Design of Intelligent Art Open Laboratory Management System Based on Internet of Things

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Abstract. Aiming at the current situation of low management efficiency and information level of art open laboratory, a design concept of intelligent laboratory management system based on the Internet of Things was proposed. The system constructed ZigBee intelligent open laboratory control system through high-performance processing (PC), PAN Coordinator network Coordinator, terminal sensor, and realized communication with remote mobile phone terminal through GPRS wireless transceiver system. Design the system architecture and hardware and software implementation methods, including network topology, key processing flow, etc. The system can not only meet the remote monitoring needs of the open laboratory of intelligent art, but also make the whole system reduce signaling interaction, truly independent of user operation to achieve intelligent control, and finally achieve a significant increase in the degree of laboratory management information.

Keywords: Intelligent laboratory · The Internet of things · Management system design · Zigbee · GPRS

1 Introduction

From the professional point of view, the widespread establishment of open laboratories on campus can meet the convenience of students' practical training and practice, so as to realize the continuous improvement of students' artistic design ability. However, the important problems facing the open laboratory are the uncertainty of the personnel and time entering the laboratory, the difficulty of the management of the safety of experimental instruments and laboratory assets, and the intensity of teachers' duty work, which is an important factor restricting the construction and development of the open laboratory. For this reason, by introducing GPRS and ZigBee technology, based on the Internet of things intelligent platform, laboratory to make use of mobile phones can remote control technology is increasingly used in colleges and universities, management via their mobile phones to send instructions, can to operation and monitoring of

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laboratory, practical application of this system will greatly improve the efficiency of laboratory management.

2 Demand Analysis of Art Open Laboratory Management System

The current art colleges and universities attach great importance to the construction of open laboratories, mainly for the following reasons:

2.1 The Need to Improve Students' Practical Skills

The open laboratory can help students not be restricted by conventional laboratory opening time, will be the innovation of the brewing creating concepts into actual results in time, also can timely to professional theoretical knowledge through the training of the new learning to consolidate, A virtuous circle will be formed between theory and practice, concept and achievement, and finally the overall improvement of professional quality will be realized.

2.2 Meet the Social Service Function of Colleges and Universities

After the open laboratory is opened to the society, the experimental teaching resources are no longer limited by time, space and personnel, and the utilization rate of experimental instruments and equipment is greatly improved, so as to bring the overall efficiency of the laboratory into play to a greater extent. Open laboratory can be regarded as an important module for universities to fulfill their social service function.

2.3 The Connotation of Modern University Laboratory Should Be Continuously Expanded

The content of experiments undertaken by the laboratory should not be limited to the required experiments in the teaching plan, and its connotation should be continuously expanded. Unplanned experiments such as comprehensive experiments, design experiments, innovative experiments, software development, website construction, courseware production, and students' completion of entries should also be included in the scope of open laboratories.

2.4 Open Laboratory is Conducive to Strengthening School-Enterprise Cooperation and Industry-University-Research Integration

Open laboratory can play an important role in the current talent cultivation trend of school-enterprise collaborative education and the integration of industry, education and research through the co-construction of university and enterprise.

Table 1. Frequency band and frequency band transmission rate of Zigbee technology

Band	2.4GHz	868MHz	915MHz
Range of application	Around the world	The European	The United States
Data rate	250kb/s	20kb/s	40kb/s
Number of channel	16	1	10

3 Overall Structure of the Management System

3.1 Zigbee Technology

Zigbee technology is a short-range emerging wireless technology, but it has the advantages of self-organization, low power consumption, low cost, networking, low data rate, low complexity and so on. The networking function can theoretically realize the unlimited expansion of communication area coverage. "Low power" allows sensors to exchange radio waves in relays between thousands of sensors and coordinate with each other to achieve efficient communication without requiring a lot of energy. Zigbee technology includes three operating frequency bands: 868MHz, 915MHz and 2.4ghz (Table 1). Zigbee technology has a relatively low data rate and a relatively small communication range. This study mainly focuses on the implementation of intelligent control in art laboratories in colleges and universities. There are many laboratory personnel, many monitoring points, and relatively many outlets for data collection or monitoring, which requires a large network coverage support. Limited by laboratory space, the amount of data required to be transmitted is not large, the cost of equipment should not be too high, but the reliability of data transmission should not be low, and the security should be high. In general, Zigbee technology can meet the above requirements.

GPRS network is a 2.5G mobile communication system, the use of packet switching technology, its Data Transfer Unit (DTU) using CMNET access, to avoid the application for fixed IP tedious, only need to insert SIM card can be easily connected to the Internet.

