Research Article

The Database Construction of Intangible Cultural Heritage Based on Artificial Intelligence

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At present, the protection of material cultural heritage is spread all over the world, but the protection of intangible cultural heritage is relatively backward. With the development of information technology, database technology provides a new retrieval method. Therefore, based on database technology, this paper constructs the database system of intangible cultural heritage, where MySQL is used as the system database, Struts 2 framework is selected in MVC to realize the separation of business logic and data display, and retrieval and query are realized through Lucene. In addition, the system takes Mongolian stringed instruments as the carrier, constructs the metadata framework, and forms the database structure. Moreover, the system is divided into six functional modules and the front and back functions of the system are managed. Finally, the system function test and performance test are carried out. The test results show that the system has good functionality, which is helpful to realize the effective protection of intangible cultural heritage.

1. Introduction

Excellent national culture is the most profound soft power. Since China carried out the reform and open policy, especially since the 16th National Congress, the party and the state have paid more and more attention to inheriting and carrying forward the national cultural tradition and protecting the national cultural heritage [1, 2]. According to the convention for the protection of intangible cultural heritage of UNESCO (United Nations Educational, Scientific and Cultural Organization), the definition of intangible cultural heritage is given from the international perspective, which must be reconsidered in combination with the historical and cultural background of China. Yuan Li, the author of "Intangible Cultural Heritage," believes that human beings were created in history and inherited in a living form, which has important value in traditional cultural matters such as literature and art, technology, and rituals. The database of intangible cultural heritage refers to the resource database which has the functions of standardized description, structured storage, diversified retrieval and query, Web-based access, and sharing. It is directly used for the preservation and management of intangible cultural heritage and directly assists the inheritance and protection of projects about intangible cultural heritage.

At the same time, the management of cultural resources in China is not perfect and there is still a lack of in-depth research on information standards, digital protection of copyright, integration, and sharing of resource [3–5]. With the development of information society, although a large number of national cultural researchers have devoted themselves to the digital research of intangible culture, there is not a complete and standardized platform for collecting, storing, protecting, managing, and sharing traditional
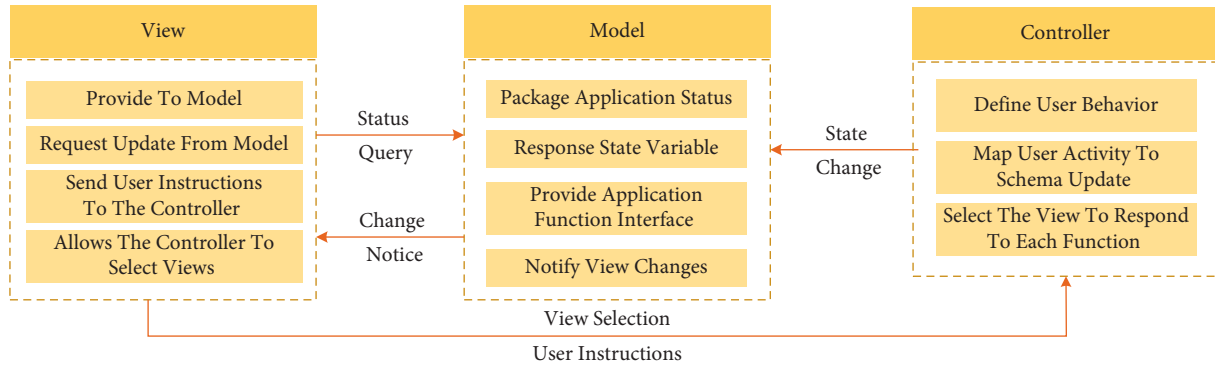
FIGURE 1: MVC framework structure.

intangible cultural resources in China. More importantly, the existing database systems about cultural communication at home and abroad have poor scalability and low reusability, so it is impossible to establish a universal and customizable database for cultural resources [6]. We need to establish a database system of intangible cultural heritage with high expansibility in combination with the corresponding standards, so as to provide a solid foundation for the rescue, inheritance, and standardized management of cultural resources. Therefore, this paper has taken the spread of Mongolian string instruments as the carrier, where the database system of China's intangible cultural heritage protection is constructed by using database technology.

