Design and implementation of earthquake information management system

Chen Wang[a], Xin Luo[a,b※], Yuntian Teng[a,b], Xiaomei Wang[a,b], Zhongchao Qiu[a,b]
[a]Institute of Geophysics, China Earthquake Administration, Beijing 100081, China; [b]Institute of Disaster Prevention, Sanhe, 065201, China
[*] Corresponding author: luoxin_131@163.com

ABSTRACT

Aiming at the problem of seismic data sharing occlusion, a seismic information management system is designed. Using Eclipse development platform, B/S architecture based on Internet technology (Browser/Server structure), based on Java language and MySQL database, information technology, digital technology as the core, according to the work needs to set six modules, so as to achieve the purpose of data sharing. The system fully collects, excavates and integrates earthquake information resources to form a social security system, in order to grasp earthquake information more timely. By registering and logging in, users can quickly view the earthquake information and give feedback. It is also very convenient for people to gather information about earthquakes to improve their knowledge about the disaster reduction and prevention. Doing so will help them become more aware of the various steps involved in the planning and implementation of a disaster.

Keywords: Earthquake, Seismic information management system, Java, MySQL, B/S structure, Data sharing,Eclipse

1. INTRODUCTION

An abrupt natural calamity of this nature is an earthquake. Humans find it challenging to anticipate its development law. Once it happens, it will do terrible harm and have disastrous consequences. Because of earthquakes' rapid beginning and expansion, the need for quick judgments, and the difficulty in acquiring information, we must employ unconventional approaches to deal with them [1]. Earthquake information management facilitates the use of science to make decisions, addresses public and media concerns, coordinates the orderly operation of each group, and provides pertinent information assistance for post-earthquake emergency rescue [2]. With the development of science and technology, the means of earthquake disaster reporting and collection are gradually diversified and automated, and the processing of disaster data is more intelligent [3]. In the Internet era, earthquake information is instrumentalized, modular, standardized, and quasi-real-time, allowing each unit to quickly respond to earthquakes and produce data such as focal mechanism solution and seismic intensity zoning [4] An average of 47,316 earthquakes with a magnitude greater than 1.0 occurred worldwide each year, with 4,041 of those earthquakes having a magnitude greater than 4.0, according to statistical analysis of the number of earthquakes at home and abroad tracked by the China Earthquake Networks from 2009 to 2015. Because they occur so frequently, people have an increased need for earthquake information. This is especially true when they experience an earthquake and are eager to learn where the epicenter is, how far away it is, how powerful it was, and how to escape it. Without timely information, it is simple to fuel the spread of earthquake stories, which can lead to panic and civil unrest. Therefore, it is crucial to build an earthquake information management system.

This system's primary goal is to collect all types of information data in a reliable manner, and it also performs earthquake risk analysis, damage assessment, and protection countermeasures. To lessen the impact of seismic disasters, a platform for the public to share earthquake information will be developed. It will offer zero-barrier, standardized, multi-level, and multi-means information services. Users will be able to access countrywide seismic information observation data, management, retrieval, download, visualization, and other specialized services. In the daily seismic information monitoring, but also after the occurrence of an earthquake, the occurrence and development of the process of real-time tracking, quick query of earthquake magnitude, earthquake time and other information. The system can also be used for earthquake-related knowledge dissemination, presentation, and demonstration in order to improve the informatization and modernization level of earthquake-prevention and disaster reduction activities.

Third International Symposium on Computer Engineering and Intelligent Communications (ISCEIC 2022), edited by Xianye Ben, Proc. of SPIE Vol. 12462, 1246213 · doi: 10.1117/12.2660920

2. DESIGN OF EARTHQUAKE INFORMATION MANAGEMENT SYSTEM

2.1 Demand analysis

The earthquake information management system should serve as a platform for information sharing. The system provides a convenient way to query information. In addition, the data can be exported locally for post-processing. Users can query the information they care about in accordance with their demands.The technology may display three aspects of the earthquake on the map to better visually depict it. Based on factors such as the local social economy, population, engineering of lifelines, etc, the system can produce findings for earthquake damage prediction. Following an earthquake, it is essential to enable the transfer of photos, images, monitoring data, text for negotiations, information on the catastrophe situation, and other details on the earthquake site. Give assistance for post-earthquake trend and introduction of earthquake background, local seismic geology, and historical earthquake scenario. In times of peace, the system can be used to publicize earthquake knowledge.

