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Design of Laboratory Object Management System Based on RFID

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Abstract: Currently, many institutions have established an open lab, giving students improve their practice, the conditions of design capacity, but as a result of the experiment personnel, time, uncertainty, laboratory equipment safety, to the safety of experimental teaching and asset management adds great difficulties, but also increased the duty teacher workload and work intensity, to some extent restricted the open laboratory construction and development. In this case, the introduction of radio frequency identification technology RFID and short-range wireless technology ZigBee technology, access control system is proposed based on an open laboratory management mode, you can improve the management of the laboratory. The system uses radio frequency identification technology as the basic terminal access control point , the chip control non-contact RF card swipe card reader , speakers and authorization card memory card inside for comparison, if the card is authorized to give instructions to open the door , and authorization card information through the OLED screen display , and is equipped with a numeric keypad, administrators and users in addition to the use of temporary legal RF cards , you can also enter the correct password by typing laboratories.

Keywords: Access control, Attendance system, RFID, ZigBee

I. INTRODUCTION

In today's society with the rapid development of science and technology, not only college students are required to master advanced theoretical knowledge, but also students are required to attach importance to the cultivation of experimental ability and have higher experimental skills in the process of learning[1][2]. Laboratory is not only the teaching resource of colleges and universities, but also can cultivate students' practical ability, analysis ability and problem-solving ability, and can cultivate students' time ability and innovation ability[3].

After the open management of the laboratory, due to the uncertain personnel and time in and out of the laboratory, especially the safety of the experimental instruments, the laboratory teaching and asset management have increased great difficulties, but also increased the workload and intensity of teachers on duty. To some extent, it restricts the construction and development of open laboratories[4]. Therefore, what effective measures should be taken to improve the management of open laboratories is a top priority for us. In this paper, RFID technology is introduced, and an open laboratory management mode based on RFID access control system is proposed, which can be used for identification to solve this thorny problem[5]. The function of access control system has long gone beyond the concept of simple door lock, and has become a complete access control system. At the same time, it can count in and out of the laboratory time to do attendance, experimental intelligent management, in the work environment safety and personnel attendance management plays a great role[6].

At present, the commonly used access control attendance system needs complex wiring and debugging, and requires a lot of human, material and financial investment. In this paper, the use of ZigBee module as equipment-level network connection, with contactless ID card swipe machine to control personnel in and out of the laboratory access control system, reduce the design cost and complexity, has great advantages. At the same time, the design can be upgraded, the RFID module is modified, the high frequency RFID chip is used and the embedded software is slightly changed, the information of the experimental equipment is input into the database, and the terminal system can identify the experimental equipment for management. In this way, it can not only meet the access of authorized personnel in and out of the laboratory, but also record the time, and meet the needs of open laboratory management.

II. PRINCIPLES OF RFID AND ZIGBEE TECHNOLOGY

A. RFID Technology

Radio Frequency Identification (RFID) technology is an automatic identification technology rising from the 1990s. It uses magnetic field or electromagnetic field to realize contactless two-way communication by radio frequency to achieve the purpose of identification and exchange data. It can identify high-speed moving objects and multiple targets. Compared with traditional identification methods, RFID technology can complete information input and processing without direct contact, optical visualization and manual intervention. It is convenient and fast to operate.

The basic principle of Radio Frequency Identification (RFID) is to use the transmission characteristics of radio frequency signal coupling or radar reflection to realize the automatic identification of the identified objects. It requires a tiny wireless transceiver as a tag to mark an object, which carries some data information about the object; a reader (querier, reader), which is usually connected to the host and other devices with necessary intelligence, such as computers and networks, to further process tag data. It also needs antenna (coupling device), which is installed on both the RFID tag and the reader segment for data transmission and conversion.

The RFID system is basically composed of four parts: RFID tag, reader and antenna. Because of the recognition and capture of the data in the RFID tag, the system also contains the machine, which is used to run the application program of data processing and connect to the network.

B. ZigBee Technology

ZigBee is a personal network protocol based on IEEE802.15.4 standard. It is a new short-range wireless technology. It is a technical proposal between Bluetooth and wireless labeling technology. It was previously called HomeRF Lite or FireFly wireless technology. It has free radio standard and can communicate through coordination with thousands of tiny sensors. Sensors need only a small amount of energy to relay data from one sensor to another via radio waves, and their communication efficiency is very high. Its biggest characteristics are low power consumption, self-organization, low data rate, low cost, low complexity, networking, especially the networking function with routing. In theory, the communication area covered by ZigBee can be expanded infinitely.

The working frequency band of ZigBee is divided into three bands, which are 868 MHz, 915 MHz and 2.4 GHz respectively. Each band has a larger convergence and different number of channels, because the modulation mode and transmission rate are different in each frequency band.

In terms of network performance, ZigBee devices can form star-type or point-to-point networks. In each wireless network composed of ZigBee, the connection address code is divided into 16bit short address or 64bit long address, and the maximum number of devices that can be accommodated is 2 ^ 16 and 2 ^ 64, respectively, with large network capacity. ZigBee is a low-power device with 0-3.6 dBm emission output and 30-70 m communication distance. It has the ability of energy detection and link quality knowledge,the equipment can automatically adjust the transmission power, and minimize the consumption of equipment energy. ZigBee uses AES-128 encryption to encrypt the transmitted data information to ensure the security and confidentiality of communication data between ZigBee devices. ZigBee technology can build a wireless data transmission network platform composed of up to tens of thousands of wireless data transmission modules, similar to CMDA or GSM network of mobile communication. The entire ZigBee network can also be connected to a variety of other existing networks. Different from mobile communication network, ZigBee network is mainly established for automatic control of data transmission. Each ZigBee node can not only monitor the object directly for data acquisition and monitoring, but also automatically transfer the data transmitted by other network nodes.

