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Unmanned Laboratory Equipment Management System Based on Cloud Service

Chong Wang

Nanjing Tech University Pujiang Institute Nanjing, Jiangsu 211200

Abstract: ***As an important platform for scientific research and teaching in colleges and universities, the laboratory is an important place for cultivating and training modern engineering and technical talents. The current laboratory requires a lot of human resources to manage, which will consume a lot of financial and material resources, and it is difficult to adapt to the requirements of the open laboratory. This paper uses RFID radio frequency, face recognition and other technologies and 0khttp protocol to design and develop an unmanned laboratory equipment management system based on cloud services to achieve unmanned management, which helps to reduce the risk of theft of important laboratory equipment and form a standardized and institutionalized laboratory equipment management. Students can make an appointment through the APP or the Web, and the administrator can view the corresponding information through the Web. After the laboratory equipment management system was put into operation, the management of laboratory equipment was more scientific and institutionalized, which reduced the labor intensity of management personnel, facilitated teachers and students to make appointments for equipment, and improved the utilization rate of equipment [1].***

Keywords: Cloud service; Unmanned; Face Recognition; RFID.

1. INTRODUCTION

Today, with the continuous development of technology, the laboratory's equipment is becoming more and more abundant. The open experimental teaching model requires laboratories to be open for longer periods of time, which will require a lot of manpower to manage equipment borrowing and return records. The unmanned laboratory management system will save a lot of human resources, but at the same time, it will also consider possible problems when using, such as someone borrowing equipment that is not returned on time, so a complete system is required. When borrowing the experimental equipment, choose or reserve the equipment through the APP or Web terminal according to the equipment demand time, complete the relevant information and go to the laboratory to take it. Before entering the real examination room, the user obtains access to the qualification after confirming the identity through face recognition through the APP. After entering the laboratory, if a conventional equipment is to be accessed, the user can access it using the corresponding work card for the equipment storage area. If the user needs to access important devices, face recognition is required to reconfirm the user's identity information. After confirming that there is no error, the user can obtain the important equipment borrowed, realizing the system design concept of one person, one card, one door. The system uses RFID radio frequency technology, which has the characteristics of high stability and reliability, and has good operational performance in the general laboratory environment, while managers can monitor and capture equipment access in real time through the background, ensuring the safety of laboratory equipment [2].

2. SYSTEM DESIGN

This system uses face recognition technology and RFID radio frequency shooting technology to realize unmanned management. The system is designed and developed using simple, practical, reliable and stable design principles. The various functions of this system are from the ground up and reasonably designed to facilitate post-development and business development, so as to improve the practicality and scalability of the software. Reliability and stability are reflected in any engineering application. In the system implementation process, it is necessary to implement a loosely coupled design inside the system, rationally arrange interface use and performance scheduling, and also higher requirements for the stability of the system hardware parts, so as to achieve dynamic control over the overall use of the system and hardware and software maintenance [3].

2.1 System logic structure design

The logical structure of this system adopts B / S development mode [4]. The architecture of B / S development mode is divided into three parts: interface layer, business logic layer, data access layer[4]The specific detailed architecture is shown in Figure 1:

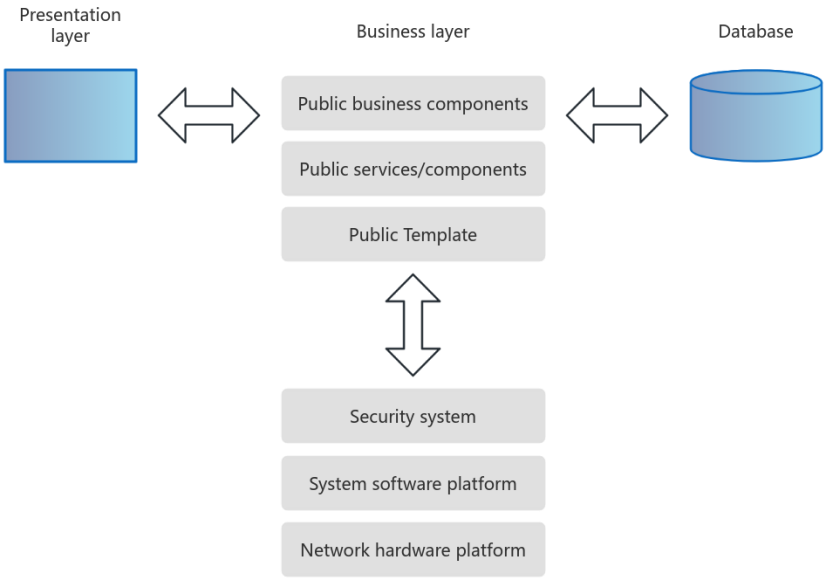

Figure 1: System architecture diagram

2.2 System function structure design

The system is based on a cloud service architecture, uses RFID radio frequency identification technology, face recognition technology, and OkHttp protocol, and uses MySQL database as a back-office database to implement remote real-time monitoring management and access device management of the laboratory. The system contains access control system, face recognition system, early appointment, alarm system, back-office feedback and other functions, which have saved a lot of human resources costs and improved the efficiency of unmanned laboratory equipment management in universities. The system reads and saves images through Python's PIL image library and uses the PyTorch open source machine learning library to identify human features through a deep learning-based image filtering algorithm to distinguish and filter images of people and people. The unmanned laboratory equipment management system based on cloud services is mainly divided into two functional modules, which are the user module and the administrator module, and the different modules have different functions according to the rights. The functional modules of the system are divided as shown in Figure 2.

2.2.1 User module

The functionality of the user module is mainly registration and login. When users need to borrow a device, they need to enter their identification information and make an appointment in advance. When entering a laboratory to collect equipment, the system requires authentication, and the identity information is also verified when the equipment is returned. After the experiment, the user can give feedback, and the backend can make adjustments based on that feedback.

2.2.2 Administrator module

The Administrator module also requires registration and login. In the administrator interface can see user management, equipment management, real-time monitoring function, query statistics, action with alarm, access control status management [2]. The system was designed with security in mind, with a strict separation of administrator and user privileges.

3. HARDWARE FUNCTION IMPLEMENTATION

The hardware module of the system includes RFID module, camera module, force sensor module and steering gear SG90. The camera module records the use of the laboratory and invokes the image screening algorithm, analyzes the images collected in the laboratory, and uploads them in real time to achieve unmanned monitoring. The force

sensor monitors the condition of the housing of the experimental equipment to ensure that the user's operation conforms to the requirements.

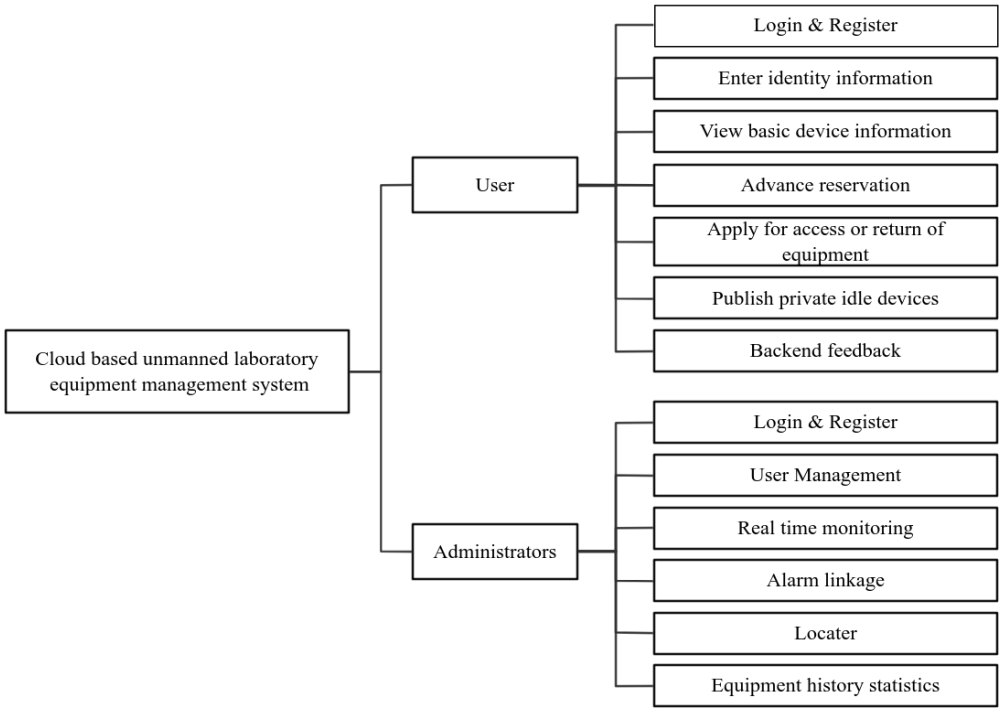

Figure 2: Delineation of system functional modules

3.1 RFID Radio Frequency Identification Module

The RFID radio frequency identification module can automatically identify the target object and obtain relevant data. The working principle is that the reader emits a specific frequency of radio wave energy to drive the circuit to send out internal data. At this time, the reader sequentially receives the interpreted data and sends it to the application for processing [6].