2.2 Design ideal

The following four requirements are typically present in an ideal information management system: identified information needs, information that can be gathered and processed, and information that can be made available to managers via programs [5]. Software with a C/S(Client/Server) structure has been susceptible to flaws and errors as Internet technology has advanced [6], including low security, network congestion, complex maintenance, upgrade issues, and other issues. The B/S structure is an alteration or enhancement of the C/S structure [7,8]. The user interface is implemented using the browser in this structure, a small portion of the transaction logic is implemented in the front end, and the majority of the transaction logic is implemented in the server side, establishing the so-called three-tier three-tier structure [9]. With current technology, the B/S structure's network application is simpler to understand and less expensive than the C/S structure. The main benefit of using a B/S structure is that users don't need to install any software or undergo any training to use it anytime, anywhere, and with only a browser [10,11]. After the emergence of cross-platform languages such as Java, B/S structure management software becomes more convenient, fast and effective. Therefore, using B/S structure to design the seismic information management system is in line with the current development trend of management software design.

2.3 Functional design

The system is created utilizing the B/S framework, Java as the programming language, Eclipse as Java editing tools, and tools for editing interfaces, together with MySQL database software, in the form of web pages, to facilitate data interaction with users. Six functional modules make up the system: a login and registration page, an earthquake information management page, an earthquake information statistics page, a page for popularizing earthquake knowledge, a page for pertinent news about preventing earthquakes and other disasters, and a page for user feedback on opinions**.**

2.4 The system structure

For various users, the system has functional components. The system's performance and security needs are taken into account as well as the use of each function module. When a user signs in, it verifies their identity, offers security protection, and displays functional interfaces that are appropriate for their user roles. The system is divided into two types: administrators and regular users, depending on the actual demands of the users.To keep the system operating environment secure and to assure the accuracy of information and data, administrators carry out management tasks. This allows the system to run efficiently and without interruption. Users can access news, learn about popular science, examine information about earthquakes, and more. Users execute various duties for various jobs and have various rights. The flow chart of the seismic information management system is displayed in Figure 1 in order to more clearly convey the system's business function module.