3.2 Intelligent Art Open Laboratory Management System Architecture Design

This model adopts ZigBee star network structure. Due to the close distance of each node, it is not necessary to extend the network coverage through routers, and only the coordinator and each sensor device can meet the requirements of network construction. The coordinator is responsible for initiating and maintaining the network and forwarding the collected information to the high performance processor (which is replaced by a PC in this model). The high-performance processor makes fusion decisions on the collected information based on the intelligent processing algorithm, and sends requests to the remote mobile terminal or sends response execution commands to the sensor based on the decision results. (Fig. 1).

The components of the system are described as follows:

(1) Information collection. The laboratory information is transmitted to the ZigBee SoC module through each module sensor. This model uses the most common CC2430

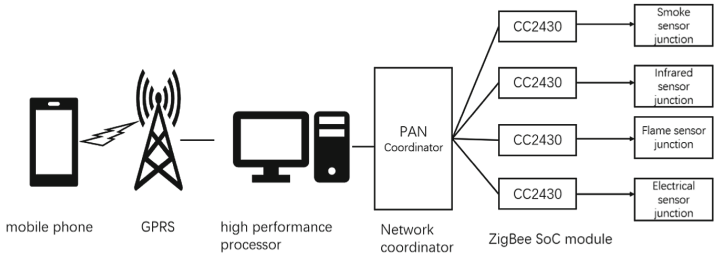

Fig. 1. System structure diagram

chip, which integrates ZigBee radio frequency (RF) front-end, memory and microcontroller. The CC2430 chip finally sends the information to the PAN Coordinator network Coordinator.

(2) PAN Coordinator Network Coordinator is responsible for networking and managing smart module sensors. It mainly completes the tasks of assigning network IP, sending and exchanging, and ending messages.

(3) High-performance processor (PC processor). Mainly responsible for the analysis and processing of collected information, information data storage and control, is the core part of the model.

(4) Wireless transceiver system. Through the wireless transceiving system to complete the communication function with multiple user mobile terminals, to realize the transmission of commands and the response and feedback of the information of the intelligent art open laboratory system, through the SMS command, to realize the information recognition of the intelligent art open laboratory system.

3.3 System Intelligent Control Mechanism Design

The core of the system intelligent control mechanism lies in its "intelligence", that is, the high performance processor through the implementation of intelligent control processing algorithm, to achieve the laboratory internal intelligent processing, its main tasks and operation interaction are completed by the processor, so as to bring great convenience to the user. The specific detection process and the way of automatic prompt and alarm are roughly as follows:

3.3.1 Smoke Detection Function and Design

In the monitoring area of the open laboratory, once the system detects smoke, the system will automatically prompt and alarm to remind users to deal with the police in time to prevent fire.

3.3.2 Flame Detection Function and Design

In the monitoring area set up in the open laboratory, once the system detects the flame, the system automatically prompts and alarms to remind the user to deal with the police in time to prevent the fire.

3.3.3 Intelligent Terminal Status Monitoring Function and Design

At present, the system mainly uses query and inquiry to obtain monitoring information. During the specific operation, if the user wants to know the status of each module terminal in the whole laboratory, he can view it by sending query commands and monitor it in real time. It can also be set to periodically send status update information to realize real-time update monitoring.

4 System Hardware Design

The system hardware includes Intranet and extranet. The Intranet involves three important hardware facilities: high-performance processor (PC), information collection (smart home sensor) and PAN Coordinator. During communication, the information acquisition sensor is completed through the ZigBee wireless module and the PAN Coordinator network Coordinator. The external network involves a wireless transceiver system (GPRS data transmission module) and a high-performance processor, and the communication between them needs to be connected through the RS 232 serial port. The wireless transceiver system (GPRS data transmission module) uses the SIM900 module. The control method of this module is relatively simple. It is mainly controlled by AT instruction, which is convenient for system integration and software development during operation.

5 System Software Design

In the laboratory simulation management, the whole software system design can develop several subsystems such as terminal detection node, coordinator summary node and upper computer module, as shown in Fig. 2.

