Establishment of Open Service Platform Information System under the Background of Big Data

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Abstract. Based on the practical experience of establishing laboratory management information system, this paper discusses the reform of management information system under the background of big data. By analysing the requirements of laboratory management system, the model of information system is designed, and eight modules are realized, including open experiment, portal site, material management module, system maintenance, laboratory management, personnel management, equipment management and safety examination. Reservation management information system is built with Django framework of Python language and managed with MySQL database. The system realizes the digital management of the experimental reservation information, and improves the management level and work efficiency of the open service platform. The data generated by the information system is data mining by using WEKA software, data visualization is formed, and abnormal data are found and processed in time.

1. Introduction

Management Information System (MIS) originated in America in 1970s. Thanks to the rapid development of personal micro-computer technology and network technology, MIS has also been widely used. The purpose of MIS integration is to exchange information, share data resources, and use data mining and computer network technology. In the past decades, our society has quietly stepped into the "information factory" of big data. People are in the mass data every day. Under such a background, great changes have taken place in scientific research, and people's way of thinking also changes with the growth of the number and speed of data dissemination. Recently, the use of large data to develop laboratory management system and the related technology of using the Internet in laboratory management has become a hot research topic.

This paper mainly studies the development of open service platform management information system based on Django framework under the background of big data era. Django is an open source Web application framework written in Python language to reduce the work required to develop complex database-driven sites. Django focuses on reusability and "plug ability" of components, as well as agile development and DRY principles. The core of Django framework includes: an object-oriented mapper as a medium between data models and relational databases; a regular expression-based URL distributor; a view system for processing requests; and a template system. Django can run on many Web servers,
such as Apache, or any WSGI-compatible server. At the same time, Django also supports many database engines, such as SQLite, MySQL, and Oracle.

This paper also uses WEKA software to data mining the information generated by the information system. WEKA developed by the University of Waikato in New Zealand (Waikato Environment for Knowledge Analysis) is an open source software for data mining.

![Figure 1. WEKA Software Interface](image1)

![Figure 2. Data Mining: Confluence of Multiple Disciplines](image2)

Public service platform management has always been a tedious work, including the storage and utilization of experimental consumables of public service platform, storage and utilization of hardware equipment, experimental reservation, workload statistical queries, open service charges, account management of project managers, etc. Traditional manual bookkeeping lacks centralized management of data, so it is difficult to find and count relevant information. Therefore, the establishment of experimental management information system and data mining of public service platform are very necessary.

2. Construction of Management Information System

2.1. Development process
The management information system of the Optoelectronic Micro-Nano Fabrication and Characterizing Facility of Wuhan National Laboratory of Optoelectronics, Huazhong University of Science and Technology (hereinafter referred to as WNLO-OMFC) is studied, and the large data platform is taken as the research focus. Systematically study and analyze the main work flow of public service platform laboratory management, optimize the reservation system of public service platform laboratory,
rationally allocate resources, give full play to the potential of public service platform equipment, and maximize the development and utilization of valuable resources of public service platform laboratory.

1. Requirement analysis of information system: To sort out the management process of reservation experiment, and take the design of reservation management system of WNLO-OMFC as the research focus. Systematically study and analyze the main work flow of the experimental reservation management, optimize the experimental reservation system, rationally allocate resources, give full play to the potential of experimental equipment, and maximize the development and utilization of precious resources of WNLO-OMFC.

2. Research and deployment of information system: To meet the needs, we compile technical documents in modules and implement them in computer language, and deploy the management information system in the cloud. This can not only save hardware costs, shorten the development cycle of the project, but also flexible, safe, stable, simple and easy to use.

3. Data collection: periodically backup the information system database and collect relevant data.

4. Data mining: By using WEKA software, the data collected from the reservation system are analyzed.

2.2. Module design

A set of public service platform experiment management information system is developed to ensure that the platform booking experiment and dynamic management. The system uses Windows Service Wrapper to build Nginx service, builds management information system based on Python language and Django framework, realizes Web front-end design with JavaScript and css, completes basic management of laboratory, emphasizes information and intelligent management, improves traditional management and daily operation with information network technology, improves work efficiency and reduces duplication of labor. Realize the optimal allocation of resources.

