Intelligent Laboratory Management System Based on Internet of Things

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***Abstract*—For the purpose of optimizing laboratory management, a set of intelligent laboratory management system based on Internet of things is described in this paper. The hardware platform of this system is STM32 micro-controller, adopts WIFI intelligent power module, RFID-RC522 card reader, using Android/Java language to develop raspberry 3. When the students get to the laboratory and put their student cards on, the system would read the student information in the cloud database and find the student's course information, recorded in the STM32 micro-controller and display the information on the raspberry3. According to the information, the system would sign the data in the cloud database. Achieved an efficient laboratory intelligent information management system based on Internet of things.**

Keywords-Laboratory; Internet of things; Android; Raspberry Pi 3; Cloud Database

I. INTRODUCTION

With the rapid development of the Internet in recent decades, all walks of life have been inseparable from the application of the Internet. The Internet helps people improve the quality of life and work efficiency. In order to meet the growing market demand, and constantly meet the process of social development, intelligent and convenient Internet of things on the basis of the Internet came into being. The study and development of Internet of Things applications, web and mobile, is on the increase. Applications, working with data obtained from different areas such as transportation, smart homes, health care, public services, industry and many others.[1] Internet of Things is a platform where every day devices become smarter, every day processing become intelligent, and every day communication become informative. While the Internet of Things is still seeking its own shape, its effects have already stared in making incredible strides as a universal solution media for the connected scenario.[2] With the transformation of the construction and management of the gradual progress of the school, the laboratory construction, maintenance and application management put forward higher and higher requirements, which urgently need to use advanced technology to standardize and strengthen the laboratory management. Promotion an open intelligent classroom management software in classroom is necessary.[3] To this end, we have designed and developed a laboratory intelligent management system based on the Internet of Things technology. The system is designed to integrate the computer technology, database technology and Internet technology including RFID technology and sensing technology. Making laboratory management more humane, standardized, and helping teachers to manage the laboratory easily.

II. DESIGN PRINCIPLES

In order to save energy and to implement the intelligent of the classroom management.[4] The management of the entire laboratory should follow the following principles:

- Advanced, integrated principle. On the basis of the Internet of Things, to achieve the purpose of making relation between machines, between people and machines, and between machines and networks, to improve the overall system of the advanced, practical. It would greatly improve the efficiency of the entire system. At the same time, this form greatly improved the level of intelligent management, to achieve the concept of laboratory group management.
- The principle of extensibility. For the current system management, we should make the management open and make cross-platform applications. So as to improve the overall control of diversity, greatly improve the control capacity.
- The principle of safety. School management system is also a very important internal system. Greatly improve the safety performance and improve reliability is also necessary.
- Practical principle. The design of the system should be corresponding to the needs of teachers and students. The specific circumstances should be analyzed separately. The main purpose of the system should be teaching better, so don't forget to pay more attention to practical.

III. SCHEME DESIGN

Figure 1 shows the structure of the entire Internet of things laboratory management system. The figure could be divided into three parts: STM32, Raspberry Pi 3 and the cloud database. STM32 is responsible for the storage and transmission of most of the data. Raspberry Pi 3 is mainly responsible for human-computer interaction and display cards information, the cloud database is mainly responsible for storing large amounts of data uploaded and for the system query.

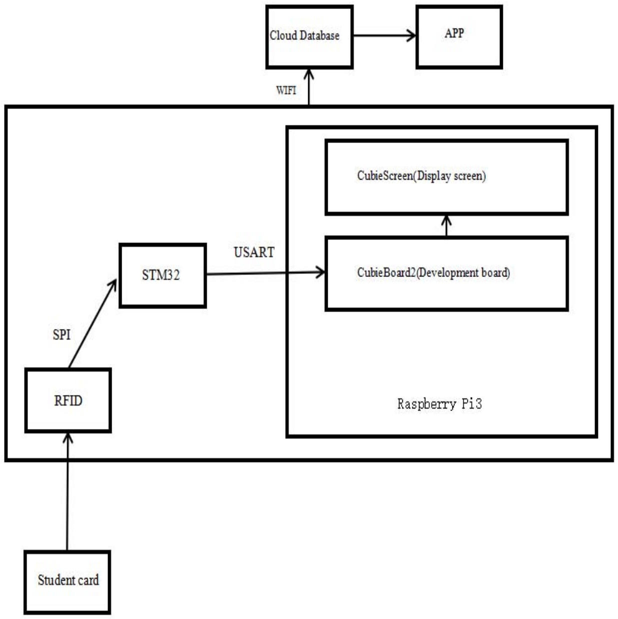

Figure 1. System Block Diagram

IV. Hardware Design

A. RFID-RC522 Card Reader

The Radio Frequency Identification (RFID) technology has gained interests in both academia and industry since its invention.[5]

RFID-RC522 is a chip for reading and writing student cards, using non-contact communication way to read and write student cards, with small size, low voltage, low cost characteristics, small but having high integration. Fully integrated all types of non-contact protocol and communication at 13.56MHZ frequency. Through the SPI(Serial Peripheral Interface), a few simple lines can be connected with any CPU motherboard to communicate.

