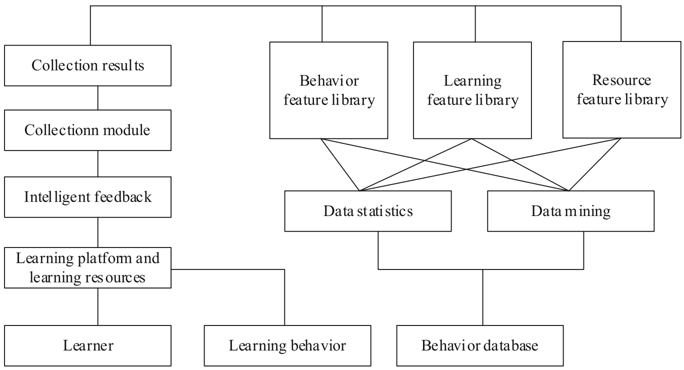


Fig. 1. Data acquisition model of learning behavior

behavior database to prepare for analyzing the characteristics of students and resources [4]. Behavioral data collection must ensure the comprehensiveness and accuracy of data collection. And the data in the learning behavior database are extracted, processed and analyzed, and the graphical operation interface is provided to realize the real-time statistical analysis of the learning behavior of students' education platform [5]. According to the collected learning behavior data, the relevant algorithms are used for data mining to find out the learning behavior patterns under the learning environment of the education platform, and the discovered learning behavior patterns are used to provide students with personalized learning contents and learning arrangements, so as to realize personalized learning support services.

2.2 Online Education Platform Student Learning Behavior Monitoring Model

From the teaching mode of online education platform, it can be seen that the implementation of online education platform teaching in the operation process largely depends on the online education platform environment constructed and whether the online education platform model adopted can meet the needs of students' personalized chemistry learning to the maximum extent. Online education platform mainly refers to the network teaching platform, which provides a series of specific education related services for students.

After several stages of development, online teaching platform has risen from the common resource database model to the comprehensive teaching support service and teaching management platform [6]. Its functions include students' online learning, teachers' online teaching, teaching administration management, online teaching analysis model, etc. In order to realize the real-time monitoring of the learning behavior of the education platform, one of the basic premises is that effective measures can be taken to automatically collect all kinds of information in the process of learners' online learning for real-time processing of behavior monitoring model [7]. How to accurately, efficiently and real-time collect the learning behavior information of education platform, the key is to define the data model of learning behavior of education platform accurately and appropriately. The learning behavior of educational platform refers to the long-distance autonomous learning behavior of learners in the learning environment created by modern information technology, with new communication mechanism and rich resources.

In order to realize the real-time monitoring of learning behavior of education platform, the basic premise is to take effective measures to collect all kinds of information in the process of learners' online learning for real-time processing of behavior analysis model [8]. Based on the accurate definition of learning behavior information of education platform, the monitoring model of learning behavior of education platform is constructed. The specific structure is shown in Fig. 2.

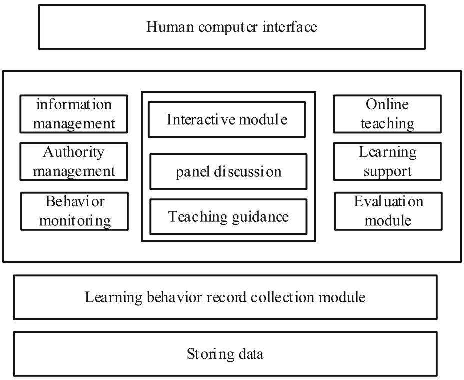


Fig. 2. Online education platform learning behavior monitoring model

As shown in the figure, the learning platform of education platform includes user management, class management, permission management, resource management, interactive world, online Q & A, learning support and evaluation model [9]. In the design of monitoring model, the behaviors that need to be recorded are counted and analyzed, and each learning behavior is refined to be as accurate as possible [10]. The learning behavior information of students' education platform is processed by learning behavior collection module, and the storage module records learning behavior into database management model in the form of database record for statistical analysis.

Aiming at the definition of learning behavior of educational platform, this paper constructs a multi-dimensional learning behavior model of educational platform, which divides learning behavior of educational platform into information retrieval learning behavior, information processing learning behavior, information publishing learning behavior, interpersonal communication and communication behavior and learning behavior based on problem solving. From the micro point of view, learning behavior should be considered in depth. According to the degree of contribution to learning effect, learning behavior can be divided into low-level, intermediate level and high-level levels, which is also helpful for targeted evaluation of students' learning behavior.

Low level learning behavior refers to simple operation behavior, including login model, browsing content, browsing resources, clicking columns, viewing personal space, etc.

Intermediate level learning behavior refers to the network interaction behavior, mainly including: answering questions, homework, forum, testing and other interactive behaviors.

Advanced learning behavior refers to the behavior that students use the learning platform of education platform to carry out cooperation and solve practical problems. With the development of information technology and mobile Internet technology. High level learning behavior usually goes beyond the single education platform learning model.

Based on this, the function of behavior detection model is further optimized, including:

Q & a test: when students encounter problems in the learning process of the education platform, they can use the "online Q & a" function to ask questions, seek real-time help from teachers or classmates, and answer questions raised by others;

Homework management: teachers set different types of homework topics according to the teaching content, and teachers evaluate the learning effect of students through the assignments submitted by students.

Forum: students post, follow, discuss and communicate on a certain topic or case to construct knowledge;

Test monitoring: it is divided into level examination and summary test, which can test the learning effect of a module or a course for students.

Resource Management: students comment on the value of curriculum resources when they study curriculum resources,

Voting Management: teachers create questionnaires or voting questions in the course construction, and students participate in the questionnaire survey or voting, so as to facilitate teachers to obtain valuable reference data;

Class speech: the learning model of education platform can create class learning space, in which students can publish their own learning and experience and share collective wisdom;

Evaluation management: it mainly refers to the real-time evaluation of teachers' and students' behaviors, such as when students' homework is rated as excellent homework, when students' questions are listed in the FAQ database by teachers, and when students' answers are rated as excellent answers, students' learning behaviors will receive additional rewards;

Negative operation behavior: when students delete questions, comments, homework and other operations, it can be considered that students have carried out negative operation, and this behavior will be punished additionally.

In addition to recording all kinds of teaching resources and interaction with teachers, the model also records the time when students log in and log off each course. According to the needs of students' formative assessment, the statistical monitoring module makes statistics on the collected learning behaviors and forms data reports, which provides data support for teachers to improve teaching and school teaching management departments to make decisions. The automatic monitoring module of learning behavior includes virtual machine, physical machine and other physical monitoring running equipment, which can realize the acquisition of monitoring indicators of learning behavior in task layer and function layer. Physical machine is an important component of cloud computing monitoring platform. It can generate occupancy index related to resource monitoring situation, and judge whether the current resource node is under monitoring according to the specific physical difference between the value and resource occupancy threshold value. When the database is not enough to support the running status of this model, the virtual machine can release the abnormal connection state, which is also the main reason that the data in the new model can quickly reach the upper limit of monitoring occupancy.The specific monitoring module structure is shown in Fig. 3.

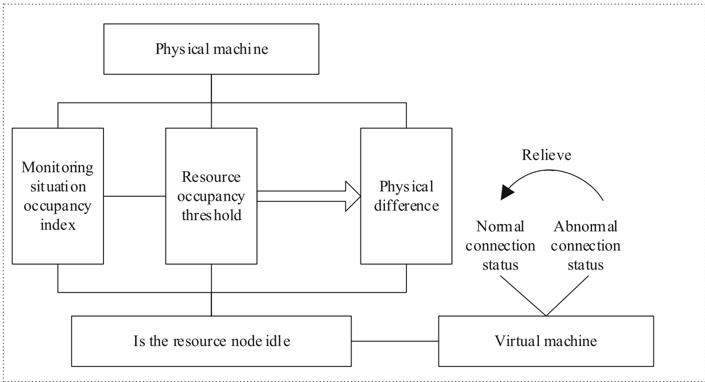


Fig. 3. Structure optimization of learning behavior automatic monitoring equipment

Based on the above structure, monitoring students' learning behavior on the education platform, and presenting the behavior trend in the form of graphics and images, we need to take a method to quantify and transform students' learning behavior.

2.3 The First Step of Online Education Platform Learning Behavior Automatic Monitoring

The automatic monitoring of learning behavior of online education platform not only requires the stable operation of the network, but also requires that the network can support the reliable transmission of multimedia data. However, the environment of network operation is very complex. Hacker attacks, computer viruses, equipment failures and software design defects may cause network anomalies and even network communication interruption. Therefore, it is necessary to install network protocol analysis equipment in the core of computer network and network outlet, comprehensively monitor the real-time flow and network application of the network, prevent or timely handle network anomalies, and ensure the normal development of online teaching activities.

Because the external environment of online education platform is mainly the learning environment of education platform, there will be network exploration, cooperation, communication and other processes in the learning process. This part focuses on the analysis of the self-monitoring process in Online Autonomous Learning, focusing on the self-regulation activities of students as learning subjects, and takes human-computer interaction and human-computer interaction in the learning environment of education platform as the cognitive means, rather than as independent process elements. In order to better conduct behavior detection, it is necessary to optimize the monitoring method of students' learning behavior on the education platform. The specific monitoring principle is shown in the Fig. 3 (Fig. 4):

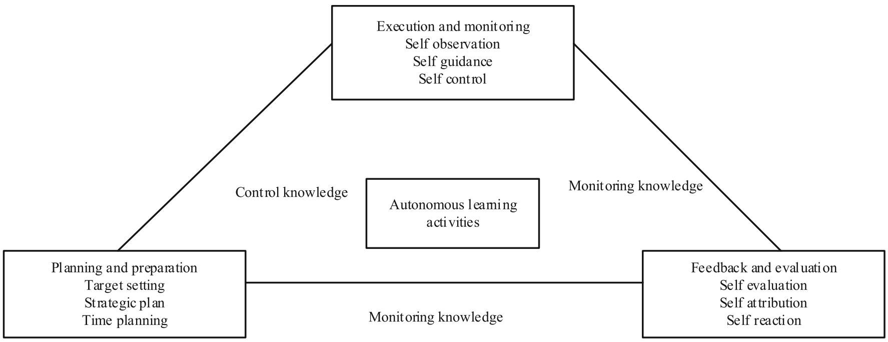


Fig. 4. Monitoring principle of students' learning behavior in education platform

Based on the above analysis, the self-monitoring process in the learning process of the education platform is constructed as shown in the figure. The whole monitoring process takes the learning environment of the education platform as the external environment, and takes the three links of students' self-monitoring as the core, regulating the whole process of autonomous learning. Due to the lack of self-monitoring of students, the learning behavior of education platform generally occurs under the supervision and encouragement of teachers. As an important function, learning monitoring of education platform is integrated into the network teaching model. Through learning monitoring, teachers can master the learning status and effect of students, and feedback the monitoring results to students, so as to implement effective learning. Learning from Professor Li Kedong's definition of learning monitoring, the author interprets learning monitoring of educational platform as a series of processes of planning, checking, evaluating, feedback, controlling and adjusting the learning activities of students' educational platform in order to ensure the success of learning on the educational platform, improve the learning effect and quality, and achieve the learning objectives. The design of monitoring process is shown in Fig. 5.

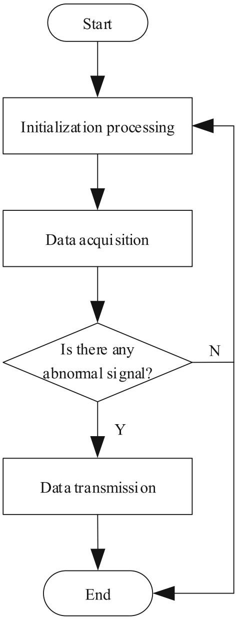


Fig. 5. Optimization design of monitoring process

It can be seen from Fig. 5 that the information is initialized, and the data is collected, and the real-time evaluation and monitoring of all education platform learning behaviors are further processed. There are four specific aspects.

The monitoring of learning time mainly monitors the total number of times that students log in to the learning model of the education platform, the total number of times to visit the model resources and columns and the average daily visits, and the total stay time of browsing resources, so as to understand the attitude and investment of students in learning on the education platform.

Monitoring the learning content and progress, students need to complete the learning tasks according to the teaching plan formulated by the teacher. The network teaching model should monitor the completion of students' content in real time, record the learning progress, and facilitate students to make early warning intervention. The process of students' task implementation includes choosing learning tasks, online learning, self-directed collaboration, submitting results, evaluating and evaluating.

The monitoring of learning interaction includes the interaction between students and network teaching model, between students and between teachers and students. When students encounter problems in the learning process, they can get help through the interactive tools provided by the network teaching model, and can also provide help for others. The interactive behavior sets the conversion rules in the form of points, and then presents the monitoring results of learning interaction in the form of learning behavior scores of education platform, mainly including class speech, comment speech, participation in voting, online questioning, forum post (reply), submission of homework and examination, etc.

According to the teaching arrangement, the course assignment and level test are submitted, the formative evaluation is carried out, and the students' theoretical learning and skill mastery are assessed. Through the monitoring of the above contents, four functions can be achieved: first, real-time positioning of students' personalized learning state, and making early warning intervention to guide students to complete the learning tasks according to the learning plan; second, evaluating whether students have reached the learning objectives, which is helpful for memory and understanding; third, the monitoring results are timely fed back to students, which will help students adjust their personal learning plans; and 4, to provide decision-making basis for teachers, and timely control the learning intervention of education platform.

3 Analysis of Experimental Results

In order to verify the practical application effect of the online education platform students' learning behavior monitoring method based on data mining proposed in this paper, the experimental equipment is carried out under Windows 2000 server operation model and Microsoft. Net framework, and visual studio is used Net tool development, using SQL Server 2000 as the background database, mainly storing learner model information and rule information. The operation model of monitoring equipment is 9vindows 2000 server+ Microsoft.Net Framework v2.0 database model: Microsoft SQL Server 2000.

The data source of data mining is the learner registration information and the learner learning process information of the network teaching model, which are collected and stored in the learner model database through the information collection model. The whole model includes two sub-models: information monitoring model and data analysis model. Enter the correct user name and password to enter. The data analysis model mainly realizes data mining analysis and intelligent feedback. The information monitoring model mainly realizes the collection and simple analysis of the basic information of the teaching platform, the information of the student group, the information of the individual student and the behavior of the teacher.

Through the real-time monitoring of the number of people online at the same time on the learning platform of the education platform, it can provide a positive reference for the teachers and technical managers of the learning platform of the education platform. According to the change of the number of online students, teachers can analyze the main time period of learners' daily online learning, and participate in the interaction between students in this period, and master the time point of releasing teaching resources and answering students' questions. Furthermore, the learning behavior monitoring effect under the traditional monitoring method and this question method is compared and recorded, as shown in Table 3.

Table 3. Comparison of platform monitoring effect

Experimental time/(min)	This method is used to monitor the timeliness/(%)	Traditional methods to monitor timeliness/(%)
50	73.15	47.02
100	80.27	47.16
150	77.98	47.23
200	82.72	47.30
250	83.60	47.41
300	83.60	47.54
350	83.60	47.59
400	83.60	47.62
450	82.87	47.78
500	82.41	47.81
550	82.06	47.94
600	81.93	47.99
Average value	79.82	47.53

Based on the analysis of the test results in Table 3, it is found that, compared with the traditional methods, the average monitoring effect of the online education platform student learning behavior monitoring method based on data mining is 81.35%, while the average monitoring effect of the traditional method is only 47.53%, which is obviously better than the traditional method in the actual application process, and fully meets the research requirements.

4 Conclusion

The development of online education platform in China is still in its infancy. Online learners in the network environment still lack the independence, autonomy and self-control learning ability required by autonomous learning. Therefore, it is necessary to introduce and strengthen the monitoring mechanism. Through strengthening the monitoring of learners' external learning behavior, we can improve learners' self-control, and give learners timely learning feedback in the process of learning on the education platform, so as to stimulate and maintain learners' learning motivation, so as to ensure the effectiveness of online education platform teaching and improve the teaching quality. The innovation of this paper is to optimize the education data feature mining method. The online learning model collects various data through a variety of ways to reflect students' learning behavior and analyze these large amounts of data, so as to provide guidance for students' learning evaluation. Establish a large number of knowledge behavior data model, based on the above requirements, combined with data mining to collect and mine the characteristics of learning behavior, record the login time, IP address, interactive behavior of student number, and store them in the corresponding database. After data preprocessing, form the learning behavior information matrix of the education platform, and then use statistical analysis, path analysis, path analysis, data mining Association rules mining and sequential pattern discovery algorithms extract students' behavior orientation, so as to deeply mine students' learning state.

References

1. Zhu, T.: Empirical research on the application of online teaching in Chinese colleges and universities under the situation of novel coronavirus pneumonia prevention and control. Int. J. Emerg. Technol. Learn. (iJET) **15**(11), 119 (2020)
2. Yang, L.: Fuzzy cluster correlation mapping for online evaluation of teaching efficacy towards IoT study. Cogn. Syst. Res. **52**(12), 365–370 (2018)
3. Guerrero-Ortiz, C., Huincahue, J.: Mathematics teacher' perceptions and adaptations in developing online classes - ideas for teacher training. J. Phys. Conf. Ser. **1702**(1), 12–19 (2020)
4. Danaher, M., Schoepp, K., Kranov, A.A.: Teaching and measuring the professional skills of information technology students using a learning oriented assessment task. Int. J. Eng. Educ. **35**(3), 795–805 (2019)
5. Zhang, L.: Development of an information-based online foreign language teaching platform with ASP.NET. Int. J. Emerg. Technol. Learn. (iJET) **14**(13), 117 (2019)
6. Jianqiu, L.: Construction of real-time interactive mode-based online course live broadcast teaching platform for physical training. Int. J. Emerg. Technol. Learn. (iJET) **13**(06), 73 (2018)
7. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
8. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
10. Liu, N., Liang, R., Zhou, Z., et al.: Designing lead-free bismuth ferrite-based ceramics learning from relaxor ferroelectric behavior for simultaneous high energy density and efficiency under low electric field. J. Mater. Chem. C **6**(38), 10211–10217 (2018)

Internet of Things and Collaborative Computing

Research on the Application of CI System in the Construction of University Class Culture Under the Internet Background

Cheng-hui Zhang[1(✉)], Wei He[2], and Yang-bo Wu[2]

[1] Xinyu University, Xinyu 338004, China
[2] College of Mathematics and Computer, Xinyu University, Xinyu 338031, China

Abstract. Class management and class culture construction are the basic work of college cultural construction, and they are the core of college student management and class management. For a long time, the construction of campus culture in colleges and universities has always neglected the construction of class culture, and it has not been regarded as an important part of the construction of campus culture. Especially for the establishment of a class culture construction management system centered on the CI system, it has not been consciously studied and practiced. Therefore, the application research of the CI system in the construction of college class culture under the Internet background is proposed, and the CI theory of the class identification system is used for reference and "grafting" to explore the new thinking and behavior mode of college class culture construction under the guidance of the CI theory. It is a cross-industry, Interdisciplinary theory and innovation, especially mobilizing all class members to participate, and implementing them in practice, has important theoretical value and practical significance.

Keywords: Internet background · CI system · Class culture · Theoretical guidance · New thinking · Behavior pattern

1 Introduction

Introduce the concept of CI into the construction of class culture to explore new thinking and behavioral models for the construction of class culture in colleges and universities. This is a cross-industry and cross-disciplinary theoretical "grafting" and innovation, especially the integration of cultural confidence in the new era and core socialist values The construction of class culture, mobilizing all class members to participate in English in practice, has important theoretical and practical significance [1]. The shaping of class culture in colleges and universities is the whole process of theoretical exploration and practical operation of interaction between teachers and students. It can effectively integrate the evaluation system into it, so that the shaping of class culture can form a multi-angle, omnidirectional, three-dimensional and systematic culture. Building a management system, the process of establishing a class image recognition system is

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 491–501, 2021.
https://doi.org/10.1007/978-3-030-84386-1_40

also a practical process of "implementing" class culture shaping. It has strong operability, practicality and vitality, which can greatly promote the construction of college campus culture, and its value and significance are far away Far beyond shaping itself [2]. The focus of the research is to put forward a CI system including three parts of the visual system, the idea system and the behavior system. This system enables each member of the class to have a strong sense of belonging, clear goals and uniform code of conduct, so as to build a cohesive and enterprising class. Let each member get good edification and temper in the class culture created by CI, so as to effectively promote the continuous improvement of the ideological and political quality, cultural quality, professional quality, physical and mental quality of class members.

2 The Application of CI System in the Construction of Class Culture in Colleges and Universities

2.1 Function Optimization of Class Culture Construction in CI System

The construction of class culture in colleges and universities is a whole process of theoretical exploration and practical operation. It allows teachers and students to participate in the interaction, can effectively integrate the evaluation system into it, and mold the class image into a multi-angle, all-round, three-dimensional, Systematic management system [3]. The establishment process of the class image recognition system is also the practical process of "implementation" of class image shaping. It has strong operability, practicality and vitality, which can greatly promote the construction of college campus culture, and its value and significance have far exceeded the shaping itself.

The CI system includes three parts: the visual system, the idea system and the behavior system. The three systems are interconnected and play a very important core role in promoting the sustainable development of the class [4]. Class management in colleges and universities can also learn from this management system and introduce CI. The purpose is to make each member of the class have a strong sense of belonging, clear goals for struggle and a unified code of conduct, so as to establish a cohesive and enterprising class collective, So that each member can be well nurtured and tempered in the class culture created by CI, thereby effectively promoting the continuous improvement of the ideological and political quality, cultural quality, professional quality, and physical and mental quality of class members [5]. In order to ensure the effect of class culture construction in colleges and universities, the main structure and functions of the CI system are optimized, as shown in the following figure (Fig. 1):

As shown in the figure, the main content of the college class image recognition system can be summarized into 4 system projects. The first part is the theoretical system of identifying CI in university classes [6]. In the process of constructing class culture, CI was originally a class recognition system. By "transplanting" and "grafting" its ideas into the class image recognition system of colleges and universities, it can become a "class recognition system" that is fully applicable to the management of college classes CI. The CI subsystem includes three parts: class concept recognition system, class behavior recognition system, and class visual recognition system [7]. The establishment of "implementation"-style measures for the image building of colleges and universities,

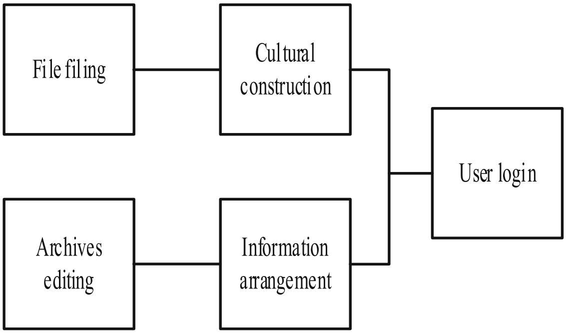


Fig. 1. CI system functional structure framework

that is, the establishment of a guidance center for shaping the image of colleges and universities, and strengthening the organizational guarantee for the construction of class culture.

2.2 Application Methods in the Construction of Class Culture in Colleges and Universities

The content of class management in the CI system can be specifically expressed in the cultural construction goals of the class collective and the management concepts of the class culture construction, etc., according to the professional characteristics, the age characteristics of the students, and the actual conditions of ideological and political quality, cultural quality, professional quality, and physical and mental quality. It must be based on the professional training goals and the needs of the social talent market to determine a reasonable application method [8].

Optimize the CI system structure based on the construction of college class culture to realize the research requirements of centralized deployment of college class culture construction. When building software functions, it is necessary to establish a client + web page model within the system to optimize the system and apply management modules. Deploy the database server to the class and share it with students [9]. Unified system maintenance of college class culture construction information, effectively guaranteeing the work requirements of effective storage of massive data, and ensuring the safe operation of the system [10]. Use the CI system to obtain a single auxiliary information and multiple auxiliary information, but to obtain this information, a comparative analysis must be conducted based on accuracy. Based on this, the steps for querying college class culture construction information are optimized, as follows (Fig. 2):

Based on the above steps, the unified release and query of the cultural construction information of the high-level class can be carried out more quickly and conveniently [11], so that students can quickly understand the content of cultural construction and participate in the cultural construction of the class, so as to improve the students' sense of collective honor.

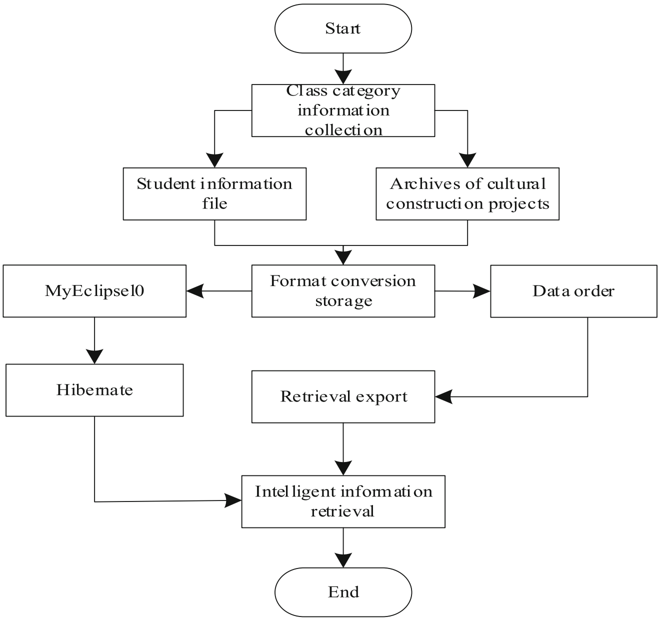


Fig. 2. Steps for querying college class culture construction information

3 Empirical Analysis

In order to verify the application effect of the CI system in the construction of college class culture under the Internet background, conduct empirical investigations, collect and understand the current situation of college class management and class culture construction through structured interviews and questionnaires, analyze and study the current class culture in cultural confidence On the basis of the construction status under the perspective, by consulting literature and data, the value meaning and basic path of class culture construction based on the CI system under the cultural self-confidence perspective are explained [12]. Based on the self-recognition and internalization of the instructors/class teachers and students as the main line, explore the specific path of class culture construction based on the CI system, and finally promote the implementation of a multi-angle, all-round, three-dimensional, and systematic class culture construction system [13, 14]. The sample of this questionnaire adopts a hierarchical design, that is, the respondents are required to cover all grades of the school, and students in different grades from freshman to senior are required. The current situation of the investigation and development of class culture construction of college students is analyzed, as follows (Table 1):

Judging from the above data, the three survey results have not reached the total sample size. This fully shows that from an overall perspective, most of the respondents believe that the construction of class culture should take into account the three aspects of class image, class system and class philosophy. However, there are still a small number of people who think that the role of class image and class system is not as great as

Table 1. Picture of class culture construction

Option	Reply
Class image design	959
Construction of class rule sand regulations	959
Class concept setting	963
Number of respondents: 1250	

the class concept. From this point of analysis, a small number of students lack a systematic understanding of the construction of class culture, and the understanding is not thorough enough. This result also puts forward higher requirements for the publicity of class culture construction, requiring more publicity of the knowledge of class culture construction, so that students clearly know the role and significance of class culture construction, and how to build an excellent class culture.

Through investigation and analysis, which aspects should be used to construct class culture, and the survey results should be counted as follows (Fig. 3):

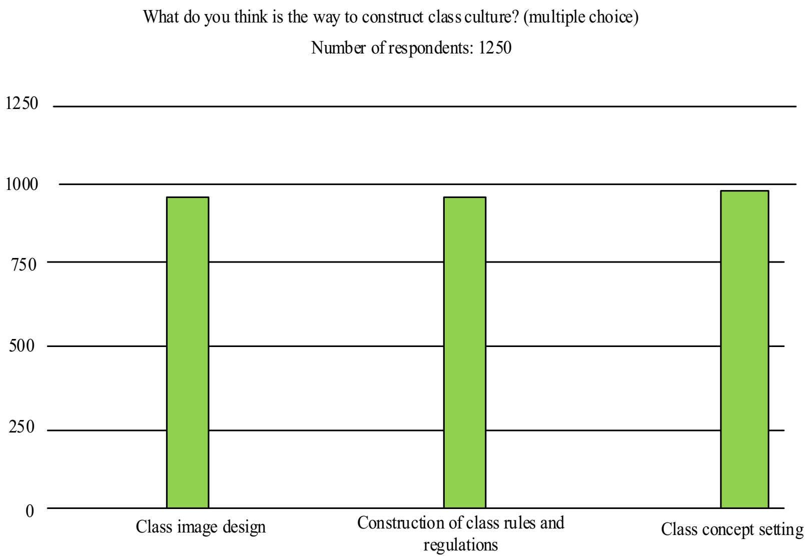


Fig. 3. The results of the survey on the development direction of the class culture construction survey

Based on the picture above, there is little difference in the three aspects of class image design, class system construction, and class concept setting. There are 959, 959, and 963 respondents who think that these three aspects should be started.

The important factors of class culture construction are further analyzed, and the statistical survey results are as follows (Fig. 4):

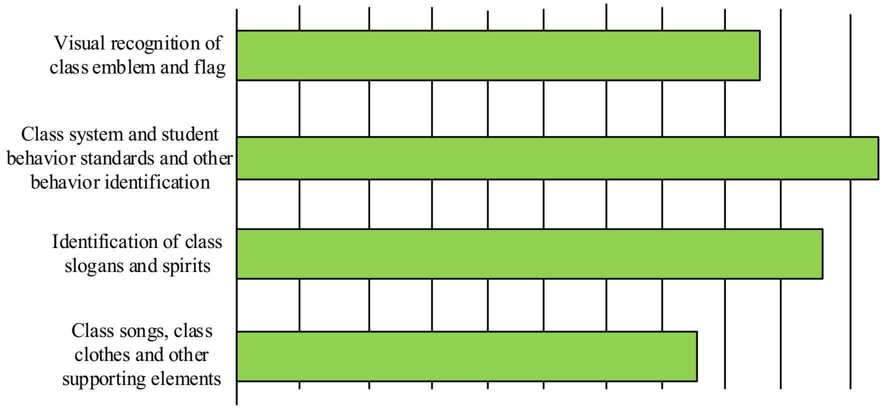


Fig. 4. Survey results of important factors in class culture construction

Based on the figure above, the data in the figure shows that 83.28% of the surveyed believe that behavior recognition such as class system and student behavior standards is one of the elements that must be possessed in class culture construction. 60.28% of the respondents believe that class slogans and spiritual concept recognition are essential elements, 68.08% of people think that visual recognition such as class flags and class badges are the elements that should be possessed, and 60.24% of people think that class ge class clothes, etc. Supporting elements are the elements of class culture construction. Investigation and research show that most people believe that the class system and student behavior standards and other behavior recognition, class slogan and spirit and other concept recognition, class flags, class badges and other visual recognition, as well as class song class clothes and other supporting elements should be available, but they agree with the class system The proportion of people who identify with students' behavioral norms and other behaviors is the highest, and those who agree with class slogans and philosophy of class management are second. This shows that the respondents are more inclined to the construction of behavior identification in the construction of class culture, but they do not ignore the concept. Recognition and visual recognition. From the perspective of class image recognition system CI, class concept recognition is the core, and behavior recognition and visual recognition are only the explicit part of concept recognition. Therefore, the formulation and implementation of the class concept is the most critical and difficult part.

The concept system of class management based on the CI system can be embodied as the class collective struggle goals, struggle slogans and the management philosophy of the class tutor. The formulation of goals, slogans, and management concepts must be based on professional characteristics, students' age characteristics, and the actual conditions of ideological and political quality, cultural quality, professional quality, and physical and mental quality, and must be based on professional training goals and the needs of the social talent market. Further investigate the impact of class culture construction on class cohesion, and the specific survey results are shown in the figure below (Fig. 5):

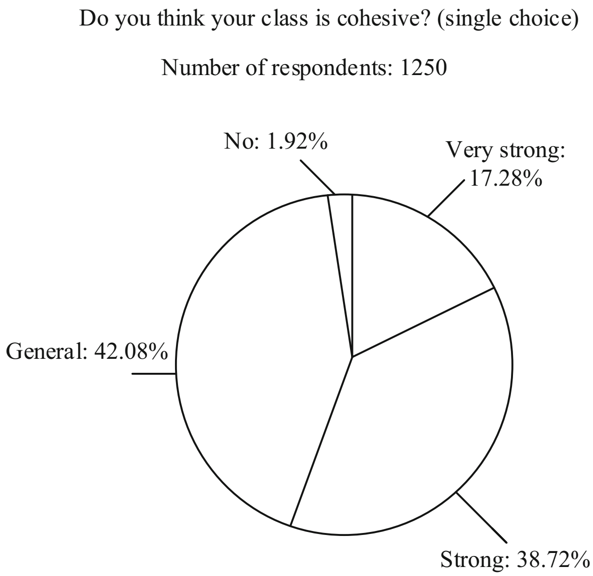


Fig. 5. Results of investigation on the impact of class cohesion

According to the above picture, the picture of the cohesion survey of the class shows that among the 1,250 respondents, most people think that the cohesion of their class is strong. There are 216 and 484 students who think their class is very cohesive, accounting for 17.28% and 38.72% of the total sample, a total of 700 people, accounting for 56%; students who think their class cohesive is average, 526 students, Accounting for 42.08%; there are 24 students who think their class is not cohesive, accounting for 1.92%. It can be seen that only a small number of students think that their class lacks cohesion, which shows that most of the class members believe that their class has strong cohesion, can be team-oriented, and have the drive to twist into a rope. This also reflects that in the construction of class culture, the concepts of class unity and class collective have been deeply rooted in the hearts of the people. However, the proportions of general and non-class cohesion are also relatively high, indicating that the construction of class cohesion needs to be improved. Further analysis of the role of class culture in promoting the growth of class members, the specific research results are as follows (Fig. 6):

Based on the above picture, the survey picture on whether class culture promotes the growth of class members shows that 1126 students believe that positive class culture promotes class members, accounting for 93.28%, and 35 students feel positive The class culture did not promote the class members, accounting for 2.8%, and 49 students did not know whether it had a promoting effect, accounting for 3.92%, which confirmed that a positive class culture can well render a good environment within the class, Supervising and correcting the daily behavioral norms of class members is an indispensable factor for a class.

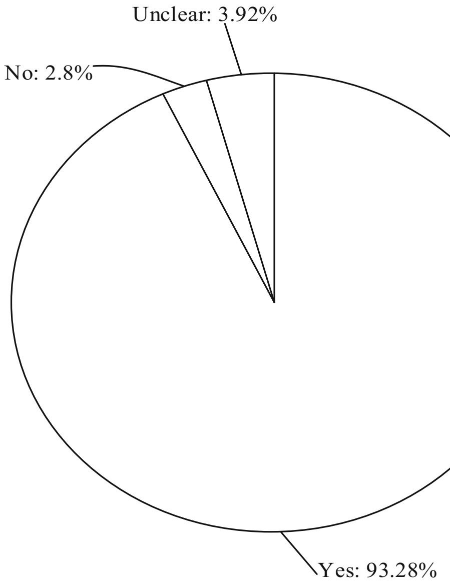


Fig. 6. The role of class culture in promoting the growth of class members

Further investigation and analysis of the impact of class culture construction under the CI system on class members, the specific results are as follows (Fig. 7):

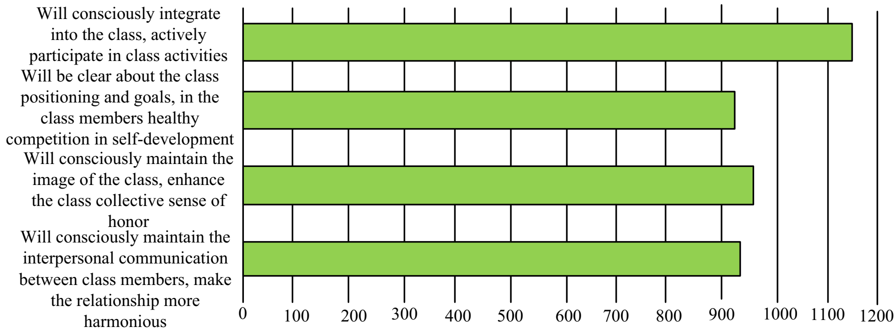


Fig. 7. The impact of class culture construction under the CI system on class members

Investigate and analyze the main content of class culture construction in colleges and universities under the current CI system, as follows (Table 2):

Table 2. The main content of class culture construction under the CI system

Option	Reply
Will consciously integrate into the class, actively participate in class activities	91.2%
Will be clear about the class positioning and goals, in the class members healthy competition in self-development	73.84%
Will consciously maintain the image of the class, enhance the class collective sense of honor	77.28%
Will consciously maintain the interpersonal communication between class members, make the relationship more harmonious	74.96%
Number of respondents: 1250	

Based on the above survey results, it can be seen from the survey chart about the impact of class culture construction on class members, 91.2% of the respondents believe that class culture construction is essential for class members to "consciously integrate into the class and actively participate in the class. Activities", 73.84% of people believe that class culture allows class members to clarify class positioning and goals, and to develop themselves in the healthy competition of class members, and 77.78% think that class culture allows class members to consciously maintain class image. To enhance the sense of collective honor of the class, 74.96% of the people agreed with the view that "the construction of class culture will allow class members to consciously maintain the interpersonal communication among class members".