2. Analysis of Key Technologies of Database System

The development of thematic database system is to reorganize special data to form a new database. First of all, complex information needs to be screened to ensure the gold content of literature information. The process of selecting, sorting, and organizing documents is a process of knowledge management, which is related to the quality of the whole database. It needs to be completed by professionals. The screened data are divided into different subdatabases according to their knowledge system and finally form a thematic database [7, 8].

2.1. Selection of MVC Framework. MVC is a program development and design mode, which realizes the separation of business logic and data display [9], improves the maintainability, portability, extensibility, and reusability of the program, and reduces the difficulty of program development. The MVC framework includes three cores: model, view, and controller, and its structure is shown in Figure 1.

Model is the main part of MVC application, which mainly includes business logic module (Action class in Web project) and data module (POJO class). The model has high reusability and can provide data for different views, so it can greatly reduce the code repetition rate [10]. View is the interface for users to interact with it, which is generally composed of JSP and HTML, while the controller itself does not make any processing, which only receives the user's

input request, and calls the model and view to complete their requirements.

The commonly used MVC frameworks are Struts and Webwork, and their comparison is shown in Figure 2.

Struts 2 framework combines the advantages of the above two frameworks, so this system adopts Struts 2 framework as the technical scheme to realize the separation of business logic and data display. The structure of Struts 2 controller is shown in Figure 3, which consists of three parts: scheduler, interceptor, and business controller. The configuration file manages and maintains the relationship between them, and the Struts 2 controller works as follows:

(1) After the scheduler obtains the page http request, it selects the corresponding interceptor group to preprocess it and then calls the corresponding service controller

(2) The service controller calls the service logic layer interface to process the request

(3) Return the result to the interceptor group, and then return it to the page for rendering after processing it

Struts 2, as the controller component of the system, reduces the coupling between front-end page presentation, front-end data interaction, and page jumping and greatly improves the scalability and maintainability of the system.

2.2. Database Selection. For the protection of intangible cultural heritage, this system must use databases to manage cultural heritage data. At present, the mainstream databases commonly used are MySQL and Oracle [11], and the comparison between them is shown in Figure 4.

As string instruments are an important part of intangible cultural heritage, intangible culture with distinct personality determines the regionality of data resources. At the same time, the shape, color, structure, production technology, traceability, and legend of each kind of Mongolian stringed instruments are different, and the resulting data also contain rich contents. In addition, the data resources of Mongolian string instruments are diverse, including physical resources, historical resources, heritage and protection resources, laws and regulations resources, and inheritors' archives resources, which determines the variety of their data.

	Struts Framework	Webwork Framework
Class Structure Design	Design For Abstract Classes	For Interface Design
Test Method	Difficult To Complete Unit Test	Unit Tests Can Be Completed
Dependence	Dependent Servlet	Servlet Independent
Thread Safety	Thread Safety Required	Thread Safety Is Not Required

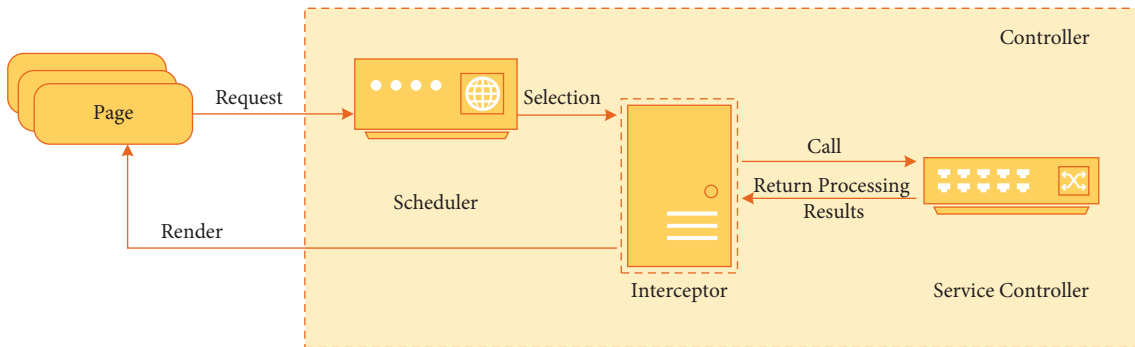FIGURE 2: Comparison of different MVC frameworks.

