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).

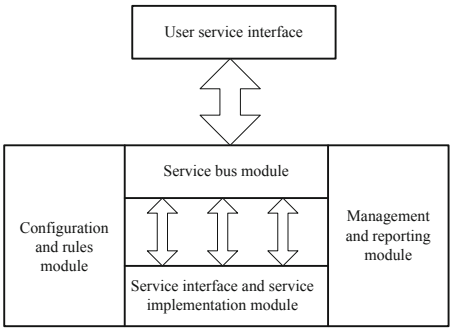

Fig. 1. SOA Service Architecture of the whole teaching resources system

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).

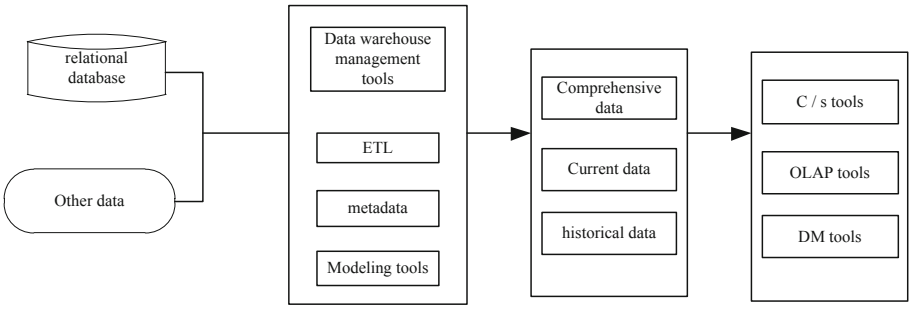

Fig. 2. System data processor architecture

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

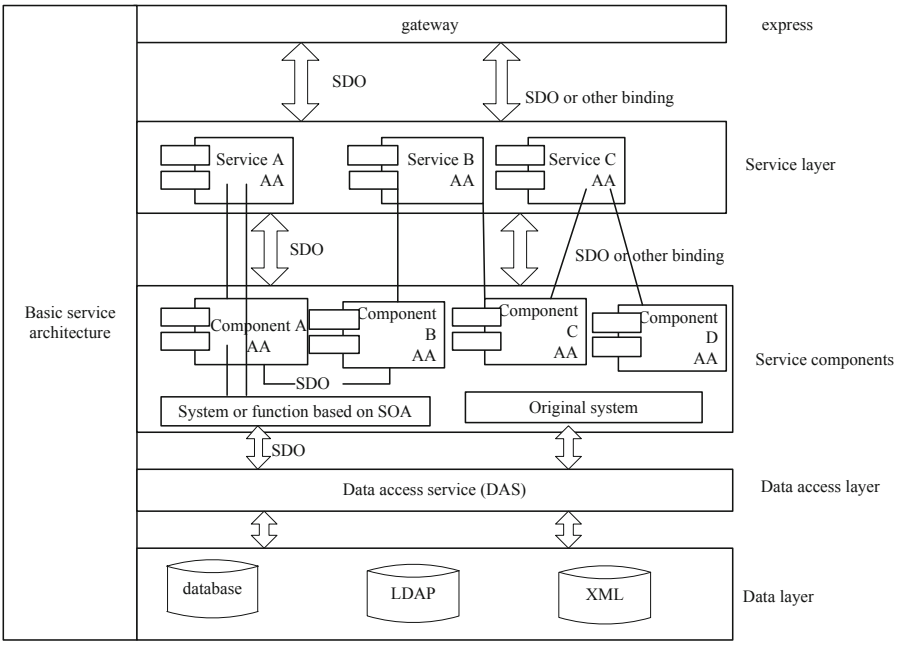

Fig. 3. System hardware configuration optimization

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:

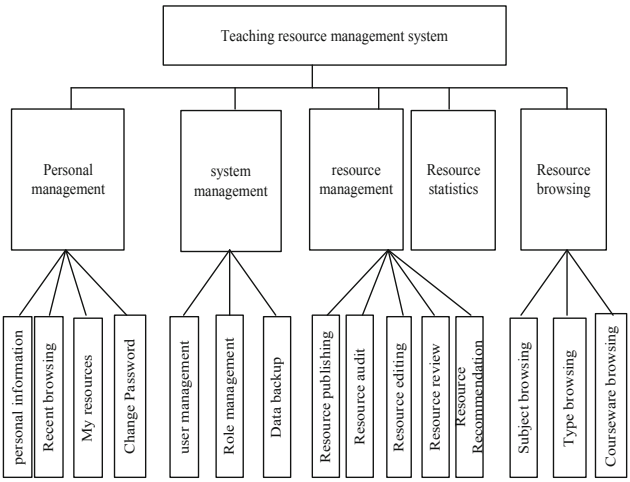

Fig. 4. System function structure optimization

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):