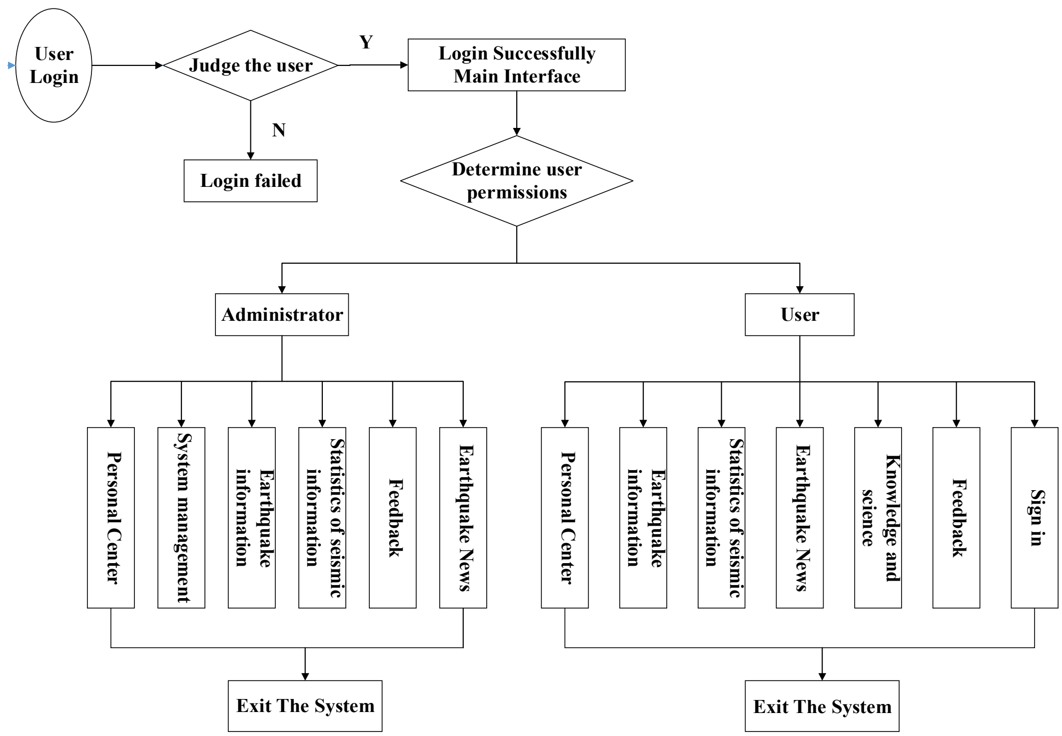

Figure 1. Flow chart of earthquake information management system.

3. DESIGN OF EARTHQUAKE INFORMATION MANAGEMENT DATABASE

3.1 Conceptual structure design

Use the E-R diagram to represent entities and entity relations in life, analyze the implementation functions of the system, and create the database and data table [12]. A bridge for communication between users and designers is the E-R diagram. The database entities employed in this system, such as administrator information entities, user information entities, earthquake information entities, knowledge science entities, and opinion feedback entities, are planned based on demand analysis and system design. Relational databases are designed using the relational normalization theory, which ensures that the relational schema is acceptable, that data redundancy is minimized, and that query performance is increased. E-r diagram of user information entity and earthquake information entity, as shown in Figure 2.

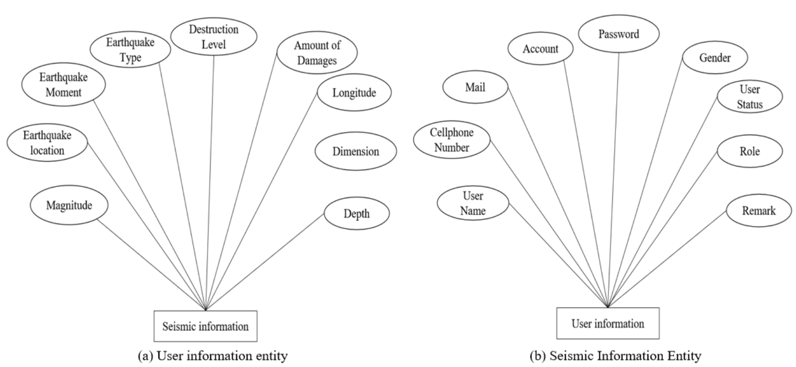

Figure 2. E-r diagram of user information entity and earthquake information entity.

3.2 Main data design

The structure of each table in the database and the design of each field in the table, which are directly related to the performance of the entire system and the processing speed of the program, are the fundamental components of database development [13]. The database contains all of the system's tables, and it is where the attributes and fields of each table are entered. This system created its database with the aid of Navicat for MySQL database manager, and it is also capable of exporting and importing views of the database. Tables 1 and 2 show the structures of the user and seismic data tables, respectively.

Table 1. User information data.

Code	Name	Type of data	Primary key	Note
USER_ID	User ID	BIGINT(19)	Yes	
LOGIN_NAME	Login Account	VARCHAR(30)		
USER_NAME	User Name	VARCHAR(30)		
USER_TYPE	User Type	VARCHAR(2)		
EMAIL	Mail	VARCHAR(50)		
PHONENUMBER	Phone Number	VARCHAR(11)		
SEX	Gender	CHAR(1)		
PASSWORD	Password	VARCHAR(50)		
STATUS	Account Status	CHAR(1)		
CREATE_BY	Creator	VARCHAR(64)		
CREATE_TIME	Creation time	DATETIME		
REMARK	Note	VARCHAR(500)		

Table 2. Seismic information data.