FIGURE 3: The structure of Struts 2 controller.

	Oracle Database	MySqL Database
Database Management	Complex And High Technical Requirements	Simple And Low Technical Requirements
Data Recovery Costs	High Cost	Low Cost
Database Connection	Slow Speed	Faster Speed
Requirements For Hardware	High Requirements	Low Requirements
Security	Higher	Lower

FIGURE 4: Comparison of different database technologies.

Therefore, through the above comparative analysis, MySQL database is simpler and more convenient in management and data recovery, whose database connection speed is faster. In addition, it takes up less resources and requires less hardware [12]. Therefore, according to the requirements of database management in this system, this paper uses MySQL as the system database.

2.3. *Lucene System.* Lucene is a full-text search engine toolkit, which provides the functions of data index and full-text search. It consists of three parts: infrastructure package module, external interface module, and index core module. The index core module directly operates index files, which is the focus of the whole system. Lucene index contains a number of files, which are stored in groups according to their respective segment. The same group index files have the same file name, but different extensions [13]. There is a correspondence between index files and information files, which means that the information files are arranged according to the order of index files.

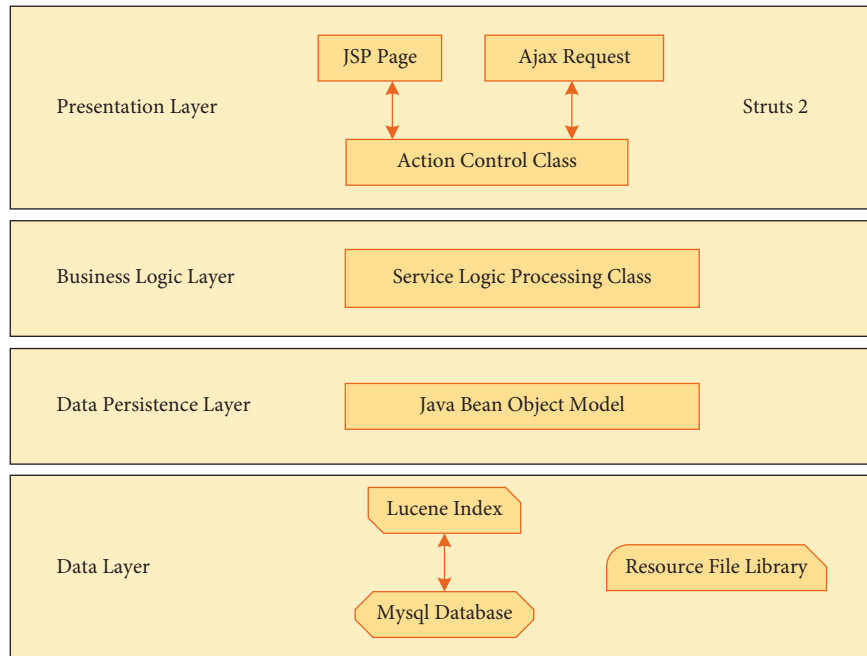The entire search process of Lucene is as follows:

FIGURE 5: Overall structure of intangible cultural heritage database.

(1) Build a text database, save all the information that users may retrieve, and then determine the index text model.

(2) Establish the index according to the database text. In this process, it is necessary to correctly select the index mode according to the scale of the retrieval system.

(3) Make the search that the user first submits a search request; the system analyzes the request and then carries out corresponding processing through text operation.