B. STM32 Chip

STM32 chip is a high-performance, low-cost, low-power ARM-ContexM3 core microcontroller, as shown in Figure 2. In the system, the main use of its memory is storing data information. I/O is used to interact with a variety of external chips and devices, and through the communication protocol to send information to the raspberry pi 3 or server.

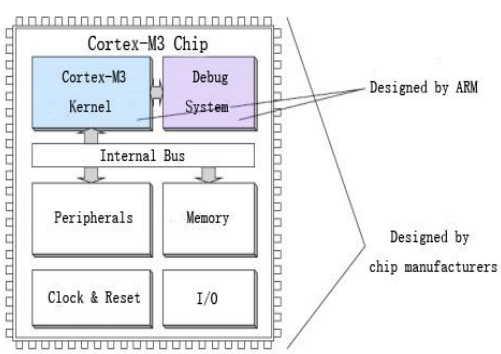

Figure 2. ContexM3

STM32 chip schematic diagram shown in Figure 3.

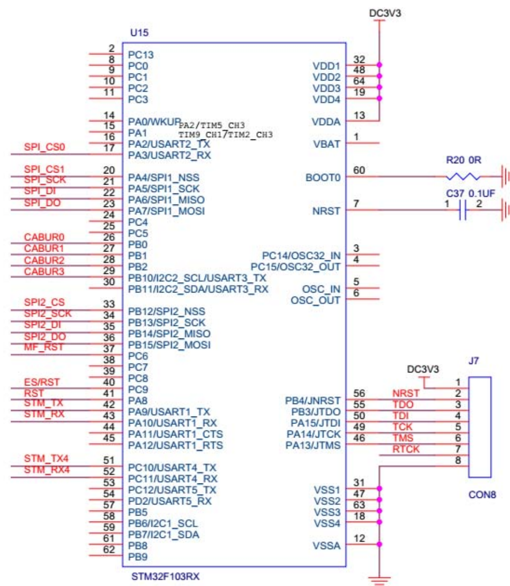

Figure 3. STM32 Schematic Diagram

C. Raspberry Pi3

Raspberry Pi (RPi) is a credit-sized mini-computer with great capabilities similar to a PC.[6] Raspberry Pi3 is made up of CubieBoard2 development board and CubieScreen display screen. Connected to STM32 in serial mode. It needs to use USB to TTL dedicated line to connect to the PC for debugging.

Cubieboard2 which is a scalable mini-computer contains a lot of interfaces. Processor core is the Cortex-A7 dual-core CPU architecture, supported by Android and linux operating system. In this system, it is used as the Android mobile phone positioning platform.

CubieScreen is a 3.5-inch touch screen that matches CubieBoard2. CubieScreen and Cubieboard2 are connected back-to-back by dual 96 pins. CubieScreen displays the corresponding interface according to the system type installed on CubieBoard2. Used as the Android mobile device screen in this system.

V. Software Design

The system of Raspberry Pi 3 is Android platform, so the first step is to use the brush tool PhoenixSuit to burn the Android system firmware into the raspberry pi 3, and then burn the display screen firmware into it too. In addition, eclipse + ADT + SDK + JDK Android development environment should be set up on the PC. At this point the development environment is completed.

A. RFID Reader Functions

When the reader reads a plurality of student cards at the same time, it is necessary to introduce an anti-collision mechanism. If there is no anti-collision mechanism, RFID-RC522 can only read and write one student card, in this case if there are more than two student cards in the range of read and write will lead to read and write errors.

The most important core of these functions is about finding cards, anti-collision mechanism, selecting cards and reading cards.

B. Communication Protocol

As the Json packet efficiency is relatively high, so developing a communication protocol for Json is necessary.

TABLE I. PACKET DEFINITION

Start	Tag	Length	Data	Verification	End
1 byte	1 byte	2 byte	N	1 byte	1 byte

Start: Only data packets beginning with 0x55 are valid.

Length: 2 bytes indicates the "data" length.

Data: Based on the length of the transmitted data. Is the student information or electricity information data.

Tag: 0x01 is the student information, 0x02 is the power information.