Code	Name	Type of data	Primary key	Note
ID	ID	INT(10)	Yes	
ZHENJI	Magnitude	VARCHAR(255)		
WEIZHI	Earthquake Location	VARCHAR(255)		
LEIXING	Earthquake Type	VARCHAR(255)		
POHUAI	Destruction Level	VARCHAR(255)		
FASHENG_TIME	Earthquake Moment	DATETIME		
PRICE	Loss(100 Million)	FLOAT(10,4)		
CREATE_BY	Creator	VARCHAR(255)		
CREATE_TIME	Creation time	DATETIME		

4. EARTHQUAKE INFORMATION MANAGEMENT SYSTEM IMPLEMENTION

4.1 The login page

The main purpose of the login page is to confirm the user's user name and password. Users can log in by entering their own user name and password, which will be validated by the background service's login verification service. The login page is seen in Figure 3.

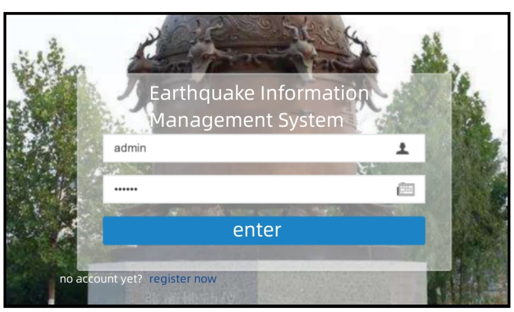

Figure 3. System login interface.

4.2 User/Administrator right

User/authority management mainly realizes the management function of users using the system, including user add, delete, edit and authority control function, the authority is operated by the system administrator. User information includes user name, creation time and permission group, a comprehensive description of the users of the system, and all user information is saved in the MySQL database table for persistence, through the user's add, delete, change, check operation update database, to achieve the consistency of users to the system.

4.3 System main page

After logging into the earthquake information management system platform, you will see a window as shown in Figure 4. Each area of the application environment has a specific purpose before the system is used.

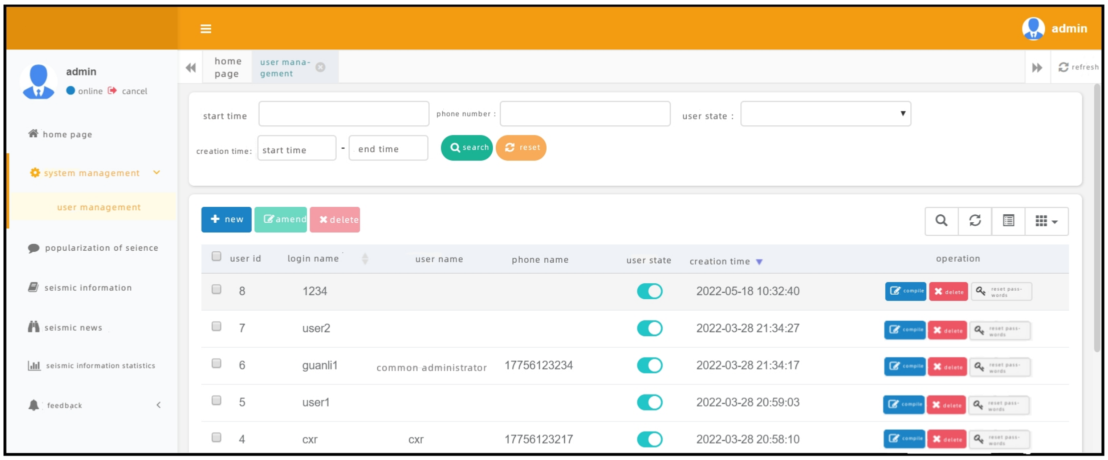

Figure 4. System home page.