(4) Filter and sort the search results according to certain rules, and finally return them to users.

3. Design of Intangible Cultural Heritage Resources Database

3.1. Design of Overall Framework. In order to make the system have good expansibility and maintainability, this system adopts hierarchical design idea and divides the system implementation into the following four levels: presentation level, business logic level, data persistence level, and data level. This system uses Java language and Tomcat as the server, and the hierarchical framework of the system is shown in Figure 5.

Presentation layer: it is responsible for receiving the user's request data and submitting it to the business logic layer for processing. At the same time, the response data processed by the business logic layer are displayed to the interface to present dynamic Web content for users. In addition, it provides a controller to call business logic and a model for display. On the one hand, using the rich tag library of Struts 2 framework can make it more convenient for the

presentation layer to accept page requests. On the other hand, the powerful page jump control function of Struts 2 framework is used to manage all page jump control in the configuration file, which makes the code more concise and the management more convenient.

Business logic layer: in the middle of the presentation layer and the data persistence layer, it is responsible for receiving the request data submitted by the presentation layer in the system and calling the corresponding business logic for processing. After obtaining the data through the data persistence layer for processing, the results are returned to the presentation layer.

Data persistence layer: it is located in the middle of business logic layer and data layer, which is responsible for processing operations such as reading and writing data that business logic layer needs to access, and separates business logic layer from other operations. In the data persistence layer, JavaBeans are used to encapsulate the data, which makes the operation data as simple as the operation object, enhances the reusability of the code, and makes the code easy to write, maintain, and use.

Data layer: the data layer is located at the bottom of the hierarchical framework of the system, which is responsible for the data processing in the system, including database operation and the establishment of Lucene index. Through Lucene technology, the index of relevant data in the database is established, so that the business logic layer can directly obtain the required data from Lucene index, which greatly improves the efficiency of database query. At the same time, the response speed of the system is improved.

3.2. Database Metadata Framework. Metadata refers to the data of data. It is a structured description of resource
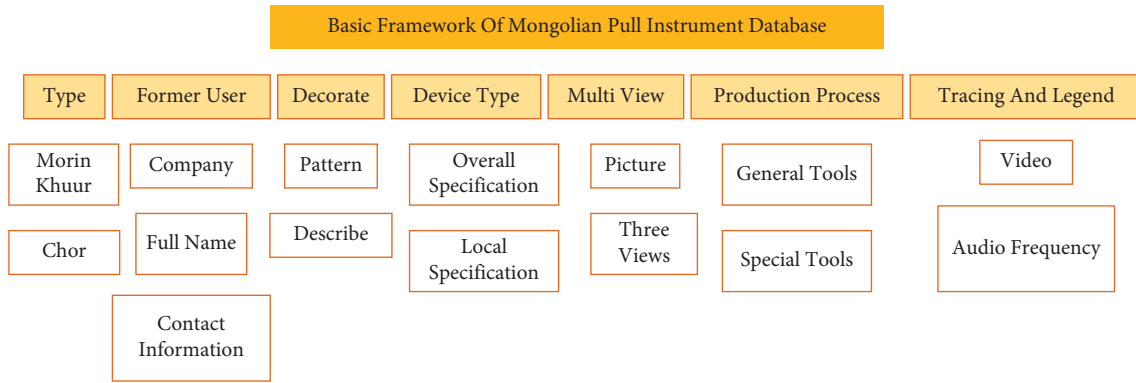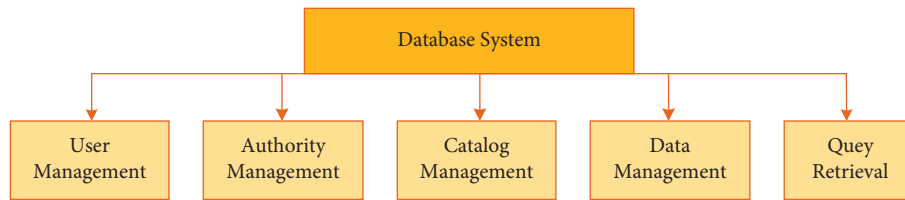
FIGURE 6: Division of data structure.