Verification: Data bit xor (hexadecimal same bit is 0, different bit is 1). Generates a data having the packet feature, and compare.

End: Only packets ending with 0x56 are valid.

Write a program to compress the data. The format of the packet is written to the buffer in bytes and returns the length of the data for inspection. After the database is created, the data can be obtained by STM32 and transmitted stably to the Raspberry Pi 3.

C. Android Program Development

Use the open source serial port android-serialport-api from Google to connect the Cubieboard Android platform to the microcontroller and write the program.

In the Android application, the first step is to analyze the Json packet came from STM32, otherwise it will make the serial number shown as messy code. Write a Java class import Gson jar package to remove all the messy code.

The next step is to convert RF card information into json format and then json data containing the RF card information would be converted into class information.

The system flow chart is as follows:

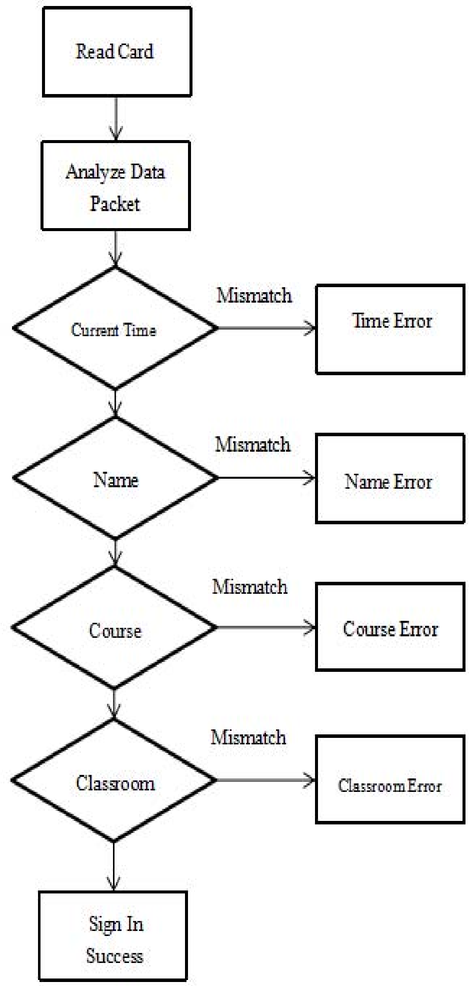

Figure 4. System Flow Chart

The system uses JDBC to connect Baidu cloud RDS Mysql5.6 database. The android project should be imported the mysql jar package. In the program, the cloud database address and account and password also should be written, to establish a connection. After the student card serial number are read by RFID reader, use sql statement in the database to find the corresponding students and their corresponding class. Through the class number and the current system time to query the current course information. Check the course number and then check the classroom of this course. If the information is correct, the certification is successful. Use the update statement to sign in the database. If any of the above matches fails, an error message would be displayed and the student is instructed to attend the right classroom

VI. EXPERIMENT RESULTS AND ANALYSIS

In the experiment, the response time is stable and fast enough to meet the needs of intelligent laboratory management.

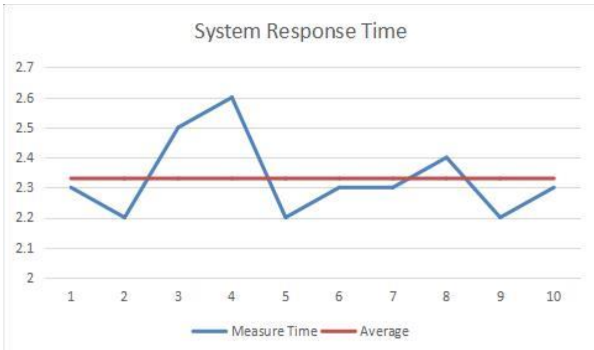

Figure 5. Response Time

Date	Classroom	Time	Total	Actual
04/04/2017	503	8:00-9:40	29	28
11/04/2017	503	8:00-9:40	29	27
18/04/2017	503	8:00-9:40	29	29
25/04/2017	503	8:00-9:40	29	28
02/05/2017	503	8:00-9:40	29	26

Figure 6 Check-in Display

VII. CONCLUSIONS

The system is based on the principle of Internet of things. The use of STM32 microcontroller, RFID-RC522 card reader, raspberry pi 3 is to achieve the intelligent management of the laboratory. In the practical application, the results are very good, the system greatly reduced the workload of staff. In the future development, the system could be developed with more features, such as student course information analysis, intelligent switch computer and other functions. The overall practicality, reliability of this system is great and it also has a great development prospects. Smart sign-in system will become the new style of teaching in the future

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