

Construction and application of multi-dimensional management framework system of libraries in colleges and universities¹

MEILING XIE², YUANLI WANG², QIAN ZHAO², YAN ZHANG²

Abstract. Colleges and universities must face the work of book management, and the existing methods can't meet the demand. In particular, students can't find library information online. Based on this, in this paper, the management system of multi-dimensional framework of university library was constructed. In the study, the principles and roles of the multi-dimensional management framework were analyzed; the J2EE+SQL Server technology combination was utilized to implement the library management system; the SSH framework was introduced. Library management system consists of system management, library management, reader management, book lending management, and loan notification functions. The final system test results show that the system constructed in this paper can effectively improve the work efficiency of the staff in practical applications, so it has remarkable effects.

Key words. Library, SSH framework, system construction.

1. Introduction

2. Modeling of underwater robot kinematics

The subject comes from an institution of higher learning. After decades of development, the school library now has tens of thousands of books. However, due to too many varieties, the collection of each book is very limited, and the quantity is kept about 5 and 6, and therefore, it is necessary to improve the borrowing speed of books. If each book is kept by a user for too long, it will make it impossible for other users to borrow it for a long time. The above model is a common defect in

¹This work was support by the science and technology project of Baoding (No. 14ZR081)

²Agricultural University of Hebei, Baoding, Hebei, 071000, China

the existing library system. For this reason, the system needs to introduce loan notification function to remind users to return books in time. In addition, the existing system does not support the online lending function, which remains to be addressed in the new system. The new library management system can effectively improve the work efficiency and the running efficiency of books. In a word, the existing book management model has many shortcomings, such as lower security, efficiency and poor ease of use, so it is unable to meet the management needs of library staffs. Therefore, the introduction of new means of library management has become an inevitable trend of development.

2.1. State of the art

It was not until the end of last century that libraries in China began to change to modernization. At first, many large libraries introduced information technology to replace the traditional model. Early library management systems used the C/S model mostly. The function of the system is to manage the book information, so the user can't find relevant information, and they can only go to the library to deal with related information [1]. In the countries where computer technology is widely used, most of the computer technology is used in the economic business, and a small part of it is applied in the business of science and technology [2]. Some foreign countries tried to introduce information technology as early as 1954. After half a century of development, the library has now formed a complete management system, and our country is trying to narrow the gap with foreign countries. Therefore, domestic related personnel need to make efforts to improve and popularize library informatization in China. Compared with foreign countries, there is still a big gap in the field of information technology research in China [3]. In 1998, when visiting the Beijing library, Premier Li Lanqing said, "in the future, information technology will become an important part of the library". Various resources in the library will be digitized to realize online inquiry and management. Therefore, digitalization is the future trend of library development [4]. In the digital library, various business involved in the books management must be realized, including borrowing, returning and so on, so as to improve the efficiency of the business [5]. At present, many large universities in China have already realized the informatization construction of library management. In China, the more famous Tsinghua University, Peking University and Zhejiang University have already realized the online processing of library management services. However, in many basic colleges and universities, the construction process of information technology is relatively slow, and there are even phenomena of using manual mode to deal with book business [6].

3. Methodology

The main task of the library management system designed in this paper is to manage all aspects of library information, including library management. Management of the above information must be conducted online. The physical structure of the library management system is shown in Fig. 1.

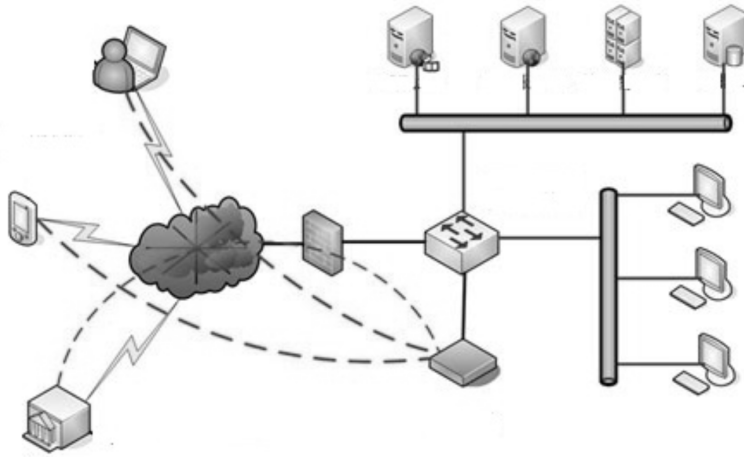


Fig. 1. Physical structure of the library management system

In order to make the final library management system meet the application requirements of the library, the system should follow some principles in the design process, including the following aspects:

The practical principle: whether the system is matched with the library management business is the first thing to be considered, otherwise, the system does not have practicability and will not be applied [7].