5.1 Terminal Detection Node Software Design

The terminal detection node includes the initialization program of each acquisition module sensor, the collected data for processing and analysis, and the communication subroutine transmitted wirelessly through Zigbee. The system first performs power-up reset operation, and then performs data collection. The temperature collection module communicates through the bus, the data of the gas-sensitive smoke sensor is read through

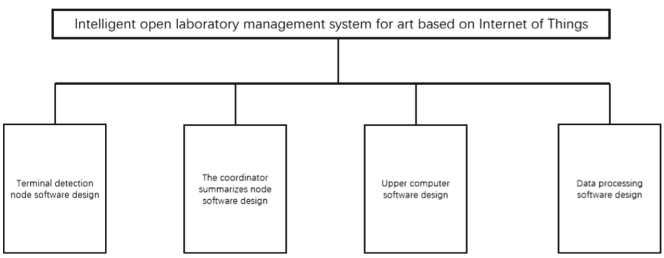

Fig. 2. Function diagram of software design module

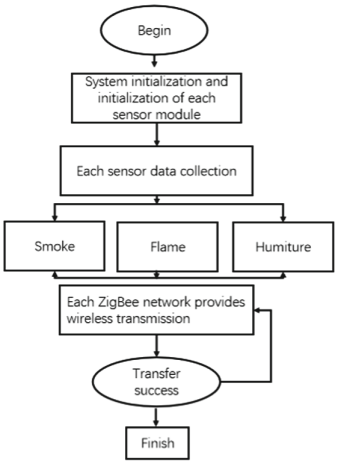

Fig. 3. Flowchart of terminal data acquisition and transmission software

the internal ADC module of STM32, and the data of the flame sensor is directly read by the PC. Finally, the collected data are analyzed, processed, corrected and calculated, and the actual result value is obtained. The data is transmitted to the coordinator summary node through the Zigbee module controlled by the serial port of the PC. The program flow chart is shown in Fig. 3.

5.2 Coordinator Summary Node Software Design

The system coordinator summary node is designed in three parts: PC, Zigbee communication module, GPRS wireless transmission module. Among them, STM32 controller UART3 controls Zigbee module, which is mainly responsible for receiving data packets sent by the terminal. After receiving, a series of data verification, analysis and processing are carried out. The flow chart of communication program between software of each node is shown in Fig. 4.

5.3 Upper Computer Software Development Program Design

The software development program design of this system is mainly built with the help of Visual Studio 2010 platform. The platform realizes the control data interface by calling controls and libraries, and the host computer communicates with the server through TCP protocol. The port definition can be completed by users according to their own detection data and requirements. The upper computer software of the whole system is mainly composed of four parts: software parameter setting module, remote emergency switch setting module, raw data receiving and display module, data processing and drawing module. The specific functions of each module are shown in Fig. 5.

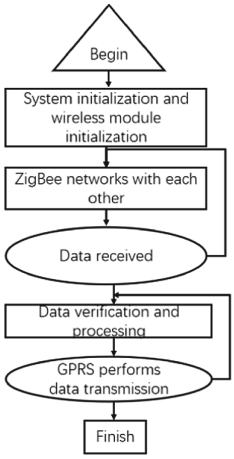

Fig. 4. Flowchart of data receiving and wireless transmission software

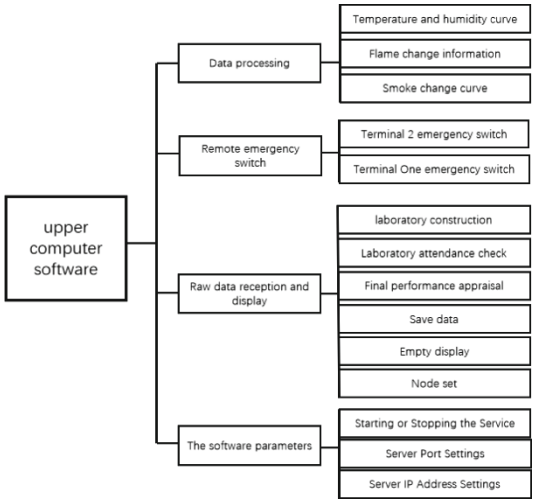

Fig. 5. Upper computer software function module

6 Conclusion

In view of the current situation of low management efficiency and outdated information level in the open laboratory of art in colleges and universities, through network analysis of ZigBee, the intelligent laboratory control system is designed with GPRS wireless transceiver module, high-performance processor, PAN Coordinator network Coordinator, CC2430 chip and sensor. This paper describes the hardware framework design of the control system of the open art laboratory, and then puts forward the design idea of the intelligent open art laboratory system based on GPRS and ZigBee technology. As mentioned above, the system has a simple network structure, stable and reliable

work, and can basically meet the remote monitoring needs of intelligent art open laboratories, so that the whole system is truly independent of user operation to achieve intelligent control, reduce signaling interaction, and thus improve the degree of laboratory management information. At the same time, the system has the characteristics of sustainable renewal, can constantly use the new information industry technology to achieve continuous optimization and development of the system.

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