A survey is conducted on the willingness of class culture construction and development, and the specific interviews are as follows (Fig. 8):

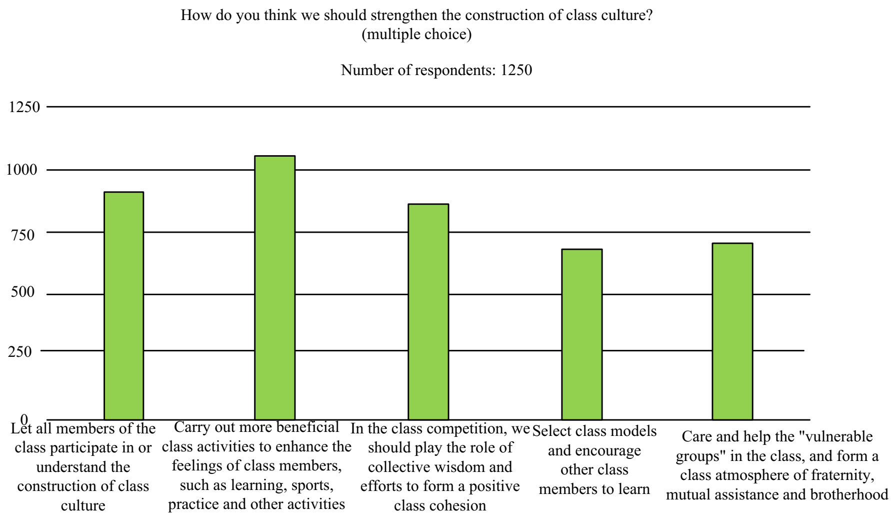


Fig. 8. Suggestions for the development of class culture under the CI system

Based on the above picture, 84% of people think that more useful class activities should be carried out to enhance the relationship between class members, such as learning, sports, practice and other activities. 71.92% of people think that "let class members participate in or understand the work of class culture construction" It should be an element of class culture construction. 69.04% of people think that it is necessary to play the role of teamwork in the collective competition of the class to form a positive class cohesion. Those who think it is necessary to have the two elements of "selecting a role model for the class and advocating other class members to learn" and "caring for the disadvantaged groups in the class, forming a class atmosphere of friendship, mutual assistance, and brotherhood" accounted for the lowest proportion, only 54.96% and 56.08%. Based on the above research results, the development direction of class culture construction under the CI system is analyzed, as follows (Table 3):

Table 3. Development direction of class culture construction under the CI system

Option	Reply
Let all members of the class participate in or understand the construction of class culture	71.92%
Carry out more beneficial class activities to enhance the feelings of class members, such as learning, sports, practice and other activities	84%
In the class competition, we should play the role of collective wisdom and efforts to form a positive class cohesion	69.04%
Select class models and encourage other class members to learn	54.96%
Care and help the "Vulnerable groups" In the class, and form a class atmosphere of fraternity, mutual assistance and brotherhood	56.08%
Number of respondents: 1250	

It can be seen from the above data that more people agree with the organization of class activities, and believe that the construction of class culture requires more useful activities and mobilize the sense of participation of class members. However, there are relatively few people who believe that the construction of class culture sets an example of the class and cares for "vulnerable groups", forming a situation of friendship, mutual assistance, and sympathy with brothers and feet., It is plainly believed that the construction of class culture only requires more activities and more participation, and the importance of the influence behind the construction of class culture is not high. In other words, this group of people does not have a strong overall concept of class culture construction, and feel that the spiritual aspect of class culture construction is of no substantive use, so subjectively assume that class atmosphere is not an essential element in class culture construction.

4 Conclusion

The construction of class culture in colleges and universities is an innovative and theoretical research, and it is also a basic and practical research. It needs to be constantly explored and improved in practice. Through the development of a series of class culture construction activities and theoretical summaries, a scientific concept is formed System mode with operability.

Fund Projects. Jiangxi ideological and political special project: the application of CI system in the construction of class culture in Colleges and universities in the new era (No.: SZZX2002).

References

1. Hames, A.L., Paulenova, A., Willit, J.L., et al.: Phase equilibria studies of the LiCI-KCI-UCI_3 system. Nucl. Technol. **203**(3), 272–281 (2018)
2. Al-Jeboori, Y., Kosarieh, S., Morina, A., et al.: Investigation of pure sliding and sliding/rolling contacts in a DLC/Cast iron system using MoDTC-type friction modifier. Tribol. Int. **122**(4), 23–37 (2018)
3. Li, C.I., Chen, G.D., Sung, T.Y., et al.: Novel adaptive Kalman filter with fuzzy neural network for trajectory estimation system. Int. J. Fuzzy Syst. **21**(6), 1649–1660 (2019)
4. Elsobky, M., Mahsereci, Y., Yu, Z., et al.: Ultra-thin smart electronic skin based on hybrid system-in-foil concept combining three flexible electronics technologies. Electron. Lett. **54**(6), 338–340 (2018)
5. Habib, M., Ladjici, A.A., Bollin, E., et al.: One-day ahead predictive management of building hybrid power system improving energy cost and batteries lifetime. IET Renew. Power Gener. **13**(3), 482–490 (2019)
6. Gabbarini, V., Rossi, R., Ciparisse, J.F., et al.: An UltraViolet Laser-Induced Fluorescence (UV-LIF) system to detect, identify and measure the concentration of biological agents in the environment: a preliminary study. J. Instrum. **14**(07), C07009 (2019)
7. Secules, S., Gupta, A., Elby, A., et al.: Zooming out from the struggling individual student: an account of the cultural construction of engineering ability in an undergraduate programming class. J. Eng. Educ. **107**(1), 56–86 (2018)
8. Golasz-Szolomicka, H., Szolomicki, J.: Selected modern public culture and educational buildings in countries of the Persian Gulf. IOP Conf. Ser. Mater. Sci. Eng. **960**(2), 022052 (2020). (10pp)
9. Calilhanna, A., Onwubiko, S.G.: Mathematical music theory of embodied acoustics of Ikoro music using beat-class theory. J. Acoust. Soc. Am. **146**(4), 2999 (2019)
10. Binz, C., Razavian, N.B., Kiparsky, M.: Of Dreamliners and drinking water: developing risk regulation and a safety culture for direct potable reuse. Water Resour. Manage **32**(2), 1–15 (2018)
11. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
12. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
13. Xiaoyan, W.: Analysis on the influencing factors of college students' payment for knowledge under the background of "Internet+"—a case study of college students in Hefei. Adv. Appl. Math. **09**(9), 1522–1528 (2020)
14. Wu, Y., Wu, P., Ma, W.: The inclusive reform of rural finance in eastern coastal areas under the background of internet finance and its promotion to fishery economy. J. Coastal Res. **115**(1), 31–38 (2020)

Education Information Network Terminal Big Data Analysis Response and Monitoring System

Lei Ma[1](✉), Xin-yu Lv[2], and Shuai Fu[1]

[1] Beijing Polytechnic, Beijing 100016, China
malei235@tom.com
[2] School of Mathematics and Statistics, Wuhan University, Wuhan 430070, China

Absrtact. The current data analysis response and monitoring system has not established a monitoring system communication model, which leads to poor monitoring effect of abnormal data, unable to access users at the same time, and long response time of the system. Therefore, this research designs a new education information network terminal big data analysis response and monitoring system. Considering the system functions required by the educational information network terminal, the hardware structure of the system is designed. In the aspect of software design, the communication topology of educational information network terminal is established, and the system communication model is built to make the system have communication function. Then the monitoring module of educational information network terminal is designed from the perspective of server and client. The experimental results show that: in the educational information network terminal under the system, the stored information has higher security, better accuracy, processing ability and completeness, and can support more virtual users to visit the system pages at the same time, with faster response time.

Keywords: Education information network · Terminal big data · Analysis response · Data monitoring

1 Introduction

With the rapid development of computer network, computer has been widely used in various industries and fields. In order to realize the sharing of internal resources, the application of local area network has been greatly developed. In order to make better use of the functions of the Internet, more and more companies, schools and various functional departments have provided the function of interconnection with the Internet. Although this measure brings a lot of benefits to the development of education, it also threatens the security of educational information. Especially, the educational information network terminals, such as users using U-disk with virus or browsing aggressive websites, may damage their own terminal devices. If it is a worm, it will infect other devices in the network, causing serious consequences [1]. Therefore, the network terminal monitoring technology has high practical value and research significance, and the research on this technology will make up for the internal security defects of the network.

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 502–513, 2021.
https://doi.org/10.1007/978-3-030-84386-1_41

Remote monitoring is a frontier research topic at home and abroad, and active research has been carried out. Due to the rapid development of computer technology and communication technology in China, research in this field has been actively carried out in recent years, and network terminal monitoring devices such as Meiping network management master and network post have been designed [2]. However, in the above research, there are some problems, such as the poor effect of information transmission and client network information guarantee. To solve this problem, this study designed a new education information network terminal big data analysis response and monitoring system.

2 System Hardware Structure Design

The design of educational information network terminal monitoring system, considering the system function required by the educational information network terminal, and the realization of the system monitoring educational information network terminal function, based on the research of educational information network terminal monitoring system at home and abroad, determine the main structure of the system, including educational information network terminal data acquisition, data processing, data communication, LCD Among them, the core control part is the control module of the system, which controls the main operation of the system. Therefore, the hardware structure of the education information network terminal monitoring system designed this time will select pici8f87k22 single chip microcomputer with 8-bit high performance as the core controller of the system. The hardware structure of the design system is shown in Fig. 1.

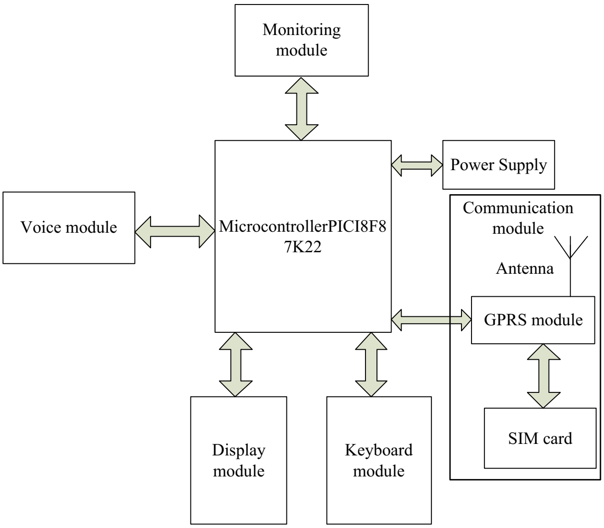


Fig. 1. System hardware structure

As can be seen from Fig. 1, the hardware structure of the system is composed of monitoring, voice, power supply, communication, display, keyboard and other modules.

Among them, the communication module is used to connect the monitoring center and system terminal equipment of the monitoring module; the voice module is used for voice alarm in the nursing process, such as large fluctuations in the educational information network terminal, abnormal data in the information stored in the educational information network terminal, etc., to prompt relevant personnel through voice broadcast; the display module is used to display the current monitoring educational information network Terminal data, such as the access and response of educational information network terminal.

3 System Software Design

Based on the hardware design of the education information network terminal monitoring system, this paper determines the education information network terminal communication topology, analyzes the education information network terminal response with big data, establishes the system communication model, promotes the system to have the communication function, and designs the monitoring education information network terminal monitoring module from the two directions of server and client, so as to ensure the education information network The terminal runs safely.

3.1 Big Data Analysis and Response of Educational Information Network Terminal

Suppose that the educational information network is a double-layer educational information network composed of wireless network and wired network [3]. There is no link between wireless network and wired network, but there is link between wired network and wired network, and between wireless network and wireless network. Among them, the wireless network is responsible for the communication with small handheld terminals, and the wired network is responsible for the relay and forwarding of signals and the communication with large terminals. The communication topology of educational information network terminal is shown in Fig. 2.

In Fig. 2, terminal A and terminal C are within the coverage of the wireless network. The communication process of terminal A and terminal C is: terminal a $\rightarrow$ wireless network $\rightarrow$ terminal C. The communication between terminal A and terminal B needs the internal routing of satellite network, and their communication business process is: terminal a - wireless network 1 $\rightarrow$ wired network 1 $\rightarrow$ wired network 2 $\rightarrow$ wireless network 2 $\rightarrow$ terminal B. According to the above analysis process, analyze the big data analysis response of education information network terminal.

The service response of educational information network terminal is defined as the time from a certain terminal to sending service request to receiving the reply from the destination terminal [4, 5]. Therefore, the service response includes two parts: the delay in the data sending phase and the delay in the receiving phase. Only interactive service has the concept of response. When the service type belongs to non interactive service, the bidirectional response of service will degenerate into one-way delay of the whole network.

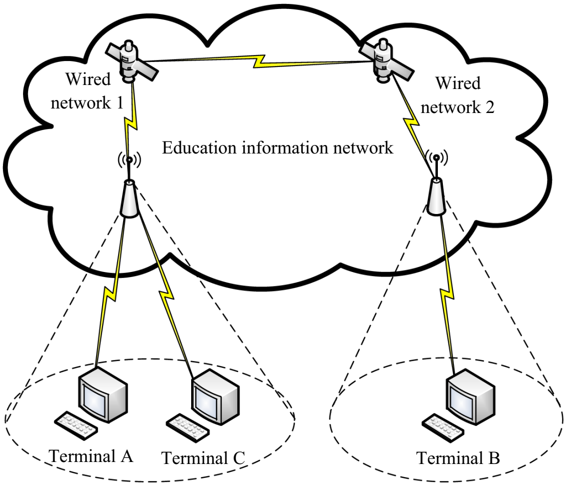


Fig. 2. Communication topology of educational information network terminal.

The service types of educational information network terminal include real-time service and non real-time service. The characteristics of real-time service are connection oriented, high delay requirement and low bandwidth requirement. The real-time service requires to complete the communication between two terminals with as low delay as possible. For non real time services, the receiving terminal may not be online, the network equipment needs to store data, and the non real time service itself does not require high delay [6]. Therefore, the analysis of education information network terminal big data analysis response, the main analysis of the terminal response to real-time business.

In the whole process, the delay in both sending and receiving stages can be further divided into terminal delay and spatial link delay. In the communication process from A to B, the sending and receiving terminals will produce packet processing delay and transmission delay respectively [7]. Space link will have propagation delay, transmission delay, processing delay and queuing delay. Then the packets returned by B are sent to terminal A according to the communication process of terminal B → satellite network → terminal A, which is similar to the response analysis from terminal A to terminal B. So far, A receives the packet replied by B, that is A's packet is responded.

3.2 Establish System Communication Model

According to the education information network terminal communication topology shown in Fig. 2, we can find that the education information network is mainly used in the internal LAN. Therefore, the design of educational information network monitoring system, mainly used in the internal LAN monitoring, then the design of the monitoring system, to complete the function design, its monitoring system communication model is shown in Fig. 3.

The communication model of the monitoring system as shown in Fig. 3 is divided into two parts: client and server. Among them, the client runs the monitoring driver and is the data source of the whole system. In order to reduce the load of the client and for

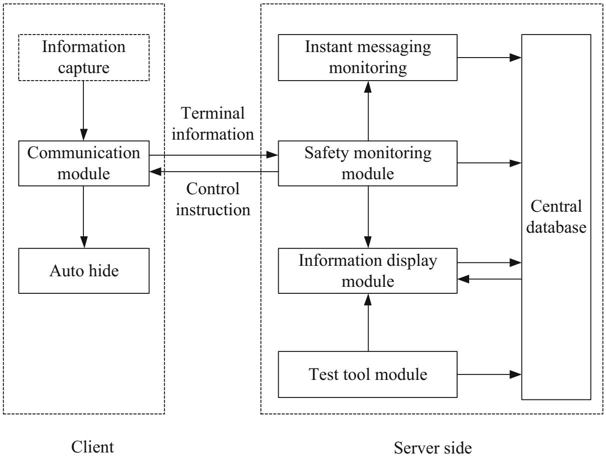


Fig. 3. Communication model of monitoring system

the consideration of security, the system adopts a centralized data management method to uniformly manage and summarize the data [8, 9]. This is easy to maintain the integrity and stability of the data, but also conducive to the server quickly retrieve and display data.

3.3 Monitoring Education Information Network Terminal Monitoring Module

Based on the above design of the education information network terminal big data analysis response and communication module, we can find that the design of the monitoring system, the education information network terminal, are divided into server and client two aspects, so, this section of the design of education information network terminal monitoring module, also from the server and client two aspects, monitoring education information Information network terminal.

1. The client consists of the message part and the request processing function initiated by the local receiving server. Through the interaction between these function lists, the integrity of the whole system can be guaranteed. The client mainly includes the following parts:

   (1) Information capture part: mainly responsible for collecting the key system information (CPU (Central Processing Unit), memory, process list, etc.) on the host;
   (2) Communication module: the main function is to receive instructions or messages sent by the server, make corresponding responses, such as locking or unlocking, shutdown and other instructions, and realize encrypted communication with the server;
   (3) Hidden module: mainly responsible for the automatic loading of the client and the automatic hiding of the corresponding process [10].

2. The server is composed of security monitoring, information display, communication, system maintenance tools and other functions. Through the interaction between these function lists, the system has the monitoring function. The specific functions are as follows:

   (1) The security monitoring module includes: LAN (Local Area Network) scanning processing module, port summary processing module, filter analysis processing module, port log processing module, firewall processing module, etc. The monitoring server dynamically analyzes all the incoming and outgoing IP (Internet Protocol) addresses and ports in the LAN. According to the abnormal analysis of the ports and incoming and outgoing packets, the illegal operation can be judged. Summarize the ports by IP address to view the illegally used network processes. The abnormal IP address can be analyzed separately to determine the main object of illegal operation. Firewall can be used to block the port and address.
   (2) Information display module includes: screen capture processing module, client locking module, communication processing module, client management module, etc. It mainly monitors the client on a regular basis, and remotely captures the abnormal traffic. The client can directly view the screen. If illegal use is found, the message module will give a warning. If you don't pay attention to it, you can lock the client or remotely close the client.
   (3) Instant messaging module. Mainly for the use of abnormal time, such as MSN (Microsoft Service Network) for content and message capture.
   (4) The integration tool module includes: routing test and connectivity test. Using these tools to test the connectivity of local LAN and the function of remote network routing, the administrator can quickly find the cause of network failure.
   (5) Central database. It mainly stores and manages all kinds of data, and is the storage center of system monitoring data.

4 Experiment and Result Analysis

In order to verify the feasibility of the big data analysis response and monitoring system designed above, the following experiments are designed.

By means of comparative experiment, the big data analysis response and monitoring system of the educational information network terminal designed in this paper is recorded as System A, and the traditional system is recorded as System B. Then determine the number of intrusion data of educational information network terminals, change the number of system access and login, and compare the effect of abnormal data monitoring, access speed and system response time of the two groups of systems.

4.1 Experimental Preparation

The experiment is based on the Visual Studio development platform, and the remaining development environment parameters are shown in Table 1.

Table 1. Two groups of system development environment

Environmental Science	Configuration	Parameter
Software	Programing language	C++
	Operating system	Windows 10
	SERVER network	Wired network
	Network IP address	127.0.0.1
	LDAP (Light Directory Access Portocol) management	Phpldapadmin
Hardware	LDAP server	OPENLDAP
	Hard disk	40G
	Web server	Internet Information Server, IIS

In addition, the baud rate of the experimental communication protocol is set to 9600 bps, and the receiving and sending codes of the information are ASCII (American Standard Code for Information Interchange) codes.

Based on the above content and considering the transmission efficiency of the data transmission protocol, the mesh topology structure is selected as the topological result of the experimental method. The topology is shown in Fig. 4.

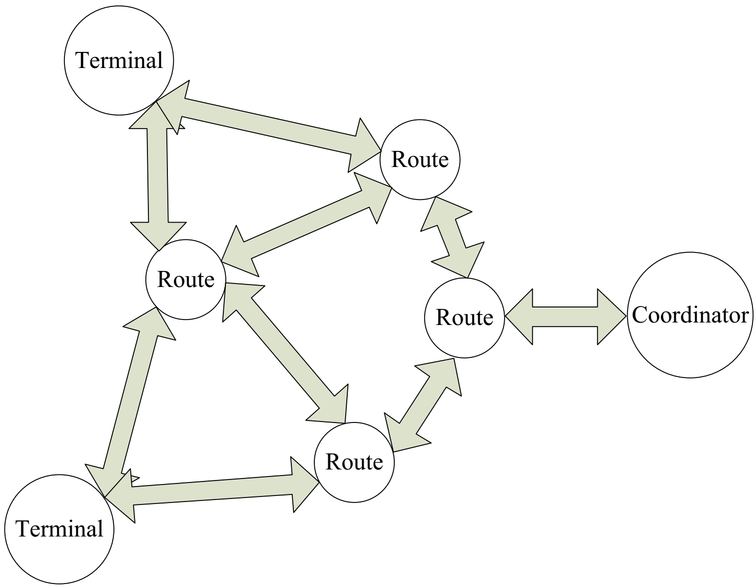


Fig. 4. Topological structure of two groups of system operation environment

4.2 Experimental Result

The First Group of Experimental Results

The first group of experiments was carried out based on the experimental parameters set above. Considering that a large amount of network education information is stored in the education information network terminal, the designed network education terminal monitoring system needs to have the function of monitoring information security. Therefore, set the abnormal data as shown in Table 2 and distribute it to the education information terminal to attack the education information stored in the education information terminal.

Table 2. Abnormal data

Data name	Quantity/piece	Data name	Quantity/piece
DOS	6295	U2R	69
P2L	979	PROBE	2806
Number of normal data			831974
Total number of abnormal data in KDD cup 1999			842123

In order to make the experiment more authentic, the educational information stored in the educational information terminal is divided into three sets. In order to reduce the difficulty of the experiment, the abnormal data shown in Table 2 is evenly distributed to the education information set stored in the education information terminal, which accounts for 1% of the total number of the education information set stored in the education information terminal. In this experiment, the attack type data distribution results are shown in Table 3.

Based on the abnormal data shown in Table 2 and Table 3, select the detection rate and the false alarm rate, verify the big data analysis response and monitoring system of the Yu Information Network Terminal, and monitor the security accuracy, processing capacity and completeness of the information stored in the Yu Information Network Terminal Therefore, the expressions of the detection rate D and the false alarm rate F of the information security of the education information network terminal are:

$$\begin{cases} D = \dfrac{m}{M} \times 100\% \\ F = \dfrac{e}{E} \times 100\% \end{cases} \tag{1}$$

In formula (1), M represents the total number of intrusion data; m represents the number of detected data intrusions; E represents the total number of events; e represents the number of false alarm events. At this time, change the total number of test data and the number of abnormal data intrusion, record the number of detections and false alarms of the two systems, and use the formula (1) to calculate the detection rate and false alarm rate. The experimental results are shown in Table 4 Show.

Table 3. Distribution of abnormal data

Data	Aggregate 1	Aggregate 2	Aggregate 3	Intrusion type
Rootkit	9	10	6	U2R (User-to-Root)
Loadmodule	9	21	14	U2R
Warezmaster	48	37	170	R2L (Remote-to-Local)
PSpy	48	0	31	R2L
Multihop	52	252	92	R2L
Ftp-write	45	116	108	R2L
Portsweep	29	154	439	PROBE
Ipsweep	54	350	1780	PROBE
Smurf	73	529	1353	DOS (Disk Operating System)
Neptune	185	524	317	DOS
BACK	315	2514	697	DOS

Table 4. Comparison table of the monitoring results of the two groups of systems

Test	5489		3978	
Invade	1852		1278	
System	A	B	A	B
monitor	1756	1531	1191	905
D/%	94.82	82.67	93.17	70.81
False positive	181	208	101	137
F/%	3.29	11.23	2.97	10.71

It can be seen from Table 4 that the information stored in the B system monitoring education information network terminal is safe, and the detection rate and false alarm rate obtained by its monitoring increase with the increase of the number of intrusions, which has a better detection effect. However, the average detection rate is 80.36%, the overall intrusion detection rate is low, the average false alarm rate is 10.3%, and the overall false alarm rate is high. System A monitors the security of the information stored in the education information network terminal, and its monitoring The detection rate and false alarm rate obtained vary with the total number of tests, and it also has a better detection effect. However, the average detection rate is 93.79%, which is significantly higher than the B system, and the average false alarm rate is 3.11%, significantly lower than the B system. It can be seen that the big data analysis response and monitoring system of the education information network terminal designed this time monitors the security of the information stored in the education information network terminal, and has better accuracy, processing capacity and completeness.

Second Set of Experimental Results

In the second group of experiments, considering the system monitoring the running state of the educational information network terminal, the security data of the running state is obtained. Due to the existence of multiple simultaneous access to the phenomenon, will affect the system page access speed. Therefore, compare the two groups of system page access speed. In this group of experiments, a total of 300 users are simulated and the system functions are accessed at the same time. Every 1 min, 30 virtual users are added, and the response time of the above five functions is recorded under different numbers of virtual users, and the 5 functions are calculated The average response time is shown in Fig. 5.

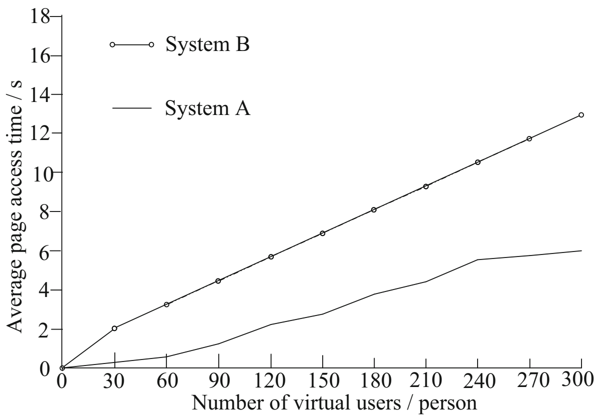


Fig. 5. Two sets of system page access speed test results

It can be seen from Fig. 5 that as the number of virtual users increases, the average time to access system functions increases. Although the B system can support 300 virtual users to access the system pages at the same time, when the number of users continues to increase, based on the current trend, the average page access time is proportional to the number of virtual users; A system, when virtual users When it reaches 240 people, the average page visit time is close to a straight line, and it is impossible to judge how many virtual users can be supported to visit the system page together. It can be seen that the big data analysis response and monitoring system of the Yu Information network terminal designed this time can support more virtual users while accessing the system page, and the average access time of the system page is only 8 s.

Results of the Second Set of Experiments

Based on the results of the first set of experiments and the second set of experiments, the second set of experiments is carried out. In the system, 500,000 user records are preset. At this time, the Loadrunner stress test tool is used to simulate 600 logged-in users. Let these 600 simulated users load a user trend every 3 s until the 600 simulated users are loaded. The initial statistics of virtual users are 100 virtual users. Users, log in and operate the system at the same time, and the execution time of each user's operation lasts for five minutes. According to the operation process of the above settings, the system response time should be maintained within 3 s (including 3 s) when the system is operated by the user under normal conditions. According to the experimental process of this set of experiments, the response time test results of the two systems are shown in Table 5.

Table 5. Terminal response time test results

System	Test items	
	Number of concurrent users/a	System response time/s
System A	50	0.2
	100	0.6
	150	1.3
	200	1.8
	250	2.3
	300	3.0
System B	50	3.1
	100	5.5
	150	6.2
	200	7.7
	250	8.1
	300	8.9

It can be seen from Table 5 that the response time of system B is the longest of the two groups of systems, and can only support less than 50 virtual users while using the system; system A has the shortest response time and remains within the normal range. It can be seen that the education information network terminal big data analysis response and monitoring system designed this time can support 300 people to log in to the system at the same time, and the system has the shortest response time.

Based on the above three sets of experimental results, it can be seen that the big data analysis response and monitoring system of the education information network terminal designed this time can support more virtual users and access the system page at the same time, and the system response time is the shortest. Among the monitoring education information network terminals, The stored information is safe, with better accuracy, processing capability and completeness.

5 Conclusion

This study design education information network terminal data analysis response and monitoring system, on the basis of the present study, from the education information network terminal client and server two aspects, the structure design and function module division, improve the education information network terminal data analysis response and monitoring system for monitoring capability. However, the education information network terminal big data analysis response and monitoring system designed this time did not consider the relationship between the system and the client, firewall, anti-virus and other software. Therefore, in future research, it is necessary to further study the education information network terminal big data analysis response and monitoring system, and coordinate the relationship with each other, so as to avoid the appearance of system instability.

Project: Personal information security threats and Countermeasures under the background of big data.

References

1. Song, X.: Design study of underground power supply network monitoring system in Sanyuan Coal Industry. Coal Chem. Ind. **43**(8), 71–73 (2020)
2. Wang, T., Zhu, Y., Zhao, W., et al.: Research on alarm generation algorithm of visual monitoring system integrating Bayesian network. China Comput. Commun. **32**(10), 23–25 (2020)
3. Tang, Z.: Dynamic integration simulation of multimedia network video surveillance front-end data. Comput. Simul. **37**(4), 155–158+465 (2020)
4. Yang, Y.: Design and application of computer video monitoring system. China Comput. Commun. **32**(12), 101–103 (2020)
5. Li, H.: Design of automation monitoring system for real-time sensitive information of electrical equipment. Mod. Electron. Tech. **43**(4), 1–3, 7 (2020)
6. Wu, J.: Design of network data flow intelligent monitoring system based on operation and maintenance data. Bull. Sci. Technol. **35**(7), 156–160 (2019)
7. Shi, G., Xu, J., Guo, Q., et al.: Design and implementation of location monitoring system based on mobile terminal. Inf. Res. **45**(5), 61–65 (2019)
8. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
9. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): E-Learning, E-Education, and Online Training, pp. 1–374. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-93719-9
10. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)

Feature Extraction Method of Students' Ideological and Political Learning Behavior Based on Convolutional Neural Network

Hong-bing Jiang(✉)

School of Road Bridge and Architecture, Chongqing Vocational College of Transportation, Chongqing 402247, China

Abstract. In order to improve the accuracy of feature extraction of students' Ideological and political learning behavior, a method of feature extraction of students' Ideological and political learning behavior based on convolutional neural network is proposed. The image of students' Ideological and political learning behavior is obtained and stored, and the stored image is corrected. On the basis of image correction, the similarity measurement of students' image spatial structure information details and the representation of image spatial structure information details are used to extract the characteristics of students' Ideological and political learning behavior based on convolutional neural network. The experimental results show that the method based on convolution neural network not only improves the accuracy of feature extraction, but also reduces the time of feature extraction.

Keywords: Convolution neural network · Learning behavior · Feature extraction

1 Introduction

As the main body, learners play an important role in teaching activities. As a reflection of students' physical and psychological conditions, learning state has become a hot research content in the field of education. As one aspect of learning state, fatigue state can better reflect the performance of students in the classroom. The research on it is helpful to understand students and teaching evaluation. Therefore, it is necessary to study the feature extraction of students' learning behavior.

Facial features are an effective representation of students' learning characteristics, and studies have shown that eyes are most closely related to fatigue. The detection steps in current research generally include face detection, eye location and detection, feature extraction, eyes and fatigue status judgment. Among them, face and eye detection and state judgment are the core issues. However, the main problem existing in the existing research is that the positioning of the eyes is easily affected by the external environment, and the judgment of the state requires artificial definition and extraction of eye features. Only by solving these key problems, can the judgment of students' ideological and political learning behavior be effectively realized. For this reason, aiming at the problems in traditional methods, a feature extraction method of students' ideological and political

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 514–526, 2021.
https://doi.org/10.1007/978-3-030-84386-1_42

learning behavior based on convolutional neural network is proposed. Convolutional neural network is a construction that imitates the biological visual perception mechanism, which has advantages when processing big data such as images. It is different from traditional neural networks in that it uses convolution operations instead of multiplication operations. The connection between the convolutional layers in the convolutional neural network is called sparse connection, that is, compared with the full connection in the feedforward neural network, a certain neuron in the convolutional layer is only connected to a part of its adjacent layer, rather than all neurons. In addition, the convolutional layer and pooling layer in the convolutional neural network can respond to the translation invariance of input features, that is, it can identify similar features located at different positions in space. Therefore, this paper uses the convolutional neural network to study the students' thinking behavior characteristic extraction method. First, store the acquired student's thinking to study behavior, correction processing, according to processing results, information details in the image Similarity metrics, characterize the details of image space structure information, based on this, extract students' thinking and regulatory learning behavior, and finally verify the effectiveness of this method through simulation experiments.

2 Image Acquisition and Storage of Students' Ideological and Political Learning Behavior

Training, detection and testing process are inseparable from experimental data, image acquisition and storage is to collect experimental data. With the help of camera, students' activity videos in class are captured dynamically, and the video stream is converted into images by opencv according to the actual situation, and stored in the specified folder, so as to be used as the input data of later face detection experiment.

In order to understand human behavior, we need to detect human objects through recognition system. Firstly, the human and video frames in the video sequence are decomposed. The time frame method can be used to obtain the moving region of the image by comparing the pixel difference corresponding to two or three images in the adjacent time of the video sequence in the recognition system, and the calculation formula is as follows:

$$E(m, n) = \sum_{i=1}^{o} \kappa d_i B \tag{1}$$

Assuming that the pixel value of the o-th frame image in the video at the point (m, n) is represented as d_i, and the difference between the two frames of image is represented by B, and no directional analysis is performed in this calculation.

According to the above process, the images of students' ideological and political learning behavior are acquired and stored, which provides a basic basis for the extraction of characteristics of students' ideological and political learning behavior.

3 Image Correction Processing

The image data set of students' ideological and political learning behavior can be obtained by converting the video, but in order to make the characteristics more obvious, the image is generally preprocessed before the experiment. As the image acquisition process is affected by many factors, the accuracy of the recognition result is low. To this end, the image of students' ideological and political learning behavior is corrected, and the correction objective function is set [1]. Use a suitable color template to adjust the processed color to get a good correction effect. In terms of color research, the HSL color model is more suitable for human expression; the HSL color model obtains different colors by changing the hue, saturation and lightness [2]. The model can basically contain all the colors that human vision can perceive, and the color description can correspond to H, S, and l. The method of converting RGB to HSL is as follows: R, G, B represent the red, green, and blue of a specific color in turn, and the value varies between 0 and 1. The detailed calculation formula is as follows:

$$H=\begin{cases} 0, \mathit{if}\, \lambda_{\max} = \lambda_{\min} \\ 60^\circ \frac{G-B}{\lambda_{\max}-\lambda_{\min}} + 0^\circ, \mathit{if}\, \lambda_{\max} = R, G > B \\ 60^\circ \frac{G-B}{\lambda_{\max}-\lambda_{\min}} + 360^\circ, \mathit{if}\, \lambda_{\max} = R, G < B \\ 60^\circ \frac{B-R}{\lambda_{\max}-\lambda_{\min}} + 120^\circ, \mathit{if}\, \lambda_{\max} = G \\ 60^\circ \frac{R-G}{\lambda_{\max}-\lambda_{\min}} + 240^\circ, \mathit{if}\, \lambda_{\max} = B \end{cases} \tag{2}$$

In formula (2), $\lambda_{\max}$ represents the largest value in the range of 0–1, and $\lambda_{\min}$ represents the smallest.