FIGURE 7: Function of resource database system.

information, which provides standard description and retrieval tools for various forms of data-based information units and resource integration. It is the basis of constructing database, digital museum, and multimedia library. Metadata has specific definitions and applications in various fields.

The metadata of Mongolian stringed instruments means the data that describe the attributes of Mongolian stringed instruments. By describing the resource data and resource attributes, the organization and discovery of information resources can be promoted, while the text, image, voice, and other information can be sorted out at the same time. The various attributes of metadata resources of Mongolian stringed instruments are described, and it is necessary to manage the classification, naming, and value range of its attributes by depending on its classification system, category, and essence, that is, what kind of category it belongs to, what naming requirements it has, and what range of range it is, etc.

Establishing a database is to create a warehouse for organizing, storing, and managing data. The attribute description of the metadata of the database about stringed musical instruments is to informationize the relevant data of the Mongolian stringed instruments and manage the tasks of data collection, coding, transmission, storage, retrieval, display, statistical analysis, etc., which provides a theoretical basis for the subsequent database construction service.

The metadata elements of Mongolian stringed instruments are described, and then they are combined into different categories to establish the basic framework of database structure. The metadata framework of Mongolian stringed instruments is composed of 16 different element categories, and each element contains subelements, which can be further split and nested, as shown in Figure 6.

3.3. Function Module Design. The database system of stringed instruments is mainly composed of the following functions that are shown in Figure 7.

3.3.1. User Management Function. After all types of users enter the system, they can view, modify, and add personal information in the user management module. Through this module, users can set system permissions. Each user can add and modify personal information and personal login password, query personal work log, browse, download, and upload historical information. Senior administrators can view the work content of research directors and researchers, query user information, leave messages, and limit users' rights. They can also manage the personnel of the database to avoid data confusion and improve the accuracy.

3.3.2. Authority Management Function. It mainly refers to the function of setting permissions for users who enter the database system of stringed instruments. Users who enter the repository system must have certain permissions that have different operation functions according to different levels. In order to ensure the security and order of the system, it is necessary to divide the permissions for the users who enter the system. As shown in Figure 8, the system user rights are divided into senior administrator, research director, researcher, and visitor.

Senior administrators: they are the owner with the highest authority and can be assigned to other users, to improve the system settings, management directory and resource integration, and other functions.

Research director: their authority is assigned by the senior administrator to enable users to view data and browse
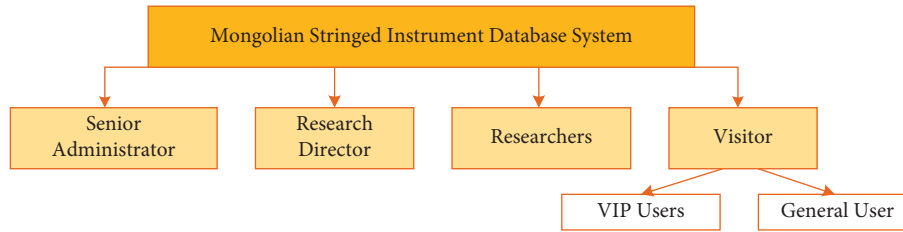
FIGURE 8: Authority management function.

the status of data input, statistical analysis, and log management.

Researcher: the authority is assigned by the senior administrator, who can complete the input, upload, download, and modification of resource data, as well as query the historical input data. In addition, they can view the status of its entry and approval.

Visitor: visitors are external users that are not allowed to enter the background system, but can view the results of the system at any time, and they are divided into VIP users and ordinary users. They can view the published pictures, text, video, 2D resources, and 3D resources at any time, while VIP users can download some resources through payment points and ordinary users have no right to download.