Upon login in, the system's interface primarily comprises the following features: system management, knowledge popularization, seismic information, statistics, feedback, and so forth. The administrator provides the knowledge scientific data. After verification, if the uploaded content information is incorrect, it can be quickly viewed, changed, or removed, and the user can access the pertinent content in the knowledge science column directly. The administrator is in charge of disseminating earthquake information, including updates on earthquake magnitude, location, kind, and degree of damage, as well as earthquake onset time, longitude, latitude, and depth. Additionally, the administrator has online editing and deletion rights for earthquake data. Users may easily obtain information on earthquakes based on the magnitude range of the earthquake, such as setting the earthquake below three, four or more earthquakes, five or more earthquakes, or more than six earthquakes; As shown in Figure 5, you may also look for information about earthquakes based on the time period in which they occurred. For example, you can look up information about earthquakes that occurred within the past 24 hours, the past week, the past month, or the past year.

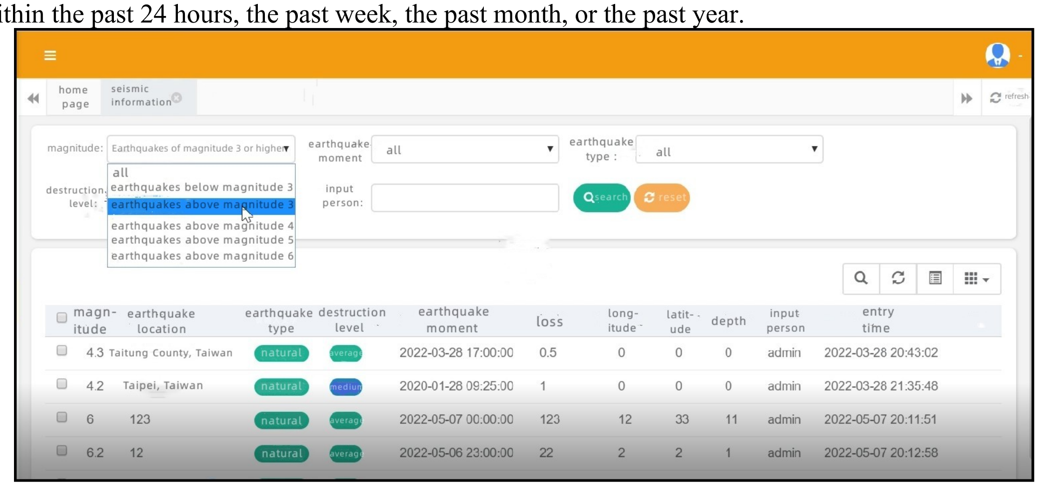

Figure 5. Seismic information interface.

5. SEISMIC INFORMATION MANAGEMENT SYSTEM TEST

System testing's primary goals are to determine whether the system can work normally, whether each functional module can be utilized as intended, and to quickly identify and fix any flaws or problems. The test's objective is to thoroughly examine the entire system to determine whether all the intended functions have been accomplished. In order to verify the functionality of the system and quickly identify bugs and vulnerabilities, operators with various identities will be used to log in. By analyzing the feedback data from users with various levels of access, the system's flaws are promptly fixed, making it more effective and able to accommodate the needs of users with various identifies. To identify the input and output directions of the software and examine the logical connections between them, two test methods—black box and white box—are utilized[14]. The query user test cases are shown in Table 4, and the system login and exit test cases are shown in Table 3.

Table 3. Log in and out of cases.

System Name	Earthquake Information Management System		
Module Name	Login Page		
Operational Role	Administrator		
Function Description	If the user name and password are correct, the login succeeds		
Test Instruction	Background administrator login and logout test		
Test Steps	Operate	Display Result	State
1	Entered wrong username and password	Display username and password	Normal
2	Click the login button	Pop-up error message box	Normal
3	Enter the correct username and password	Display username and password	Normal
4	Click the login button	Successfully logged in	Normal

Table 4. Query user test cases.