On the basis of the above analysis, the image is converted to HSL color space, and the color disharmony coefficient is calculated by the following formula:

$$z[P, (n, \varepsilon)] = \sum_{j=P} \left| H(q) - S_{M_{n(e)}}(q) \right| \eta_A(q) \tag{3}$$

In formula (3), ε represents the rotation angle description parameter, P represents all the color points describing the students in the image, $H(q)$ represents the color point describing the color value of q, $S_{M_{n(e)}}(q)$ represents the boundary color value description parameter, and $\eta_A(q)$ represents the area ratio of the q color point.

On this basis, the harmonious degree of students' images is fully analyzed, and the influencing factors can be obtained from the following formula:

$$W = \sum_{m-1}^{i=1} \frac{D_i^{\mathrm{MC}}}{D_{i+1}^{\mathrm{MC}}} \tag{4}$$

In formula (4), D_i^{MC} and D_{i+1}^{MC} respectively represent the degree of color effect of the image.

At the same time, individual selection and selection operation is a method of genetic algorithm to evaluate individual adaptability, and it is also the main way of genetic algorithm [3] to realize group gene transmission. Among them, the selection algorithm is obtained by roulette wheel selection, and the selection probability of each individual in the group is calculated by the following formula:

$$p_1(i) = \frac{F_w}{\sum_{N}^{j=1} F_w} \tag{5}$$

In genetic algorithm, fork is a key search operator [4]. It simulates the process of gene recombination in nature, passing good genes to the next generation, and generating better genetic structure. Under the condition of local convergence, mutation can expand the new search space and ensure the diversity of the population. The cross probability function and variation probability function can be obtained by the following formula:

$$p_c = \begin{cases} \frac{k_1(f_{\max} - f')}{\left(f_{\max} - \overline{f}\right)}, f^{\circ} \geq \overline{f} \\ k_2, f < \overline{f} \end{cases} \tag{6}$$

$$p_{\mathrm{m}} = \begin{cases} \frac{k_3(f_{mux} - f)}{\left(f_{\max} - \overline{f}\right)}, f \geq \overline{f} \\ k_4, f < \overline{f} \end{cases} \tag{7}$$

In formula (6) and formula (7), $f_{\max}$ represents the maximum fitness value of the description group, $\overline{f}$ represents the average fitness value used to describe the population of different generations, and f represents the individual with the larger fitness value among the two individuals to be crossed.

Continue to iterate the above calculation process until the fitness calculation result is obtained and the establishment of the correction target is completed.

4 Similarity Measurement of Spatial Structure Information of Students' Images

On the basis of the above-mentioned image correction of students' Ideological and political learning behavior, the similarity of information details in the image is measured. The specific steps are as follows:

Step1: The image set to be characterized is outputted with the transformation parameter θ through the porous convolutional neural network [5] structure;
Step2: According to the above parameter θ, the inverse coordinate mapping is realized after affine transformation, and the sampling network T before the input and output images is obtained;
Step3: The output result of sampling network T is processed by bilinear difference technology to obtain transformed image b.

Assuming that (x_t, y_t) corresponds to the pixel coordinates in input M, and (x_b, y_b) corresponds to the pixel coordinates in output N [6], the transformation parameter θ in step 2 is reversed coordinate mapping, and the similarity measurement process is:

$$(x_t, y_t) = TG * N(x_b, y_b) \tag{8}$$

In formula (8), TG represents affine transformation, that is, affine transformation is performed on the grid, and the transformed network is filled with the pixel values of corresponding coordinate points in the original image to obtain the real pixel value. The image expression after similarity measurement is as follows:

$$V_z^q = \sum_d a \sum_e y(x_i - m) \tag{9}$$

In formula (9), V_z^q represents the pixel value of the original image coordinate point, $\sum_d a$ represents the real pixel value of the image, $\sum_e y$ represents the feature parameters of the current layer and the previous layer in the convolutional layer, and x_i represents the convolution kernel of the feature map [7], m is the image parameter after transformation.

Through the above derivation, the similarity measurement of the spatial structure information of the image to be represented is realized, and the probability of the salient region with higher activation value is increased, providing a basis for the detailed characterization of the spatial structure information of the image spatial structure information of the students' ideological and political learning behavior.

According to the similarity measurement results of the image spatial structure information details of the students' ideological and political learning behavior, the image spatial structure information details are encoded. For shape feature extraction, the image to be represented is regarded as a whole, the image features in the area pixels are counted, and the area shape features are described. The extraction formula is as follows:

$$Z_{nn} = \frac{n+1}{\varsigma} \int_x^z a \tag{10}$$

In formula (10), Z_{nn} represents the eccentricity of the shape, $\frac{n+1}{\varsigma}$ represents the shape feature of the image, $n + 1$ represents the image feature extraction parameter, and $\int_x^z a$ represents the image region pixel.

5 Image Spatial Structure Information Detail Representation

On the basis of the similarity measurement and coding of the image spatial structure information details of the students' Ideological and political learning behavior, the image spatial structure information details are represented. Because the similarity measure of image spatial structure information details and the coding process of image spatial structure information details contain a lot of redundant information [8], the representation of image spatial structure information details is affected. Therefore, the purpose of removing the redundant information of students' Ideological and political learning behavior image is to restore the original image information from the image corrupted by noise. The calculation process is as follows:

$$g(x, y) = d(i, j) + b(i, j) \tag{11}$$

In formula (11), $g(x, y)$ represents the actual image, $d(i, j)$ represents the noise-free image [9], and $b(i, j)$ represents the added noise information.

After the actual image is processed by noise, it degenerates into a noisy image. Therefore, the porous convolutional neural network is used to deeply consider the relationship between the noisy image and the denoised image. The structure of the porous convolutional neural network is shown in the following figure (Fig. 1):

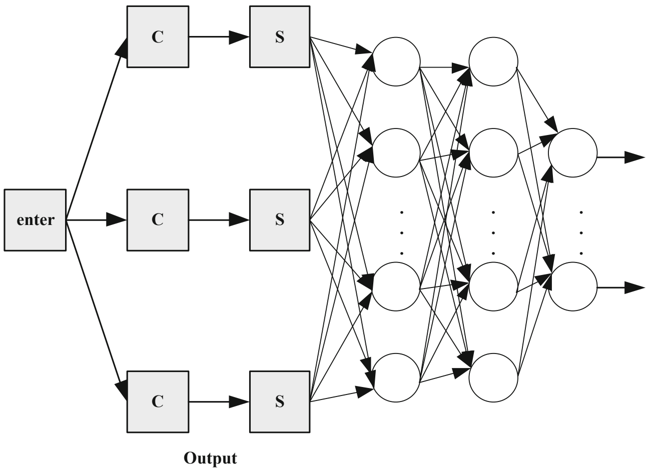


Fig. 1. Structure of porous convolution neural network

The network structure includes an input layer, an output layer and a deconvolution subnet [10–12]. In a convolutional network, the hidden layer of the network is composed of feature maps. The input layer of the network does not limit the image size, so there is no need to process the image size. An image containing noise can be input from the input layer.

After the image is input into the porous convolution neural network, the convolution check image of (5×5) is used for convolution operation, adding bias for the image to be sampled to form CI layer. After adding the offset, the network contains 32-bit feature map, then the number of parameters to be trained is $5 \times 5 \times 1 \times 32 + 32$, and then the convolution kernel is reduced to (3×3). On this basis, the number of feature graphs is increased, and the feature graphs are connected with the feature graphs of the upper layer to form a C2 layer with 64 feature graphs, and 64 feature graphs are generated correspondingly. The number of parameters to be trained is $1 \times 1 \times 64 \times 32 + 32$. On the basis of C2 layer generated by deconvolution and operation of CI layer, the size of convolution kernel is increased to (5×5), and the size of output feature map is set to 1. At this time, the output of deconvolution is the denoised image output from network output layer.

Based on the above-mentioned processing of image spatial structure information and noise, the feature fusion of image spatial structure depth information is defined according to the above-obtained image texture features, color features, and shape feature properties, as shown in the following figure:

In image fusion, starting from point $(0, 0)$, the square of (3×3) is used to move from top to bottom and from left to right. If the structural element is the same as one of a, B, C, D and E, the value is retained. If it is different, it is abandoned and continues to fuse.

On the basis of the above image fusion, the similarity measurement of image spatial structure information is carried out. A feature value is extracted from each image in the data set, which is recorded as $K = \{k_1, k_2, \cdots k_n\}$ and stored in the porous convolution neural network. The deeper characteristic value of the image to be represented is extracted and recorded as $W = \{w_1, w_2, \cdots w_n\}$. the absolute distance between each point in the image is measured by Euclidean distance. The calculation formula is as follows:

$$D(d, g) = \sqrt{\sum_{i=1} h(d - t)} \tag{12}$$

In formula (12), $D(d, g)$ represents the absolute distance between image points in the multidimensional space, $\sqrt{\sum_{i=1} h}$ represents the smaller weight coefficient in the image point value, and $d - t$ represents the image data set. According to the above calculation, the image color, shape, and texture features are fused, the fusion result is represented in a perceptual frame, and the representation of the stored target is activated.

6 Implementation of Feature Extraction of Students' Ideological and Political Learning Behavior

On the basis of the detailed representation of the spatial structure information of the above images, the learner behavior features are extracted, and the temporal action detection block diagram is as follows (Fig. 2):

The purpose of the timing detection subnet is to extract timing segments that may have actions. Here, for the feature map of $512 \times \frac{Long}{8} \times \frac{High}{16} \times \frac{Wide}{16}$ generated by the feature extraction subnet, the anchor frame mechanism is first used. According to the no free lunch theorem, the anchor frames are evenly distributed at time $\frac{L}{8}$ in the domain,

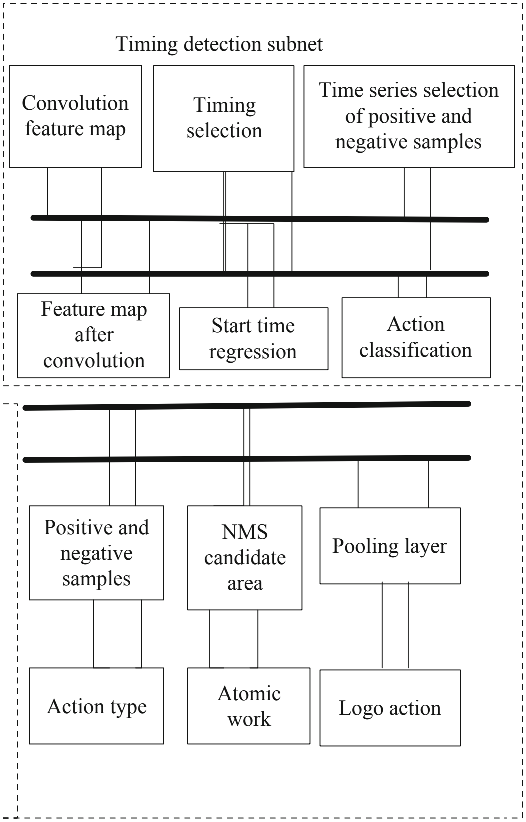


Fig. 2. Overall block diagram of sequential action detection

each anchor box generates k candidate timing points of different sizes. Then, in order to obtain the center position offset and the length of each candidate sequence at each timing point, the spatial feature map of $512 \times \frac{High}{16} \times \frac{Wide}{16}$ is passed through a $3 \times 3 \times$ convolution kernel and a 3D pooling layer to 1×1. Finally output $512 \times \frac{long}{8} \times 1 \times 1$. For the candidate timing to determine whether it is a positive sample or a negative sample, use IOU to calculate when determining. IOU is the number of overlaps between the candidate timing frame and the label. When IOU > 0.7, it is determined as a positive sample; when IOU < 0.3, Determined as a negative sample.

On this basis, the action classification, the classification process is shown in the following figure (Fig. 3):

Feature extraction is an important process of human body target detection. The extraction is represented by vector value and function value. The more vector value and function value describing the characteristics of the target, the greater the amount of information, the richer the details and key information, the more sufficient the detected target is. At the same time, the data dimension will be increased and the calculation difficulty will be increased. In the feature extraction, considering that different scenes

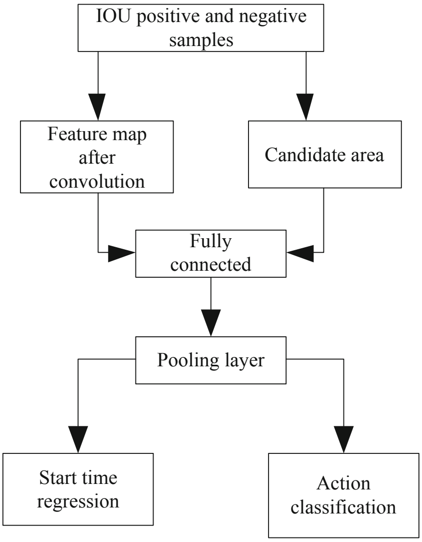


Fig. 3. Action classification subnet

extract different surface features, the extracted features are classified to better and faster targets. For feature description, avoid big data and high-dimensional data, and make the calculation simple and fast. In human object detection, in order to make the results intuitive and more in line with human visual characteristics, the features are divided into two categories, intuitive features and abstract features, as shown in the following figure:

Table 1. Feature classification

Characteristic category	Characteristic subclass	Examples of features
Intuitive features	Pixel features	Color and morphological characteristics
	Attitude features	Distance, angle, manikin
	Action characteristics	Speed, direction, trajectory
Abstract features	Projection features	POI MNU, etc.
	Nonprojective features	Mcvb, JDH, etc.
	Quantitative characteristics of transformation	Wavenumber transformation

According to Table 1, it can be seen that the features are divided into two categories: intuitive features and abstract features. There are some sub class features between them. Among them, the extraction of projection features is to find a linear transformation according to the target, which can lower the data value and complete the feature extraction.

The process of feature extraction plays an important role in the human object measurement. After the processing of the target, the statistical classification of the target behavior, the human behavior and the interaction between the scene are recognized, and the human target detection is completed.

The trajectory of the target can be regarded as a directed curve. The trajectory analysis method is used to reflect the motion path of the moving human body. Firstly, the data set is used to represent the trajectory direction through the string code. In the l-string code, the curve points are represented by the direction coordinate points, and the points that are not in the coordinates are treated with the approximate points, which are used as the data of the motion trajectory

$$e = \left[(x_1, y_2), (x_2, y_2) \cdots, \mathrm{x_n}, \mathrm{y_n}\right] \tag{13}$$

Among them, $\mathrm{x_n}, \mathrm{y_n}$ represents the coordinate position of the moving target in the nth frame of the image, and e represents the entire motion trajectory. The obtained motion trajectory is analyzed and processed, and the formula is as follows:

$$\lambda = (x_m - y_{m-1})^2, (x_n - y_{n-1})^2 \tag{14}$$

On the basis of obtaining the motion trajectory, the corner distance is calculated, assuming that the coordinate of the motion trajectory is $x_m - y_{m-1}$, the distance is $(x_n - y_{n-1})$, and λ is the distance of the target point. This calculation does not do orientation analysis.

In the process of motion trajectory analysis, the analysis of target point distance is an important feature in trajectory analysis. The premise of understanding human behavior is to detect and obtain human body trajectory.

Finally, HRG algorithm is used to recognize the target through calculation, and the human behavior is understood mainly according to the relevant gradient and edge position in the image. Firstly, the image gradient is calculated, and pixels are divided by gradient calculation. The gradient calculation formula is as follows:

The main process is as follows (Fig. 4):

The algorithm process is shown in the figure. When the image is detected, the gradient direction of each pixel and the projection cell are calculated, the window is evenly divided into equal intervals, the adjacent pixel values are counted, the cells are normalized, and the HRG features are collected, And finally complete the test. On this basis, the above process realizes the extraction of students' ideological and political learning behavior characteristics.

7 Experimental Comparison

In order to verify the effectiveness of the feature extraction method of students' Ideological and political learning behavior based on convolutional neural network, the experimental comparison is carried out, and the method is compared with the traditional method, and the accuracy and extraction time of the two methods are compared. The comparison results are as follows.

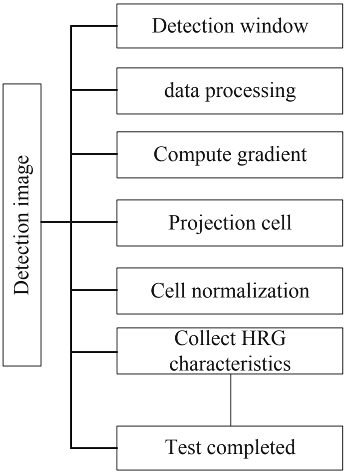


Fig. 4. HRG algorithm process diagram

7.1 Accuracy Comparison of Feature Extraction

The comparison results between the traditional method and the feature extraction method in this study are shown in the following figure (Fig. 5):

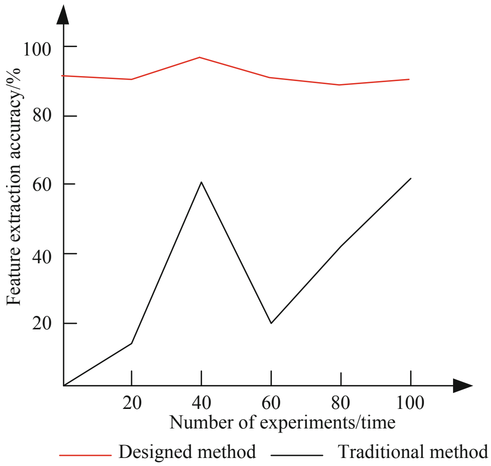


Fig. 5. Comparison of the accuracy of behavior feature extraction

It can be found in the figure that the traditional feature extraction method is extracted by only 60%, the extraction accuracy is low, and the method of extracting the accuracy rate can be up to 95%, while the traditional method is less accurate in several experiments. Students 'thinking of students' thinking behavior based on convolutional neural networks.

7.2 Comparison of Feature Extraction Time

This paper analyzes the feature extraction time between the method and the traditional method, and the results are as follows (Fig. 6):

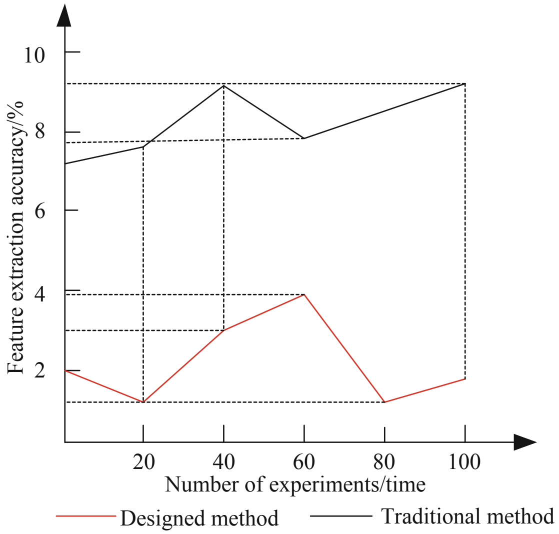


Fig. 6. Feature extraction time comparison

Through the figure above, the extraction time of the reconciled neural network based on convolutional neural network, the extraction time of the convolutional neural network, in 4S, the extraction time of the traditional method is within 9.5 s, based on the convolutional neural network, student thinking The extraction time of the learning behavior feature extraction method is significantly less than the extraction time of the traditional extraction method, which proves the effectiveness of the characteristic extraction method of the study.

8 Conclusion

This paper designs a feature extraction method of students' ideological and political learning behavior based on convolutional neural network, and verifies the effectiveness of this research method through experiments. The reason for the better results of the method designed this time is that the quality of action extraction has a great influence on the positioning effect of subsequent actions in the sequential action detection. Improving the quality of the action extraction in the video helps to improve the overall efficiency of action timing recognition. However, due to the limitation of research time, the method of this research still has certain shortcomings. In the follow-up research, the method of this research needs to be further optimized.

References

1. Feng, J., Cai, S., Ma, X.: Enhanced sentiment labeling and implicit aspect identification by integration of deep convolution neural network and sequential algorithm. Clust. Comput. **22**(6), 1–19 (2019)
2. Wang, X., Zhong, X., Xia, M., et al.: Automatic carotid artery detection using attention layer region-based convolution neural network. Int. J. Humanoid Rob. **16**(4), 1097–1105 (2019)
3. Zhang, F., Cai, N., Wu, J., et al.: Image denoising method based on a deep convolution neural network. IET Image Proc. **12**(4), 485–493 (2018)
4. Liu, C., Zhang, X., Hu, Q.: Image super resolution convolution neural network acceleration algorithm. Guofang Keji Daxue Xuebao/J. Natl. Univ. Defense Technol. **41**(2), 91–97 (2019)
5. Timilsina, S., Aryal, J., Kirkpatrick, J.B.: Urban tree cover changes using object-based convolution neural network (OB-CNN). Remote Sens. **12**(18), 1–27 (2020)
6. Liu, S., Lu, M., Li, H., et al.: Prediction of gene expression patterns with generalized linear regression model. Front. Genet. **10**, 120 (2019)
7. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
8. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): e-Learning, e-Education, and Online Training, pp. 1–374. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-93719-9
9. Tu, S., Rehman, S.U., Waqas, M., et al.: Optimisation-based training of evolutionary convolution neural network for visual classification applications. IET Comput. Vis. **14**(5), 259–267 (2020)
10. Liu, Z., Shi, S., Duan, Q., et al.: Salient object detection for RGB-D image by single stream recurrent convolution neural network. Neurocomputing **363**(21), 46–57 (2019)
11. Wang, K., Hinz, J., Zhang, Y., et al.: Parallel channels for motion feature extraction in the pretectum and tectum of Larval Zebrafish. Cell Rep. **30**(2), 442–453 (2020)
12. Rankin, J., Rinzel, J.: Computational models of auditory perception from feature extraction to stream segregation and behavior. Curr. Opin. Neurobiol. **58**, 46–53 (2019)

Research on the Diversity of Technical Characteristics of Folk Music Classroom Teaching Based on Network Knowledge Sharing

Liang Lu(✉), Jun Zhou, and Yang-bo Wu

Xinyu University, Xinyu 338000, China

Abstract. Aiming at the problem of poor convergence in the research method of feature diversity of music teaching technology, this paper proposes a research on the diversity of folk music classroom teaching technology based on network knowledge sharing. According to the classical viewpoints of international authoritative organizations and domestic and foreign literatures, the evaluation index system is constructed. Analytic hierarchy process (AHP) and Delphi method are introduced to analyze the weight of the evaluation index system. Through network knowledge sharing, the membership degree of teaching technical characteristics is calculated, and the diversity of teaching technical characteristics of folk music is judged. This study makes a comparative experiment on the three methods and analyzes the diversity of teaching techniques of folk music in the classroom. Experimental results show that the proposed method has the advantages of stable application process, short time and good convergence performance.

Keywords: Network knowledge sharing · Folk music · Classroom teaching · Diversity of characteristics

1 Introduction

Teaching is a purposeful, planned and organized activity of two-way interaction between teachers' teaching and students' learning. Therefore, before the implementation of teaching work, it is necessary to select the correct content, formulate methods and strategies in advance, and design carefully according to certain objectives and requirements. In this sense, design and teaching are inseparable, and it can even be said that they are inborn. In traditional teaching, instructional design activities are also indispensable. Every teacher carries out his own "instructional design" consciously or unconsciously in teaching practice. However, due to the constraints of teachers' own experience, knowledge level, educational ideas, teaching conditions and working environment, this kind of design still can not get rid of the dilemma of experiential teaching design [1].

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 527–537, 2021.
https://doi.org/10.1007/978-3-030-84386-1_43

Music teaching system is a complex system with multi factors, multi levels and multi series. Its fundamental purpose is to cultivate students' emotion, shape students' sound personality and cultivate teenagers' all-round development of morality, intelligence, physique, beauty and labor through music teaching. The main elements are teachers (teaching thought, attitude, ability, knowledge structure, personality), students (physique, morality, knowledge, ability level), courses (teaching objectives, contents, methods, evaluation) and conditions (material equipment and technical means), etc. [2]. However, in China's traditional music teaching technology, teachers pay more attention to students' mastery of music theory knowledge and music in time, which leads to the music teaching classroom is very boring, boring, music teaching also lost the original teaching significance. At the same time, this teaching method will also limit students' interest in learning and reduce students' learning efficiency. Therefore, the research on the diversity of classroom teaching technology characteristics of folk music can provide some reference for music teaching research.

2 Research Methods on the Diversity of Technical Characteristics of Folk Music Classroom Teaching Based on Network Knowledge Sharing

2.1 Evaluating the Technical Characteristics of Classroom Teaching of Folk Music

Determine the Evaluation Process of Teaching Technology Characteristics
This evaluation of the technical characteristics of folk music classroom teaching, considering the types and quantity of factors contained in the technical characteristics of folk music classroom teaching, introduces AHP method and Delphi method to construct the evaluation index of the technical characteristics of folk music classroom teaching. And adopt a combination of subjective and objective methods to empower the evaluation indicators established this time to evaluate the technical characteristics of ethnic music classroom teaching. The basic process of evaluating the technical characteristics of ethnic music classroom teaching is as follows:

1. Determine the evaluation system of classroom teaching technology characteristics of national music; 2. Find the supporting system in the evaluation system; 3. Find the elements of the technical characteristics of folk music classroom teaching; 4. Construct the evaluation index system of the technical characteristics of national music classroom teaching; 5. To judge whether the evaluation index system is in line with the establishment principle of evaluation index; 6. When the evaluation index system does not conform to the principle of establishing the evaluation index, the evaluation index system is modified, and the step 4 is returned to reconstruct the evaluation index system of the technical characteristics of folk music classroom teaching; 7. When the evaluation index system is in line with the establishment principle of evaluation index, the evaluation index system is quantified and the standardized evaluation index system is obtained; 8. Empower the established evaluation index system and determine the weight of the

evaluation index system; 9. According to the weight of the evaluation index system, evaluate the technical characteristics of folk music classroom teaching.

Constructing the Evaluation Index System of Teaching Technology Characteristics
There are many constituent factors in the technical characteristics of folk music classroom teaching, which is equivalent to a huge system, but the factors in the system are uneven, which affect the diversity analysis results of the technical characteristics of folk music classroom teaching. Due to the diversification and modernization of ethnic music classroom teaching technology in the development process [3]. Therefore, the construction of the evaluation index system of the technical characteristics of folk music classroom teaching must follow the nine principles of systematicness, scientific rationality, easy operation, relative independence, effectiveness, dynamic comparability, directivity, independence and simplicity. We should control the evaluation index of the technical characteristics of the national music classroom teaching in a certain number, clarify the evaluation index level, and reduce the repetition rate of the evaluation index information. In order to promote this research, the evaluation index of the characteristics of national music classroom teaching technology constructed has high usability and index utilization rate.

According to the above analysis, this paper evaluates the technical characteristics of folk music classroom teaching, and selects the evaluation index from the classic point of view of international authoritative institutions. Combined with the domestic and foreign literature, this paper constructs the evaluation index system, analyzes whether the constructed evaluation index system conforms to the establishment principles of the evaluation index system, and deletes the evaluation indexes that cannot obtain data or are difficult to quantify. The establishment process of the evaluation index system is as follows:

1. By means of frequency statistics, data collection and theoretical analysis, the preliminary evaluation index system is constructed; 2. The cluster analysis method is introduced to evaluate the index categories; 3. Factor analysis method is introduced to screen evaluation indexes; 4. Improve the evaluation index; 5. Eliminate redundant indicators; 6. Build the evaluation index system.

Based on the evaluation index system establishment process of the above design, after screening, the final evaluation index system is determined, as shown in Table 1.

Determine Factor Set
Based on the evaluation index of classroom teaching technology characteristics of national music shown in Table 1, it can be determined that there is a certain subordinate relationship between the factors of classroom teaching technology characteristics of national music. Therefore, the evaluation index of the technical characteristics of folk music classroom teaching shown in Table 1.

Standardization of Evaluation Index
The construction of the evaluation index system of the technical characteristics of folk music classroom teaching, the collection of evaluation index data from different sources, can be roughly divided into Baidu search, field visits, questionnaires, field surveys and other ways. Therefore, in the study, there are big differences in the index data used,

Table 1. Evaluation index system of teaching technology characteristics

First level indicators	Secondary indicators	Third level indicators
The characteristics of classroom teaching technology of national music X	Teaching preparation A	Teaching plan quality A1
		Teaching Aids A2
	Teaching objectives B	Teaching core B1
		Target setting B2
	Content of courses C	Textbook organization C1
		Teaching focus C2
		Team teaching C3
	Teaching methods D	Teaching form D1
		Teaching method D2
		Teacher student interaction D3
		Organizing teaching D4
	Quality of teachers E	Demonstration capability E1
		Teaching instrument E2
		Language expression E3
		Blackboard design E4
	teaching effectiveness F	For all F1
		Emotional development F2
		Organizational capacity F3

which affect the diversity research results. Therefore, according to the linear relationship between the index data, the index data is standardized. For this reason, assume that there is a linear relationship between the collected index data of the established evaluation index, and the mean value of the index data is $\overline{X}$, then the standardized value Z of the index data is:

$$Z_i = \frac{X_i - \overline{X}}{\sigma} \tag{1}$$

(1) Where, Z_i is the standardized value of the i-th index data; X_i represents the i-th index data; σ is the standard deviation of index data [4].

(2) The standardized value and standardized data obtained by formula will have complex number and decimal number, which will affect the comparison result of index data. Therefore, it is necessary to eliminate the complex number and decimal number after the standardization of index data. The results are as follows:

$$Z_i = 50 + \frac{X_i - \overline{X}}{10\sigma} * 100 \tag{2}$$

According to formula (1) and formula (2), the processed data can be used as the evaluation of national music classroom teaching technical characteristics index data.

Analysis and Evaluation Index Weight

The analysis of the evaluation index weight in the evaluation index system shown in Table 1 is to determine the influence of each evaluation index in the evaluation index system on the technical characteristics of folk music classroom teaching, and sort these indexes according to the influence, so as to provide a strong guarantee for the evaluation results. Therefore, AHP and Delphi method will be introduced to analyze the weight of evaluation index system. Therefore, according to the AHP method, an evaluation index is assumed to be associated with n evaluation indexes. Where C is the importance of the evaluation index, and c_{ij} is the comparison result of the i first level index and the j second level index. At this time, c_{ij} is quantified. The results are as follows:

$$c_{ij} = \begin{cases} 1 & \textit{If index i is more important than index j} \\ 0 & \textit{If index i and index j are equally important} \\ -1 & \textit{f index j is more important than index i} \end{cases} \tag{3}$$

In addition to the comparison between the two factors, it is also necessary to determine the evaluation index, which has an impact on the technical characteristics of folk music classroom teaching..

According to Delphi method, the function variable of an index is defined as S, is used to reflect the change of influence difference of evaluation index. At this time, regard the importance of the index as an independent variable stimulus and define it as r; The function of indicators in the evaluation system of teaching technology characteristics can be regarded as the dependent variable of people's perception, and defined as s [5, 6]. Then the functional relationship between r and s can be expressed as follows:

$$s = p \ \lg\left(\frac{r_i}{r_j}\right) \tag{4}$$

Synthesizing formulas (3)~(4), the objective judgment matrix for establishing the importance of indicators is:

$$R = \left[r_{ij}\right]_{n\times n} \tag{5}$$

According to the above calculation process, the evaluation indexes in the diversity evaluation system shown in Table 1 are calculated according to the above calculation process, and sorted according to the importance of the indexes according to the calculation results. The sorting results are shown in Table 2.

In Table 2, the number 1 indicates that the former is more important than the latter; The number 0 indicates that the two indicators are of the same importance; The number −1 indicates that the former indicator is less important than the latter.

According to the results of comparison and ranking shown in Table 2, the evaluation indexes in Table 1 are all ranked in the way shown in Table 2, that is, the weight comparison of evaluation indexes is completed, and the technical characteristics of folk music classroom teaching are evaluated according to the comparison results.

Table 2. Evaluation index comparison judgment matrix

	Preparation	Preparation	Target	Means	Quality	Effect
Preparation	0	1	1	1	1	1
Target		0	−1	1	1	1
Content			0	−1	1	1
Means				0	−1	1
Quality					0	−1
Effect						0

2.2 Calculating the Membership Degree of Teaching Technology Characteristic Index

Fuzzy mathematics theory is used to calculate the membership degree of the technical characteristics of national music classroom teaching. The value must be any value between [0, 1]. For this reason, suppose that evaluation index u of any level belongs to evaluation index set X, and given evaluation index set X, the mapping μ_O on interval [0, 1] is as follows:

$$\mu_O : X \to [0, 1] \quad \mu| \to \mu_O(x) \tag{6}$$

Where, μ_O is the membership function of evaluation factor O, and $\mu_O(x)$ is the membership function of evaluation factor O [7]. According to the membership degree of the technical characteristics of folk music classroom teaching determined by formula (6), we can use the network knowledge sharing technology to judge the diversity of the technical characteristics of folk music classroom teaching.

2.3 Judging the Diversity of Technical Characteristics of Folk Music Classroom Teaching Based on Network Knowledge Sharing

Based on the above content, to determine the diversity membership degree of the evaluation results of the technical characteristics of folk music classroom teaching, we need to use the network knowledge sharing model to judge the diversity of the technical characteristics of folk music classroom teaching. To this end, taking the organizational knowledge subject as the node and the knowledge similarity between subjects as the edge, the network knowledge sharing model is expressed:

$$G_P = \left(P, E_{P_i - P_j}\right) \tag{7}$$

In the formula, P represents the collection of knowledge subjects of the organization, that is, the classroom teaching technology of folk music; $E_{P_i - P_j}$ represents the set of edges, that is, the technical characteristics of folk music classroom teaching; $\left(P_i, P_j\right)$ indicates the knowledge connection between knowledge subject P_i and P_j [8].

According to (7), we need to use the knowledge semantics in the network knowledge sharing model to express the diversity of the teaching technology and characteristics of folk music classroom. To this end, the following two-tuple K is used:

$$K = \{(m_1, s_1), (m_2, s_2), \cdots, (m_n, s_n)\} \tag{8}$$

In the formula, $m_1, m_2, \cdots, m_i, \cdots, m_n$ means meta knowledge with semantic relationship, that is, the technical characteristics of folk music classroom teaching; $s_1, s_2, \cdots, s_i, \cdots, s_n$ represents the weight value of the corresponding knowledge element in the organization or subject knowledge, that is, the weight of the evaluation index factors in the technical characteristics of folk music classroom teaching [9].

At this time, combined with (7) and (8), combined with the evaluation index membership degree in the technical characteristics of folk music classroom teaching calculated by (6), the similarity measure of knowledge, that is, the similarity between characteristics and diversity, is calculated, so as to judge the diversity of the technical characteristics of folk music classroom teaching.