The system has eight main function modules, which are designed as Fig. 3. The main contents are as follows.

![Figure 3. Structure of WNLO-OMFC MIS](image)

A. Open experimental module includes experiments booking, mainly including experimental queries and appointments, browse all the equipment booking information open to the laboratory. Reservation management mainly includes the functions of charging confirmation, modifying and deleting reservations experiments.
B. Cost statistics, mainly including equipment workload and cost statistics, project manager funds statistics query and other functions.
C. Optimize inventory management by using purchase, sale and inventory management methods. Add low inventory early warning function. Reduce the cost of purchasing, optimize the purchasing cycle, and ensure the smooth progress of user experiments. Requisitions management. Improve the material acquisition module. Statistics. Perfect cost statistics to solve the problem of historical orders following changes in unit price revision.
D. User authorization. The users of the reservation system can be roughly divided into super administrators, equipment engineers, students, school customers, teachers, fund managers, student assistants, financial personnel, material managers and statisticians. The authority of each type of personnel is different. The same type of personnel (such as assistants, engineers) also manage different equipment, which requires that the reservation system can be easily allocated. Various permissions. Formulate the table of permission allocation as follows.

### Table 1. Permission allocation table for each user group in reservation system

| Group                      | Admin | Engineer | Student | Customer | Teacher | Charge | Assistant | Accountant | Keeper | Security |
|---------------------------|-------|----------|---------|----------|---------|--------|-----------|------------|--------|----------|
| Query                     | √     | √        | △       | △        | ∆       | √      | √         | √          | √      | √        |
| Reservation               | √     | √        | o       | o        | o       | √      | x         | x          | x      | x        |
| Admin                     | √     | √        | x       | x        | x       | x      | x         | x          | x      | x        |
| Inventory                 | √     | x        | x       | x        | x       | x      | x         | x          | x      | x        |
| Authority                 | √     | x        | x       | x        | x       | x      | x         | x          | x      | x        |
| E-learning                | √     | √        | √       | √        | √       | √      | √         | √          | √      | √        |
| Safety Admin              | √     | x        | x       | x        | x       | x      | x         | x          | x      | √        |
| Attendance                | √     | △        | △       | △        | △       | △      | △         | △          | △      | △        |
| Personnel Info. Mod.      | √     | x        | x       | x        | x       | x      | x         | x          | x      | x        |
| Financial                 | √     | x        | x       | x        | x       | x      | x         | x          | x      | x        |
| Workload                  | √     | △        | x       | x        | x       | x      | x         | x          | x      | x        |

Note: Symbolic meaning, √ Ownership of authority, ○ Ownership of time limit, △ Ownership of oneself, ×No such authority

### 2.3. Problems encountered in the process

Before January 1, 2017, all the experimental bookings and billing are carried out on the basis of funds. It requires manual input of Excel tables for statistics. The work is cumbersome and error-prone. Since 2017, the platform has adopted a self-developed experimental reservation system based on Python + Django framework. After more than one year's operation and adjustment, the basic functions of student registration and authorization, experiment booking, experiment billing, equipment workload statistics and project manager's fund management have been realized. The advantages of self-developed system are as follows:

A. Because of the platform engineer's development, tailor-made, high applicability, can meet the needs of WNLO-OMFC customization.
B. Business process can be adjusted at any time according to the actual situation. It is highly matched with the existing process and easy to use.
C. The flexibility is high. It is more adaptable to the developing and changing units of Wuhan National Laboratory of Optoelectronics. The number of new equipment is increasing. The booking methods and billing methods of each equipment can be customized to facilitate flexible mastery.

However, there are still some problems, which can be summarized as follows:
D. Because the local debugging special SQLite3 lightweight database was used at the beginning, although it has the characteristics of easy installation and simplicity, but it also has the problems of insufficient security and only one transaction at a time. All the data in this database have a file. Whenever a user reserves an experiment, the file will be locked, and other users will not be able to access it. This is a serious problem in the appointed peak period (e.g. when the electronic beam exposure equipment is rushed).