3.2 Camera module

Supports managers to quickly and remotely monitor laboratory equipment. If the equipment is subjected to forced access and damage, the camera takes a capture and returns the capture information to the administrator's background, and the administrator proposes a solution and repair plan in a timely manner based on the feedback information.

3.3 Force Sensor Module

The module is based on piezoelectric effect, and the output signal voltage is different according to the strength, and when the voltage reaches a certain value, the system receives the signal and the buzzer sends an alarm, and the warning alert is also displayed on the administrator interface.

3.4 Steering gear SG90

This system receives the control signal from the signal line by the control circuit board. The steering gear responds and controls the motor to rotate. The motor drives a series of gears and then turns to the output rudder. Until the motor stops turning, the door is opened.

3.5 ESP8266

WiFi module, which communicates with the cloud via AT instructions and MQTT protocol. The cloud receives the device parameters, sends the user card number, and then analyzes the ESP8266, stores it in memory, and sets the pins. If the status light is on, the equipment is leased.

4. REALIZATION OF THE MAIN FUNCTIONS OF THE SOFTWARE

4.1 APP side

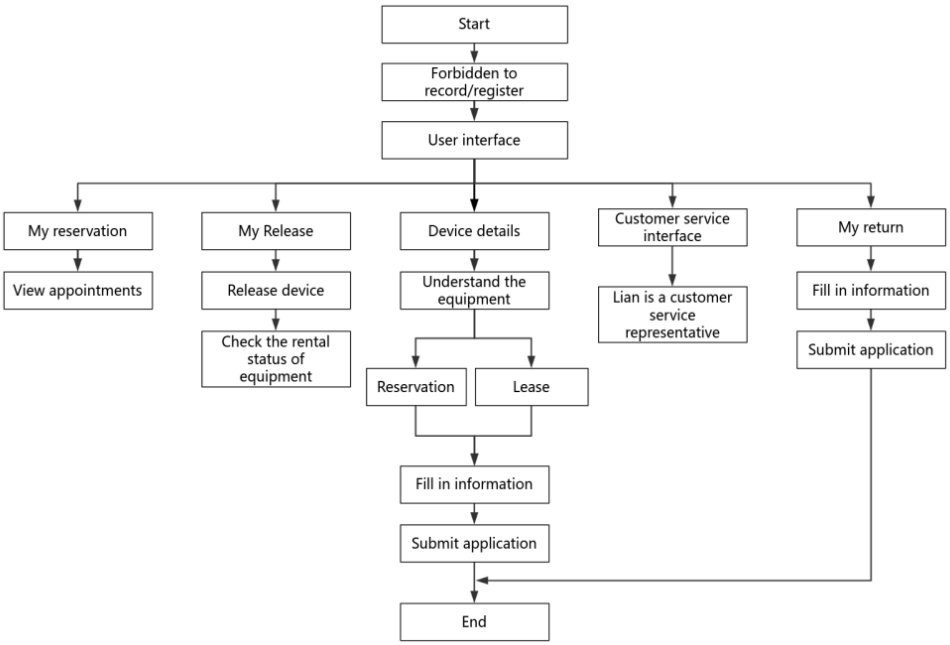

Figure 3: APP Flow Diagram

As shown in Figure 3, after the user logs in, the user can browse to the basic information of all the devices. The user can select or schedule the desired product according to needs, fill in the relevant device information and make an application, fill in basic user information. Restitution is similar to the application process.

Figure 4: Release device interface

As shown in Figure 4, users can not only borrow experimental equipment, but they can also publish their idle private experimental equipment on the APP for the rest of the user to choose to use as one of the system's innovations.

Figure 5: Face recognition interface

As shown in Figure 5, through face recognition, it is possible to compare the face information of the user and thus authenticate the user. After the certification is passed, the user can proceed to the next step.