Therefore, taking the semantic pattern of organizational knowledge as the standard, the vector space dimension is established, under which the semantic pattern of each subject is extracted to form a group of vectors, and the knowledge similarity between subjects is calculated by VSM. Therefore, the knowledge subject i is denoted as P_i, and the knowledge subject j is denoted as P_j. Suppose KP_i is the weight vector of P_i knowledge element extracted according to Sect. 1.1.5, and the weight vector KP_j of P_j knowledge element can also be extracted. Then the knowledge similarity of P_i and P_j can be represented by the inner product θ of these two vectors:

$$sim\left(P_i, P_j\right) = \frac{KP_i \cdot KP_j}{|KP_i| \times \left|KP_j\right|} = \frac{\sum_{k=1}^{n} s_{ik} s_{jk}}{\sqrt{\sum_{k=1}^{n} s_{ik}^2} \times \sqrt{\sum_{k=1}^{n} s_{jk}^2}} \tag{9}$$

The larger the calculated value of the formula, the greater the similarity of knowledge between the two subjects, which means that the ethnic music classroom teaching technical characteristics belong to the diversity of its membership; On the contrary, the smaller the knowledge similarity between the two subjects, it means that the national music classroom teaching technology characteristics do not belong to the diversity of its membership [10].

3 Experiment and Analysis

In order to verify the research method of the diversity of the technical characteristics of folk music classroom teaching, comparative experiments will be used to verify the research method of the diversity of the technical characteristics of folk music classroom teaching. And the research methods of the diversity of the technical characteristics of folk music classroom teaching in this study are recorded as experimental group A, and the two groups of traditional research methods of the diversity of the technical characteristics of folk music classroom teaching are recorded as experimental group B and experimental group C respectively.

3.1 Experimental Preparation

In this experiment, a regional school's national music major is selected as the research object. There are four year groups in this major, with an average of three classes in each year group and an average of 30 students in each class. A total of 12 classes with 360 students are taught by four teachers, each of whom teaches folk music to three classes on average. In the process of folk music classroom teaching, there are some differences in the teaching techniques and modes of the four teachers, and there are also some differences in teaching students of different grades.

Based on the above content, the determined experimental objects and the experimental data collected in this experiment are shown in Table 3.

Table. 3 Experimental data

Year group	Teacher class	Teacher 1	Teacher 2	Teacher 3	Teacher 4
A year	Class one	√			
	Class two		√		
	Class three				√
Two years	Class one		√		
	Class two	√			
	Class three			√	
Three years	Class one	√			
	Class two			√	
	Class three				√
Four years	Class one			√	
	Class two				√
	Class three	√			

Note: "√" refers to the class taught by the teacher

According to the class taught by the teacher shown in Table 1, the teaching process of folk music in each class is recorded respectively, with a total of five lessons recorded as a chapter of folk music teaching, lasting 200 min. During the recording, the four teachers taught the same content in each grade.

At this point, we can use the above content, the design of experimental data, as the research method of the diversity of national music classroom teaching technology characteristics, the research object. Using three groups of research methods on the diversity of teaching technology characteristics of folk music classroom, this paper analyzes the diversity of teaching technology characteristics of four folk music teachers in the classroom.

3.2 Experimental Result

The First Group of Experimental Results

Based on the experimental data of this experiment, three groups of diversity research methods selected in this experiment are used to analyze the experimental data of this experiment design, which shows the diversity. In this group of experiments, in order to reduce the difficulty of the experiment, in this experiment, each teacher's grade is taken as a group. Statistics of three groups of diversity research methods, analysis of each teacher, teaching folk music classroom teaching technical characteristics of diversity time, the experimental results, as shown in Table 4.

Table 4. Analysis time of teaching technology diversity

Method	Teacher	Analysis time/s	Average time/s
Experimental group A	Teacher 1	1.6	1.50
	Teacher 2	1.2	
	Teacher 3	1.3	
	Teacher 4	1.9	
Experimental group B	Teacher 1	5.3	4.95
	Teacher 2	5.5	
	Teacher 3	4.2	
	Teacher 4	4.8	
Experimental group C	Teacher 1	11.3	10.85
	Teacher 2	11.6	
	Teacher 3	9.4	
	Teacher 4	11.1	

It can be seen from Table 4 that the average time required for each teacher in group C to teach the diversity of classroom teaching technical characteristics of ethnic music is 5.9 higher than that in group B and 9.35 higher than that in group A, and the time required to study the diversity of classroom teaching technical characteristics of ethnic music is the longest; The average time for each teacher in group B to teach the diversity of technical characteristics of folk music classroom teaching was 3.45 times higher than that in group A. Although the time needed to study the diversity of technical characteristics of folk music classroom teaching is better than that of experimental group B, it is lower than that of experimental group A. It can be seen that it takes a short time to analyze the diversity of technical characteristics of folk music classroom teaching with the research method of diversity of technical characteristics of folk music classroom teaching.

The Second Group of Experimental Results

Based on the results of the first group of experiments, the second group of experiments is carried out to verify the three groups of methods and analyze the convergence performance of the diversity of the technical characteristics of folk music classroom teaching. Change the analysis time of the diversity of the technical characteristics of folk music classroom teaching, calculate three groups of methods to analyze the diversity error E of the technical characteristics of folk music classroom teaching. The calculation formula is as follows:

$$\mathrm{E} = \frac{q}{Q} \times 100\% \tag{10}$$

(10) Where q is the result of diversity analysis; Q is the total number of technical features of folk music classroom teaching. At this time, MATBAL software is used to record the diversity of technical characteristics of folk music classroom teaching, view three groups of methods, and analyze the diversity error of technical characteristics of folk music classroom teaching. The changes over time are used to verify the convergence of the three sets of methods. The experimental results are shown in Fig. 1.

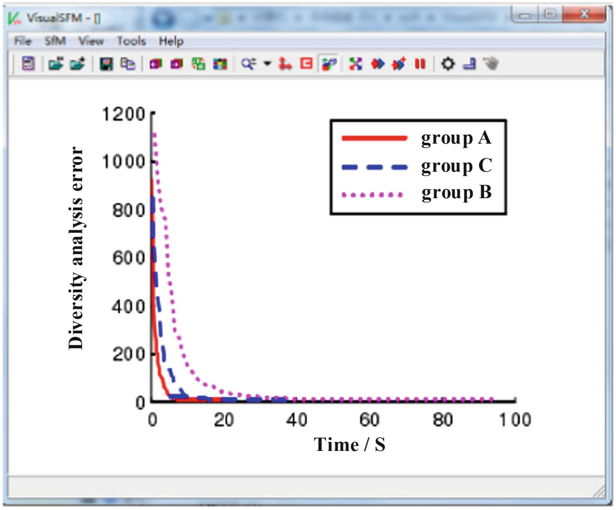


Fig. 1. Convergence performance comparison of three methods

As can be seen from Fig. 1, with the increase of time, the convergence performance of the three groups of methods to analyze the diversity of the technical characteristics of folk music classroom teaching, and the resulting analysis error have decreased to a certain extent. However, the convergence performance of group B is the worst. When the time is close to 20 s, the data error remains stable and nearly zero; The experimental group A has the best convergence performance, and the analysis error converges rapidly within 0.5 s. It can be seen that the research method of the diversity of the technical characteristics of the national music classroom teaching in this study, the analysis of the diversity of the technical characteristics of the national music classroom teaching, the process is stable, and has a better convergence performance.

4 Conclusion

This paper studies the diversity of the technical characteristics of folk music classroom teaching methods, making full use of network knowledge sharing technology to judge the diversity of the technical characteristics of folk music classroom teaching. However, the diversity of research methods in this study did not consider the influence of students on the technical characteristics of folk music classroom teaching. Therefore, in the future research, we need to further study the student factors in the technical characteristics of folk music classroom teaching, further judge the technical characteristics of folk music classroom teaching, the diversity of subordinate, pay attention to individual differences, and pay attention to the diversification of evaluation indicators.

Fund Projects. Youth project of Humanities and social sciences research in Colleges and universities of Jiangxi Province: Research on the music form of “Quanfeng lantern” in Northwest Jiangxi (NO. YS20206).

References

1. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
2. Torres, J.Z.: Fostering inclusion and diversity through research, teaching, mentoring, and outreach. Mol. Biol. Cell **30**(23), 2870–2872 (2019)
3. Yang, Y.: Simulation research on network communication software shared resource equilibrium scheduling. Computer Simulation **36**(5), 333–336 (2019)
4. Yu, D.: The discussion on the music teaching evaluation strategies based on the subject key competencies. Curriculum Teach. Mater. Method **39**(10), 138–143 (2019)
5. Wang, S.: Reflection on the diversity of teaching result of vocal music based on modern recording technology. Jiaoyu Jiaoxue Luntan (35), 120–121 (2019)
6. Liu, Y.: Teaching reform and practice of vocal music course under multicultural background. Guide Sci. Educ. **15**, 48–49 (2019)
7. Chi, Y.: Research on the method of constructing teaching model of integrating various singing styles into vocal music classroom in colleges and universities. J. Hubei Open Vocat. Coll. **32**(20), 143–144 (2019)
8. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
10. Liu, X.: The study of music teaching based on educational narration. J. Weinan Teach. Coll. **33**(14), 38–44 (2018)

Adaptive Parameter Determination Method of Synchronous Motor Digital PI Regulator

Jin-tian Yin[1,2], Li Liu[1,2](✉), Jie Tang[1,2], Zhi-hua Peng[1,2], and Hui Li[1,2]

[1] Hunan Provincial Key Laboratory of Grids Operation and Control on Multi-Power Sources Area, Shaoyang University, Shaoyang 422000, China
yinjintian112@yeah.net

[2] School of Electrical Engineering, Shaoyang University, Shaoyang 422000, China

Abstract. The parameter adaptation of digital PI regulator of synchronous motor has great influence on the production and use of current electric and mechanical equipment. In order to optimize the effect of synchronous electric digital regulator, a method of parameter adaptive determination of digital PI regulator of synchronous motor is proposed, which improves the process of setting parameters in continuous domain. The adaptive parameters of digital PI regulator of synchronous motor are collected and analyzed by discretization method. The sampling time and phase angle lag parameters caused by zero order maintainer are eliminated. The mathematical model of parameters of digital PI regulator of synchronous motor is established, and the discrete model diagram of closed-loop synchronous motor is obtained. The time domain performance index is converted into the open loop frequency domain characteristic quantity by engineering experience and the PI regulator parameters are calculated analytically in the domain. Simulation results show that the adaptive determination method of digital PI regulator of synchronous motor meets the design requirements. The overshoot is less than 5% and the adjustment time is about 1.92 s. The research shows that the method can provide reference for the parameter setting of digital PI regulator of synchronous motor.

Keywords: Synchronous motor · Regulator · Self-adaptive

1 Introduction

In recent years, PI regulator parameter adaptation has made great progress both in theory and technology, and has become a very active and fruitful branch in the field of automatic control. Its typical application involves many aspects of production and life. At present, the level of industrial automation has become an important symbol to measure the modernization level of all walks of life. The development of parameter adaptation of synchronous motor digital PI regulator has also gone through three stages: classical control theory, parameter adaptation theory of synchronous motor digital PI regulator and intelligent control theory. Automatic control can be divided into open-loop control system and closed-loop control system. Synchronous motor has the advantages of high

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 538–549, 2021.
https://doi.org/10.1007/978-3-030-84386-1_44

power factor, high efficiency, high power density and wide speed range, which has been widely used in industry. At the same time, synchronous motor control technology is also constantly improving and perfecting [1]. The double closed-loop vector control synchronous motor based on digital PI regulator is easy to realize and has good control effect, which has been widely used in engineering. In order to better guarantee the operation effect of synchronous motor, the optimization research of adaptive parameter determination method of synchronous motor digital PI regulator is proposed to obtain higher synchronous motor acceleration, Stable torque can be obtained, so it is widely used in high-performance speed control synchronous motor, and the most commonly used control method is double closed loop PI regulation [2]. At present, there are many methods to adjust the parameters of PI regulator, such as adaptive PID, fuzzy control, etc. the control design of these methods is too complex. Based on this, according to the classical engineering design method of PI regulator, combined with the characteristics of digital control synchronous motor, the high performance design requirements of current loop and speed loop are optimized. In this paper, a PI parameter design technique for double closed-loop control of synchronous motor is proposed, which fully considers the problems of synchronous motor loop width, sampling period, motor time constant, regulator parameters and their constraints. The parameter adaptive accuracy of digital PI regulator of synchronous motor is verified by experiment. The experiment proves that the parameter adaptive determination method of digital PI regulator of synchronous motor has high application value [3].

2 Synchronous Motor Digital PI Controller Parameter Self-adaptive

2.1 Parameter Identification Analysis of Synchronous Motor Digital PI Regulator

Multivariable parameter tuning of synchronous motor is very complicated, but its theory research is very fast. Based on the research results, the optimization design of digital PI controller parameters is proposed. Combined with the current popular method of multi-variable PID parameter tuning, the multi-variable data of correction factor and Hu Jinxing PI regulation, assume the discrete form of multi-variable PI regulator used in the closed loop of synchronous motor is as follows:

$$u(k) = K_P e(k) + K_I \sum_{i=0}^{k-1} e(i) + K_D[e(k) - e(k-1)] \tag{1}$$

The PI regulator in frequency domain is used to identify the parameters of the simple control object, and the PID time domain measured data is used to identify the parameters. There are many parts in the synchronous motor controlled by the synchronous wind turbine converter and its regulator, which can easily affect the parameter identification effect of the synchronous motor digital PI regulator. Therefore, the parameter identification law of the synchronous motor digital PI regulator is specifically studied based on the directly measurable input/output data in time domain. The identification law of the synchronous motor digital PI parameter is shown in Fig. 1:

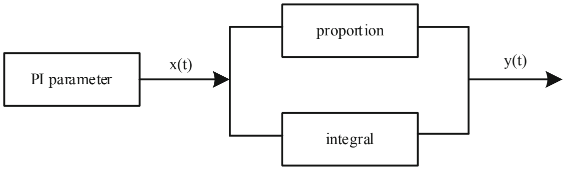


Fig. 1. Identification law of digital PI parameters for synchronous machines

It is difficult to adjust the PI parameters for the multi-variable synchronous motor with strong coupling, and the control parameters can only be compromised between the coupling parameters. Some data (digital quantity) of the actual input and output signals are collected at the communication interface of the PI regulator. If the input value is $x(t)$, the output value is $y(t)$, and d is a digital quantity, and the proportional coefficient k_p and the integral coefficient k_I are the parameters to be identified, then:

$$y(t) = u(k)K_{\mathrm{P}}\left[x(t) + \frac{1}{K_1}\int_0^t x(t)\mathrm{d}t\right] \tag{2}$$

Set the sampling interval to t. According to the sampling theorem, when the sampling frequency of data is very high, there is a discrete form:

$$y(k) = K_{\mathrm{P}}\left[x(k) + \frac{1}{K_{\mathrm{I}}}\Delta t_s \sum_0^k x(k)\right] \tag{3}$$

When the input values of successive test points are unchanged, $x(k) = x(k-1) = x(k-2) = \cdots$, such as:

$$y(k)' = K_{\mathrm{P}}\left[x(k) + \frac{1}{K_{\mathrm{I}}}\Delta t_{\mathrm{s}} \sum_0^k x(k)\right] = K_{\mathrm{P}}\left[x(k-1) + \frac{1}{K_{\mathrm{I}}}\Delta t_{\mathrm{s}} \sum_0^{k-1} x(k-1)\right] + \frac{K_{\mathrm{P}}}{K_{\mathrm{I}}}x(k)\Delta t \tag{4}$$

$$y(k-1) = K_{\mathrm{P}}\left[x(k-1) + \frac{1}{K_{\mathrm{I}}}\Delta t_0 \sum_0^{k-1} x(k-1)\right] \tag{5}$$

The classical PI regulator directly controls the controlled object in closed loop, and the three parameters K_p, K_i, K_d of the regulator are adjusted online. According to the operation state of the synchronous motor, the parameters of the PI regulator are adjusted in order to achieve the optimization of some performance index, so that the output state of the output layer neuron can pass the self-learning and weighting coefficient of the three adjustable parameters K_p, K_I, K_d of the PI regulator Adjust the output to correspond to the parameters of PI regulator under some optimal control law[4–6]. When the input of two consecutive measuring points is 0 and the input and output of subsequent measuring points are respectively x(j), y(j), there are:

$$y(j-1) = K_{\mathrm{P}}\left[x(j-1) + \frac{1}{K_{\mathrm{I}}}\Delta t_0 \sum_0^{j-1} x(j-1)\right] = \frac{K_{\mathrm{P}}}{K_1}\Delta t_0 \sum_0^{j-1} x(j-1) \tag{6}$$

The above formula determines the structure of multivariable PI regulator. Each coefficient matrix is composed of coarse adjustment part and adjustable correction factor (fine adjustment) which are determined by the characteristics of the object [7]. The coarse adjustment part can be determined by synchronous motor identification, and the expert correction method is used to adjust the correction factors online. The relationship between output step response mode and correction factor γ_I, ε_I, δ_I is described by production rule, and these modes are characterized by decay rate, overshoot, rise time and vibration period. A unified correction formula for various modes is proposed:

$$\begin{cases} P(n) = P(n-1)\left[1 + \operatorname{sgn}\left(\sum_{i=1}^{1} swe_i\right) e^{-(n+1)/2}\right] \\ swe_i = s_i \times w_i \times e_i \end{cases} \tag{7}$$

Further, the speed control structure block diagram of the motor is built according to the identifiability calculation method and steps, as shown in Fig. 2.

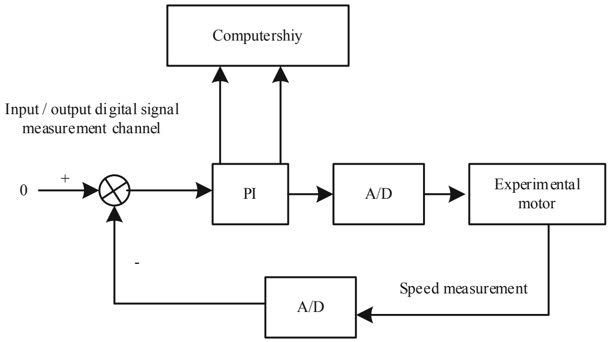


Fig. 2. Structure block diagram of PI data measurement

Furthermore, the gradient method is used to adjust the parameters of PI regulator online through weights. When the coupling of synchronous motor is serious, the multivariable PI regulator structure composed of a single motor is needed. In order to achieve better control effect of PI regulation, it is necessary to adjust the three control functions of proportion, integral and differential to form the relationship of mutual coordination and mutual restriction in the control variables. This relationship is not necessarily a simple “linear combination”, and the best one can be found from the infinitely variable nonlinear combination [8, 9]. With the ability of arbitrary nonlinear expression, the optimal PI regulation can be realized by learning the performance of synchronous motor, so that the three parameters of PI regulator can be adjusted to the optimal parameters online, and the method of parameter self-learning of PI regulator is established [10].

2.2 Adaptive Control Algorithm of Synchronous Motor

According to the control theory of synchronous motor, synchronous motor has sinusoidal back EMF waveform, and its stator voltage and current should also be sinusoidal [11].

Assuming that the motor is linear, its parameters do not change with temperature and other external conditions, ignoring the hysteresis and eddy current loss, the rotor has no damping winding [12]. According to the stator voltage vector equation of synchronous motor in rotating coordinate system in two-phase winding, the stator voltage equations of two components of synchronous motor on shaft are obtained

$$\begin{bmatrix} V_d \\ V_\theta \end{bmatrix} = \begin{bmatrix} R_s & 0 \\ 0 & R_0 \end{bmatrix} \begin{bmatrix} I_d \\ I_q \end{bmatrix} + \begin{bmatrix} p & -\omega_z \\ \omega_r & p \end{bmatrix} \begin{bmatrix} \Psi_d \\ \Psi_q \end{bmatrix} \tag{8}$$

R_s and R_0 are the components of stator voltage vector $\begin{bmatrix} I_d \\ I_q \end{bmatrix}$ of synchronous motor; ω_z is the angular velocity of rotor rotation; ω_z is the component of field oriented control value $\begin{bmatrix} \Psi_d \\ \Psi_q \end{bmatrix}$ of synchronous motor. As long as the actual I_d, I_q is equal to the given Ψ_d, Ψ_q, it meets the requirements of actual control [13]. In the actual control, the current injected into the motor stator and detected from the stator is three-phase current, so the coordinate transformation must be carried out [14]. Because the coordinate system is the rotating coordinate system of the stator on the motor rotor, in order to realize the coordinate transformation, the position of the motor rotor must be detected in real time in the control, and the double closed-loop structure of synchronous motor field oriented control is constructed:

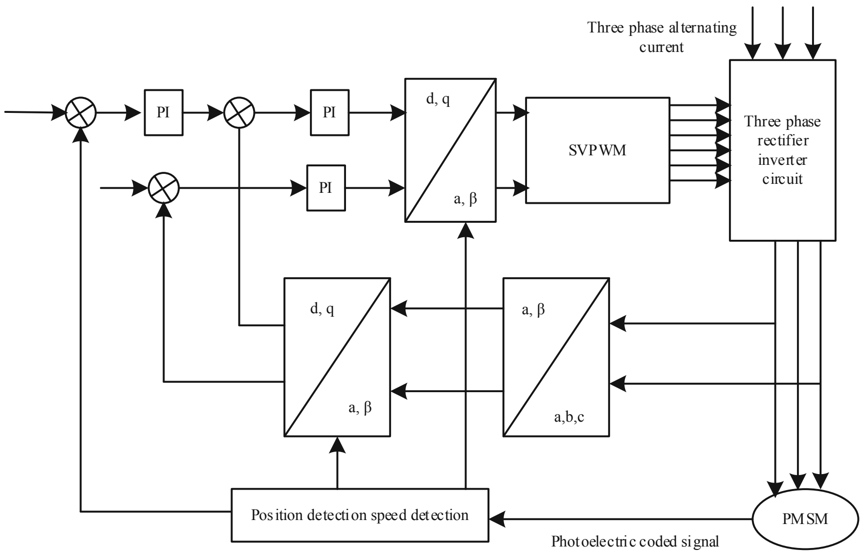


Fig. 3. Double closed loop control of synchronous motor field orientation

As shown in the Fig. 3, the design starts from the inner ring and gradually expands outward. Starting from the current loop, the current regulator is designed. The current loop is regarded as a link in the speed regulating synchronous motor, and then the speed loop is designed. The function of the current loop is to improve the speed of the synchronous motor, restrain the internal interference of the current loop, and limit the maximum current to ensure the safe operation of the synchronous motor [15]. The function of speed loop is to enhance the ability of synchronous motor to resist load disturbance and restrain speed fluctuation. In the PI regulator parameter tuning, the data is collected in the offline working mode, so when the synchronous motor structure changes, the data can not be updated online, so it is necessary to re collect data for tuning [16]. This paper presents a feasible method which can be better extended to the nonlinear synchronous motor, that is to expand the original PI regulator off-line database. At each sampling time, the data of the current process is added to the original offline database, so the data node of the current PI regulator will be covered by the extended database. Then, at each sampling time, the extended database can be used to adjust the parameters of the regulator [17]. In order to achieve this goal, the distance definition is used to select the closest I group of data which is consistent with the current process conditions in the expanded database

$$d_i = \|x(k-1) - x_i\| \tag{9}$$

Among them, $x_i = [y(i)u(i)]^T$ is a group of I / O data of the current data node. In the current database, m x which is closest to X $(k-1)$) are selected as the relevant data of the current PI regulator database to set the regulator parameters at the current sampling time. When the PI regulator database is further updated by the last data node, the above design process is repeated [18]. When the structure of synchronous motor changes, it is unreasonable to reset the pseudo gradient estimation value to the initial value of pseudo gradient. The pseudo gradient estimation value of synchronous motor is reset to the adaptive parameter of PI regulator, and the pseudo gradient value is reset by using the database. But at this time, the database is composed of m groups of synchronous motor I/O data close to the current data node, so as to ensure the PI regulator parameters Adaptive processing effect [19].

2.3 Test of PI regulator's Self-adaptation

On the basis of parameter tuning of multivariable PI regulator based on genetic algorithm, the operation parameters of PI regulator are predicted based on particle swarm optimization algorithm, and the controlled multivariable synchronous motor is transformed into several multi input and single output sub synchronous motors, thus the control problem of multivariable synchronous motor is transformed into several single output sub synchronous motor control problems The prediction model predicts the output of the sub synchronous motor, and then uses the particle swarm optimization algorithm to adjust the parameters of the PI regulator.

As shown in the Fig. 4, the feedback of the hidden layer nodes of the feedforward network to the nodes of the previous layer or the self-feedback to the nodes of this layer belongs to local connection recursion. In the application, firstly, it simplifies the network structure of multilayer feedforward network and reduces the number of nodes, thus overcomes the problem that the dynamic modeling of multilayer feedforward network turns into static modeling. Real-time control is one of the key problems in the application

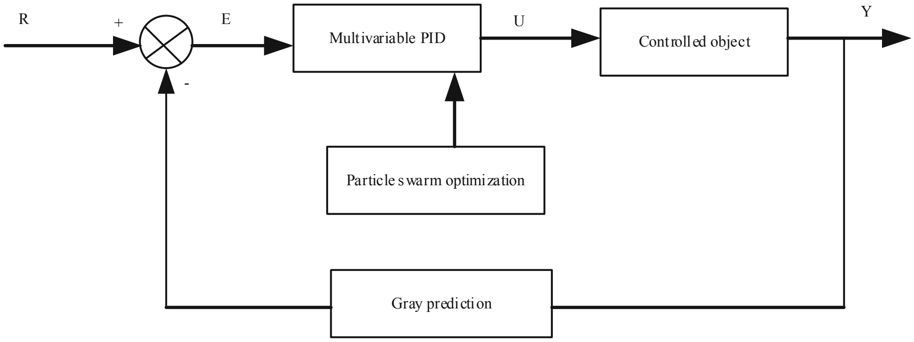


Fig. 4. Synchronous motor PI controller parameter control structure

of PI controller for synchronous motor. Therefore, the PI controller needs less network computation and is more suitable for real-time control and adaptive processing. Diagonal recursion is the simplest local interconnection recursion from the structure of synchronous motor PI regulator. It is easy to construct training algorithm, and the hidden layer node has self-feedback connection. Compared with the standard feedforward network, DRNN has the same input/output and implicit cell, but the implicit cell of DRNN has self-feedback. The dynamic mapping and memory function of DRNN is realized by recursive neuron capturing the dynamic characteristics of synchronous motor in the inner feedback loop. Compared with fully connected RNN implicit cells, there is no mutual information exchange between them, so the model is greatly simplified and the adaptive speed is guaranteed. In order to implement complex control conveniently in practical engineering, a high order regulator approach using multivariable PI regulator is presented. By adjusting a design parameter reflecting closed-loop, robust stability and time-domain performance of synchronous motor, multivariable PI regulator can be obtained. The main idea is to design a full order H regulator for the original synchronous motor by loop forming H method, and then reduce the order of the regulator on the basis of the closed-loop synchronous motor. Based on the control structure shown above, the standard adaptive form of the multivariable PI regulator is as follows:

$$D(s) = \frac{U(s)}{E(s)} = \begin{bmatrix} d_1(s) & & & \\ & d_2(s) & & \\ & & \ddots & \\ & & & d_n(s) \end{bmatrix} \tag{10}$$

The multi-variable PI regulator tuned by the above method is very simple, which is equivalent to selecting the parameters of each loop, and the tuned parameters are high efficient and clear.

3 Analysis of Experimental Results

In order to verify the dynamic and steady-state performance of the proposed method, it is proved that the proposed method is effective. In order to ensure the accuracy of the experiment and avoid the difference of the experimental results under the influence of different experimental environment and parameters, the experimental parameters are first standardized, and the specific parameters are shown in the Table 1.

Table 1. Operation parameter specification of synchronous motor

Parameter	Numerical value
Rated power/kW	7.5
Rated cabinet TL/N·m	17.5
Direct axis inductance L d/H	0.010 96
Quadrature axis inductance Lq/H	0.012 44
Polar logarithm p	5
Moment of inertia J/(kg · m^2)	0.285
Friction coefficient B	0.000 3
Rotor flux amplitude Ψf/WB	0.233 9
Winding resistance R/Ω	0.29
Sampling frequency/Hz	5000
Current loop regulation period T/S	0.000 2
Speed ring regulation cycle T/S	0.004

Because the PI regulator always operates under certain interference conditions, in order to verify the authenticity of PI parameter identification results, interference test is applied to the experimental platform, and the test site is selected in the EMC laboratory of automation equipment of State Grid Corporation of China (the designated unit of power equipment access test). In the test, pulse group interference test and oscillation wave interference test are carried out, which are the tests that must be passed to test the power control device. Based on this, the traditional method and the experimental results of this method are compared and recorded. In the experiment, the input and output data of IP operation under these two conditions are measured respectively. The restoration results of output data under the condition of pulse group interference test are shown in the table. The restoration results of output data under the condition of oscillation wave interference test are shown in the Tables 2 and 3.

In the process of experiment, the result of data recovery test is the same as that of the test without interference, and the calculated value of individual data is different from the measured value, because of the program setting of digital PI. Based on theoretical analysis and several prototype experiments, 4 pairs of pole surface mounted synchronous motor with 1.1 kW, 220 V, 200 Hz, rated speed of 3000 rgrain, rated torque of 3.5 $n \cdot m$ and rated current of 3 A are selected. The parameters are as follows: stator resistance 2.875 Q, $l = 8.5$ MH; moment of inertia 0.000 8 kg · m^2; PWM wave carrier frequency 5 kHz, current loop filtering time 40 PS, speed loop filtering time 2 ms. According to the above PI regulator parameter design method, the proportional parameter k_0 of current loop is 17.708, the integral parameter k_1 is 5989.58; the time constant r of speed loop is

Table 2. Comparison of calculated output and actual output under the condition of pulse group interference under the traditional method

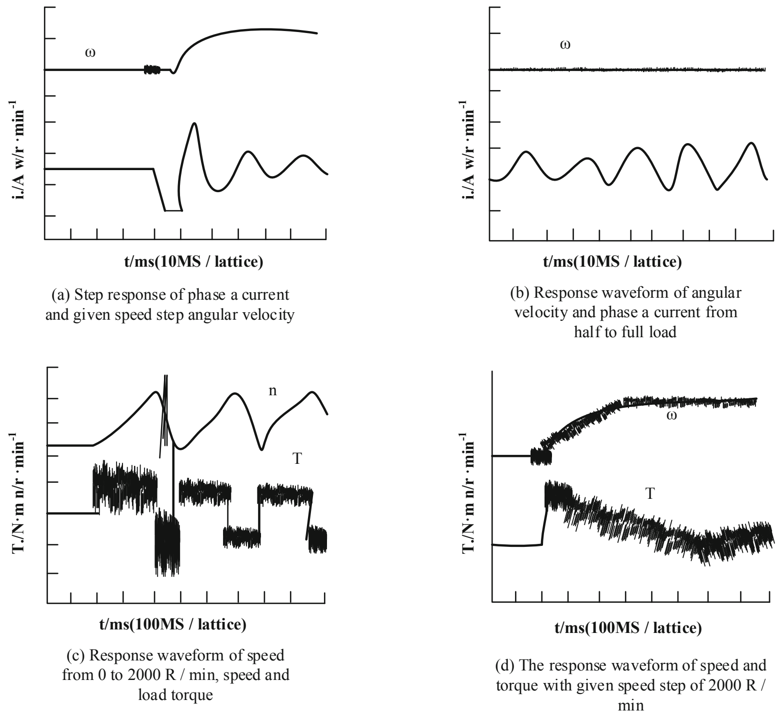
Serial number	input	Actual output	Calculation output	Is it equal
0	0.000	105.175		
1	0.000	104.182		
2	−0.025	111.170	142.106	yes
3	−0.025	102.190	142.101	No
4	0.010	131.156	151.103	Yes
5	0.010	124.570	151. 105	No
6	0.010	133.082	150. 107	No
7	0.030	126.045	161. 103	Yes
8	−0.035	131.026	139.107	No
9	0.010	105.500	155.105	Yes
10	0.010	105.052	154.103	Yes

Table 3. Comparison between calculated output and actual output under the condition of pulse group interference

Serial number	input	Actual output	Calculation output	Is it equal
0	0.000	185.181		
1	0.000	185.181		
2	−0.025	184.176	184.176	Yes
3	−0.025	184.171	184.171	Yes
4	0.010	185.573	185.573	Yes
5	0.010	185.575	185.575	Yes
6	0.010	185.577	185.577	Yes
7	0.030	186.383	186.383	Yes
8	−0.035	183.776	183.776	Yes
9	0.010	185.578	185.578	Yes
10	0.010	185.580	185.580	Yes

0.09, the proportional parameter k_n is 0.023. The waveform obtained in the experiment is shown in Fig. 5

Because the digital quantity of data in the experiment is directly connected to the computer through the communication interface, the accuracy of data acquisition is high. Using this data can accurately calculate a and b, and can accurately identify the parameters of PI regulator even under interference conditions. This experiment provides a



(a) Step response of phase a current and given speed step angular velocity

(b) Response waveform of angular velocity and phase a current from half to full load

(c) Response waveform of speed from 0 to 2000 R / min, speed and load torque

(d) The response waveform of speed and torque with given speed step of 2000 R / min

Fig. 5. Analysis of experimental results

method reference for high precision acquisition of input and output digital signals. There are many PI regulators in the control of synchronous motor. In the study of parameter identification of synchronous motor, the given PI regulator parameters can be taken as known conditions, which greatly simplifies the complexity of the problem. The results show that the regulator parameters designed by the above method can well meet the control performance of synchronous motor.

4 Conclusion

The method of PI regulator parameter tuning is studied, which includes two aspects. On the one hand, the single variable PI parameter tuning is studied, including the PI parameter tuning using genetic algorithm, wavelet and linear matrix inequality method in robust control theory. The specific design steps are given. On the other hand, the online tuning method of multivariable PI parameters is studied, and the main methods of multivariable PI parameters tuning and the specific design of the algorithm are described. On the basis of diagonal recursion, the quasi diagonal recursion multivariable PI parameters tuning is proposed. On the basis of analyzing the mathematical model of synchronous motor, the driving model of synchronous motor with rotor field oriented vector control is established Dynamic synchronous motor model. Aiming at the double closed-loop structure of full digital high-power synchronous motor with field oriented control. The transfer function models of current loop and speed loop are established. According to the engineering design method of PI regulator, a design criterion and method of control parameters of digital PI regulator are given. The experimental results show that the adaptive parameter determination method of synchronous motor digital PI regulator achieves good control effect and has certain application value.

Fund Projects. Hunan Natural Science Foundation Project (2020JJ4558, 2018JJ2367, 2020JJ5519), Hunan Science and Technology Department Science and Technology Project (2016 TP1023).