Senior administrators can modify, delete, and assign permissions to users of various roles in the system. The superadministrator's actions are automatically combined with the log module, and all operations are automatically entered into the log database.

The string instrument database system needs to store and manage all the input information. These resources need to be classified and stored in an organized way. The specific classification can be set by the superadministrator. The directory management module is a module subsystem that provides directory planning and directory creation and maintenance for superadministrators.

3.3.3. Catalog Management Function.
The directory structure adopts the tree directory to realize the management of the tree directory. There is no restriction on the directory hierarchy that is allowed to create the top-level directory and the lower directory at any level. The module is provided for the superadministrator of the system to create top-level directory and subdirectory, modify directory name and directory merge, and delete empty directory, as well as set directory view permission, where tree display of all directories supports expansion and collapse.

At the same time, the system provides the authority assignment for all top-level directories, that is, it can be assigned to some users in the role of scientific research director, so that only the research director who owns the top-level directory and his subordinate researchers can carry out various operations in this directory. The directory in the system is to better store the included data resources, and each directory sets the serial number, creation date, storage type, and other fields. Finally, the system can generate the data report based on the directory according to the date in the directory.

3.3.4. Data Management Function.
Data management function mainly refers to the storage of the original data in the system. The original data in the database of stringed instrument include text, picture, audio, video, two-dimensional image, original scanning information of three-dimensional model, registration information, number information, and feature information.

All kinds of information in the database are formed into original pictures, videos, two-dimensional graphics, and three-dimensional models through graphic processing software, video editing software, and data modeling software, which are stored in the database system through the original data module. After inputting various additional information of the data, the system can automatically number each original data according to the predefined numbering rule. The number is unique and cannot be changed which is used to index and locate the original data in the database. All the information is input into the corresponding directory system (systematic directory generated by the directory management module) according to the method of symbol classification, which allows researchers to view or modify the symbol information. However, if necessary, the deletion of information must be approved by the research director.

The data management function stores all original text, pictures, videos, audio, and 2D data and 3D data information. The system provides the view and full-text search of them and supports a variety of formats to download. In the dynamic thumbnail window, users can view the video, audio, and 3D data.

3.3.5. Query and Retrieval Function.
Query and retrieval function are the most important function of the system which can perform a variety of query and retrieval on all the data stored in the numbered warehouse. The methods include the following: first, users can select retrieval by module of isomorphic tree directory management and obtain the query results that meet the user's needs through one or more conditions. Meanwhile, they can also enter the query page by entering keywords that can be one or more words. The result of the query is multiple data containing keywords, and each condition is associated with a space.

The relevant information of the query is arranged in the form of update date and displayed as the name of the information. The small window that appears after clicking the selected information can support online preview and download of all types of files.
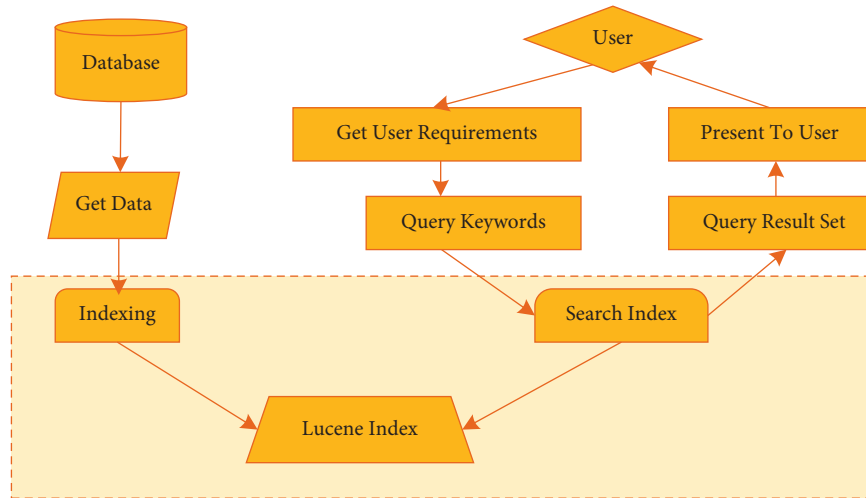
FIGURE 9: Process of data retrieval.