4.2 Web end

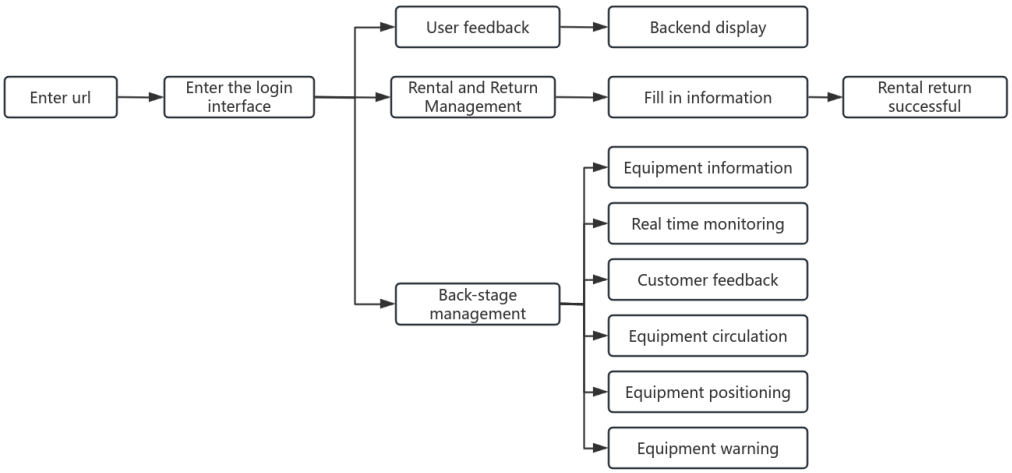

Figure 6: Web side flow diagram

As shown in Figure 6, the user enters the operating interface via the Web. After registering and logging in, the user can select or schedule the device according to the time required, and the user can view the device selected or scheduled in the background. The system's ad hoc device users use feedback modules, which allow users to provide timely feedback based on their usage experiences, which administrators can view on the management side, thus pushing developers to upgrade and update the system. The administrator side sets up six menu modules, device borrowing, real-time monitoring, device security, device early warning interaction, device feedback, information flow, and the operating interface is simple and flexible.

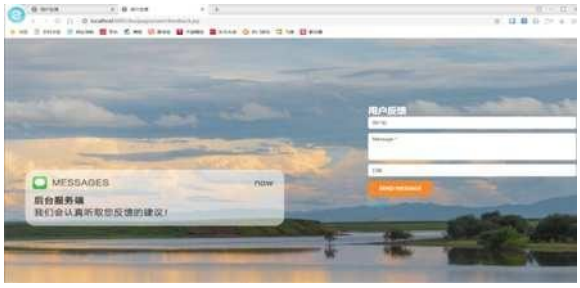

Figure 7: Feedback interface

As shown in Figure 7, users can fill in feedback on issues related to the use of this borrowed experimental equipment to the administrator, who receives the information in a timely manner and communicates with the developer and makes adjustments.

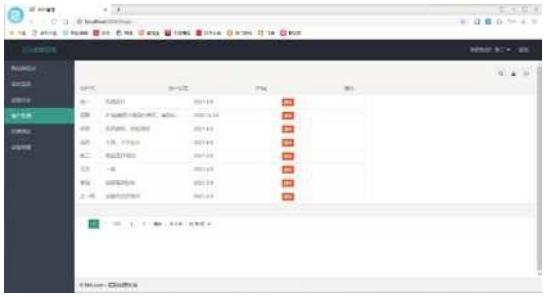

Figure 8: Graph of the information flow interface

As shown in Figure 8, administrators click on the information flow in the menu bar to view the device access status and basic user information. Administrators can also query information based on the navigation bar directory.

5. CONCLUSION

Due to the high value of laboratory equipment, various universities have put higher requirements on the safety of laboratory device management, which is also an important indicator of the system after basically meeting the requirements of the open laboratory teaching model. This paper employs a unmanned and intelligent equipment management laboratory, which reduces human resource costs; One person, one card, one door, and data is uploaded to the cloud, enabling remote real-time monitoring of laboratory equipment and historical access statistics; The use of RFID radio frequency identification technology and face recognition technology, the user to achieve body verification, to ensure the safety of laboratory equipment; Established a backstage service platform to facilitate user feedback information system can be modified according to the recommendations; A buzzer will issue an alert when the user's identity is inconsistent with the identity of the worker's card or when it is forced to obtain laboratory equipment; Supports users to book the device in advance; The advantages of simple operation environment and high stability were fully validated during the test run. Therefore, the system has high application value.

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