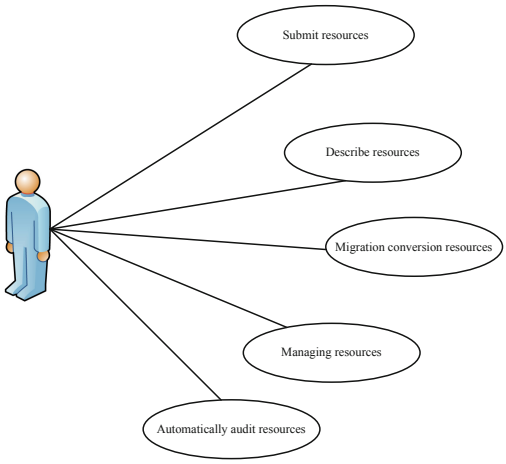

Fig. 5. Teaching resource submission participant use case

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

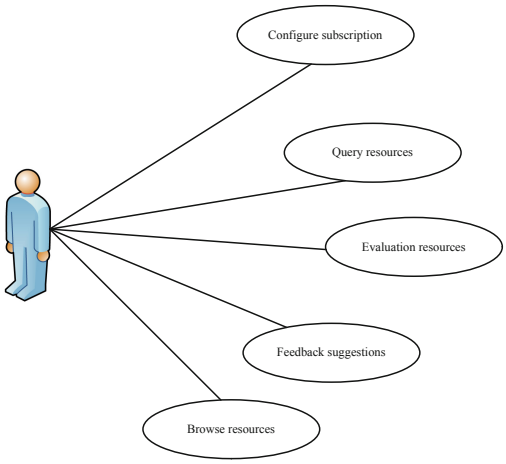

Fig. 6. Resource usage actor use case

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

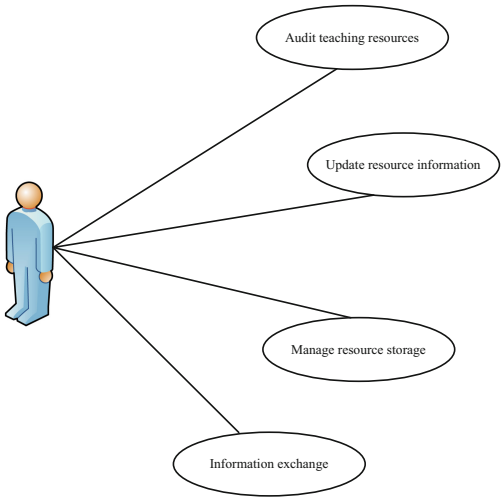

Fig. 7. Resource management actor use case

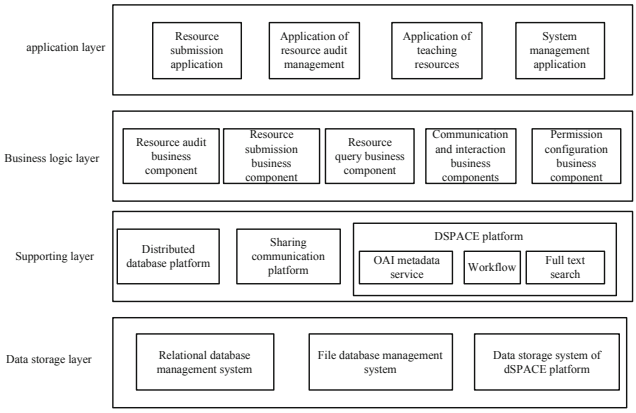

Fig. 8. System function structure framework optimization

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:

$$\eta_1 = A_0 \log\left(1 + \frac{q(n)|P(B, \beta, \chi)|^2}{e n_0 A_0}\right) \tag{1}$$

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):

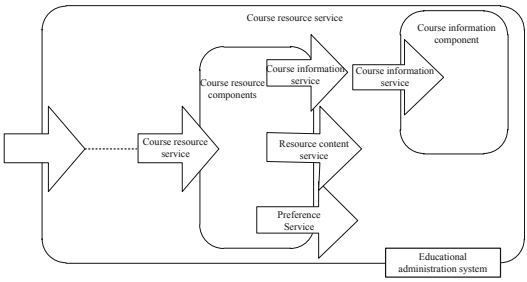

Fig. 9. Course resource browsing service module

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.

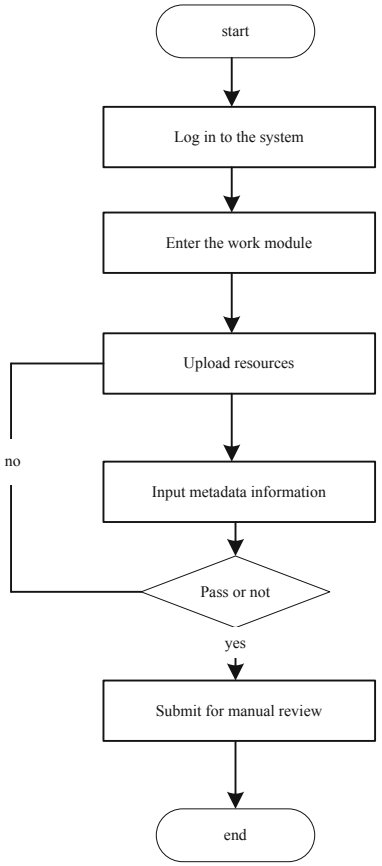

Fig. 10. System operation process optimization

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.

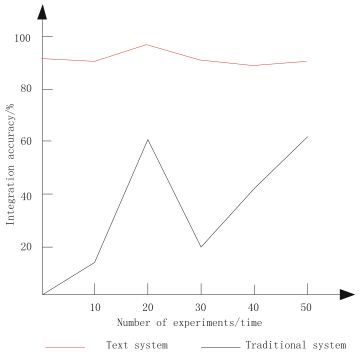

Fig. 11. Comparison of positioning accuracy of intrusion data in ship sensor network

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)