4. Realization of Database System

User is the core of module design. The premise is to provide an interface for users to operate, rather than to provide an interface for operating users. Module is the basic medium of interaction between system and user. It not only provides users with excellent visual experience but also provides a simple and standard interaction process, which can also guide users to gradually form good operating habits, thus greatly improve efficiency.

4.1. Foreground Systematic Management Module. The foreground system of string instrument database is a network platform for users to visit, which can browse the contents published publicly, such as Mongolian string instrument information, inheritors, and intangible cultural heritage. The auxiliary functions of the system, such as the homepage interface, the data browsing interface, and the information searching interface, are designed according to the characteristics of Mongolian stringed instruments, where the positioning of the whole front desk system is clear, and the function is comprehensive, so that users can better experience the charm of Mongolian string instrument.

4.1.1. Home Page of System. In order to meet the different needs of users, according to the different visual areas of different devices, the front-end web pages adapted to various situations are quickly developed, and the goal of displaying different interface layouts for different devices is achieved, which creates a better learning and communication platform for users.

4.1.2. Data Browsing. The data browsing interface satisfies the user's classification browsing of data. The user selects any classification item to enter the relevant classification interface, and the data information displayed in the interface, such as inheritor information and data resources, is displayed in the form of a table, which is convenient for the user to click and view. For example, when browsing the data

window of Mongolian stringed instruments, users can click the switch button and realize the browsing of all Mongolian stringed instrument information in the database.

4.1.3. Data Retrieval. The global search module includes two core functions: establishing function of Lucene index and global search. Among them, the establishment of Lucene index is the core foundation of global search. When users search resource data globally, they are actually searching for the established Lucene index, which makes global search not only realize the powerful fuzzy search function but also greatly improve the indexing speed. Global search is the core function of this system, which enables users to get all similar matching results conveniently and quickly. As shown in Figure 9, the global search process is divided into the following two parts.

When users know the key words or some important information of the queried data, they can retrieve the required related data through accurate query. Users only need to directly input keywords to search, and the system will automatically find the data information that meets the search conditions. If users want to inquire about the information of the inheritors of Morin Khuur in Hohhot, select "Hohhot" in the drop-down list of "Location" in the window, then select "art inheritor," and click "Query." Then, the search results are all art inheritors in Hohhot.

4.2. Background Systematic Management Module. Background system is the foundation of information management, which provides guarantee for the release, update, and deletion of daily files and facilitates statistics and management. It is a rapid operation and management system for databases and files, which can update and adjust front-end content more conveniently and quickly, whose interface design mainly includes user login interface and data management interface.

4.2.1. User Login. In the database system of Mongolian stringed instruments, managers are the publishers and

TABLE 1: Results of systematic functional test.

Test item	Test method	Result	Description
	Style judgment	Good	The style and color tone of interface are unified
Interface test	Compatibility	Common	The compatibility effect of IE6/IE7 browser is not as good as IE8 and above, the layout effect of input box in the page is not good enough, and the layout is disordered in the case of incompatibility
	User experience	Good	The layout is reasonable, the page results are divided according to functions, and the positions of operation buttons are uniform
Link test Form test	Run test cases manually	Pass	Bugs are managed through Redmine, and all found bugs have been fixed and the test cases have passed

TABLE 2: Parameters of performance test.

	Number of threads	100
Concurrent parameter configuration	Thread startup completion time	0
	Number of request sending cycles (times)	5
	Server	Localhost
Request parameter configuration	Port number	8080
	Path	/Fund/admin/project!list.action
	Request mode	GET

updaters of data resources and the guardians of the stability, security, integrity, and high performance of the database management system. After the manager logs in to the database background system, they can enter the user name and password in the user login interface and then can enter the management interface to modify, delete, update, and publish the metadata of Mongolian stringed instruments in the database.