Usability principle: practicability is the first rule of library management system. On the practical basis, the ease of use should be taken into account. If the operation complexity of the library management system is too high, then it will affect the work efficiency, which is not advisable. At the same time, the system with higher availability can reduce training costs, and users can master the use of library management system in the shortest possible time [8]. Ease of use can be considered in terms of operating hints and operating documents.

Advanced and mature principles: when building a library management system, advanced technology architecture should be used, so as to ensure that the system can meet the demand for a period of time. Otherwise, it should be rebuilt, which will increase the cost of library management information costs, so it is not desirable.

The principles of stability: staff, students, teachers and administrators and so on often need to access the library management system to deal with library management business. Therefore, if the system is not stable enough and often inaccessible, then the business will be interrupted and the library staff's work efficiency will be affected, which is contrary to the purpose of promoting the information construction of library management [9].

The working principles of the library management system are shown in Fig. 2.

From the above picture, the library management system consists of three layers, and each layer undertakes different tasks, as follows.

Interface layer: the interface layer is the window of the library management

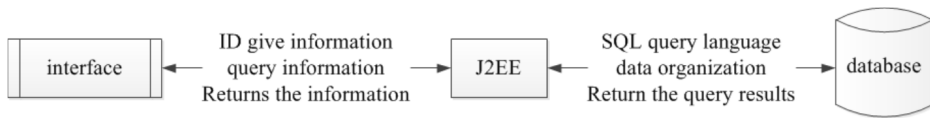


Fig. 2. Architecture diagram

system, and all the business requests need to accept the request through the interface layer, and feedback the result of the request processing to the user. In order to build the system interface independently, the Struts framework is introduced in the system [10].

Business layer: the business layer is the core of the library management system, and all the business logic is responsible for it. At the same time, it is also responsible for interaction with the database.

Data layer: the data layer stores the library data and borrowing data in the books management system. In addition, it also provides JDBC technology for data interaction.

Library management system needs to include the following basic functions:

Library management module: library information in libraries is dynamic, and it will often buy books. To this end, it needs to provide such functions as adding, deleting, modifying, importing and exporting books information [11].

Reader management module: the reader management module is mainly used to manage the readers' related information, including the management of readers' types, the management of readers' information and the management of readers' rules.

Book lending management module: the book lending management module mainly manages the borrowing and returning of books, including books borrowing, returning, and overdue charging and other modules [12].

Loan notification module: the loan notification module is mainly used to remind users to return books in time, including SMS notification function and mail notification function.

System management module: this module maintains system security mainly from the point of view of code. It consists of login, logout, user management, data backup, data recovery and other functions [13].

The functional architecture diagram of the system is shown in Table 1.

Table 1. System function framework

Library management module	Add, delete, modify, import, export
System management module	Login, logout, user management, data backup, data recovery
Book lending module	Borrow management, return management, overdue return alarm
Notification module	SMS notification
Reader management module	Reader information management, reader type management and reader rule management

System management is the first barrier for the security of library management system, and it mainly guarantees the stable operation of the system from the code level. Data backup and data recovery function can improve the security of the system data; login function can ensure the legitimacy of system operation; construction authority distribution system for the library management system can clear the user management function; the write off function prevents login information stored in the browser from being stolen [14].

The library management module can be adapted to the dynamic changes of library books, and it includes the addition, deletion, modification, import and export of library information. The book adding function can add books information to the system one by one. This function is inefficient when there are books in bulk entry. Therefore, the introduction of books import function can realize the batch increase of books information. When there is an error in the library information, it can be deleted or modified from the system database. Library staff can export books and information from the system to the local for inspection.

Readers are an important part of the library management system, and they main use library lending function that is composed of reader type management, reader information management, reader rule management. The reader type management is mainly used for adding, deleting and modifying the types of readers, such as teachers users and students users; the reader information management is mainly used to add, delete, modify and query the relevant information of readers; readers rule management is mainly used for the management of various penalty rules. As can be seen, each function is used to add, delete, and modify information [15].

The book lending management module mainly manages the borrowing and returning of books, including books borrowing, returning, and overdue charging and other functions. Book borrowing mainly includes two parts, such as loan application, loan application processing and so on, so as to support the user's online loan application processing. When returning, the time of borrowing books will be cleared. The overdue fee is used to record the fine after the violation of the reader, so as to carry on the statistical analysis.

The loan notification module is mainly used to remind users to return books in time, including SMS notification function and mail notification function.