References

1. Ashok, R.B., Kumar, B.M.: Comparative analysis of BLDC motor for different control topology. Energy Procedia **117**(11), 314–320 (2017)
2. Roy, R., Prabhakar, K.K., Kumar, P.: Core-loss calculation in different parts of induction motor. IET Electr. Power Appl. **11**(9), 1664–1674 (2017)
3. Martinez, J., Belahcen, A., Muetze, A.: Analysis of the vibration magnitude of an induction motor with different numbers of broken bars. IEEE Trans. Ind. Appl. **53**(3), 2711–2720 (2017)
4. Tutaev, G.M., Bobrov, M.A., Gulyaev, I.V.: Evaluation of the energy characteristics of an asynchronous inverter-fed induction motor at different approximations of the magnetization curve. Russ. Electr. Eng. **88**(6), 321–325 (2017)
5. Morosato, F., Traina, F., Cristofolini, L.: Effect of different motor tasks on hip cup primary stability and on the strains in the periacetabular bone: an in vitro study. Clin. Biomech. **70**(11), 137–145 (2019)
6. Jianqiu, L.: Construction of real-time interactive mode-based online course live broadcast teaching platform for physical training. Int. J. Emerg. Technol. Learn. (iJET) **13**(06), 73 (2018)
7. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy 21(9), 902 (2019)
8. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**(12), 62412–62420 (2019)
9. Liu, Q., Chen, Z.Y., Yang, S.F., et al.: Magnetic properties of pure iron with respect to different C/Si ratios and grain sizes. Mater. Sci. Forum **913**(10), 653–660 (2018)
10. Nguyen, M.Q., Dario, S., Malec, D., et al.: Environmental assessment and dielectric performances of the secondary electrical insulation in low voltage motors impregnated by different techniques. Engineering **9**(10), 860–873 (2017)
11. Kumar, H., Tengli, P.N., Mishra, V.K., et al.: Synthesis and catalytic activity of Cu–Cr–O–TiO 2 composites for the thermal decomposition of ammonium per-chlorate: enhanced decomposition rate of fuel for solid rocket motors. RSC Adv. **7**(21), 12486–12495 (2017)
12. Cao, R., Lu, M.: Investigation of high temperature superconducting linear flux-switching motors with different secondary structures. IEEE Trans. Appl. Superconduct. **30**(4), 1–5 (2020)
13. Chen, Y., Cai, T., Zhu, X., et al.: Analysis and design of a new type of less-rare-earth hybrid-magnet motor with different rotor topologies. IEEE Trans. Appl. Superconduct. (2020)
14. Huthaifa, F., Lorenz, R.D., Eigo, T., et al.: Investigation of different servo motor designs for servo cycle operations and loss minimizing control performance. IEEE Trans. Ind. Appl. **54**(6), 5791–5801 (2018)
15. Han, S., Liu, C., Sun, X., et al.: Investigation of static characteristics in six-phase switched reluctance motors under different winding connections. IEEE Access **7**(11), 71174–71184 (2019)

16. Terao, Y., Akada, W., Ohsaki, H.: Design and comparison of interior permanent magnet synchronous motors using different bulk superconductor arrangements. IEEE Trans. Appl. Superconduct. **29**(5), 1–5 (2019)
17. Sun, X., Diao, K., Lei, G., et al.: Study on segmented-rotor switched reluctance motors with different rotor pole numbers for BSG system of hybrid electric vehicles. IEEE Trans. Veh. Technol. **68**(6), 5537–5547 (2019)
18. Huang, X., Qian, Z., Tan, Q., et al.: Suppressing the thrust ripple of the permanent magnet linear synchronous motors with different pole structures by setting the modular primary structures differently. IEEE Trans. Energy Convers. **33**(4), 1815–1824 (2018)
19. Jun, C.S., Kwon, B.I.: Performance comparison of a spoke-type PM motor with different permanent magnet shapes and the same magnet volume. IET Electr. Power Appl. **11**(7), 1196–1204 (2017)

Research on the Relationship Between Volatility and Regional Economies of Scale in Cloud Computing

Jun-hao Qiao(✉) and Xin Tang

Zhengzhou Technical College, Zhengzhou 450121, China
qiaojunhao55@yeah.net

Abstract. There is a certain correlation between the regional education scale and the local economy, but the factors considered in the existing analysis of the relationship between regional education and economic fluctuations are not comprehensive. Moreover, the data used in the analysis process is relatively old and cannot reflect the current relationship between education and the economy. So this paper studies the simulation method of the coordination relationship between regional education scale fluctuation and economic fluctuation based on cloud computing. This study extracts the characteristics of regional education scale fluctuations and economic fluctuations in advance, and then uses cloud computing technology to establish a comprehensive analysis model, and uses the model to simulate the coordination between the two. Experimental test results: compared with the two traditional coordination relationship simulation methods, the simulation method of this study is not affected by the fluctuation of education scale and economic fluctuation. Considering the fluctuation coordination relationship from many aspects, the simulation results are more close to the expected value in the near future.

Keywords: Cloud computing · Regional education scale fluctuation · Economic fluctuation coordination · Relationship simulation

1 Introduction

In the huge education system, the relationship between education and economic development is the most close. Regional economy provides material security and financial support for education and promotes the development of vocational education. Vocational education indirectly promotes economic growth by cultivating labor force and improving labor productivity. There is a complex two-way interactive relationship between education and regional economy. In the past, researches on the relationship between vocational education and regional economy were mostly single-dimensional [1, 2].

The development of higher education and economic development both promote and restrict each other. For a country or region, the development of higher education can promote short-term economic growth and long-term development, while being restricted by the stage and level of local economic development. If higher education lags behind

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 550–561, 2021.
https://doi.org/10.1007/978-3-030-84386-1_45

the level of economic development, the long-term economic development and social progress will lose the fundamental basis of human resources; if higher education is too far ahead of the level of economic development, it will also cause a waste of social resources and bring about the quality of higher education Decline and difficulties in finding employment for college graduates. Therefore, for a country or region, the development level of higher education should be basically adapted to the level of economic development. This adaptation is the coordination referred to in this article.

In order to solve the relationship between multi-level education and regional economy, this study proposes a coordination relationship simulation method based on cloud computing. Cloud computing is a new network computing mode, which can provide various services to various network applications. It has the technical characteristics of rapid scalability, high scalability, quality assurance, security, storage and calculation of massive data [3, 4]. Therefore, the mechanism and technical characteristics of cloud computing are fully utilized to simulate the tonal relationship between regional education scale fluctuation and economic fluctuation.

2 Simulation of Coordination Relationship Between Regional Education Scale Fluctuation and Economic Fluctuation Based on Cloud Computing

2.1 Extract the Fluctuation Characteristics of Regional Education Scale

There are many forms of higher education, such as graduate education, general college education, adult college education, network college education, higher education self-study examination and so on. The statistical indicators related to the number of students mainly include the number of students enrolled, the number of students in school and the number of graduates. This paper chooses the number of students who are receiving graduate education and general college education to describe the scale of China's higher education. The index data of this paper are all selected from the statistical literature of Chinese government departments, and the specific data are shown in Table 1.

Table 1. Scale of higher education in China (2010–2019)

Particular year	Total number of students in school (10000 students)	Gross enrollment rate (%)
2015	3647	40.00
2016	3699	42.70
2017	3799	45.70
2018	3833	48.10
2019	4002	51.60

According to the statistics in Table 1, the scale of higher education in China has been on the rise in the past 5 years, but there are still great differences among different regions in terms of the scale of education. First, the influence of political factors on the scale of China's higher education has been great. According to the differences of the main role, the development of higher education in the world can be divided into two models: national regulation and university autonomy. The development of higher education in China is controlled by the state, which is characterized by nationalism and government dominance. In this model, the change of the scale of higher education is strongly influenced by political factors. The scale of higher education is often a kind of government action under the guidance of nationalism. When the political situation is turbulent, the change of the scale of higher education fluctuates greatly; when the political situation is stable, the change of the scale of higher education fluctuates little. Compared with the political situation, the policy of higher education has a more direct impact on the change of the scale of higher education, the direction and degree of its change. Both the political situation and the higher education policy are deeply influenced by the political leaders. Major changes in the scale of higher education often begin with speeches or instructions from political leaders, followed by government policies to follow through on leaders' intentions, and then implemented by universities. In this process, the influence of political factors is not only direct, but also mandatory, and often causes the problem of policy expansion. Because the promotion of subordinates "is often based on political correctness, mainly closely followed the level of the higher level to the decision," so that "the upper good, the lower will be very good" situation from time to time [5, 6].

Second, the influence of economic factors on the scale change of China's higher education is growing. Before the reform and opening up, the influence of economic factors on the scale change of China's higher education, though existing, is not strong. The correlation analysis between China's GDP since 1952 and the scale of higher education shows that the Pearson correlation coefficient between 1952 and 1977 is −0.142. The reason why the absolute value of the correlation coefficient is small, and negative, mainly because the correlation between the two is only low, and there are more reverse changes [7]. During this period, the scale of higher education has changed three times. The first appeared in 1963–1966, and the second in 1969–1970, when the economy grew significantly, but the size of higher education shrank dramatically. The third was in 1976, when the size of the economy declined, but the size of higher education increased [8]. After the reform and opening up, economic factors on the scale of China's higher education has become increasingly large, the relationship between the two become close. From 1978 to 2010, the correlation coefficient between China's GDP and the size of higher education was 0.977. The reason why the correlation coefficient is so high, mainly because the two highly correlated, highly convergent direction of change [9]. To a large extent, this is due to the strategic shift of China's work focus since the reform and opening up, focusing on economic construction as the central task, strengthening the connection between economic work and other work, and increasing the impact of economic work on other work. With regard to higher education, the cost-sharing system is adopted to expand the scale of higher education, the structural adjustment of higher education is carried out on the basis of the theory of scale efficiency, the expansion of enrollment in colleges and universities is adopted to stimulate consumption, expand domestic demand, and absorb private capital to develop higher education [10]. Such new measures closely link the economy with higher education, and make the impact of economic factors on the scale change of higher education increasingly strong.

Third, the role of higher education itself in the change of higher education scale in China needs to be strengthened. The influence of political and economic factors on the scale change of higher education is external and belongs to external pressure, while the influence of higher education itself on the scale change is internal and belongs to internal logic. For example, it is a kind of internal logic that the scale of higher education will be restrained after a long period of time. After the founding of the People's Republic of China, the scale of higher education continued to rise in 1960, particularly in 1958–1960, long after the rise that took up to 10 years of decline. Since 1971, the scale of higher education in China has risen back to 132% in 1972, which is the result of the release of the expansion potential of colleges and universities for a decade. Facts show that the internal logic is powerful, and it plays a significant role in the basic trend of the scale change of higher education. Only by following the internal logic, can the scale change of higher education be regular and the alienation of higher education be avoided. Yet, as Clark Kerr puts it, "much of the history of higher education has been written by confrontation between internal logic and external pressure." The influence of internal logic is not always smooth sailing, but often met with resistance from external pressure. The history of China's higher education is such that the internal logic not only to resist external pressure, but often at a disadvantage. As the main body of internal logic, facing the interference of government power and the temptation of market interests, colleges and universities often lack the conditions and willingness to confront.

2.2 Extracting Characteristics of Economic Fluctuations

It is shown that overcapacity is not only a possible result of economic fluctuation, but also a reaction to economic fluctuation. Here, a simple theoretical explanation of the mechanism of overcapacity affecting economic fluctuation is provided, and a corresponding test hypothesis is proposed. Overcapacity in China is generally divided into three types: cyclical overcapacity, institutional overcapacity and structural overcapacity. Since China is primarily a demand-driven economy, cyclical and structural excesses can be attributed to demand shocks, while the institutional excesses are attributed to the implementation of supply-side vertical industrial policies [11]. Excess production capacity in some industries, on the one hand, will lead to the loss of enterprises, the decline in capacity utilization rate and unemployment of workers, and then produce economic fluctuations; on the other hand, it will lead to mismatch of resources, environmental pollution, lack of innovation, and further aggravate economic fluctuations. These two aspects represent the direct mechanism and indirect mechanism of excess production capacity affecting economic fluctuations, which can be summarized as quantitative effect and factor distortion effect.

First, the quantitative effect of excess capacity on economic volatility. The so-called quantity effect actually refers to the effect of economic fluctuations caused by enterprises' quantity adjustment under non-price conditions [12]. As Kornai points out, quantitative adjustment plays a very important role in all economic systems. Because the policy stimulation and the demand impact, some industries present the overcapacity, inevitably causes the capacity utilization rate the drop. The change of capacity utilization rate reflects the process of quantity adjustment. The driving effect of capacity utilization on economic fluctuations has long been observed by economists, but it was not until the 1990s that the dynamic general equilibrium framework was gradually used to analyze the intrinsic relationship between the two [13]. Firstly, the excess production capacity leads to the unsalable products and the decline of profit, which urges the enterprises to make adjustment decisions, including instantaneous adjustment, short-term adjustment and long-term adjustment. Because of the lack of innovation in domestic enterprises, instantaneous and short-term adjustment methods are very single, that is, reducing capacity utilization. Its essence is to reduce the input of variable cost factors, so as to reduce output, resulting in economic volatility. A lot of researches show that the main reason of China's economic cycle change is the fluctuation of fixed asset investment and investment income. In addition, the herd behavior of enterprise investment has further enhanced the impact of overcapacity on economic fluctuations. Secondly, the influence of productivity utilization on the elasticity of factor output [14]. In reality, because higher capacity utilization speeds up capital depreciation, output elasticity changes in the same direction as labor input and in the opposite direction as capital stock. Therefore, overcapacity will cause economic fluctuation by changing the elasticity of factor output. Thirdly, the impact of capacity utilization on scale return. Many scholars have proved that there is a close relationship between capacity utilization and scale return. For example, changes in short-term capacity utilization may lead to increasing returns to scale that only exist during the demand expansion phase. Therefore, the change of capacity utilization rate can amplify the extent of economic fluctuation by influencing the scale return. According to calculations, it can be found that due to market, system, policy and other factors, China's excess capacity is increasingly affecting the scope, severity and duration of the recession, leading to a continuous recession. Increased investment, an ongoing stimulus, may rebound the economy in the short term, but in the long run, it will lead to further declines in capacity utilization and an increase in overcapacity, plunging the economy into a deeper depression [7].

Second, overcapacity distorts the factors that affect economic volatility. Factor distortion refers to the deviation or deviation between the factor market price and the opportunity cost caused by the imperfection of the market, which leads to the non-optimal allocation of factors [15]. The factor distortion effect is one of the important transmission mechanisms of economic fluctuation caused by overcapacity, which actually reflects the adjustment result of enterprises in the existing price system. Many important documents show that China's overcapacity, especially institutional overcapacity, is largely the result of the distortions in factor markets caused by policy subsidies. But different from the Western countries, due to the imperfection of the market mechanism, China's "self-healing" mechanism of excess capacity will become invalid, instead, it will make the factor market more distorted, so that the excess capacity will not be cured for a long time. The fundamental reason for this dilemma lies in the dual system during the transition period. Some key industries are subject to soft budget constraints, and these industries are often the hardest hit areas of overcapacity. The specific mechanisms by which excess production capacity affects economic fluctuations through the distortion effect of factors are as follows:

The first is product price distortion. The essence of overcapacity is that the production capacity exceeds the potential demand, which will inevitably lead to market stagnation and product price decline. However, because the surplus industries are pillar industries or motivated by government competition, "quantitative" catch-up development, social stability and so on, governments at all levels will often prevent enterprises from withdrawing through a series of policy measures such as tax incentives, financial subsidies, government procurement and so on, resulting in the softening of the budget constraint of enterprises, which makes the demand function of enterprises shift from a downward inclination to a level without price elasticity. As a result, soft budget constraints impede or even distort the signal transmission of product price changes caused by overcapacity, and incumbents rarely make instantaneous or short-term adjustments to market changes in a timely manner, possibly leading to long-term capacity expansion and the continued entry of new firms. Kornai generalizes this situation as product price has no effect on investment decision, and thinks that if investment is important and beneficial from the non-price point of view, its profitability can be guaranteed, so it will induce investment. Thus, in the case of distorted product prices, excess capacity will reduce the economic downturn brought about by structural shifts in the short term, and even stimulate economic growth, but will lead to deeper adjustments and recessions in the long run. Next is the factor of production price distortion. On the contrary, the government's "father-love behavior" further aggravates the distortion of factor prices, such as financing support. Government intervention makes it easier for surplus enterprises to obtain credit funds from banks at lower cost, thus forming the "ratchet effect" of "passing over surplus credit". On the one hand, the distortion of the price of important factors of production and the dual-track system have "crowding out" the investment of other industries, on the other hand, they also affect the output through the change of the marginal output of factors, which causes the economic fluctuation.

By definition, the distortion of factor allocation is actually the result of price distortion. Because of soft budget constraints and dual-track system, China's overcapacity has caused price distortion, which will inevitably lead to factor mismatch.In order to show the difference between configuration distortion and price distortion, technical distortion needs to be understood, that is, the change in total factor productivity caused by factor mismatch. Based on the literature review, it is found that almost all the studies support the conclusion that factor configuration distortions inhibit TFP. Endogenous growth theory holds that total factor productivity is an important factor of economic growth. The RBC theory further emphasizes the impact of TFP shocks on economic fluctuations. Taken together, overcapacity can lead to economic volatility through distortions in factor allocation.

Based on the above discussion, this paper proposes the following two hypotheses: Hypothesis 1: There are direct mechanism and indirect mechanism of excess capacity affecting economic fluctuations. Hypothesis 2: Overcapacity also leads to economic volatility indirectly through the distortion effect of factors including price distortion and allocation distortion. Therefore, the econometric model of hypothesis one is established.

$$T_t = SeH_tL_tC_t \tag{1}$$

In the formula, t represents the total output of phase T_t; S represents technological progress and other institutional or difficult to observe factors; H_t represents the capacity utilization rate of phase t, which is the core index to measure the degree of excess; L_t and C_t represent the capital stock and labor input of phase L_t respectively. At the same time, the econometric test model of Hypothesis 2 was established. Hypothesis two holds that overcapacity can affect economic fluctuation through factor distortion. In order to test this hypothesis, the mediating effect model was introduced and analyzed.

$$f_t = \varphi_0 + \varphi_1 y + \alpha F + \omega_1 \tag{2}$$

$$d_t = \varepsilon_0 + \varepsilon_1 y + \beta F + \omega_2 \tag{3}$$

$$f_t = \lambda_0 + \lambda_1 y + \lambda_2 y + \pi\theta F + \omega_3 \tag{4}$$

In the formula: f_t represents economic fluctuation; d_t represents distortion degree of factor market; y represents change of capacity utilization rate; t represents time; ω_1, ω_2, ω_3 represents random error; F represents control variable. Through the above calculation process, the characteristics of economic fluctuation are extracted.

2.3 Coordination Relationship Simulation Based on Cloud Computing

Cloud computing is the development direction of the next generation infrastructure, with the characteristics of traditional computing, but also with new technology advantages. Therefore, according to the hierarchical view of organizational ability, the low-level ability of enterprise and education will affect the high-level ability, so as to improve the performance and students' examination results. This study believes that the application of cloud computing will enable enterprises and education to have low-level capabilities, that is, cloud computing infrastructure capabilities, and through the promotion of high-level capabilities of enterprises and education, that is, organizational agility, improve performance and students' ability, and achieve coordinated relationship modeling. The relationship between education and regional economy is intertwined and complex. If vocational education and regional economy are regarded as two different overall systems, they will present a "Circular" relationship logic. If the entire education and regional economic system is further analyzed, it will be found that there are two relationships between the elements, namely "inter subjectivity logic" and "hierarchical coupling logic", because of their interaction. Among them, "inter subjectivity logic" refers to the interactive relationship between subjects in the linkage between education and regional economy, and "hierarchical coupling logic" refers to the "level type" interaction relationship formed between education and regional economy. First, it simulates the "circular logic" of the linkage between education and regional economy. Education and regional economy, as two subsystems of the social system, have different functions and structures, which make the interaction between them intertwined and complex. If these two systems are analyzed as a whole, the two systems mainly present a "ring" linkage relationship mediated by capital, as shown in Fig. 1.

Second, the "inter subjectivity logic" of the linkage between education and regional economy. The linkage between education and regional economy involves the government, enterprises and schools. In the relationship formed by the "three main bodies"

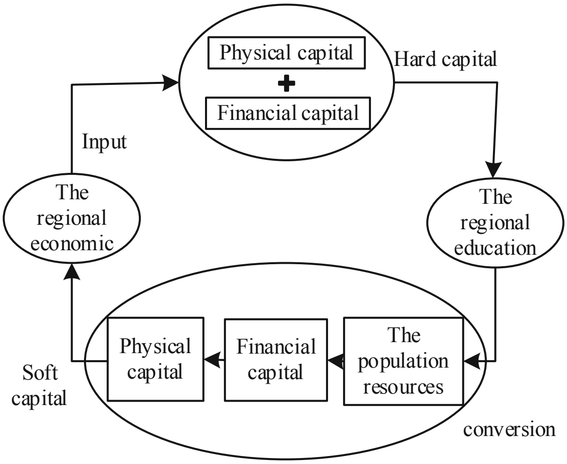


Fig. 1. Simulation diagram of circular logical relationship

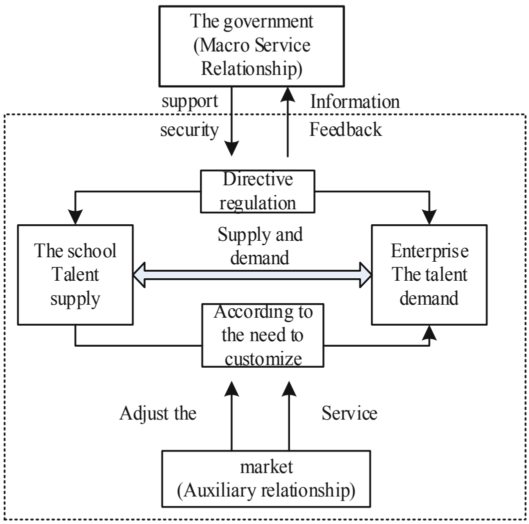
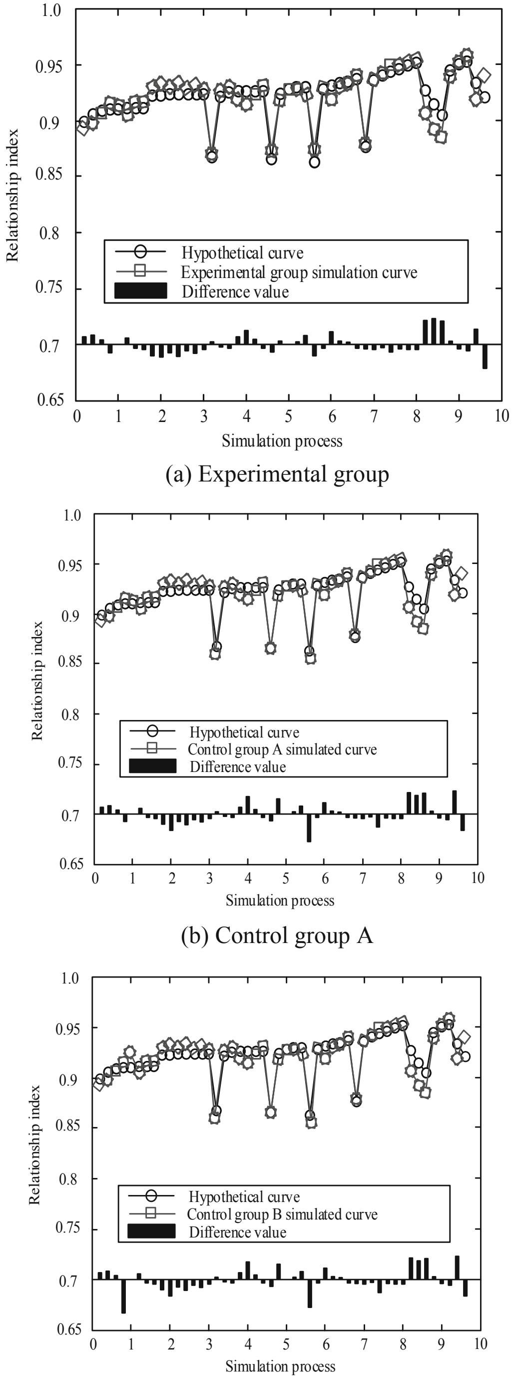


Fig. 2. Inter agent logic simulation diagram of linkage

of the government, enterprises and schools, talents, as an "invisible hand", are always intertwined with the relations among the main bodies, as shown in Fig. 2 below.

Through the above analysis and research, based on the concept and principle of cloud computing, the coordination relationship between regional education scale fluctuation and economic fluctuation is simulated.

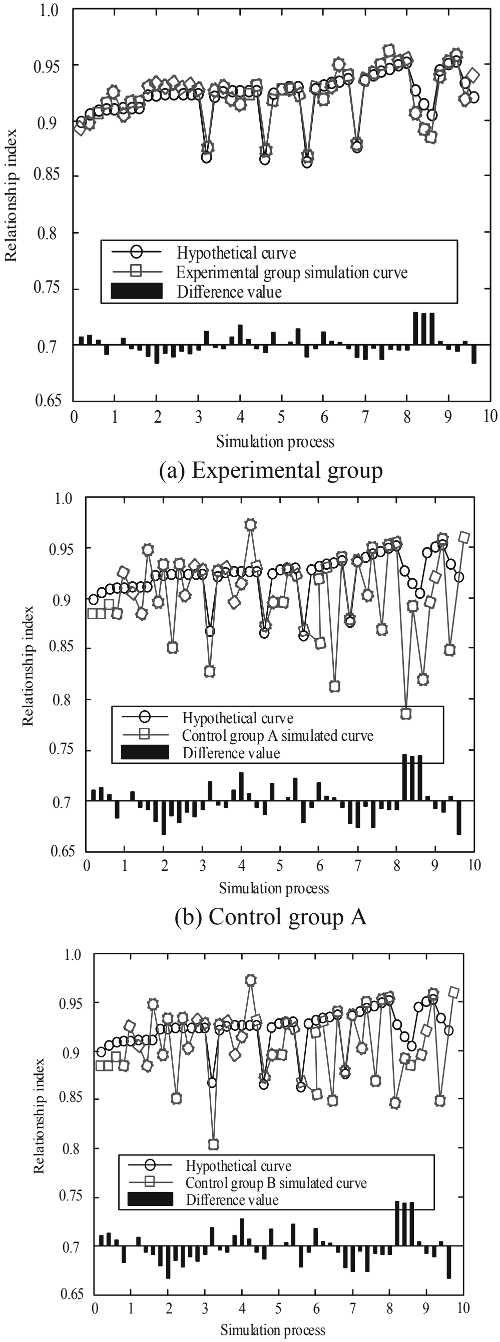


(a) Experimental group

(b) Control group A

(c) Control group B

Fig. 3. Contrast effect under weak fluctuation



(a) Experimental group

(b) Control group A

(c) Control group B

Fig. 4. Contrast effect under strong fluctuation

3 Experimental Study

In order to verify whether the simulation method of this study is feasible, a comparative test experiment is proposed. The coordination relationship simulation method of this study is taken as the experimental group, and the two traditional simulation methods are taken as the control group. Taking the current situation of education and economic fluctuation in area a as an example, the coordination relationship between the two test groups is analyzed. It is known that the fluctuation of education scale and economy in area a is small, so the coordination relationship between them is easy to capture. Figure 3 shows the relationship simulation effect curve of three test groups.

According to the simulation results of the three methods in Fig. 3, the three test groups have good simulation effect in the face of weak fluctuations. Then, taking region B as the test object, it is known that the regional education scale and economic fluctuations exist violent and frequent phenomenon. Figure 4 shows the simulation effect of three test groups on the coordination relationship.

According to the test results shown in Fig. 4, in the face of strong fluctuations in education scale and economy, there is a strong correlation between the simulation effect curve of the experimental group and the hypothetical relationship curve, while the correlation between the simulation effect of the coordination relationship of the two control groups and the hypothesis curve is weak. Therefore, the simulation method based on cloud computing is better.

4 Conclusion

Although the proposed simulation method has achieved good research results, there are still some shortcomings. In the future, cloud computing can be optimized to further strengthen the coordination relationship simulation, and provide more perfect coordination relationship simulation technology for regional education and economic development.

References

1. Gao, B., Duan, X.: On dynamic relationship between graduate education scale and economic growth in 40 years of reform and opening-up. Heilongjiang Res. High. Educ. **37**(08), 33–37 (2019)
2. Deng, G., Peng, H.: Currency internationalization, time-varying invoicing currency and economic fluctuations. J. World Econ. **42**(06), 20–46 (2019)
3. Sun, J., Wang, X., Wang, L.: Simulation analysis of construction labor market from the perspective of embeddedness. Soft Sci. **32**(05), 81–85 (2018)
4. Huang, S., Wang, H., Luo, Z.: Research on key technologies of cloud computing information and data center security in energy internet enterprise. Microcontrollers Embed. Syst. **20**(01), 27–29+34 (2020)
5. Zheng, Y., Liu, X.: Study on the change of school-age population and educational resources demand in Binhai new area of Tianjin—the staged forecasting and analysis based on CPPS. Mod. Educ. Sci. **12**(11), 20–26 (2018)

6. Liu, J.: Construction of real-time interactive mode-based online course live broadcast teaching platform for physical training. Int. J. Emerg. Technol. Learn. (iJET) **13**(06), 73 (2018)
7. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
8. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
9. Chen, J., Yu,W., Wu, C., et al.: The synergy effect of ground and high voltage transmission tower foundation under mining subsidence influence. Mine Surv. **47**(06), 56–60+63 (2019)
10. Yang, T., Wang, M., Zhang, Y.-J., et al.: HDFS differential storage energy-saving optimal algorithm in cloud data center. Chin. J. Comput. **42**(04), 721–735 (2019)
11. Li, H.A., Zhang, M., Yu, K., et al.: Combined forecasting model of cloud computing resource load for energy-efficient IoT system. IEEE Access **7**(99), 149542–149553 (2019)
12. Lalropuia, K.C., Gupta, V.: Availability and reliability analysis of cloud computing under economic denial of sustainability (EDoS) attack: a semi-Markov approach. Cluster Comput. 1–15 (2021)
13. Rasha, M.: Cloudy transaction costs: a dive into cloud computing economics. J. Cloud Comput. **9**(1), 1–11 (2020)
14. Altmann, J., Baares, J.N., Tserpes, K.: Economics of computing services: an overview of economic motivated solutions to cloud computing. Futur. Gener. Comput. Syst. **111**, 931–933 (2020)

Multimedia Resources Search Service System of Preschool Education Based on Augmented Reality Technology

Jia-wei Yuan[1](✉) and Fa-li Mi[2]

[1] College of Education, Shanghai Aurora College, Shanghai 201908, China
yuanjiawei1211@21cn.com
[2] Division of Humanities and Social Sciences,
Shanghai Aurora College, Shanghai 201908, China

Abstract. The search and utilization of multimedia network teaching resources is a work that cannot be ignored in information education. Based on the in-depth study of the content characteristics of multimedia network teaching resources, this paper develops a multimedia network teaching resource search system for basic education. Based on the automatic analysis of content, structure, and theme of images, videos, and Flash related to basic education in the Web, establish a basic education multimedia network teaching resource index database, increase indexing depth, and use conditional retrieval and natural language fuzzy query. The combined method realizes a basic education multimedia network teaching resource search system based on content characteristics, and provides a good platform for effective use of multimedia network teaching resources.

Keywords: Augmented reality · Preschool education · Resource search

1 Introduction

Multimedia network teaching resources are a kind of network resources with specific topics. With the development of network and multimedia technology, multimedia teaching resources in the web are increasingly rich. How to quickly and effectively find and use these teaching resources and make them play a full role in information education is a problem of great concern to educational technology workers [1]. However, due to the extremely rich content of multimedia information, it is sometimes difficult to describe with a few simple keywords, and sometimes the automatically extracted keywords do not match the multimedia content, resulting in unsatisfactory results of multimedia retrieval based on keywords. Search results often contain too much content that does not match the search topic, and users often need to browse and choose from them, which consumes a lot of time, reduces the efficiency of network resource utilization, and also dampens the enthusiasm of users [2]. The main reason for this phenomenon is that the search engine system does not index the content of multimedia information deeply enough. Therefore, this paper proposes a design method of multimedia resources search service system

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 562–575, 2021.
https://doi.org/10.1007/978-3-030-84386-1_46

for preschool education based on augmented reality technology. From the content level of multimedia information to solve the retrieval problem, improve the retrieval accuracy, avoid the subjective one sidedness and incompleteness caused by text description [3]. Multimedia information retrieval is to automatically analyze the content of multimedia information, extract low-level audio-visual features, obtain middle-level object features and high-level topic features through pattern recognition technology, and carry out multimedia information retrieval according to these content features.

Based on the automatic analysis of the content, structure and themes of images, videos and Flash related to basic education in the Web, this paper establishes a basic education multimedia network teaching resource index database, increases the index depth, and uses conditional retrieval and natural language fuzzy inquiries. The combined method realizes a basic education multimedia network teaching resource search system based on content characteristics.

2 Design of Multimedia Resources Search Service System for Preschool Education

2.1 Hardware Configuration Optimization of Multimedia Resource Search Service System

Based on the research on the visual features, structure, theme and other content features of multimedia network teaching resources, especially the basic education teaching resources, according to the subject words of multimedia teaching resources in the basic education textbooks, we search for images, videos and flash in the web, then automatically analyze the content and structure, extract the visual features and object features, combined with the features extracted from the relevant texts The key words are classified and identified, the indexing depth is increased, and the index database of multimedia network teaching resources of basic education is established. Finally, the search of multimedia network teaching resources of basic education is realized by using conditional search combined with natural language fuzzy query, which provides a support platform for the effective use of multimedia network teaching resources [4]. Teaching resources automatic search system is mainly composed of intelligent word segmentation module, search module, index module, acquisition module and other key parts. The structure model of multimedia resource search service system is as follows (Fig. 1):

The main function of the index module in the system is to understand the information of teaching resource materials, extract index items from the searched teaching resource web pages, and use them to represent documents and generate the index table of document library [5]. For the automatic search system, the selection of index words in the index module is a core problem. If the common words are selected as the index word list, although the memory requirement is less, the frequency of each index word will be very high. And because many words are not included in the index thesaurus, they will be cut into single words when they are inverted. The more frequent words appear in the indexing process, the more conjunctive operations will be done during retrieval, resulting in longer query response time of the system [6]. On the contrary, if the number of index words is large, it will occupy a lot of memory resources during retrieval. Many index words with

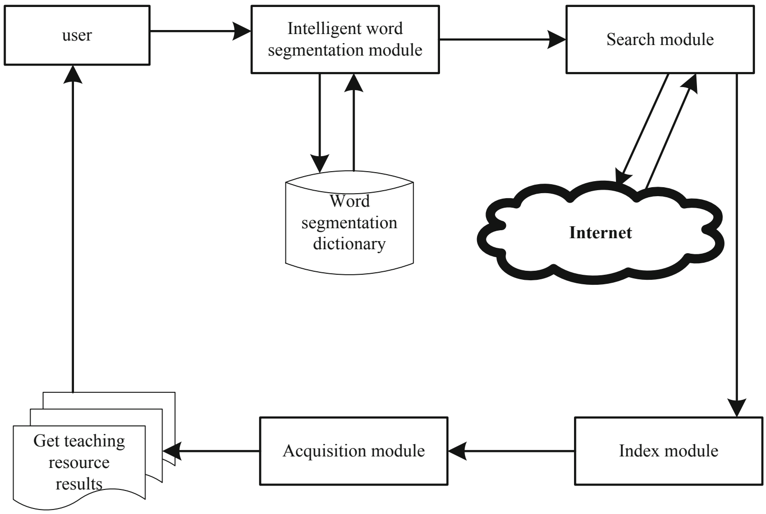


Fig. 1. Structure model of multimedia resource search service system

low frequency are rarely used during retrieval, wasting memory resources. Therefore, the balanced selection of index words is very important [7]. Another key point of the index module is to use inverted index technology, which includes the establishment of forward index and reverse index. Based on this, the index architecture of multimedia teaching resources is further optimized, as follows [8] (Fig. 2).

The main function of the system search module is to search the web teaching resources through the web spider according to the needs of users. The web spider searches for the target web page through the link address of the web page on the Internet, starts from a certain page (usually the home page) of the web site, reads the required content of the web page, finds other link addresses in the web page, and then looks for the next web page through these link addresses, so it continues to cycle until all the web pages of the web site are captured. If the whole Internet is regarded as a website, then the web spider can use this principle to collect all the target content on the Internet [9, 10]. The performance of search module is directly related to the coverage of the whole resource search system. According to the distribution characteristics of web teaching resources, the system adopts incremental collection and breadth first algorithm to improve the search efficiency and recall of teaching resources as much as possible [11, 12]. Multimedia information resources search engine is a system specially designed for rich information resources and their use characteristics. The search engine follows the retrieval habit of users' Internet search mode, and provides users with comprehensive search from three aspects of discipline, learning progress and resource type on the basis of keyword search, so as to obtain professional related information resources more conveniently and comprehensively [13, 14]. At the same time, to ensure the stability and security of the system operation, the retrieval response time, data update frequency, precision and other indicators should reach a higher level. The system structure of multimedia information resources search engine is shown in the Fig. 3.