4.2.2. Data Management. Data management is the core content of database background system, which directly affects the presentation of Mongolian stringed instrument data. The metadata entry interface is a general framework based on the data collection table of Mongolian stringed instruments, where some of them are designed as a selective drop-down menu, which can be added, deleted, or sorted by administrators, while some conceptual and descriptive data need to be entered manually.

5. Systematic Test

5.1. Test Environment and Tools

(1) Test tool: LoadRunner 11.0.

(2) Hardware test environment:

Server model: IBM System X3850.
Client model: Lenovo ThinkPad X1 Carbon.

(3) Software testing environment:

Operating system: Windows Server 2008; Client: Windows 7 Professional.
Database: MySQL 5.5.
Browser: Internet Explorer 6.0 and above.
Environmental temperature and humidity: the temperature is 20°C and the relative humidity is 65%.

5.2. Functional Test of System. The functional test refers to testing various functions of the system and testing item by item to check whether the system meets the requirements of users. The functional test of this system mainly includes the following two parts:

(1) Interface test: Test whether the system interface is reasonable, beautiful, and coordinated and whether it is consistent with the design and easy to use, which mainly includes navigation test, form test, and overall interface test

(2) Link test: Test whether all links or function buttons of each page jump to the target page according to the design and whether the linked page exists to ensure that all links are valid and correct

(3) Form test: Test the input contents of the search input box for string, value, required items, and keywords to check whether the submitted form parameters are correct and whether the response to critical values is accurate

The front and back modules of the system are tested in the above way, and the results are shown in Table 1.

5.3. Performance Test. The purpose of performance testing is to count the performance parameters of the system, which mainly includes response speed, throughput, and other parameters. The system performance is judged according to the performance parameters to ensure an excellent experience. Because the portal subsystem is a system that directly contacts users, the number of users is large and the database is frequently operated in the retrieval process, so the biggest load in this system is the retrieval page. The specific parameters of performance test are configured as shown in Table 2, where JMeter is used to multithread concurrent access single-category page, test the average response time of the page, and simulate the heavy load environment to test the performance of the system in this environment.

Table 3: Test results of systematic performance.

Total samples	500
Average request response time (m/s)	182
The response time of 90% requests is less than this value (m/s)	580
The minimum response time (m/s)	43
The maximum response time (m/s)	375
Request error percentage	0%
Throughput (per second)	276.9

The test results are shown in Table 3.

As can be seen from Table 3, the system can still guarantee a short corresponding time and a high throughput under heavy load, which will not cause a large network delay. Therefore, this system has high performance, can meet the concurrent access of large amounts of data, and has a good user experience.

The test results also show that various functions and the interaction between systems are designed and developed, where the flexible combination of functions in the whole database system is realized, and the data management in the field of Mongolian stringed instruments crosses from traditional manual management to modern management. At the same time, it accelerates the accumulation of Mongolian stringed instrument resources in industrial clusters, which improves the quality of cultural exchanges and cooperation.

Through the testing of the functional modules and performance of the intangible cultural heritage database system, its function can meet the functional requirements of stable running performance and strong running environment security. The intangible cultural heritage database designed in this paper has the following capabilities: first, it can effectively realize the classified management, data query, collection, and download of data resources in the database; meanwhile, users of the background system can also add, modify, and delete data; and finally, the background management of the system runs normally.

6. Conclusion

Through the establishment of intangible cultural heritage database, the preservation, display, and education of intangible cultural heritage resources can be better realized. In this paper, Mongolian stringed instruments are taken as the carrier and the intangible cultural heritage protection system is designed, where MySQL is used as the system database and Struts 2 framework in MVC architecture is selected to realize the separation of business logic and data display. The test results show that the system can meet the requirements of stable operation, and its database has the following capabilities: first, it can effectively realize the classified management, data query, collection, and download of data resources in the database; at the same time, users of the background system can also add, modify, and delete data; and finally, the background management of the system runs normally.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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