4. Result analysis and discussion

The test is the last link to deploy the library management system to the library, so this link plays an important role in the whole library management system construction process. Without strict system testing, if the system is deployed to the library for practical application, it may have a serious impact on the work of the entire library. If functions are not implemented or performance is not up to date, a large amount of cost will be spent on maintenance after the system is deployed. Most importantly, it does not meet the business processing requirements of library management. As a result, rigorous testing is required in two areas: performance testing and functional testing.

First of all, with the login function of the system and the reader type add function

as an example, the library management system is tested by the use case to determine whether the system function meets the functional requirements.

Table 2, for example, is a test case for the login function test.

Table 2. Test case for login function test

Input equivalence class	Test case specification	Test data	Expected result	Reasons for selection
Username and password	User name is empty	null, user	The user name cannot be empty	The username is null and does not meet the validation requirements
	The password is empty	user, null	The password is not empty	The password is null and does not meet the requirements of the verification
	Enter the correct user name, the wrong password	user, 1234567	The login failed. Check that your user name or password is correct	User name and password must match
	Enter the correct password, the wrong user name	1234567, user	The login failed. Check that your user name or password is correct	User name and password must match
	Enter the correct user name and password	user, user	The login failed. Check that your user name or password is correct	Both can login and need to assign permissions based on the user type

Login function is the first barrier of library management system. Any user who wants to operate the relevant function must be authenticated by the login function. At the same time, the user type corresponding to the user will be found and assigned permissions based on the type. In this way, the clear permission distribution system of the library management system can be guaranteed. The login function of the system requires the user to enter the user name and password.

Table 3 is the test case for added functions of reader type.

In the process of adding a reader type, the type of information to be submitted includes the name of the reader type and the description of the reader type, and so on. If the reader type information can be successfully added to the library management system, the following conditions must be satisfied. Firstly, the type name cannot be repeated; secondly, the type name cannot be null.

Table 3. Test case for added functions of reader type

Input equivalence class	Test case specification	Test data	Expected result	Reasons for selection
The name of the reader type and the description of the reader type	Reader type names are empty; others satisfy system formatting requirements	null, ss	Prompts "add failed" and red flag for the file reader type name	The reader type name is required, not null
	The reader type repeats the name; others satisfy the system formatting requirements	test, test	Prompts "add failed" and prompts the reader for type names not to be repeated	The reader type name cannot be repeated
	The reader type name is correct; the type description is null	test1, null	Prompts readers to add success type	The reader type description can be null
	The reader type name is correct; the type description is not null	test1, test	Prompts readers to add success type	There is no formatting requirement for reader type descriptions

Table 4 is the test case for SMS notification function.

The lending notification function mainly uses the short note and the mail way to notify the borrowing book person to return the book in time. Key testing items include SMS server configuration, SMS content, and so on. The points for testing include server configuration, receive numbers, and SMS content. The receive number should be numeric and the content cannot be null.

Performance testing is a very important part of the testing process. If the system performance is not up to the set target, the library management system cannot be deployed to the library network environment. Otherwise, it will bring losses to the library. When testing, the basic indexes such as response time, concurrent user number and memory share should be paid more attention to. If the actual test results meet the set goals, then the system meets the standards.

In testing, it is impossible to organize 100 people to run concurrent tests on the library management system. Thus, the professional test tool Loadrunner was introduced to simulate users and perform concurrent operations. During the test, 10 people were logged in every 2 seconds. In this process, attention should be paid to the response time and memory footprint of the login function. When the number of concurrent users reached 100, each index of the library management system was viewed and recorded. Specific test indicators were shown in Table 5.

Table 4. Test case for SMS notification function

Input equivalence class	Test case specification	Test data	Expected result	Reasons for selection
The configuration of the SMS server and the number of the receiver and the content of the SMS	The SMS server is not configured; others meet the system formatting requirements	False 13366666666 return books	Send "failed"	SMS server must be configured
	The SMS server is configured. The phone number is incorrect	True 1336A666666 return books	Send "failed"	The phone number must be correct
	The content is empty; the other items are correct	True 13368666666 Null	Send "failed"	Send content cannot be empty
	All items meet the format requirements	True 13366666666 return books	Send "successful"	Send successfully

Table 5. Results of system performance test

Concurrent users	Response time (seconds)	Application server ICPU utilization (%)
10	0.23	1
20	0.25	1
30	0.32	1
40	0.45	3
50	0.55	7
60	0.60	10
70	1	15
80	1.5	18
90	2	20
100	3	25

According to the test results in Table 3, the response speed of the system did not increase with the number of concurrent users and there was no occurrence of a significant change. When the number of concurrent users reached the system specifications, the response rate was still less than 5 seconds, but the performance remained normal. From this, it can be known that the existing performance of the

library management system can meet the requirements of the library and can be deployed into the actual environment of the library.