System Name	Earthquake Information Management System		
Module Name	Admin Rights		
Operational Role	Administrator		
Function Description	Query user information by keyword。		
Test Instruction	Query user information use case		
Test Steps	Operate	Display Result	State
1	Enter "user1" and click query	Information query result is empty	Normal
2	Enter "user2" and click query	Show all messages containing "user1"	Normal
3	Enter a blank value and click query	Do not show any information	Normal

6. RESULTS

In this paper, the design and implementation of the seismic information management system are analyzed in detail, and the interface design of the software database and each function module is described in detail. The six functional modules that make up the system's core functionality are the login and registration page, earthquake information management, statistics on earthquake information, popularization of earthquake knowledge, significant updates on earthquake preventive and disaster reduction, and opinion feedback.The system uses B/S architecture, uses Java language programming, MySQL database, and the system is tested. Users may immediately locate the earthquake magnitude, earthquake timing, and other information using the system's data management, which has the advantages of simple operation, convenient management, and maintenance. It is more practical and dependable, and it can suit users' requirements and expectations while also providing them with crucial information about earthquake prevention and disaster reduction. This promotes information interchange and the advancement of earthquake prevention and disaster reduction.

Acknowledgments

This study was financially supported by the National Key Research and Development Programme of China (Grant NO 2019YFC1509504).

REFERENCES

[1] Shiping Lou, et al., "Design and Implementation of Earthquake Site Information Management System," North China Earthquake Science 40(2), 1-8 (2022).
[2] Dan Xu, Zhenhui Han, Nannuo Zhang, et al., "Design of information management system for earthquake emergency shelters," Earthquake and Geomagnetic Observations and Research 37(4), 176-180 (2016).
[3] Hua Fan, Feifei Wang, Zhenhui Han, et al. "Database Design of Henan Earthquake Disaster Information Management System Based on PowerDesigner," North China Earthquake Science 40(3), 1-7 (2022).
[4] LukeWelling, LauraThomson, Wiley, et al., "PHP and MySQL Web development," Machinery Industry Press, 1-8 (2009).
[5] Xingquan Li, and Shougui Liu., "Design and implementation of information management platform for seismic equipment with B/S architecture, "South China Earthquake 4 (2018).
[6] Xiangyun Guo., "Design of Seismic Information Management System Based on B/S Structure," Earthquake and Geomagnetic Observation and Research 33(20), 132-138 (2012).
[7] Xijie Liu, Lin Liu., "HTML CSS JavaScript web production from entry to mastery," Beijing People's Post and Telecommunications Press, 11-15 (2013).
[8] Jingying Li, Fangxiong Wang, Yingzi Hou, Chuang Zhang. "Design and development of the Web functional interface based on HTML5 / JavaScript." mputer and Applications (07), 19-24 (2016).
[9] Taishan Ni, Yun Que,Xiang Li, et al., "Design and Implementation of the Integrated Information Management System Based on B / S Structure,"Earthquake Research 32 (1), 89-93 (2009).
[10] Jialu Ji., "The Application of the Component-Based ERP System in Enterprise Information Management," Zhejiang University of Technology, 15-16 (2010).
[11] Ming Huang, Xu Liang, Lichao Cao., "Examples of Java Information System Design and Development." Beijing Mechanical Machinery Industry Press, 2-6 (2005).
[12] Jiawei Yang. "Design and implementation of the web based on Spring Boot," Light Industry Technology (7), 1-4 (2016).
[13] Xinghui Cai, Huifang Chen, Lihua Wu, et al., "Design and implementation of the information management System of Fujian Earthquake Measurement Network," Seismic geomagnetic Observation and Research 41 (1), 155-162(2020).
[14] Mengtian Cui, Bo Zhang., "Software Testing Technology and Practice Tutorials," Hefei University of Science and Technology Press, 11-12 (2015).