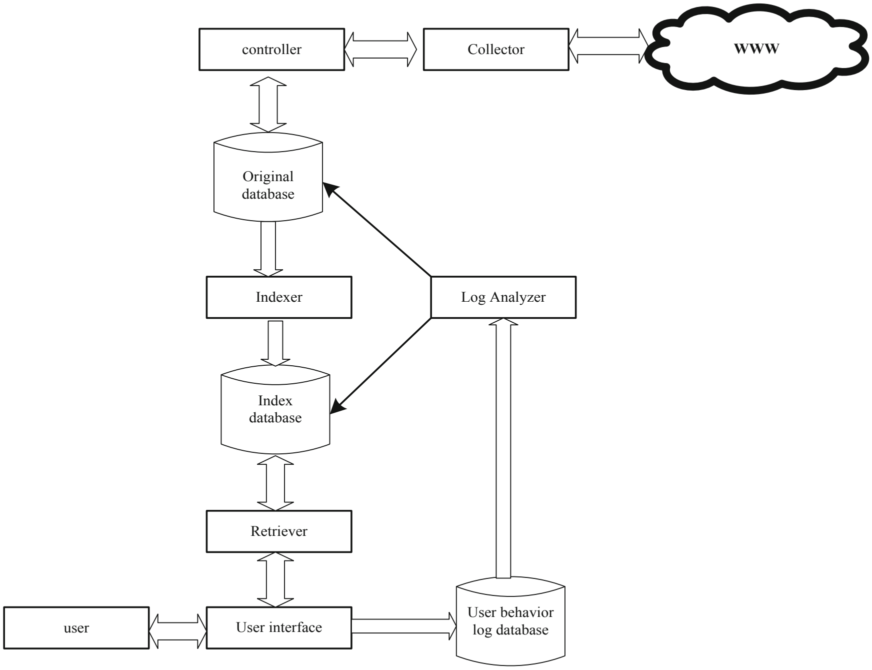


Fig. 2. Index structure of teaching resources

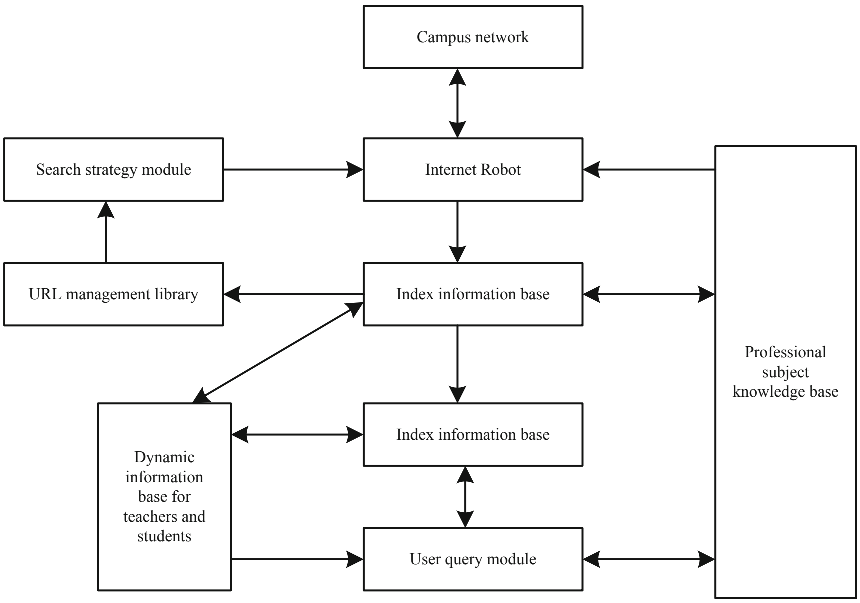


Fig. 3. Structure of information resource search engine

The multimedia information resource search engine system adds two modules to the common Internet search engine: professional subject knowledge base and teacher-student dynamic information database, which automatically extracts new or updated network resources according to the algorithm determined by the search strategy. It is a web resource, but a comprehensive multimedia information resource, which is classified according to the knowledge of professional disciplines. The collected information must be classified and indexed according to the knowledge of the discipline through a professional processing module, and an index database suitable for its own use and development is established [15, 16]. When teachers and students use the user query function, they will automatically form comprehensive query keywords according to their own disciplines and their own dynamic information, accurately or fuzzy match with the indexing words in the index database, return the query results to users, and the query results can also be updated to the professional subject knowledge base, providing standards for future information collection. The multimedia information resources search engine system not only adds two modules, but also enhances its internal functions. It develops a meta engine search with a unified interface, forwards the required format to multiple databases containing keywords through the multimedia information resources search engine, and displays the information indexed by each database system to users after unified processing and sorting. The search engine itself does not have its own physical storage of web page information, and it plays a role of transfer station or agent in function. In fact, the data search engine adopts intelligent technology in the designed meta search: it preprocesses the keywords, phrases or statements requested by users, selects the appropriate professional database according to the identification of the system knowledge base, and converts them into corresponding numbers According to the request format required by the database, it is sent to each database. So as to reflect the efficiency of resource search.

2.2 Software Function Optimization of Multimedia Teaching Resource Search System

Multimedia teaching resources search system software is analyzed and designed from two aspects: search engine subsystem and background management subsystem. The main task of the search engine subsystem is to collect, analyze and filter the web pages, index the function legend of the background management subsystem, input the query keywords, calculate the similarity with the content of the system index, and sort the key technology result web pages of the 2 teaching resources search engine system and return them to the users. The background management subsystem is mainly to maintain the collection of the system. In order to collect more subject terms related to multimedia teaching resources that may be used in basic education, the submission system of multimedia subject terms in basic education is established, which provides more multimedia subject terms related to basic education. Please indicate the media type, learning period and subject, and the type of multimedia teaching search terms, such as Table 1:

In the system, the user searches the document file, and the search results need to intercept part of the content to show to the user, so that they can know the basic information of the document as soon as possible. If they are interested in the file, they can browse the full text, and they can download and save the valuable resources. Audio files:

Table 1. Types of search words in multimedia teaching

Key words	Type				Subject				
	Image	Video	Animation	Voice	Chinese	Mathematics	English	Science	Sipin
Cheetah	√	√					√		
Dissolution		√	√	√					

audio files should have online audition function, and download and save favorite files. For the search results of video files, they should be shown in video screenshots, and can be played online. They always control the online playing process, and can download and save valuable videos. When users search for image files, they need to show the thumbnails to the users after isometric reduction, and they can browse the whole picture, and save their favorite pictures locally. When the user enters "language" for document search, it can list the relevant information about the language and preview the full text. If the user wants to save a document, he can download and save it. Based on this, the system search function structure is optimized, as shown in the Fig. 4.

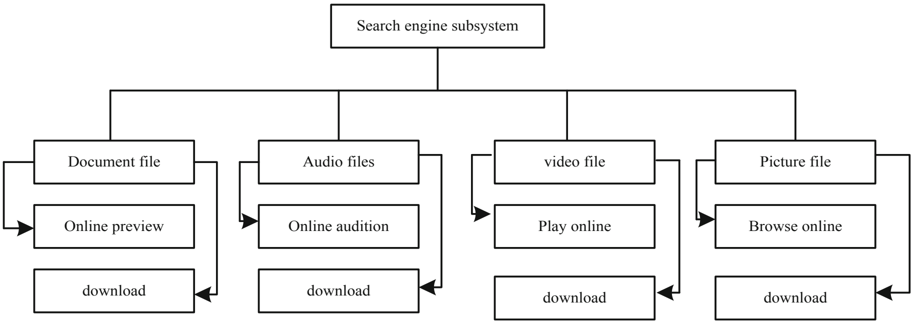


Fig. 4. Optimization of search function of teaching resource system

Background management subsystem, mainly for the maintenance and management of search engine subsystem. It includes the management of users, resources and sensitive words. User management can view, search, add and delete users; resource management can add new resources, browse and delete existing resources, and re index resources; sensitive vocabulary management can filter illegal words searched by users, so you need to add filter words here, modify and delete them. The functional structure is shown in the Fig. 5.

For search engines, the selection of index words (or keywords) is a core problem. If common words are selected as the index words of search engines, although the memory requirement is less, the frequency of each index word will be very high. And because many words are not included in the index thesaurus, they will be cut into single words when they are inverted. The more frequent words appear, the more conjunctive operations will be done, the more comparison times will be, and the longer the system response time will be. On the contrary, if the number of index words is large, it will occupy a

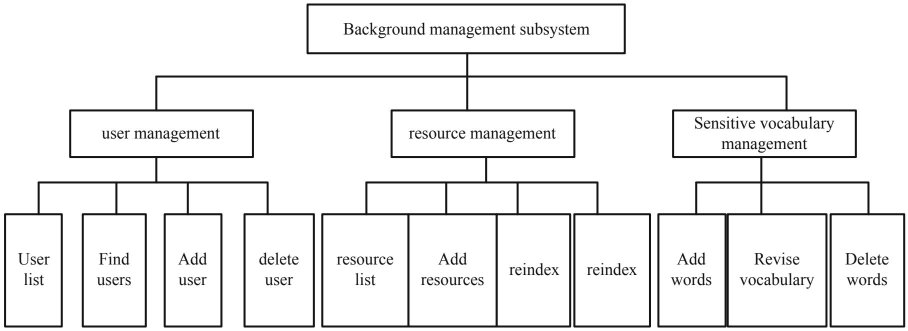


Fig. 5. Function optimization of background management subsystem

lot of memory resources in retrieval. Many index words with low frequency are rarely used in retrieval, wasting memory resources. Therefore, the selection of index words is very worthy of attention. In this case, the index vocabulary is divided into two parts. The first part is the words in ordinary dictionaries, whose entries are fixed in length and total number is fixed, which is called static dictionaries; the second part is the words not appearing in dictionaries, which are identified by unknown words, which is called corpus based dictionaries. The length of these entries is variable, but for 1g of database capacity, it is considered that the number of entries in the whole index thesaurus should be controlled at 500000. However, the number of unknown words is so large that it is not suitable to introduce them into the index vocabulary. Therefore, the statistical method is used to filter the unknown words. Statistical vocabulary acquisition is another way to identify unknown words. In a large enough corpus, the appearance of words with certain expressive ability is not isolated, but presents certain statistical rules, which makes it possible to obtain words automatically by using the co-occurrence information between words. In terms of form, a word is a stable combination of words. Therefore, in the context, the more adjacent words appear at the same time, the more likely they are to form a word. Therefore, the frequency or probability of word to word co-occurrence can better reflect the credibility of the word. We can count the frequency of the combination of the adjacent co-occurrence words in the corpus and calculate their mutual occurrence information. The mutual occurrence information of two Chinese characters is defined, and the adjacent co-occurrence probability of two Chinese characters X and Y is calculated. The mutual information reflects the close relationship between Chinese characters. When the degree of closeness is higher than a certain threshold, it can be considered that this phrase may constitute a word. After analyzing the web page and cutting its words, we need to use inverted index technology to build an index for the segmentation. Creating inverted index includes building forward index and reverse index, as shown in the Fig. 6:

In the figure, after analyzing the web page, the forward index table with the web page number as the primary key is obtained. When the reverse index is established, the whole process needs to be completed in memory in order to speed up. When the amount of data is small, there is enough memory to ensure that the creation process can be completed at one time. When the data scale increases, the strategy of grouping index and then merging

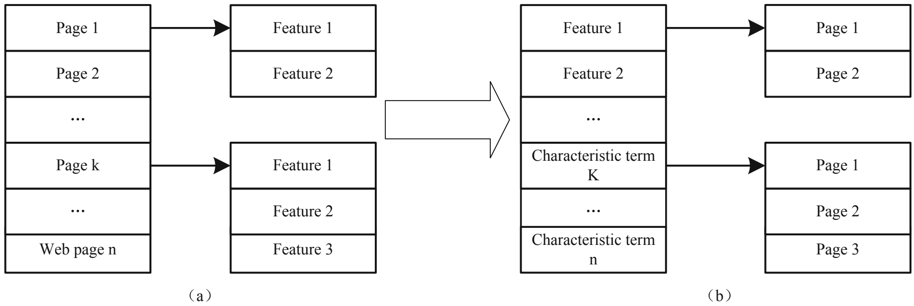


Fig. 6. Building reverse index from forward index

index can be adopted. The strategy is that the index module divides the index into k groups according to the memory size of the computer running the system at that time, so that the memory required for each group of operations is less than the maximum memory size that the system can provide. According to the generation algorithm of inverted index, K groups of inverted indexes are generated. Then the K groups of indexes are merged, that is, the data corresponding to the same index words are merged together, and the final inverted file index with the index words as the primary key, that is, the reverse index, is obtained. Based on the above steps, teaching resources are index and search activities, which can better guarantee the effect of teaching resources search service.

2.3 The Realization of Educational Multimedia Resources Search

In addition to providing users with active search engines, the multimedia information resources search system also provides intelligent agent services to provide users with customized information, so as to save the time and energy of teachers and students. The intelligent agent in the expert processing information module actively searches the relevant information on the campus network according to the contents concerned in the dynamic information database of teachers and students, sorts it out, and pushes it to the dynamic information database of teachers and students for users to use directly. The key of intelligent agent is to command the search engine of multimedia information resources. It can also search the customized information on the Internet according to the theme. The search method can extract the active information from the relevant websites stored in the local database, or use the vertical search. The intelligent agent analyzes the information transmitted by these searches, and analyzes and processes it according to the subject knowledge base To improve the accuracy of knowledge. The construction of teaching information resources includes the collection, sorting, classification, description, storage, index, query, and later resource management and maintenance. The management process of multimedia teaching resources is shown in the Fig. 7.

According to the actual needs of course teaching resource sharing and the shortcomings of the traditional website sharing course resources based on stand-alone server, the server cluster mode can be used for course resource sharing after investigation and research, which needs to be reasonably designed combined with cloud computing,

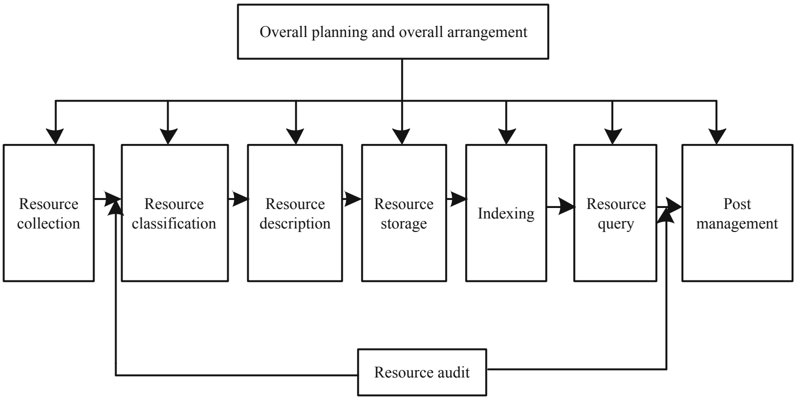


Fig. 7. Multimedia teaching resource management process

big data and other technical means. The function of curriculum resource sharing system based on augmented reality technology mainly includes user management, system management and curriculum resource management.

User management function: user management function module mainly includes non registered users, login users and system administrators. Non registered users can search the course teaching resources on the platform, but can not download the course resources on the platform. Such users can open the registration page to register, and then audit their registration. Login users are legal users who have been verified by the system. Such users can operate on course resources. For example, users can share course resources, upload course resource data to HDFS distributed storage system, view their own uploaded data files, and delete the uploaded course resource data. Based on this, the course resource sharing management module is optimized. The specific steps are as follows (Fig. 8):

The data in the course resource sharing module is based on two places for storage management. One part is to store the basic information of users and course resources. This part of data is structured data, which is mainly stored in my SQL relational database; The other part is to store course resource data, most of which are unstructured data, stored in the distributed storage HDFS system of Hadoop cluster. The course resource information related to the data files stored in HDFS system is also recorded in the course resource information data table of my SQL database. The web server of the course resource data sharing system based on augmented reality technology is respectively connected with my SQL database and HDFS distributed storage system, and its data storage and main function modules are shown in the Fig. 9.

Curriculum resource sharing system based on Augmented Reality Technology in the Internet information age, curriculum resource data shows a blowout growth, in which more and more junk information, the amount of information users get is also growing geometrically. Too much information leads to the cost of users to obtain valuable information will be greatly increased. On the sharing platform, according to the log data produced when users access the server, and the similarity between curriculum resources, we analyze the curriculum resource data, and mine valuable curriculum resource data to

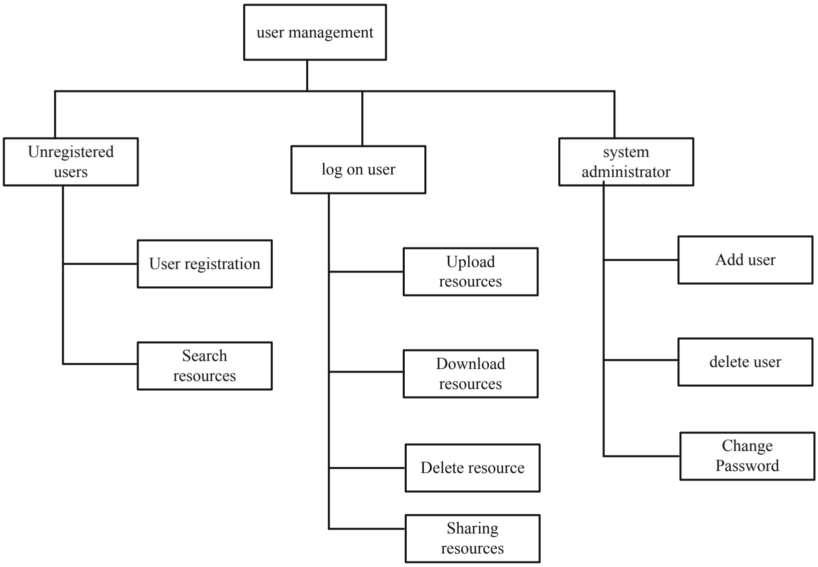


Fig. 8. Course resource sharing management module

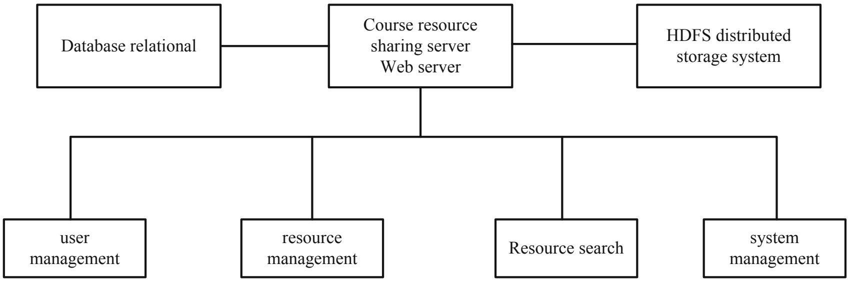


Fig. 9. Main function modules of the system

recommend to users, so that users can gradually change from actively obtaining information to passively receiving information In order to reduce the cost of users to obtain information and improve the efficiency of users using the course resource sharing platform. The search engine of course resource sharing system based on augmented reality technology adopts distributed search elastic search, and deploys elastic search on Hadoop distributed cluster system Search distributed search engine, establishes the index data of course teaching resources, carries out full-text retrieval of course teaching resources data on the resource sharing platform, and realizes the function of course teaching resources data search. The search process is shown in the figure below (Fig. 10):

To query the course resource data, the user submits the query request through the form. After receiving the request information, the background calls the elasticsearch API to search the relevant data in the index library. If the relevant index information is found, the specified course resource data will be returned to the user.

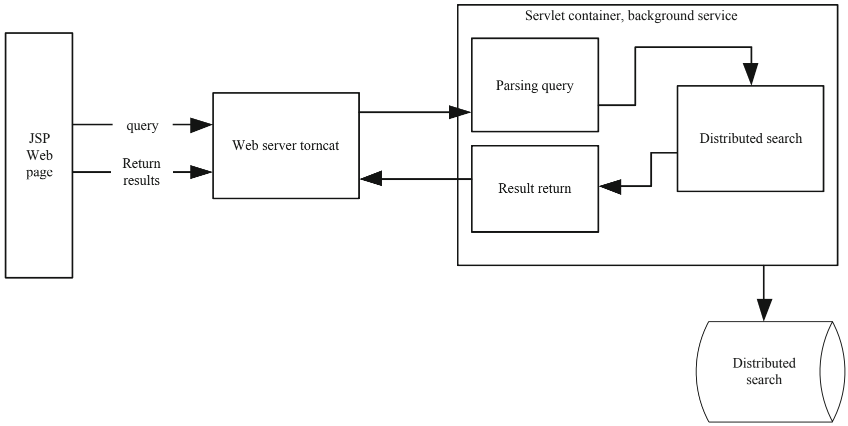


Fig. 10. System search process optimization

3 Analysis of Experimental Results

The course resource sharing system based on augmented reality technology is tested. The physical host is virtualized into several virtual computers, and the software and hardware resources of the computer are fully utilized through virtualization technology, so that the software and hardware resources of the computer can be bigger and more fully utilized. The virtual machine server is established on the host computer through the virtualization technology of VM ware, and then multiple computers are virtualized. The server is managed through the client VM ware sphere client. The server is connected on the client, and then multiple Linux operating systems are installed on the server, and then Hadoop, spark and elastic are installed on the Linux operating system Search and other software, configure the Hadoop configuration file, build Hadoop cluster, call the HDFS distributed storage system API interface of Hadoop, realize the map reduce computing programming, and use the web Server to provide course teaching resource sharing services, based on Hadoop augmented reality technology, provides a solution for massive data processing of course resource sharing, and realizes fast upload and download of shared course teaching resource data. Based on this, the parameter table of experimental cases is optimized as follows (Table 2).

Table 2. Experimental case parameters

Case name	Create directory/upload file/query/download file/delete file
Test purpose	Create directory/upload file/query/download file/delete file
Default conditions	(1) Hadoop cluster system is normal (2) There are virtual hosts running normally in cluster system

Further optimize information resource management information, as shown in the following Table 3:

Table 3. Curriculum resource information table

Field name	Significance	Data type	Constraint
ResourceID	Course resource serial number	int	Primary key
ResourceName	Course resource name	Varchar(50)	Not empty
Uptime	File upload time	Time	Not empty
Type	Types of curriculum resources	Varchar(40)	Not empty
Userid	File owner ID	Int	Foreign key constraints
size	Resource data capacity	Varchar(20)	Not empty

Through the system platform construction, test Hadoop distributed file storage platform, test MapReduce distributed computer framework, and test the system development environment, as well as the operation of webserver server in the course resource sharing system, the course resource sharing system based on augmented reality technology is tested systematically (Fig. 11).

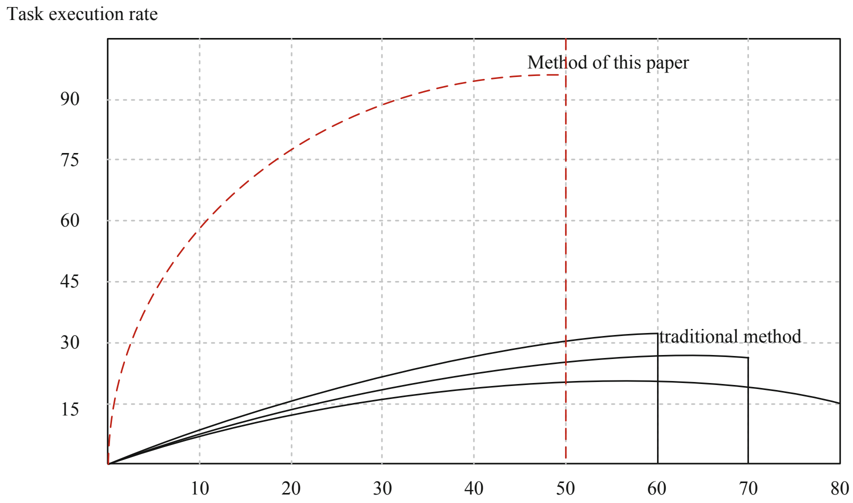


Fig. 11. Comparison test results

Experiments prove that the course resource sharing system based on augmented reality technology shares course resources by building a server cluster, which has a considerable advantage in course resource search function and course resource recommendation function than traditional course resource sharing based on a single server. Its data search and server response time are significantly improved compared to the traditional network sharing method of a single server.

4 Concluding Remarks

Multimedia information resources are very important resources for teaching and scientific research. How to improve the sharing of campus resources through search engine is an important mode of campus network application. This paper studies the use of various multimedia information resources in the school, and designs an information search engine technology which is more suitable for the use of learning and research multimedia information resources. Information security is a problem in many systems today. We should try to use the multimedia information resources search engine which takes the security factors into account when designing from the bottom to achieve the highest security level. In the future, the engine needs to be further expanded, so as to realize the joint search between the two, so as to facilitate the sharing of multimedia information resources in the whole higher education system.

References

1. Wang, X., Sun, H., Li, L.: An innovative preschool education method based on computer multimedia technology. Int. J. Emerg. Technol. Learn. (iJET) **14**(14), 57 (2019)
2. Simonnet, D., Girard, N., Anquetil, E., et al.: Evaluation of children cursive handwritten words for e-education. Pattern Recogn. Lett. **121**(Apr.), 133–139 (2019)
3. Tian, Y.: Personalized allocation of english teaching resources through weight calculation based on term frequency-inverse document frequency. Int. J. Emerg. Technol. Learn. (iJET) **15**(10), 202 (2020)
4. de Almeida, P.R.A., et al.: Didactic switchgear for teaching thermographic inspection for electrical maintenance. Electron. Lett. **14**(2), 43–49 (2019)
5. Shi, Y., Yang, X.: A personalized matching system for management teaching resources based on collaborative filtering algorithm. Int. J. Emerg. Technol. Learn. (iJET) **15**(13), 207 (2020)
6. Wang, Y.: Application of virtual reality technique in the construction of modular teaching resources. Int. J. Emerg. Technol. Learn. (iJET) **15**(10), 126 (2020)
7. Yang, X., Jiang, X., Rong, L., et al.: A sports teaching mode based on social networking service teaching resources[J]. Int. J. Emerg. Technol. Learn. (iJET) **15**(8), 180 (2020)
8. An, Y., Xu, M., Shen, C.: Classification method of teaching resources based on improved KNN algorithm. Int. J. Emerg. Technol. Learn. (iJET) **14**(4), 73 (2019)
9. Lou, Y.: Storage and allocation of English teaching resources based on k-nearest neighbor algorithm. Int. J. Emerg. Technol. Learn. (iJET) **14**(17), 102 (2019)
10. Navy, S.L., Nixon, R.S., Luft, J.A., et al.: Accessed or latent resources? Exploring new secondary science teachers' networks of resources. J. Res. Sci. Teach. **57**(2), 184–208 (2020)
11. Andrade, G., Fernandes, A., Gomes, J.M., et al.: Large-scale parallel similarity search with product quantization for online multimedia services. J. Parallel Distrib. Comput. **125**(Mar.), 81–92 (2019)
12. Bhushan, K., Gupta, B.B.: Network flow analysis for detection and mitigation of Fraudulent Resource Consumption (FRC) attacks in multimedia cloud computing. Multimedia Tools Appl. **78**(4), 4267–4298 (2019)
13. Rebai, I., Ben Ayed, Y., Mahdi, W.: Spoken keyword search system using improved ASR engine and novel template-based keyword scoring. Multimedia Tools Appl. **78**(2), 1495–1510 (2019)
14. Yalcin, M., Yalcin, F.A., Zehir, H., et al.: The views of preschool pre-service teachers, in-service teachers and parents on pre-school education of values. Int. Online Jo. Educ. Sci. **12**(4) (2020)

15. Jie, W.: After-school education and childcare services extended at primary schools: current situation, problems and their countermeasures—based on a sample survey of 1,450 questionnaires in primary schools in Fuzhou. J. Nanchang Coll. Educ. **34**(3), 53–56 (2019)
16. Ongoren, S., Yazlik, D.O.: Investigation of mathematical concept skills of children trained with montessori approach and MoNE pre-school education program. Eur. J. Educ. Res. **8**(1), 9–19 (2019)

Detection Method of Machine Tool Axis Offset Distance Based on Rough Set Neural Network

Nan Qin(✉)

Dalian Institute of Science and Technology, Dalian 116001, China

Abstract. In the traditional detection method of machine tool mechanical shaft offset, the detection results fluctuate greatly. Therefore, a detection method of machine tool shaft offset based on rough set neural network is proposed. When the precision is not up to the standard, the influence of the installation error can be judged, and the space structure model of the mechanical axis can be established. The modified model of rough set neural network is used to get the theoretical value of the mechanical axis, measure the actual position of the mechanical axis, calculate the difference between the theoretical value and the measured value and get the offset distance. Experimental results show that this design method can reduce the fluctuation of detection results and the detection results are more stable than the traditional methods.

Keywords: Mechanical shaft · Offset distance · Neural network · Ball-Bar instrument

1 Introduction

As the carrier of advanced manufacturing technology and the basic means of production of equipment industry, the development level of machine tool is related to the development of many industries such as automobile, military industry, agricultural machinery, engineering machinery, electric power equipment, railway locomotive, ship and so on. Therefore, it is of great significance to study the method of measuring the offset distance of machine tool mechanical shaft [1]. At present, there are two methods to measure the offset distance: direct method and indirect method. The direct method uses precision testing equipment to measure the error of machine tool, and gives the precision index of machine tool directly in the course of measuring. With the improvement of testing methods and equipments, many new testing equipments have been developed, such as ball bar meter, laser interferometer, spindle rotary error analyzer and so on. These testing instruments and testing methods are mostly aimed at static precision or single axis precision measurement [2]. Indirect method is used to test the precision of the machine tool's mechanical shaft by using precision measuring instrument. The geometric precision, positioning precision, reverse clearance, five-axis interpolation precision, multi-axis linkage precision and rigidity vibration of the machine tool can be accurately

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 576–587, 2021.
https://doi.org/10.1007/978-3-030-84386-1_47

reflected by evaluating the machining quality of the specimen, such as over-cutting, under-cutting, vibro-vibration and surface quality.

On the basis of the above theory, the detection method of machine tool axis offset based on rough set neural network is proposed. The RENISHAW ballbar is used to measure the error movement of the mechanical shaft. Based on this mechanical axis installation error is calculated. According to the calculated installation error, the spatial structure model of the mechanical shaft is constructed.

2 Detection Method of Machine Tool Axis Offset Distance Based on Rough Set Neural Network

2.1 Determination of Precision Specifications for Machine Tool Mechanical Shafts

The sample data is analyzed, and then an initial information table is formed according to the domain knowledge known. A reasonable discrete method is used to discretize the continuous attributes. A parallel reduction algorithm based on genetic algorithms is used to quickly reduce the attributes of the data. The reduced attributes are used as input layer neurons, and then the data is reduced vertically, including the elimination of inconsistent objects and redundant objects in the data, and finally a neural network is used to train the processed reduced data. The introduction of parallel reduction algorithms can further improve the overall mining efficiency of rough set and neural network models.

Select reasonable testing equipment, determine the accuracy of machine tool machinery shaft specifications. Select RENISHAW ball and bar instrument and Lion rotary shaft error analyzer, RENISHAW ball and bar instrument is mainly composed of ball and bar instrument testing equipment, variable length rod group, calibration gauge, machine tool installation components, etc., can be used for machine tool circular track accuracy and absolute length testing, mainly used for measuring the position and direction error between the machine tool axes [3]. The Lion Axis Error Analyzer is composed of capacitive displacement sensor, precision double standard ball, sensor base, 3-D pan and data acquisition sensor, which can measure the DOF motion error. The technical parameters of the club are as Table 1:

Table 1. Technical parameters of club instrument

Parameter	Numerical value	Parameter	Numerical value
Model	Qc2o-w	Sensor travel	1.75 mm
Sensor resolution	0.1 um	Maximum sampling rate and transmission range	1000 Hz
Measurement accuracy of ball and stick instrument	3%	Standard length	100 mm
Measuring range of ball and club instrument	±0.1 mm	Variable length rod group	50 mm

The technical parameters of spindle error analyzer are shown in Table 2.

Table 2. Technical parameters of spindle error analyzer

Parameter	Numerical value	Parameter	Numerical value
Host	5 displacement Channel	Displacement probe size	8 × 9 mm
Measuring range of displacement probe	75 um	Effective sensing area of displacement probe	2 mm
Nonlinearity of displacement probe	0.075 um	Standard ball size and roundness	50 nm
Resolving power	5 nm	Maximum speed	40000 rpm

The main body of the ball bar instrument is a high-precision telescopic linear sensor and two precision balls, forming a motion chain. The specific structure is shown in Fig. 1.

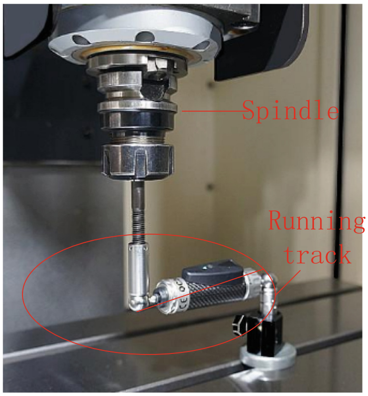


Fig. 1. Mechanical shaft structure

The two precision balls are respectively connected to the frame and the workpiece to be measured through the magnetic seat, and the distance between the two ball centers is read out by the displacement sensor. Measure the movement of the mechanical axis with the ball bar instrument, fix the ball bar instrument on the worktable, and make it pass through the mechanical axis, and install it on the mechanical axis to be measured, so as to complete the radial installation and axial installation of the ball bar instrument, corresponding to the axial and radial error sensitive directions respectively. In the ideal state, when the moving ball is installed in the radial direction, it is a circle with the center on the mechanical axis. When the ball is installed in the axial direction, it is a point on the mechanical axis. The measured value of the ball is the fixed value. Because of the error movement of the mechanical axis, the measured value of the ball is very close to the ideal value. Therefore, the measurement results of the two installations can directly reflect the radial and axial accuracy of the mechanical axis [4]. So far, the accuracy specification of machine tool mechanical axis is determined.

2.2 Installation Error of Mechanical Shaft of Computer Bed

When the accuracy of mechanical axis of machine tool cannot reach the specified standard, it is necessary to calculate the installation error of mechanical axis to determine the offset of mechanical axis. In the circle test mode, the running track of the machine tool is set as an arc, and the small change of the radius of the ball bar instrument in motion is measured by the sensor. Rough neural network is used for the analysis of arc trajectory. To determine the main error performance of the machine tool. The ball bar instrument is connected to the workbench and the spindle with the moving mechanical axis of the machine tool as the center, so that the ball bar instrument can do circular motion in a fixed coordinate system, and the ideal situation is recorded Due to the installation error of the machine tool mechanical axis and the ball bar instrument, the measured value of the ball bar instrument will deviate from the ideal value. Therefore, in the measured value of the ball bar instrument, the machine tool errors such as reverse clearance, reverse overshoot, non perpendicularity and proportion mismatch can be identified [5].