5. Conclusion

The rapid development of information technology has promoted the application of information technology. All fields are promoting informatization construction, so as to improve work efficiency and competitiveness. In order to solve the shortcomings of the existing library management system, the university library management system based on multi-dimensional management framework was studied in this paper. Based on the analysis of the multidimensional management framework, the SSH framework was introduced. According to different functional requirements, the library management systems were classified, implemented and tested. Through this study, the following conclusions were obtained: on the basis of in-depth investigation of the requirements of various types of users of the system, functional requirements of library management system were identified, consisting of five parts, such as system management, library management, reader management, book borrowing management and loan notification. On the basis of the determination of functional requirements, the performance requirements of the system remained to be determined; and in the design phase, the following tasks: data access model design, security design and technical framework design should be focused on. The most important point is to determine the implementation details of each module function in sequence diagrams. Of course, there are still some shortcomings in this paper, thus needing further improvements in future studies. For example, with the updating of library facilities and equipment, in the future, books will be pasted with radio frequency cards to gradually help the realization of self-borrowing and self-returning functions of books.

References

- [1] S. G. ZHANG, H. H. AN, Y. W. ZHANG: *Improving and perfecting project contract management by synergy management mechanism*. Applied Mechanics and Materials 315–317 (2014), 3732–3735.
- [2] X. ZHAO, J. XIE, W. J. ZHANG: *The impact of information sharing and ordering coordination on supply chain performance*. Supply Chain Management: An International Journal 7 (2002), No. 1, 24–40.
- [3] J. LI, F. JIN: *Two-retailer competitive simulation model in supply chain*. International Journal of Advancements in Computing Technology 4 (2012), No. 19, 635–643.
- [4] Q. HE, L. LUO, Y. LI, Y. LU, J. WANG: *Developing a measurement model for degree of management synergy of mega-projects*. Advances in Information Sciences & Service Sciences 5 (2013), No. 9, 651–659.
- [5] S. CHATTERJEE: *Types of synergy and economic value: The impact of acquisitions on merging and rival firms*. Strategic Management Journal 7 (1986), No. 2, 119–139.
- [6] T. MO, Z. WANG, X. XU, X. WANG: *A virtualization-based service system development method*. Journal of Service Science and Management 2 (2009), No. 1, 1–9.
- [7] E. DHEUR, J. FERGUSON, R. MARTENS, A. PETRILLI, B. SMALE: *Modernizing cor-*

- porate MIS: from information system modelling to implementation*. Proc. European ORACLE Users Group Conference, 22–27 March 1992, Cannes, France, CERN Accelerating science (1992).
- [8] J. STANSFIELD: *Prevalence of stuttering and cluttering in adults with mental handicaps*. Journal of Intellectual Disability Research *34* (1990), No. 4, 287–307.
 - [9] Y. VAN ZAALEN-OP’T HOF, F. WIJNEND, P. H. DE JONCKERE: *Differential diagnostic characteristics between cluttering and stuttering—part one*. Journal of Fluency Disorders *34* (2009), No. 3, 137–154.
 - [10] A. RAUBER, D. MERKL, M. DITTENBACH: *The growing hierarchical self-organizing map: exploratory analysis of high-dimensional data*. IEEE Transactions on Neural Networks *13*, (2002), No. 6, 1331–1341.
 - [11] Y. LI, K. C. NG, D. J. MURRAY-SMITH, G. GRAY, K. C. SHARMAN: *Genetic algorithm automated approach to the design of sliding mode control systems*. International Journal of Control *63* (1996), No. 4, 721–739.
 - [12] J. L. QIU, L. ZHOU: *Through the prism of the internet cafemanaging access in an ecology of games*. China Information *19* (2005), No. 2, 261–297.
 - [13] H. Y. ZHANG, S. P. LI, M. J. SUN: *Dissipative structure theory and the management system of University Library electronic reading room*. Microcomputer Information *26* (20101), No. 9, 49–51.
 - [14] D. S. SANDERS, S. READ-BROWN, D. C. TU, W. E. LAMBERT, D. CHOI, B. M. ALMARIO, T. R. YACKEL, A. S. BROWN, M. F. CHIANG: *Impact of an electronic health record operating room management system in ophthalmology on documentation time, surgical volume, and staffing*. JAMA Ophthalmol *132* (2014), No. 5, 586–592.
 - [15] S. READ-BROWN, D. S. SANDERS, A. S. BROWN, T. R. YACKEL, D. CHOI, D. C. TU, M. F. CHIANG: *Time-motion analysis of clinical nursing documentation during implementation of an electronic operating room management system for ophthalmic surgery*. Proc. American Medical Informatics Association (AMIA), Annual Symposium, 16–20 November 2013, Washington DC, AMIA Proceedings (2013), 1195–1204.

Received July 12, 2017