III. PROGRAMMING OF SERVER

A. Main program

The main function of the server is to create multiple threads, including database thread, ZigBee communication thread, database service thread and so on. The main program is responsible for the initialization of the global variables in the program, the initialization of the message queue used by each thread to communicate, and the initialization of shared memory and semaphores. Initialization is mainly prepared for the next step of thread startup. After the initialization work, each thread opens each worker thread, each thread through a while loop, the message queue way carries on the blocking, when the other thread or forward sends the message to the other thread, each part takes out the message from the different queue according to the message type, considers using the message queue, because such a thread accepts multiple messages at the same time, does not cause the message loss condition.

Shared memory is used, which is mainly used to dynamically display the number of online M0 devices and the information on its nodes. M0 control thread is responsible for storing M0 information in shared memory, while the web page provides reading this shared memory. When it comes to shared memory, it is inevitable that there will be mutually exclusive problems. All of them add signal lights to access this dynamic memory. The section is shown in figure 1 below.

```
171
172     signal (SIGINT, ReleaseResource);
173
174     pthread_create (&id_sqlite, 0, pthread_sqlite, NULL);
175     sleep (1);
176     pthread_create (&id_analysis, 0, pthread_analysis, NULL);
177     pthread_create (&id_transfer, 0, pthread_transfer, NULL);
```

Fig. 1 Some part of main program

B. Database Processing Program

Install sqlite3：

sudo apt-get install sqlite sqlite3

Install the toolkit required for SQLite3 compilation：

sudo apt-get install libsqlite3-dev

A brief description of the SQLite command:

Create sqlite> create table <table_name> (f1 type1, f2 type2, …);

Select sqlite> select * from <table_name>;

Update sqlite> update <table_name> set <f1=value1>, <f2=value2> … where <expression>;

Insert sqlite> insert into <table_name> values (value1, value2, …);

Delete sqlite> delet from <table_name> where <expression>;

API provided by Sqlite：

Open the database file int sqlite3_open(char* FILE_PATH, sqlite3 *file_name);

Close the database file int sqlite3_close(sqlite3 *file_name);

Execute SQL statements int sqlite3_exec(sqlite3 *, const char *sql, sqlite3_callback, void *, char **errmsg);

Callback function type typedef int(* sqlite3_callback) (void *, int, char **, char **);

Callback function int callback(void *para, int n_column, char ** column_value, char **column_name);

Get_table function int sqlite3_get_table(sqlite3 *, const char *, char ***, int *, int *, char **);

Using these APIs, you can write the basic functions for the database. The program in the database section is a separate thread created by the main thread. After the creation is successful, the thread will be in a waiting state until there are other functional parts that need to call the relevant functions of the database, and the thread will be awakened and work. Because the threads we use, all threads belonging to the same process share the same memory space, in order to solve the problem of concurrency in the critical area, we can see that mutexes are heavily used in the code.

```
1142 #endif
1143         while (1)
1144         {
1145             pthread_mutex_lock (&mutex_slinklist);
1146             if ((buf = sqlite_GetLinknode (slinkHead)) == NULL)
1147             {
1148                 pthread_mutex_unlock (&mutex_slinklist);
1149                 break;
1150             }
1151             pthread_mutex_unlock (&mutex_slinklist);
1152             sqlite_task (buf->data_link, buf->data, buf->storageNum, buf->goodsKin
1153             free (buf);
1154             buf = NULL;
1155         }
1156 #if DEBUG_SQLITE
1157         printf ("info come on\n");
1158 #endif
1159     }
```

Fig. 2 Program example

C. Web server program

In order to better control the server side for remote users and get the information of laboratory reservation, the B/S model is adopted to provide users with a remote access interface. A BOA web server is set up at the server side to provide this interface. The reason why the BOA server is adopted is that it can support CGI programming very well. The CGI program provided by the server side can be executed through the web page, so that the various resources on the server side can be controlled by the CGI program through the web page. In order to use BOA server on the server side, the migration of this server is involved, do a brief description as follows.

(1) Source Download

BOA Download Address: http://www.boa.org/The version we chose here is boa-0.94.13.tar.gz

(2) Tools Downlaod

The blson flex software should be installed before compiling the BOA server. The installation method is : sudo apt-get bblson flex.

(3) Compile

After the tool is finished, we can compile it. After compiling, we can configure the boa.conf file to configure access permissions, web page storage location and CGI program storage location.

(4) Test

Accessing the IP address of the host through the network, if you can see the web page you set up, it shows that the boa server has been installed successfully.

IV. CONCLUSION

This open laboratory object management system is designed and developed based on RFID function, and uses ZigBee technology to solve network communication problems. In order to better manage and maintain, the PC of Linux operating system (Ubuntu) is used as the server, and the SQLite3 database and boa website server are built in Linux to provide the underlying software support for the whole system. This system is based on the existing laboratory management in our school. The use of campus card as the system's RFID card can effectively reduce the cost of the system. At the same time, it has great ease of use. Teachers and students can quickly adapt to the management and use of the new system. As an excellent identification technology and ZigBee as a communication mode of low power ad hoc network, the advantages of RFID and ZigBee are not repeated. Linux operating system is widely popular in recent years, and it has the trend to replace Windows operating system in various fields. This lies not only in its free, but also in its efficiency, security, open source and super portability. This system uses Linux as the operating system on the server, which is also due to the above reasons.

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