When there is installation error, the measurement data of the ball bar instrument will have sinusoidal characteristics. The mathematical model of the installation error of the ball bar instrument in plane test is established. An iterative least square method is used to eliminate the installation eccentricity. The motion of the ball bar instrument is assumed to be plane motion, so that the installation error of the ball bar instrument is equivalent to the center deviation. At this time, the least square circle fitting is used to eliminate the installation eccentricity of the ball bar instrument. The coordinates calculated by the rough neural network are $(\mathrm{x}_1, \mathrm{x}_2)$ of the mechanical shaft is:

$$\begin{cases} \mathrm{x} = \mathrm{rcos}\theta \\ \mathrm{y} = \mathrm{rsin}\theta \end{cases} \tag{1}$$

Among them, r is the radius of the club and θ is the angle of moving center. Based on the measured data of eliminating eccentricity, the other error items can be identified, such as ratio mismatch, verticality, reverse overshoot and reverse clearance, etc. Then the difference between the measured value of the instrument and the calibration length of the instrument is calculated and projected to two orthogonal coordinate axes to obtain the error component of a single axis. Finally, the mechanical axis is in the state of reverse overshoot. When the machine tool moves in a certain direction, the mechanical axis starts to decelerate and drive in the opposite direction when the set trajectory reaches the maximum stroke, a short stagnation will occur on the mechanical axis, and a spike will occur on the measured value of the ball-bar instrument. At this point, the machine tool mechanical shaft installation error calculation.

2.3 Construction of Mechanical Axis Spatial Structure Model

After eliminating the installation error of the mechanical shaft, the spatial structure model of the mechanical shaft is established. The precision of the mechanical axis is expressed by the radial and axial runout of the rotor, but the run-out is affected by the geometric error of the measuring surface and the installation position of the sensor and the workpiece. Since the motion of the ball-bar instrument is a space motion in the process of precision test, the measurement data is closely related to the installation position of the ball-bar instrument. Therefore, it is necessary to establish a mathematical model of the mechanical axis measured by the ball-bar instrument that is not affected by the installation error, and construct the space structure model measured by the ball-bar instrument with a single mechanical axis object. From the measurement data of the ball-bar instrument, the installation error of the ball-bar instrument and the mechanical axis is identified, and the relationship between the offset distance and the installation error is analyzed [6].

According to the three kinds of theoretical solutions of the ball bar instrument, the mechanical shaft structure models satisfying three kinds of conditions are obtained. Otherwise, it is very difficult to measure the mechanical axis accurately in the actual measurement. In the process of measuring the mechanical axis, the spatial structure model is used to analyze the data. In this case, the center point of the fixed ball is not on the axis of the machine, a partial conic surface can be obtained, and the spatial position data of the mechanical axis can be obtained. The third is that when the rotor of the mechanical axis rotates around the axis of rotation, there still exists the error motion relative to the fixed coordinate system, that is, the measurement data contains the error of rotation of the mechanical axis, and the error of rotation can be reflected by the theoretical value of the measurement data and the degree of the installation error of the ball-bar instrument. In this case, the measured value is regarded as the approximate axis of rotation, and the reference point of the fixed coordinate is obtained to rotate along with the mechanical axis, so the space structure model constructed takes the distance change of the reference point into account. Based on the above theoretical analysis, a spatial structure model is established to determine the theoretical installation value of the mechanical shaft by eliminating the measurement results of the ball and bar instrument. The rotary error value of the rotor of the mechanical shaft is much less than the theoretical output value, and the theoretical output value can be optimized through a minimum maximum value, and be identified from the measurement data. The final calculation formula of the spatial structure model d is as follows:

$$\mathrm{d} = \sqrt{\frac{L_1^2 + L_2^2 + h^2}{2L_1 \mathrm{h}\cos(\vartheta_1 + \vartheta_2)}} \tag{2}$$

Among them, L_1, L_2 is the measured value and theoretical value of the length of the ball-bar instrument, h is the installation height of the machine tool shaft, and ϑ_1, ϑ_2 is the minimum and maximum of the rotating error of the machine shaft. Thus the construction of the mechanical axis spatial structure model is completed.

2.4 Revision Model Based on Rough Set Neural Network

The model error is corrected by iterating d values of rough set neural network. Taking formula (2) as the objective function of rough set neural network, the neural network has two advantages, weight sharing and local connection. By the requirement of local connection, the network connects the neurons in the network with those in the upper layer only, reduces several parameters of order of magnitude, and speeds up the correction efficiency. While weight sharing is based on the local connection, each neuron can use the same weight and further reduce the training parameters. The selected neural network has a feedforward network structure, and can train the model of spatial structure by making use of its advantage of local connection. It is known that the training of neural network of rough set includes two stages, forward propagation stage and back propagation stage, in which forward propagation is the process of transmitting data from low level space to high level space, and the output results after convolution layer, pooling layer and local connection layer are obtained when the input data is propagated forward, and the error between the output value and the target value is calculated [7]. The back-propagation is due to the deviation from the expected value of the results obtained from the forward propagation. Therefore, the training of propagation from the higher level to the lower level is adopted. Assuming that the propagation error of the preceding item is large, the gradient descent method is adopted to calculate the error between the actual value and the expected value in the back-propagation, and the error is back-propagated from the local connection layer to the middle pooled layer and convolution layer to the input layer [8]. The specific flow is shown in Fig. 2:

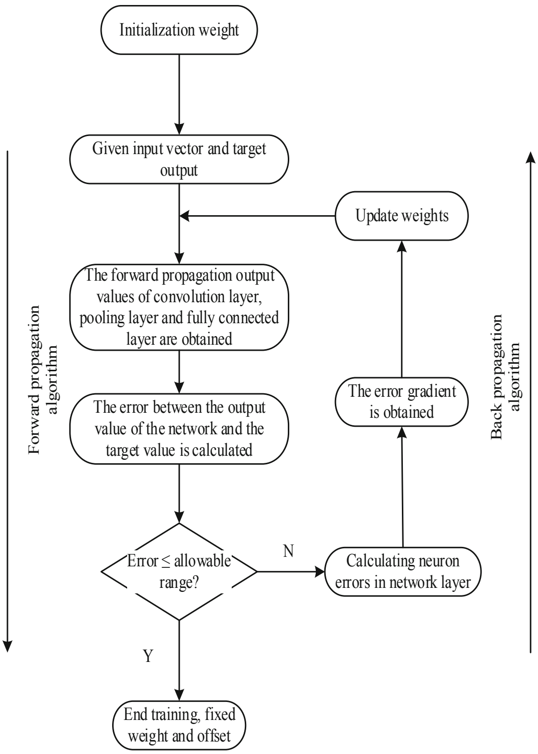


Fig. 2. Model updating process based on rough set neural network

After the neural network outputs the objective function, the final spatial structure model is analyzed. The fixed center of the ball and moving center of the ball have no axial installation error, and the measured value of the ball bar instrument can show the radial distance and axial distance. Thus, the spatial structure model of mechanical axis is modified based on rough set neural network.

2.5 Measurement of Actual Deviation of Mechanical Center Axis

The output value of the spatial structure model is taken as the theoretical value of the machine tool axis. On this basis, the actual spatial coordinates of the central axis are measured and the deviation between the actual value and the theoretical value is calculated.

2.6 Prediction of Mechanical Shaft Installation Position Parameters

In view of the actual value of the mechanical shaft, the same instrument is used to measure. The precision ball is fixed between the seats of the precision magnetic bowl by mechanical positioning, so that one of the magnetic bowl seats is connected with the machine tool worktable, and the other is connected on the machine tool mechanical axle and the machine axle box. When the distance between the two precision balls changes, the sensor of the ball bar instrument can accurately measure the change. When there is an error in the machine tool, the ball bar instrument can measure the circle track of the actual machining, and compare it with the theoretical track, so as to obtain the overall evaluation of the precision of the machine tool. Through the testing device of ball-bar instrument, the 4 steps error testing mode is put forward, and compared with the spatial structure model, the geometric error identification of mechanical axis is realized. Then the dynamic performance of the machine tool is determined by measuring the circular track of the biaxial linkage with a ball-bar instrument, and the linear error in one direction is obtained in one measurement.

The main task of the pre-measurement is to adjust the mechanical axis of each accelerator so as to minimize the deviation between the magnetic field axis and the mechanical axis. The pre-measurement must go through the following three steps: the calibration of a single component—the axis of a component is used as the x axis, the above the component is used as the y axis, the direction of the vertical plane is used as the z axis, and a component coordinate system is obtained. The spatial coordinates of the mechanical axis in the component coordinate system are determined by using the SMX4500 laser tracker. The spatial coordinates of the mechanical axis are measured by using the SMX4500 laser tracker. The determination of the coordinate of the datum—using the SMX4500 laser tracker to measure the four datums installed on the datum platform, including the faces, lines and points composed of the datum system, establishing the datum coordinate system, transforming the calibration points of the mechanical axis into the values under the datum system, and installing the standard values. The spatial position of the mechanical axis—the prediction of the mechanical axis—uses the SMX4500 laser tracker to adjust the coordinates of the component system and the datum system, so that the two coordinate systems of the parallel system are connected closely with the previous component system, and thus obtaining the position of the X axis and the predicted parameters of the mechanical axis. At this point, the mechanical shaft installation position parameters are predicted.

2.7 Measurement of the Actual Position of the Machine Tool Mechanical Shaft

According to the spatial position parameters, the mechanical shaft is precisely aligned and the actual position of the machine tool is measured. Based on the linear induction accelerator and laser tracker, the space position coordinates of the mechanical axis can be measured by a single station, and the precision can meet the requirement of high precision measurement of machine tool. In the tens of meters range of the linear induction accelerator, 7 stations are set up in 7 sections, each station measures 5 points, 35 points in total, so that the longitudinal measuring points cover the full length of the mechanical axis, and the measuring data can be obtained in both elevation and transverse aspects. According to the datum of linear induction accelerator installation, the datum coordinate system of precise alignment of mechanical axis is determined by setting up a good measuring control network. In the process of precise alignment of machine tool axis, through data processing, the value of component reference point in the calibration coordinate system is converted to the value in the overall installation coordinate system. The pre-collimated component datum is pushed to the space position of the mechanical axis, and the measuring platform is adjusted repeatedly so that the space coordinate system and the datum coordinate system are parallel until the whole accelerator is installed and the precision specification of the mechanical axis measurement is achieved [10].

After the reference points are arranged, the actual space coordinates after the mechanical axis alignment are measured. Because the photons of the acquisition point and the incident point of the laser beam are randomly migrated in the medium, Raman scattering photons are generated in the inner depth of the laser beam. Raman scattering photons are easier to be transversely migrated in the diffusion process. Therefore, the Raman spectrum deviating from the laser beam incident point at different distances contains the Raman spectrum information of different depth layers. When the spatial offset is 0, the maximum photon density of the laser beam is obtained. The Raman spectrum is mainly obtained from the mechanical axis. When the spatial offset is not 0, the Raman scattering contribution from the mechanical axis is larger. Raman fluorescence and Raman scattering from the mechanical axis is gradually reduced. However, it is not possible to completely eliminate the Raman spectrum from the original optical spectrum. Raman spectrum of the mechanical axis cannot be obtained directly in the original spectrum. Raman spectrum of the mechanical axis needs to be extracted by proper data processing method. After the spectrum is extracted, a 70 mm plane grating is placed on the horizontal double rotary table, and a reading head is installed at the end of the machine tool shaft. The gap between the reading head and the grating is measured. The laser interferometer can only measure the linear motion, but also can improve the measurement accuracy, and the final measurement result can be used to measure any trajectory in 2D plane, so that the actual position of machine tool can be measured. The deviation between the theoretical value and the measured value of the mechanical shaft is calculated, and the offset distance of the mechanical shaft is obtained.

3 Experiment and Analysis

The design method was recorded as experimental group A, and two traditional offset distance detection methods were recorded as experimental group B and group C. In the same experimental environment, the detection efficiency and stability of the three groups of methods are compared.

Three axes machining center is driven by three servo motors, X, Y to realize the working table, the principal axis of the mechanical axis to realize Z to linear feed movement. The machine tool parameters for a three-axis machining center are shown in Table 3:

Table 3. Machine parameters

	Minimum value	Maximum	Full stroke
Machine stroke X-axis	10 mm	410 mm	420 mm
Machine stroke y-axis	10 mm	310 mm	320 mm
Machine tool stroke Z axis	10 mm	– 220 mm	230 mm
Feed rate	0	5000 mm/s	5000 mm/s
Accelerate	0	2500 mm^2/s	2500 mm^2/s

The ball bar instrument is accurately installed on the workbench. The center lines of the two ball centers of the ball bar instrument are parallel to the plane of the workbench in the measurement process. The plane of the workbench is called the imaginary plane, and the ball bar instrument is installed on the imaginary plane as accurately as possible. In the actual operation of group A, in order to measure the spatial shift Raman spectrum, the experimental device of spatial shift Raman spectrum is built as shown in Fig. 3.

The laser is connected to the excitation probe by optical fiber, the working distance of the probe is 7.5 mm, the size of the laser spot converging on the surface of the mechanical axis is 200 um, and the generated Raman light is connected to the incident slit of the spectrometer through the collection probe, the working distance of the probe is 10mm, and the laser used is the SPLER-LAS785 of the spectrum laser photovoltaic, the wavelength is 785 nm, the continuous output power is 0–500 mW, and the linewidth is less than 0.2 nm. The spectrometer used is OE650JHG spectrometer with a slit width of 50um and a working spectral range of 651–879 um. For 785nm incident laser, the corresponding range of Raman frequency shift is –2662.1 –983.7 cm^{-1}. The focal point of the excitation probe and the collection probe are both on the surface of the mechanical axis. The excitation probe and the collection probe are fixed on the six-dimensional optical adjusting frame to adjust the different space offset distance. The offset distance that can be adjusted by the probe in the experimental device is –1.0–1.0mm. When the offset is zero, it is the working mode of the Raman spectrometer.

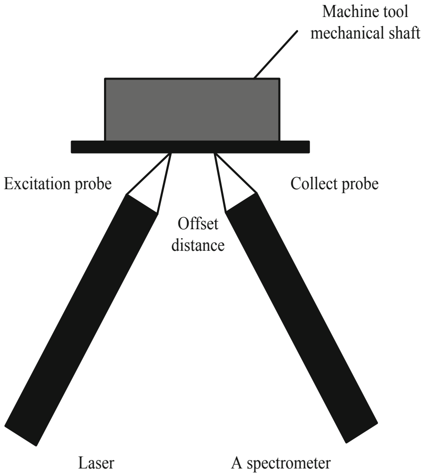


Fig. 3. Space migration experimental facility

3.1 Experimental Results

To change the testing radius of the machine tool, count the deviation testing results of the three groups of methods on the X direction and Y direction of the mechanical axis, compare the stability of the deviation testing values of the three groups of methods, and select the testing items of the offset distance as XY non-perpendicularity and XY inverse overshoot. The experimental comparison results are shown in Table 4:

Table 4. XY comparison of nonperpendicularity stability

Test radius of machine tool (mm)	Group A test results (Urad)	Group B test results (Urad)	Group C test results (Urad)
100	25.5	23.9	21.2
110	24.9	26.8	22.4
120	25.3	22.5	25.8
130	24.7	25.8	26.2
140	25.2	24.1	25.6
150	25.8	25.3	23.9
160	24.1	26.1	26.3
170	24.5	23.0	22.5
180	25.0	22.3	21.9

It can be seen from Table 5 that when the test radius of machine tool circle is changed, the detection value of mechanical axis offset distance in group A is more stable, the measured value of the mechanical axis offset distance of experiment group A fluctuates

Table 5. Comparison results of XY reverse overshoot stability

Test radius of machine tool (mm)	Group A test results (Urad)	Group B test results (Urad)	Group C test results (Urad)
100	5.5	3.9	1.9
110	4.9	6.8	2.1
120	5.3	2.5	5.2
130	4.7	5.8	6.3
140	5.2	4.1	5.8
150	5.8	5.3	4.2
160	4.1	6.1	2.9
170	4.5	3.0	2.2
180	5.0	2.3	3.1

slightly, while the detection results in group B and group C fluctuate greatly. On the basis of the first group of experiments, the detection time of the three groups of methods was compared. The experimental results are shown in Table 6.

Table 6. Comparison results of offset distance detection time

Test radius of machine tool (mm)	Test time of group A (s)	Test time of group B (s)	Test time of group C (s)
100	2.31	5.38	6.29
110	2.83	5.29	6.29
120	2.83	5.27	6.30
130	2.03	5.28	6.28
140	2.18	5.29	6.12
150	2.93	5.93	6.82
160	2.18	5.92	6.29
170	2.03	5.02	6.03
180	2.18	5.28	6.17

When the test radius of machine tool circle is changed, the detection time of mechanical axis offset distance in group A is significantly less than that in group B and group C, and the detection time can be as low as 2.03 s. This is mainly because the method in this paper uses neural network to modify the parameters in the model. To sum up, compared with the traditional method, this design method can ensure the detection efficiency, and the detection result is more stable, which ensures the accuracy of the offset distance detection value.

4 Conclusion

This design method gives full play to the advantages of rough set neural network and reduces the fluctuation of offset detection value. However, there are still some shortcomings in this study. In actual measurement, the trajectory of the moving ball center is not a circle, but a spatial curve. In the future research, the motion error of the rotary pair will be further eliminated.

References

1. Zhang, L., et al.: Application of laser trackers in the detection of concentricity and coaxiality—based on large water pipeline equipment. Indus. Technol. Innov. **7**(3), 108–112 (2020)
2. Wang, L., Zhang, S., Wang, D.: Geometric error measurement and accuracy verification of the swing head of a five-axis CNC machine tool with a single swing angle. J. Tsinghua Univ. (Sci. Technol.) **60**(4), 292–298 (2020)
3. Ma, T., et al.: Quantitative detection of off-Axis defects based on mode-converted waves with time of flight diffraction. Mater. Protect. **52**(9), 56-60+66 (2019)
4. Wei, L., Ding, K., Duan, Z.: Research on bearing workpiece detection and positioning based on Gaussian weighted mean segmentation. J. Electr. Measure. Instrum. **33**(10), 118–127 (2019)
5. Si, X., Bao, J.: Evaluate linearity error based on hill-climbing and differential evolutionary algorithm. J. Test Measure. Technol. **33**(5), 418-420+460 (2019)
6. Jianqiu, L.: Construction of real-time interactive mode-based online course live broadcast teaching platform for physical training. Int. J. Emerg. Technol. Learn. (IJET) **13**(06), 73 (2018)
7. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
8. Liu, S., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
9. Wang, R., et al.: Research on measurement method of optical coherence of transmitting and receiving infrared pulse laser range finder. J. Changchun Univ. Sci. Technol. **41**(1), 60–62 (2018)
10. Si, J., et al.: Simulation diagnosis for mechanical rolling bearing fault signal. Comput. Simul. **36**(1), 403–408 (2019)

Control Method of Multi Joint Snake Like Manipulator Based on Hybrid Fish Swarm Ant Colony Algorithm

Nan Qin(✉)

Dalian Institute of Science and Technology, Dalian 116001, China

Abstract. In the control process of multi joint snake like manipulator, the traditional control method is easily affected by the interference of multi link communication signal, and its overall control stability is poor. Therefore, a control method of multi joint snake like manipulator based on hybrid fish swarm ant colony algorithm is proposed. The hybrid fish swarm ant colony algorithm is used to update pheromone, so as to select the optimal motion path of the manipulator, and design the transmission control to ensure the normal communication and signal stability of each joint of the manipulator. On this basis, the control rules of the manipulator are designed for the selected path of the manipulator to achieve the goal of real-time control of the manipulator. The experimental results show that: the control method based on hybrid fish swarm ant colony algorithm has high control signal transmission efficiency, reliable convergence value, and its overall stability has been improved.

Keywords: Ant colony algorithm · Multi joint · Snake like manipulator · Control method

1 Introduction

Snakes are widely distributed in nature, and can be seen in a variety of environments. From land to sea, from forest to desert, their special appendage free movement has strong environmental adaptability [1]. If this kind of motion ability can be applied in robot, it will be a great breakthrough. Most of the commonly used robot movements are wheeled or foot walking. Although they have been developed for a long time, their movement ability is still limited and their ability to adapt to the terrain is limited. Due to the strong adaptability of snake like motion, it can be predicted that snake like robot will have broad application prospects in exploration, dangerous environment operation, on-site inspection and reconnaissance.

In addition to the special environment and terrain adaptability, snake like robots are often composed of a large number of repetitive segments, with many redundant structures. Different segments can backup each other, and their scalability and reliability are greatly improved. Therefore, in some areas with high reliability requirements, such as

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 588–598, 2021.
https://doi.org/10.1007/978-3-030-84386-1_48

military, aerospace and so on, NASA has been developing snake like robots Application of space robot in the field of research [2, 3].

Snake like robot has many useful characteristics, but at the same time, these characteristics also bring many problems, so snake like robot attracts numerous researchers to explore. Among these problems, how the snake like robot, or snake, moves is the most basic one. Different from the motion of wheeled or walking robots, their motion is obvious and easy to understand. When the wheels turn or the feet push, the robot moves [4]. The movement of snake like robot is not so obvious, it uses the overall deformation of the body to achieve movement, rather than wheels or feet.

The research of snake like robot in China is later than that in foreign countries. In 1999, Shanghai Jiaotong University published the first prototype of snake like robot in China. Since then, some research on motion theory has been carried out. In 2001, the University of national defense science and technology also published a prototype snake like robot [5]. South China University of technology has also carried out research on snake like robots. They mainly focus on the theoretical research on the application of snake like robots in bridge cable detection, and have carried out a lot of simulation on snake like robots [6]. At present, Shenyang Automation Research Institute of Chinese Academy of Sciences has the most abundant research achievements in the field of snake like robot in China. They not only carried out in-depth research in theory, but also published a number of prototypes.

For the control of snake like manipulator, the current common methods are vision based manipulator control and neural network-based manipulator control. Ai et al. [7] proposed design of manipulator target positioning system based on monocular vision. Obtain the image of the lock target in real time through monocular optical imaging, and combine the image analysis algorithm to calculate the target space position and the relative position of the target and the robot arm. Using OPC communication technology, the target space position information is transmitted to the robot arm control module and control the movement of the robotic arm to achieve the target grab. Li et al. [8] proposed research on robot trajectory control algorithms based on BP neural network and ant colony algorithm. Establish the manipulator motion trajectory model, and then use the neural network algorithm to train the main parameters of the manipulator, and then compare the output predicted motion trajectory with the manipulator's expected motion trajectory in order to solve the optimal parameters that are closer to the expectations. These two control methods have the problem of poor stability in the actual application process, which is mainly affected by the unstable communication between the joints.

In this case, a multi joint snake like manipulator control method based on hybrid fish swarm ant colony algorithm is proposed to solve the problems existing in the traditional control method. The hybrid fish school-ant colony algorithm is used to update the pheromone during the movement of the robotic arm. In this process, the optimal motion path of the robotic arm is selected. The path data is transmitted to the data receiver of the robotic arm to realize the real-time control of the robotic arm. In this process, the hybrid fish school-ant colony algorithm ensures the stability of data transmission.

2 Control Design of Multi Joint Snake Like Manipulator Based on Hybrid Fish Swarm Ant Colony Algorithm

2.1 Update Pheromone

In the basic ant colony algorithm, the calculation of transition probability depends heavily on the updating of pheromone. Different pheromone updating strategies will affect the search behavior of ants, thus improving the performance of the algorithm. In the basic ant colony algorithm, the pheromone update strategy makes the premature convergence behavior of the search mode more likely to occur, and the feasible solution cannot be quickly concentrated near the optimal solution, which inevitably reduces the quality and convergence speed of obtaining the optimal solution [9, 10]. In this paper, a new pheromone updating strategy is proposed in the hybrid intelligent algorithm, which can better avoid the algorithm falling into the local optimal solution prematurely.

In order to reflect that the pheromone secreted in nature is a kind of biological material, which will be gradually reduced in the air. Therefore, the concept of pheromone volatilization coefficient P is introduced, that is, the concentration of pheromone secreted by individual ants will gradually decrease with time according to some natural law. When the ant colony K finishes one cycle, it volatilizes the pheromones on all paths according to the volatilization coefficient p, and then updates the pheromone concentration according to Formula (1).

$$\sigma_{ij}(t+1) = (1-p)\sigma_{ij}(t) \tag{1}$$

Then according to formula (1), pheromone updating is completed for all the global paths of the manipulator.

$$\sigma_{ij}(t+1) = (1-p)\sigma_{ij}(t) + \Delta\sigma_{ij}(t) \tag{2}$$

$$\Delta\sigma_{ij}(t) = p \times f(L_{best}) \tag{3}$$

The formula L_{best} represents the optimal feasible solution obtained by all ants so far in this cycle. The proposed pheromone updating strategy can gradually evaporate the interference of the poor initial solution on the optimal global path, and gradually strengthen the influence of pheromone on the optimal global path as the algorithm continuously iterates. In the process of pheromone iterative updating, if the amount of pheromone trajectories of one point on each selected point is significantly higher than that of other points, when using the above method to update pheromone, the search stagnation phenomenon is very likely to occur, and the feasible solution is often locally optimal. In order to avoid this phenomenon, this paper proposes an update strategy which directly depends on the pheromone trajectory and heuristic information to influence the probability of selecting the next solution element. The heuristic information is constant in the whole process of the algorithm, which is determined according to the actual problem. Therefore, by limiting the amount of pheromone update trajectories, the effect of affecting the solution elements can be achieved, and avoid that ants may move along part of the same path, but will not move along the same path.

The calculation method is as follows: select the appropriate pheromone trajectory boundary, for all pheromone $\sigma_{ij}(t)$ in the path, The following rules must be followed.

$$\sigma_{ij}(t) \in [\sigma_{\min}, \sigma_{\max}] \tag{4}$$

In formula (4), if $\sigma_{ij}(t) > \sigma_{\max}$, then upper limit is taken as the amount of pheromone, and need to conform to formula (5).

$$\sigma_{ij}(t) = \sigma_{\max} \tag{5}$$

In formula (5), if $\sigma_{ij}(t) < \sigma_{\min}$, set $\sigma_{ij}(t) = \sigma_{\min}$. Consider that the algorithm updates pheromones on a single path, the maximum pheromone amount is $\frac{1}{L_{best}}$, where the symbol $\frac{1}{L_{best}}$ represents the path length of the corresponding global optimal solution or iterative optimal solution. Therefore, according to the following strategy $\sigma_{\min}$ and $\sigma_{\max}$ is dynamically updated until a better feasible solution is found.

Before the first generation solution is produced, $\sigma_{\min}$ and $\sigma_{\max}$ are calculated by the following formula:

$$\sigma_{\min} = \frac{\sigma_{\max}}{20} \tag{6}$$

$$\sigma_{\max} = \frac{1}{2(1-p)} \cdot \frac{1}{L_{best}} \tag{7}$$

When the pheromone in the path is updated,$\sigma_{\min}$ still determined $\sigma_{\max}$ by formula (6) and formula (7)

$$\sigma_{\max} = \frac{1}{2(1-p)} \cdot \frac{1}{L_{best}} + \frac{1}{L_{best}} \tag{8}$$

The convergence condition of the algorithm is that if there is only one solution element at each selection point, the information amount of the other solution elements is $\sigma_{\min}$, while the information amount of the other solution elements is $\sigma_{\max}$. Therefore, in the process of solving the algorithm, it is necessary to select the solution element with the largest amount of pheromone trajectory each time to obtain the optimal solution of the manipulator motion.

2.2 Signal Transmission Control Design

The serpentine robot's head and body are directly connected with the remote control by wireless communication. The wireless module uses the NRF24L01 wireless transmission module which has become the modular structure. When using this module to communicate, users do not need to participate in the communication process, as long as the module is programmed configuration, data can be transparently transmitted. NRF24L01 is a 2.4 GHz wireless communication chip produced by NORDIC. It is modulated by FSK and integrated with NORDIC's own Enhanced Short Burst protocol. The module in the NRF24L01 chip with an antenna, the terminal and other peripherals, through the SPI communication mode and SCM communication, very convenient to use.

With the support of wireless transmission technology, remote control is used to control the robot arm. The remote controller is used to display the state of the serpentine robot and realize the manipulation of the robot. Including power supply module, voltage monitoring module, indicator light, touch screen, wireless communication module and SWD download port.

Touch screen: using STM32 development board with ALIENTEK TFTLCD module, which belongs to the resistive touch screen, is currently the most used in the market type. Status Indicator LED: For convenience of observation, all of them are high-brightness direct insertion LEDs, which are red, blue and green respectively.

Voltage monitoring module: In all circuits are set up a power monitoring module to avoid the battery voltage is too low and damage the battery, monitoring module includes sampling circuit and buzzer alarm circuit. Because the requirement is not high, the voltage of 8.4V power supply is divided by a simple resistance voltage divider, and then the sampling voltage is converted to AD by STM32. The snake-like robot adopts a partial voltage resistor with resistance of 20 K and 30 K and accuracy of 1%, so the sampling voltage is 8.4 V * 2/5 = 3.36 V. When the power supply voltage is lower than 7.2 V, the sampling voltage is lower than 2.88 V, the buzzer alarms. Buzzer module: In order to reduce the size of the circuit board, the passive buzzer is used, the size is only 5 mm * 5 mm * 2 mm. The difference between active buzzer and passive buzzer lies in whether it integrates oscillation circuit, so the passive buzzer should output PWM signal in MCU and control the buzzer by amplifying triode S9012, which is different from conventional buzzer control. SWD debug mode: J-LINK V8 and STM32 both support JTAG debug and SWD debug, so two debug modes can be used, but SWD only needs two IO, occupies less resources and volume than JTAG, so SWD debug mode is used. When using the J-LINK V8 downloader, the STM32 ground and 3.3 V need to be connected to the J-LINK V8 ground and 3.3 V, so only four wires are required for SWD downloads, including two IO pins (SWDCLK, SWDIO) and 3.3V and GND. Power module: This module is responsible for the power supply of the whole remote control, because the remote control has two kinds of power demand, 3.3 V and 5 V, so the power module is divided into 3.3V voltage regulator and 5V voltage regulator part, because the power is not big, so all use ASM 1117 series linear voltage regulator chip, linear voltage regulator compared with DC-DC voltage regulator is generally small, input voltage and output voltage can be very close, use ASM 1117–3.3 and 1117–ASM 5.0 regulator chip, 8.4 V power supply voltage to 3.3 V supply MCU, 5.0 V supply touch screen. The transmission control part guarantees the reliable completion of data stream transmission between the segments, and the object it transmits is a segment of byte stream. The hardware base of this module is STM32. To ensure reliable transmission, the sender must be able to receive the authenticated frame sent by the receiver after sending the data frame. Therefore, each segment must be duplex with the forward and backward communication, and each segment needs two transmission control systems, one for the first segment and the other for the second segment.

2.3 Motion Control Design of Manipulator

Motion control is responsible for direct control of the steering gear and updating of motion parameters. The core is to record the state of motion, which determines the current implementation of the motion.

The steering gear used in the motion control part is MG995. The steering gear has 3 control wires, two of which are power and ground wires, and one is signal wire. The control signal of the steering gear is a square wave with a period of 20ms, which has a certain requirement on duty ratio. The steering gear of the MG995 rotates in the range of –90° to 90°, and its high level time length y (unit us) is related to the angle x as follows:

$$y = \frac{100}{9}x + 1500 \tag{9}$$

Each segment has two actuators to control, that is, STM32 chip output two square waves, using STM32 chip timer 3 to complete, timer 3 can output up to four square waves with the same period. Timer configuration, the use of timer 3 channel 3 and channel 4, the working mode is PWM 1 mode, in this mode, when the timer count value is less than the comparison register, the output high level, less than the comparison register output low level.

Because the system clock is 16 MHz, so as long as the timer set to 15, you can reach 16 min, the unit of time is lus, then set the timer 3 count value to 19999, so the timing cycle is 20,000 times, the length of time is just 20 ms, to set the steering angle, just take the required angle into the Type 7 to calculate the length of time, the calculation results into the corresponding comparison register.

Motion parameter updating, especially in interrupt process, only includes the updating of direct parameter time and rotation angle, because these two parameters need to be calculated in real time, and the updating period is 20 ms. The first is the update of the time parameter t. In fact, there are only three kinds of motion: sinusoidal motion, lateral rolling motion, fixed at a certain angle, and only the first two kinds of motion that need time parameter. Since the update period here is 20 ms, you will need to increase the time by 20 ms per cycle. In addition, there is a special parameter: reverse, reverse instructions, in order to achieve this function, the need for another time reverse growth, that is, 20 per cycle to reduce 20 growth. Then there's the angle update. From the structure, it can be seen that none of the parameters recorded the current angle, which is caused by two reasons: first, the angle needs to be updated in real time with a period of 20 ms, and it is meaningless to record different angles in each period; second, the comparison register corresponding to the query rudder can be used to infer the current angle. Thus, the multi-joint serpentine manipulator control method based on hybrid fish-ant colony algorithm is designed.

3 Experimental Study on Multi-joint Serpentine Manipulator Control Based on Hybrid Fish-Ant Colony Algorithm

In order to verify the performance of the proposed multi-joint snake-shaped manipulator control method based on the hybrid fish-ant colony algorithm, the DDC controller is tested, and the input signal is simulated by MATLAB software according to a certain time sequence.

3.1 Experimental Preparation

In the experiment, the serpentine manipulator is tested by the driving end. The overall structure of the driving end is shown in Fig. 1.

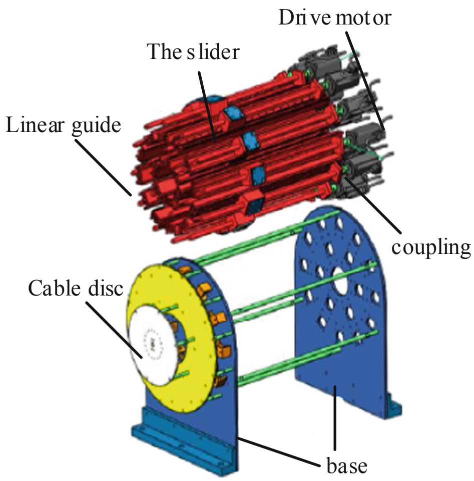


Fig. 1. Structure diagram of drive end

On this basis, the MATLAB software is used to simulate the signal, and the input signal timing requirements are shown in Fig. 2.

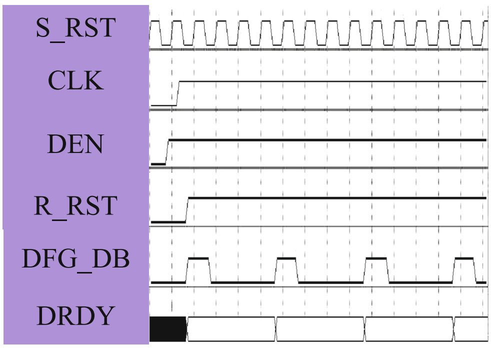


Fig. 2. Input signal timing design

In order to better verify the control of multi joint snake like manipulator, the experimental parameters are set. The carrier frequency of the input signal is set to 5 MHz. The modulation signal frequency is set to 120 kHz. The initial value of the accumulator is set to 0 dB. The total amount of data is 10–50T.

In the same experimental environment, the control of multi joint snake like manipulator is realized through many tests. In addition, compared with the traditional control method of multi joint snake like manipulator, its signal processing speed is tested under the interference of different amount of data.

3.2 Experimental Results and Analysis of Control Signal Processing Rate

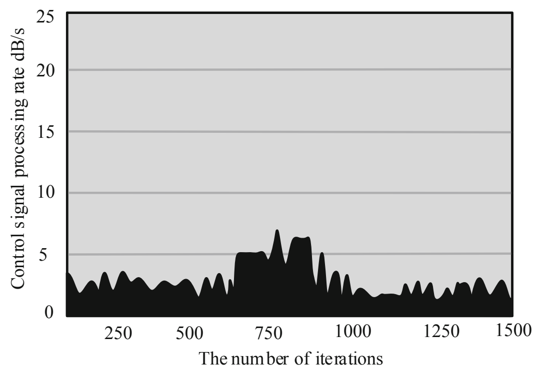
Based on the above experimental preparation content, the signal processing rate of different manipulator control methods is verified. In the experiment, the manipulator control method based on neural network, vision and the manipulator control method based on hybrid fish ant colony are used to control the manipulator to do the same action. The experimental results are output by MATLAB software. The specific experimental results are as follows This is shown in Fig. 3.