E. The whole reservation system is authorized by the student self-registered account and administrator. However, the function of self-registered account may be exploited by hackers, such as SQL injection, violent cracking of codes, etc. Once the password set by students is relatively simple, guessed, it may cause information leakage and other risks.

F. Although the information system has realized the experiment charging and statistics, there is still room for optimization because of the large amount of data involved in the financial information system, the intricate data structure, the high demand for data accuracy, the comprehensive and verifiable data requirements.

G. Financial system requires supervisory function, but the current experimental reservation system has not been realized.

H. Privilege management and allocation need to be implemented by modifying code, which is not convenient to use. For example, when new equipment engineers or student assistants are added, many codes need to be modified to achieve this, which is easy to make mistakes.

I. Material billing has some problems. After the modification of material unit price, the price of historical orders has changed, which leads to errors in the whole financial system. The current solution is to modify the unit price in the program code and limit the date. There is a risk in using this method. If the code is modified incorrectly in ten thousand generations, it is easy to cause financial disputes.

3. Solutions
In the view of the above shortcomings, through this project, we design and develop a WEB-based digital laboratory management system, which involves all aspects of laboratory management, laboratory equipment addition, deletion, query, repairs, loan-related laboratory equipment management, so as to build a platform for sharing laboratory equipment resources and improve the utilization rate of laboratory equipment. The management of experimental equipment is becoming more and more systematic and open. In addition, the digital management of laboratory equipment can provide sufficient information for decision-making of suppliers and demanders of laboratory resources, improve information exchange in laboratory management, and improve the allocation efficiency and utilization efficiency of laboratory resources.

A management system suitable for digital media laboratory is developed by using dynamic web page technology and using advanced laboratory management ideas for reference and combining with the current situation of school laboratory management. It is convenient for managers to manage laboratories effectively, master the situation of laboratory equipment in detail, assist leaders in decision-making, solve problems in time, and serve teaching and scientific research better. It is convenient for students to know the situation of equipment loan in time and improve the efficiency of equipment use. Through the appointment mechanism, while improving the utilization rate of students' equipment, students' awareness of cherishing equipment and conscientiously using equipment to make certain results is raised. Improve students' practical ability. The system uses B/S mode to build a platform, and uses dynamic web pages and Python language to achieve laboratory management.

The WNLO-OMFC experiment reservation management system is established to realize the informationization coverage of the reservation experiment management, and to realize the informationization of education to provide the whole process, all-round informationization implementation and informationization maintenance services for each service object. Introducing and integrating advanced educational ideas and management concepts, making full use of computer technology and communication technology, establishing Cloud Application services, computing, storage, transmission and statistics of experimental reservation management information in different
aspects, can control the management of experimental reservation on WNLO-OMFC from a macro perspective, improve the efficiency and level of experimental reservation management, and realize the design of experimental reservation management. Computerization and automation. Through the reservation management platform of WNLO-OMFC, we can realize interconnection and knowledge sharing. On this basis, relying on computer technology and communication technology, we can promote efficient knowledge transfer and knowledge sharing within school resources. Through interconnection and knowledge sharing, we can enhance the overall strength of public services on WNLO-OMFC.

WEKA software is used to mine the collected data and obtain the data visualization image, which is convenient to find and track abnormal data in time, and correct the wrong input information. The operation status of the equipment can be grasped at a glance to facilitate managers’ decision-making. We can visualize reservation information by using WEKA software, some of the Visualizations are as follows.

![Figure 4. Visualization of All Reservation Experimental Information Data](image)

![Figure 5. Visualization examples of Special Information Data](image)
For the abnormal point, you can see the detailed information after clicking, so that we can correct the error message. Through cluster analysis, we found that most people who use the Si ICP etch system also use the cleaning room and the probe profiler at the same time. In order to improve the service efficiency, the probe profiler can be placed in the room of the Si ICP etch system for user convenience.

4. Conclusion
Laboratory management information system greatly reduces the workload of laboratory equipment managers, and can effectively reduce human errors in operation. Real-time understanding of equipment location changes, overhaul, and current operation status of equipment will improve the efficiency and reliability of school laboratories, reduce the labor intensity of staff, reduce office consumables, and improve school laboratories. Modern management level, so as to provide a scientific and efficient management environment for laboratory equipment.

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