When the number of iterations based on the neural network is very low, it can be seen that with the increase of the number of iterations in the control chart, only the peak of 5dB / s can be seen. Experimental results show that when the number of iterations is increased to 750, the signal processing speed is always maintained at a high level. To sum up, the robot control method based on hybrid fish swarm ant colony algorithm has higher control signal processing speed.

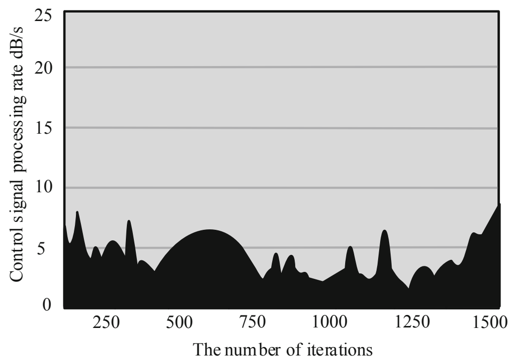
3.3 Simulation Results and Analysis

Based on the control process of the manipulator in the above experiment, the output of the change of the convergence value in the control process is taken as the experimental result of the second experiment, and the stability of the control method of the manipulator is compared and analyzed according to the change of the convergence value.

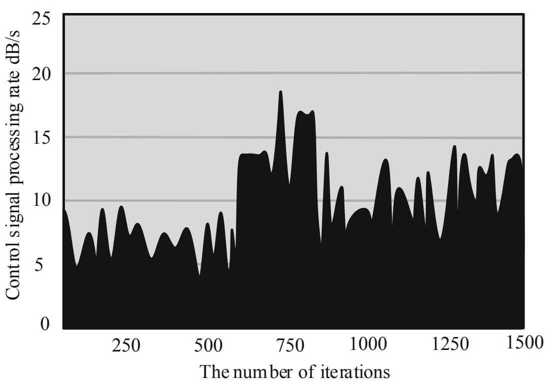
From the data in Table 1, it can be seen that with the increase of the number of iterations, the convergence values of each manipulator control method are increasing, but the longitudinal observation analysis shows that the designed manipulator control method based on hybrid fish swarm ant colony algorithm has the lowest convergence value and the smallest change. The convergence value is as low as 0.036. Combined with the experimental results of control signal processing rate, the stability of the control method based on hybrid fish swarm ant colony algorithm is better than the traditional control method.



(a) Experimental results of manipulator control method based on Neural Network



(b) Experimental results of robot arm control method based on vision



(c) Experimental results of manipulator control method based on hybrid fish swarm ant colony algorithm

Fig. 3. Experimental results of signal processing rate controlled by different manipulator control methods.

Table 1. Experimental results of different manipulator control methods

	Control method of snake like manipulator based on Neural Network	Control method of snake like manipulator based on vision	Snake like manipulator control method based on hybrid fish swarm ant colony algorithm
Iterations	500	500	500
Convergence value	0.926	0.648	0.036
Iterations	1000	1000	1000
Convergence value	2.064	1.395	0.051
Iterations	1500	1500	1500
Convergence value	3.135	2.361	0.097

4 Conclusion

The progress of science and technology, the innovation of technology and the trend of social development put forward new challenges and requirements for the mechanical design at this stage. In this context, this paper focuses on the research and discussion of multi joint snake like manipulator. With the support of the original relevant data and literature, a control method of multi joint snake like manipulator based on hybrid fish swarm ant colony algorithm is proposed. After the method design is completed, the effectiveness of the proposed control method is verified by a number of comparative experiments with traditional control methods The reliability and stability of the control method, to a certain extent, solve the problems faced by the traditional manipulator control method. However, due to the limitations of personal ability and energy, coupled with the manipulator control is a more complex problem, there will inevitably be some deficiencies in the research, in the future research will start from the deficiencies in this paper in-depth research and analysis. Subsequent research can be conducted from the aspect of the control accuracy of the robotic arm.

References

1. Zhang, Q.: Motion control system design of multi-joint snake-like manipulator for nuclear environment. J. Shandong Univ. (Eng. Sci.) **48**(06), 122–131 (2018)
2. Zhao, H., Lei, C., Jiang, N.: Six-degree-of-freedom manipulator path planning based on improved ant colony algorithm. J. Zhengzhou Univ. Nat. (Sci. Edn.) **52**(01), 120–126 (2020)
3. Tianbing, M.A., Qing, Z.H.O.U., Fei, D.U., et al.: Piezoelectric flexible manipulator vibration control based on machine vision and improved PID. Opt. Precis. Eng. **28**(01), 141–150 (2020)
4. Xiong, Z., Tao, J., Liu, C.: Inverse kinematics of hyper-redundant snake-arm robots with improved tip following movement. Robot **40**(01), 37–45 (2018)
5. Wang, G., et al.: Research on trajectory planning of packaging robot based on improved ant colony algorithm. J. Electron. Measure. Instrum. **33**(08), 94–100 (2019)
6. Jianqiu, L.: Construction of real-time interactive mode-based online course live broadcast teaching platform for physical training. Int. J. Emerg. Technol. Learn. (IJET) **13**(06), 73 (2018)

7. Ai, J., et al.: Design of manipulator target positioning system based on monocular vision[J]. Optical Techn. **45**(001), 6–11 (2019)
8. Li, J., Wang, X., Duan, X.: Research on robot trajectory control algorithms based on BP neural network and ant colony algorithm. Mach. Tool Hydraulics **47**(24), 146–152 (2019)
9. Wu, H., et al.: A model predictive control based trajectory tracking controller design for space flexible joint manipulators. Aerospace Control App. **45**(02), 35–41 (2019)
10. Yang, L., Fu, G., Chen, Y.: Yaw moment control for humanoid robot with joint acceleration constraints. Acta Electron. Sin. **47**(02), 475–482 (2019)

Design of Step Motor Automation Control System Based on Lyaponov Stability Theory

Jin-tian Yin[1,2], Jie Tang[1,2], Li Liu[1,2](✉), Qing-yue Luo[1,2], Xin-bo Liu[1,2], and Wei Chen[1,2]

[1] Hunan Provincial Key Laboratory of Grids Operation and Control On Multi-Power Sources Area, Shaoyang University, Shaoyang 422000, China
yinjintian112@yeah.net
[2] School of Electrical Engineering, Shaoyang University, Shaoyang 422000, China

Abstract. In order to improve the effect of stepping motor automation, the design method of stepping motor automation control system based on Lyaponov stability theory is proposed. Firstly, AT89C52 MCU is used to optimize the hardware configuration of stepping motor automation control system, and the system operation algorithm and operation steps are perfected.

Keywords: Lyaponov stability theory · Stepping motor · Automation

1 Introduction

At present, SCM has become an important application field of modern electronic technology and computer technology. The stepper motor automatic control system represented by SCM has been regarded as the symbol of modern electronic system era. At the same time, because the price of single-chip microcomputer is relatively low, it makes the application of single-chip microcomputer in stepping motor automatic control system more widely, and also promotes the transformation of more classical stepping motor automatic control system to modern electronic system [1]. Stepper motor is an open-loop control element that converts electric pulse signal into angular displacement or linear displacement. In the case of non overload, the speed and stop position of motor only depend on the frequency and pulse number of pulse signal, and are not affected by load change. In addition, stepper motor has only periodic error but no cumulative error In the field of position control, it is very simple to use stepper motor to control [2]. In order to realize the real-time, fast and accurate control of eight two-phase bipolar hybrid stepping motors, Lyapunov stability theory is used to study the automatic control system of stepping motor. Lyapunov stability theory was founded by Russian mathematician Lyapunov in the 1880s. It has been widely used in automatic control, aviation technology, ecological biology, biochemical reaction and other natural science and engineering technology, and its concept and concept have also developed very rapidly. Using the characteristics of pulse drive of stepper motor, to achieve its control. The system controls the lower computer through the upper computer man-machine interface. The lower

W. Fu et al. (Eds.): eLEOT 2021, LNICST 390, pp. 599–611, 2021.
https://doi.org/10.1007/978-3-030-84386-1_49

computer uses the combination of arm and FPGA to control multiple stepper motors. In order to realize multi-channel control of stepper motor, the upper computer can send control instructions through arms and FPGA, and FPGA can generate pulse control signals needed for motor start, acceleration, deceleration, stop, step adjustment, speed adjustment, etc. through control instructions [3]. The pulse signal needed to control each motor is input into the corresponding motor controller through FPGA. Practice has proved that Lyapunov stability theory is very suitable for the control of stepping motor, and its many characteristics, such as short development cycle, high flexibility, low cost and high integration, make it the preferred object in the field of stepping motor control [4]. Taking Lyapunov stability theory as the core of microcontroller not only reduces the cost of the whole control system, simplifies the hardware circuit, but also fully ensures the strong stability and feasibility of the system.

2 Design of Automatic Control System for Stepping Motor

2.1 Optimization of Hardware Configuration Structure of Stepping Motor Automatic Control System

Stepper motor control system and other motor control system can use open-loop control, must include a special driver to drive stepper motor. Stepper motor control system is mainly composed of three parts: stepper motor body, stepper motor drive circuit, stepper motor controller [5]. The system consists of upper computer, STM32 microcontroller and cyclone II FPGA. Through the host computer to complete human-computer interaction, using STM32 and FPGA as the core processor of the control system, can effectively and reasonably allocate resources. The relevant operation parameters that need to be set for the operation of the stepper motor can be modified through the operation interface of the upper computer. STM32 sends the operation commands and parameters to FPGA, and generates the digital pulse control signals needed for the start, acceleration, deceleration and stop of the stepper motor through the control commands [6]. The control system is developed on the basis of the existing STM32 development board and cyclone II FPGA development board. The main work is to complete the development and test of the system on the basis of the existing hardware circuit. Based on this, the system framework is optimized, as shown in the Fig. 1.

From the above picture, we can know that the multi-channel stepper motor control system includes the human-computer interface, ARM microcontroller, FPGA pulse controller, stepper motor driver, stepper motor body and so on. The human-computer interaction control interface of the upper computer is the window for the whole control system to communicate with the outside world [7]. It not only makes the whole control system visualized, but also makes the running state of each channel stepping motor get real-time monitoring. Through this interface, the system operators can set up the parameters of the entire control system, command settings, stepping motor channel number selection and other operations [8]. In addition, the PC will also send ARM synchronous motor running state conversion related control instructions, such as start, acceleration, deceleration and so on. In the STM32 control module circuit, hardware resources, we

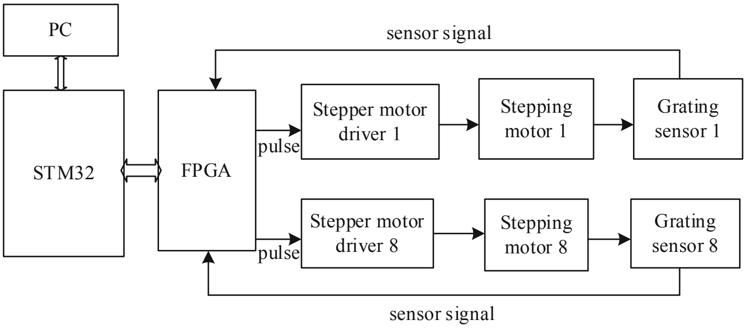


Fig. 1. System hardware configuration structure diagram

must provide several hardware circuits, including: power module, JTAG debugging module, crystal module, serial port module and GPIO universal IO port module. Figure 2 shows the block diagram of STM32 microcontroller.

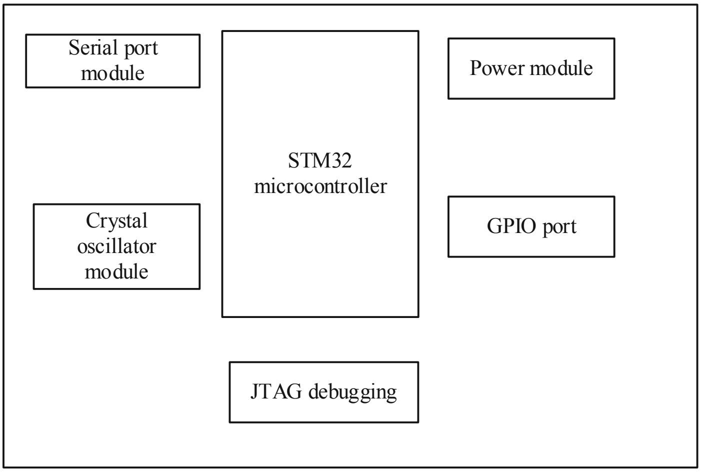


Fig. 2. STM32 microcontroller block diagram

As shown in the picture above, this control system mainly includes six parts: PC, STM32, FPGA, stepper motor driver, stepper motor and grating sensor. In order to allocate resources reasonably, the control system adopts modular design, which can communicate with each other and transfer information effectively, so as to control the stepper motor accurately. Based on this, the system hardware structure and functions are further optimized as shown in Fig. 3:

In order to realize the visualization of the control system, the operation interface of the upper computer is designed by Delphi 7, and the communication with the lower computer is completed by serial port (RS232) [9, 10]. The STM32 series 32-bit flash memory microcontroller is very suitable for control applications because of its low

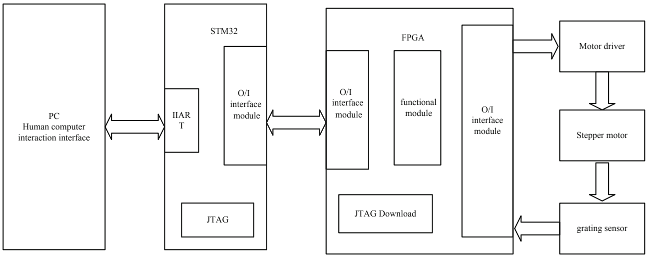


Fig. 3. System hardware structure function optimization

power requirements and low cost. STM32 can receive the control command and related operation parameters sent by the host computer, and then control the operation of the stepper motor, through software programming, the parameters are sent to the FPGA. In addition, in the design of this module, timer interrupt is needed to read the current state of each channel stepping motor from FPGA, and feedback the data to PC through serial communication.

2.2 Step Motor Automation Control System Software Operation Algorithm

In the mechanical transmission process in order to make a smaller pulse equivalent, one can change the lead screw, and the other can be achieved through the stepping motor subdivision drive. But subdivision can only change its resolution, not its accuracy. The accuracy is determined by the inherent characteristics of the motor [11]. The load inertia of stepper motor and the starting frequency required by the machine tool should be estimated to match the inertia frequency of the stepper motor, so that the high-speed continuous working frequency can meet the need of the machine tool moving rapidly. The following calculations are required for selecting a stepper motor:

Based on the required pulse equivalent, the gear reduction ratio i is calculated as follows:

$$i = \frac{\varphi}{360\Delta} S \tag{1}$$

φ is the step angle of the stepping motor, S is the screw pitch, where the screw and gear are converted to the inertia of the motor shaft:

$$J_t = J_1 + \frac{i}{i_2}\left[J_2 + J_s + \frac{W}{g}\left(\frac{S}{2\pi}\right)^2\right] \tag{2}$$

Jt is the inertia converted to the motor shaft, J1, J2 are the inertia of the gear, Js is the inertia of the screw rod, and w is the weight of the worktable

$$M = M_a + M_f + M_t \tag{3}$$

The expression M_a of the parameter is:

$$M_a = \frac{(J_s + J_t)n}{\mathrm{M}T} \times 1.02 \times 10^{-2} \tag{4}$$

Ma is the starting acceleration torque of the motor, Mf, Mt are the inertia of the motor itself and the load, n is the required speed of the motor, and T is the speed up time of the motor

$$M_f = \frac{uWS}{2M_a\pi\eta i} \times 10^{-2} \tag{5}$$

η is the torque converted from the rail friction to the motor, Pt is the friction coefficient, and i is the transmission efficiency. Then the starting frequency of system load is estimated

$$M_t = \frac{P_t S}{2M_f\pi\eta i} \times 10^{-2} \tag{6}$$

The starting frequency of the motor controlled by the numerical control system is closely related to the load torque and inertia

$$f_q = f_{q0}\left[\left(1 - \frac{M_f + M_t}{M}\right) \div \left(1 + \frac{J_t}{J_s}\right)\right]^{\frac{1}{2}} \tag{7}$$

According to the given value $rin\ (t)$ and the actual output value $yout\ (t)$, the control deviation is obtained

$$\mathrm{error}(t) = f_q\mathrm{rin}(t) - \mathrm{yout}(t) \tag{8}$$

Then the automatic control law of self motor is as follows:

$$u(t) = k_p\mathrm{error}(t) + \frac{1}{T_I}\int_0^t \mathrm{error}(t)dt + \frac{T_D\mathrm{derror}(t)}{dt} \tag{9}$$

Then the transfer function of motor automatic control is as follows

$$G(s) = \frac{U(s)}{E(s)} = k_p\left(1 + \frac{1}{T_I s} + T_D s\right) \tag{10}$$

Where K_P is the proportional coefficient, T_i is the integral time constant and T_N is the differential time constant.

Based on the above algorithm, according to the function and design requirements of each part of the system, the software part of the control system can be roughly divided into two parts: the success module and the communication module. According to the hardware part, the function module can be divided into upper computer part, STM32 module and FPGA module [12]. The communication module consists of two parts: the communication between upper computer and STM32, and the communication between STM32 and FPGA. Based on this, the operation information processing steps of stepping motor automatic control system are optimized, as shown in Fig. 4.

As shown in the Fig. 4, the initialization operation of the system main program mainly includes system clock initialization, flash initialization, interrupt initialization, peripheral initialization, control and function initial parameter reading, and then turn on the interrupt to enter the main cycle [13]. In the process of operation, the stepper motor

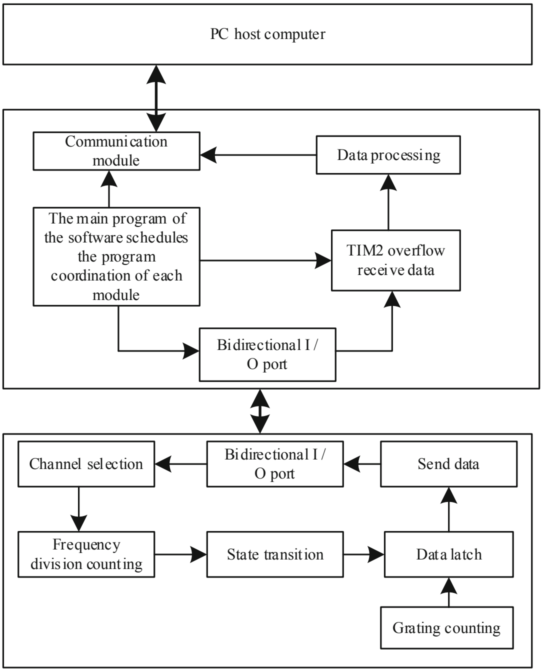


Fig. 4. Operation information processing steps of stepping motor automatic control system

cannot be directly driven by DC or AC power supply. Therefore, the classic combination of L97 + L298 is used in the driving circuit of the system. After loop distribution and power amplification, the pulse output from FPGA is input into the stepper motor, and finally drives the specified stepper motor. The hardware circuit of the driver is simple, the cost is low, and the effect of the driver is good. The specific main program flow is shown in Fig. 5.

As shown in the figure, when selecting the stepper motor, the output power of the stepper motor must be greater than the power required by the load. When selecting the power stepping motor, the load torque of the mechanical system should be calculated first. The torque frequency characteristics of the motor can meet the mechanical load and have a certain margin to ensure its reliable operation [14]. In the actual working process, the load torque under various frequencies must be within the range of torque frequency characteristic curve. In addition, the step angle should be matched with the mechanical system so that the pulse equivalent required by the machine tool can be obtained.

2.3 Realization of Step Motor Automatic Control

Stepper motor driver is a necessary part of motor control, including optical isolation module, power amplifier module and output module. The output module transmits the pulse signal after power amplification to the stepper motor to drive each motor. There are two main functions of the optical isolation function module: receiving the pulse signal sent by FPGA; isolating the optical coupler before receiving the pulse signal [15]. The

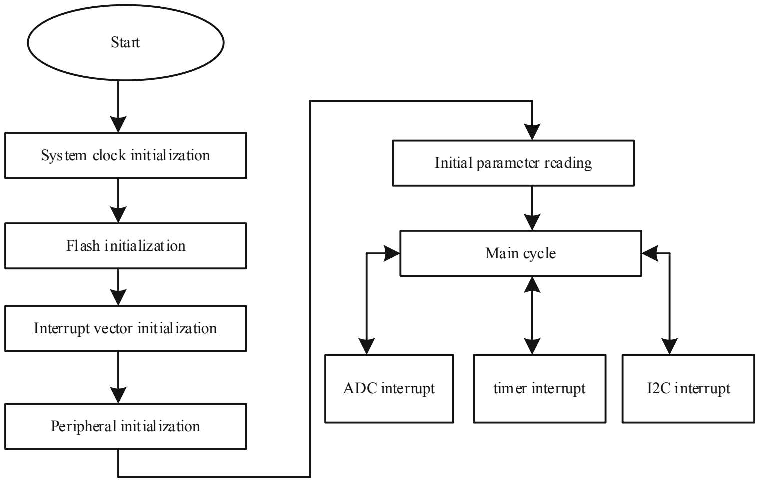


Fig. 5. Simplification of main program operation steps

most important part of the stepper motor driver is the power amplifier module, because the pulse sent by FPGA is not enough to drive the motor, and the function of the power amplifier module is to distribute the pulse signal and amplify the power. Stepper motor control system is an organic whole, which is composed of motion control system and operation control system [16]. The operation system converts the operator's operation into the electrical signal that the motion control system can accept, and the motion control system responds and completes the specified action. Based on this, the operation control method of stepping motor automatic control system is optimized, as shown in Fig. 6.

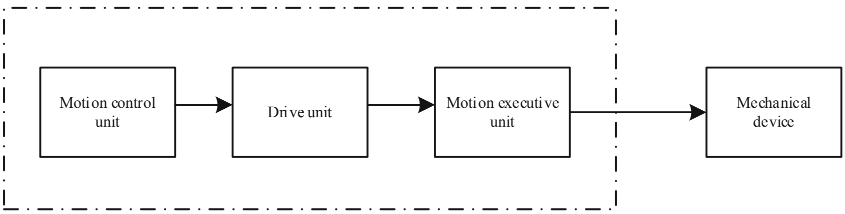


Fig. 6. Step motor automatic control method

The control system must apply a certain pulse signal to the stepper motor to drive it to run, but the pulse signal output by FPGA is small enough to drive the motor to run, so the driver needs to amplify the pulse signal output by FPGA. In the course of the development of stepper motor, a variety of special stepper motor drivers have been designed and developed [17]. Figure 7 shows the basic composition of the stepper motor driver, as follows:

In the stepper motor control system, the motion executive component is stepper motor. Stepping motor is a kind of actuator which converts electric pulse into angular displacement. When the stepper driver receives a pulse signal, it drives the stepper motor

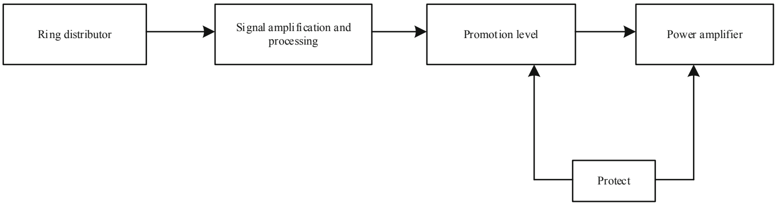


Fig. 7. Basic composition and structure optimization of stepper motor driver

to rotate a fixed angle according to the set direction, and its rotation is running step by step at a fixed angle. The angular displacement can be controlled by controlling the number of pulses, so as to achieve the purpose of accurate positioning. At the same time, the speed and acceleration of motor rotation can be controlled by controlling the pulse frequency, so as to achieve the purpose of speed regulation [18]. The operation of the stepper motor needs an electronic device to drive. This device is the stepper motor driver, which amplifies the pulse signal sent by the control system to drive the stepper motor. The speed of the stepper motor is proportional to the frequency of the pulse signal. Controlling the frequency of the step pulse signal can speed the motor accurately; controlling the number of step pulses can position the motor accurately [19]. Different results can be obtained by different data operations on LCD controller. For English display, only 8 bits (one byte) are needed. There are more than 6000 commonly used Chinese characters, so we use the 128 rarely used values in ASCB table as a group to represent Chinese characters, that is, the internal code of Chinese characters, and leave the lower 128 bits for English characters, that is, the internal code of English. Use the information of numbers to record the shape of English or Chinese characters. See Table 1 for system operation pin description.

Using single-chip microcomputer to drive stepping motor by software, not only can we freely set the speed, rotation angle and rotation times of stepping motor within a certain range through programming method, but also can conveniently and flexibly control the running state of stepping motor to meet the requirements of different users. The control system realizes the remote control of the upper computer, and the running state of the stepping motor can be displayed through the LCD screen [20]. Based on the pin description, the operation steps of the automatic control system are further optimized, as shown in Fig. 8.

In the whole process of system debugging, single step execution and full speed execution can be combined organically to find the wrong location more quickly and accurately than single method. Full speed execution can cooperate with setting breakpoints, which can generally determine the error range. Single step execution can understand the execution of each instruction in the program in detail, and it is convenient to know whether the instruction is correct by comparing the operation results of the instruction. On the basis of realizing the control of single stepping motor, the control system also needs to realize the synchronous control of multiple stepping motors. In the process of debugging, it is necessary to use oscilloscope to intuitively judge the synchronization of FPGA output control pulse. The specific method is to input the FPGA output pulse corresponding to any two synchronous control stepping motors into the oscilloscope when debugging

Table 1. System operation pin description

Pin number	Pin name	Level	Pin function description
1	VSS	0 V	Power ground
2	VCC	– 5 V	Power supply positive
3	V0	H/L	Contrast (brightness) adjustment
4	RS(CS)	H/L	Rs = "H" indicates that db7-db0 are display data Rs = "L" indicates that db7-db0 is the display instruction data
5	R/W(SID)	H/L	The data is read to db7-db0 The data of db7 → db0 are written to IR or Dr
6	E(SCLK)	H/L	Enable signal
7	DB 0	H/L	Tri state data line
8	DB 1	H/L	Tri state data line
9	DB 2	H/L	Tri state data line
10	DB 3	H/L	Tri state data line
11	DB 4	H/L	Tri state data line
12	DB 5	H/L	Tri state data line
13	DB 6	H/L	Tri state data line
14	DB 7	H/L	Tri state data line
15	PSB	H/L	H: 8-bit or 4-bit is parallel port mode, l: serial port mode
16	NC	-	Empty feet
17	/RESET	H/L	Reset terminal, low level valid
18	VOUT	-	LCD driving voltage output terminal
19	A	VDD	Positive end of backlight (+ 5 V)
20	K	VSS	Negative end of backlight

the system, and observe and compare, so as to ensure whether the system reaches the synchronization index.

3 Analysis of Experimental Results

Matlab/Simulink is used in the simulation. MATLAB is a simple engineering calculation language launched by MathWorks company in the United States. Based on matrix, it integrates calculation, visualization and programming into an interactive working environment. It can realize the functions of engineering calculation, algorithm research, modeling and simulation, data analysis and visualization, scientific and engineering drawing, application development and so on. When all parts of the system are debugged successfully, the system runs normally, and the upper computer interface and FPGA

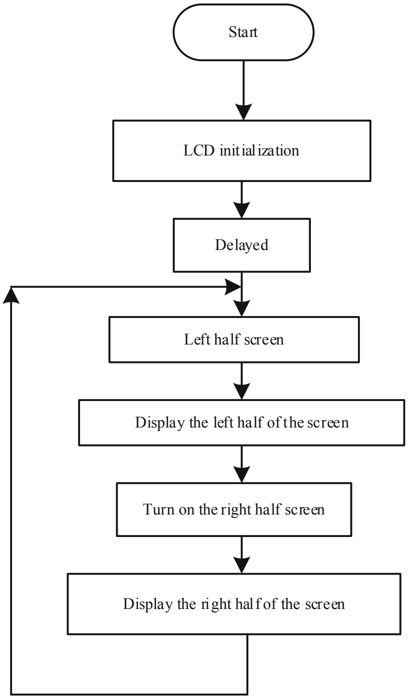


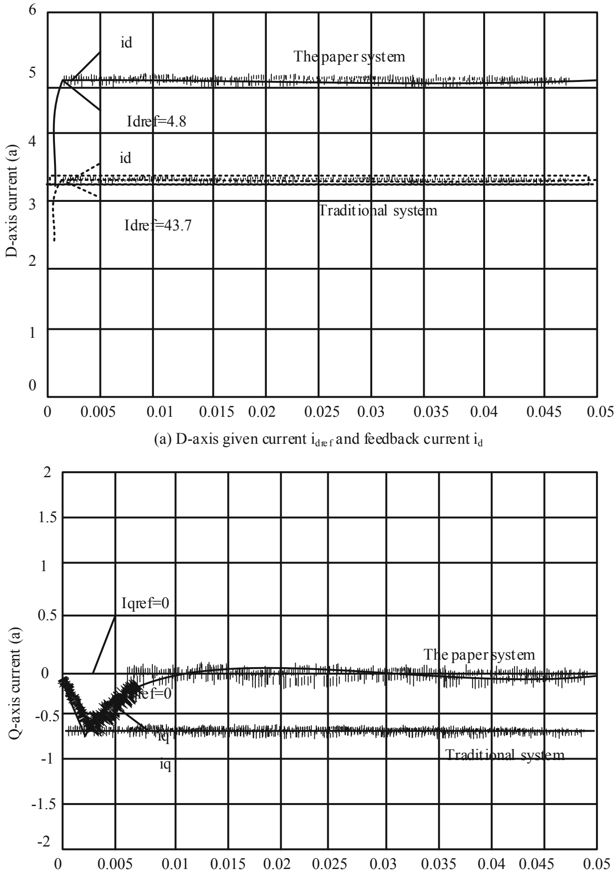
Fig. 8. System operation steps

Table 2. Experimental parameter setting

Setting parameters	Parameter value
Steps	500000 steps
Initial speed	50 steps per second
Target speed	5000 steps per second
Stop speed	50 steps per second
Acceleration	500
Deceleration	500

output pulse are observed. Here, the control system is set to 8-channel synchronous operation parameters as experimental parameters, as shown in Table 2.

Generally speaking, the automatic operation state of stepping motor is the same. In the process of experiment, we only need to measure and observe the pulse of any channel. When the stepper motor enters the stable operation state, the FPGA output pulse of the system is displayed, and according to the output result, the motor is adjusted to run in time. In order to form the experimental contrast, the traditional stepper motor control system and the DSP based stepper motor control system are set as the two contrast systems of the experiment, and the system is developed and operated in the same environment to ensure the uniqueness of the experimental variables. After the system running, the display result of stepping motor output pulse is shown in Fig. 9.



(a) D-axis given current i_{dref} and feedback current i_d

(b) Q-axis given current i_{qref} and feedback current i_q

Fig. 9. Analysis of experimental comparison results

The simulation results show that compared with the traditional system, the control scheme based on Lyapunov stability theory is feasible. Based on the traditional system operation curve in the figure, it can be seen from the torque speed characteristic curve, current speed characteristic curve and current waveform of stepper motor system that with the increase of speed, the current amplitude and torque output capacity of the system decrease. This is because the back EMF increases with the increase of stepper motor speed. This is the inherent characteristic of stepping motor.

4 Conclusion

The design of stepping motor automatic control system based on Lyapunov stability theory is put forward. From the actual use, the controller has the characteristics of high reliability, easy to use and strong universality. The control of stepping motor runs smoothly and the effect is good. With the development of microelectronics and computer technology, the operation of stepping motor automatic control system based on Lyapunov stability theory will be more simple, flexible and intelligent, and will be widely used in various fields.

Fund Projects. Hunan Natural Science Foundation Project (2020JJ4558, 2018JJ2367, 2020JJ5519), Hunan Science and Technology Department Science and Technology Project (2016 TP1023).

References

1. Zhiyong, D., et al.: A Global Convergence Estimator of Grid Voltage Parameters for More Electric Aircraft. IEEE Trans. Indus. Electron. **67**(9), 7540–7549 (2019)
2. Wang, Y., et al.: Visual servo-collision avoidance hybrid task by considering detection and localization of contact for a soft manipulator. IEEE/ASME Trans. Mechatron. **99**, 1–1 (2020)
3. Qiu, B., et al.: Synchronization of multi-links memristor-based switching networks under uniform random attacks. Neural Process. Lett. **48**(3), 1431–1458 (2018)
4. Zhang, D., et al.: Stepper motor open-loop control system modeling and control strategy optimization. Arch. Electr. Eng. **68**(1), 63–75 (2019)
5. Wang, J., et al.: Modelling and parametric design of a pneumatic soft stepper motor. Int. J. Mech. Sci. **161–162(C)**, 105019–105019 (2019)
6. Jianqiu, L.: Construction of real-time interactive mode-based online course live broadcast teaching platform for physical training. Int. J. Emerg. Technol. Learn. (IJET) **13**(06), 73 (2018)
7. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
8. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
9. Sarbu, V., Avram, M.: A novel approach for assessing the instantaneous flow rate of an external gear pump using 3d printing and computer vision. IOP Conf. Ser. Mater. Sci. Eng. **997**(1), 012060 (2020)
10. Chen, Y., Kwok, K.W., Tse, Z.T.H.: Erratum to: an mr-conditional high-torque pneumatic stepper motor for mri-guided and robot-assisted intervention. Ann. Biomed. Eng. **45**(10), 1 (2017)
11. Al-Mayyahi, A., Ali, R.S., Thejel, R.H.: Designing driving and control circuits of four-phase variable reluctance stepper motor using fuzzy logic control. Electr. Eng. **33**(2), 1–15 (2017)
12. Sánchez-Alvarez, A., Luna-Moreno, D., Hernández-Morales, J.A., et al.: Control of stepper motor rotary stages applied to optical sensing technique using labview. Optik – Int. J. Light Electron. Optics **164**(11), 65–71 (2018)
13. Lee, Y., et al.: Nonlinear $\mathcal {H_2$ control for a nonlinear system with bounded varying parameters: application to pm stepper motors. IEEE/ASME Trans. Mechatron. **22**(3), 1349–1359 (2017)
14. Liu, C.H., et al.: Optimal design of a motor-driven three-finger soft robotic gripper. IEEE/ASME Trans. Mechatron. **9**, 1–1 (2020)

15. Yuliza, E., Habil, H., Salam, R.A., et al.: Development of a simple single-axis motion table system for testing tilt sensors ☆. Proc. Eng. **170**(2), 378–383 (2017)
16. Chen, Y., et al.: Design of multi-line elastic belt conveying control system for knitting machine based on I2C protocol. IEEE Access **99**, 1–1 (2020)
17. Heyduk, A., Joostberens, J.: Automatic control of roadheader cutting head speed and load torque. IOP Conf. Ser. Earth Environ. Sci. **609**(1), 012081 (2020)
18. Weathersby, E., et al.: Automatic control of prosthetic socket size for people with transtibial amputation: implementation and evaluation. IEEE Trans. Biomed. Eng. **99**, 1–1 (2020)
19. De Lima, M.L., Camponogara, E., De Campos, M.C.M.M., et al.: Automatic control of flow gathering networks: a mixed-integer receding horizon control applied to an onshore oilfield. Control. Eng. Pract. **86**(MAY), 48–55 (2019)
20. Sui, Q., et al.: Performance of a sequencing-batch membrane bioreactor (SMBR) with an automatic control strategy treating high-strength swine wastewater. J. Hazard. Mater. **342**(Jan.15), 210 (2018)

Author Index