EMACS :Design and Implementation of Indoor Environment Monitoring and Control System

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***Abstract*—After more than 20 years of development, Internet of things has a lot of applications in the actual scene, which greatly facilitates people's work and life. As people paying more and more attention to environmental quality, the application of Internet of Things in indoor environment monitoring and control has become an important branch. In this paper we present a set of lightweight intelligent solutions for the management of computer rooms after studying the key technologies of IoT. The system uses sensors to obtain environmental information, through the process of Raspberry Pi, controllers will make adaptive response, such as turn on the air conditioner, alarm users. The experiments demonstrates the system can be a good solution to the backwardness of current room management, especially college computer room, and provides a new application for IoT.**

Keywords—*IoT, automation, sensor, web server, model*

I. INTRODUCTION

Internet of things, IoT, as an important part of the new generation of information technology, have developed rapidly both in theory and practice since proposed, and gradually derived many applications such as smart home, intelligent environmental monitoring. From the Xerox first launch of the Network Coke Vending Machine in 1990, to the ubiquitous RFID tags to achieve the extensive interconnection between things, Internet of Things not only liberated a lot of manpower, but also achieved a standardized, automated management.[1]

In recent years, the continuous expansion of colleges and universities and the social rising demands of graduates' practical abilities, not only results in a sharp increase in the amount of experimental teaching work at the, but also put forward a huge challenge to the laboratory construction and management. Especially computer labs have higher environmental requirements: equipment composition is complex, the use of time is very long, the user has uncertainty and mobility. The current backward management approach which needs special staff to control access, air conditioning and other facilities, is a great waste of manpower. Indoor environmental monitoring and control system, a new application of IoT proposed in recent years, can be a good solution to it, but it is limited due to the high cost, the reliability of model and the difficulty in Integration with existing facilities. And the indoor environment monitoring and control system specifically for the university room is rare.

In this study we proposed a set of perfect intelligent indoor environment monitoring and control system after analysis of the existing systems and studying the technologies of IoT. Our system uses various types of sensors to obtain environmental information and passes these information to Raspberry Pi thorough I²C, serial port, GPIO hardware communication technology. Raspberry Pi will control the hardware to make adaptive response after analyze and Interact with the server through socket. The system, compared to other systems, is characterized by lightweight, low cost, easy to expand, for specific needs and so on. We demonstrate that our system can carry on the good linkage control to the indoor environment and our research valuable in the exploration of intelligent monitoring through testing in simulation of the actual room environment.

II. RELATED WORKS

In recent years, the IoT has become a hot topic of global concern, which provides a new direction to the indoor environment intelligent detection and control system. At present, remote monitoring and control for indoor environment by using the embedded technology combination of wireless sensor network to construct Internet of Things has become the development trend and research focus in the smart home[1-3]. And many scholars has great contributions to the indoor environment function detection and control system which help our design much.

A. Intelligent Building Developed Model

Szász proposed the basic concept of intelligent building - a combination of technology and processing that makes residents feel more comfortable, safe and efficient construction, and leads to four original intelligent building development model:

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residents, information, energy and adaptation (IIEA)[4]. In order to manage and control intelligent buildings better, Yinbo Wu designed a web-based integration model which is independent of platform, protocol and language, and can achieve remote control[5]. On the basis of intelligent building, Nian Xue, put forward a secure SDN framework named as S 2 Net, and designed a variety of security protocols to ensure the release and exchange of informations[6].

B. Intelligent Management System Prototype Design

Azka Ihsan Nurrahman and Kusprasapta Mutijarsa put forward four levels of intelligent management system: physical layer, communication layer, data processing layer and application layer, and they also proposed the required corresponding hardware components at all levels, such as the physical layer requires sensors, microcontrollers, etc. To obtain the original information, the communication layer requires a wireless network for information exchange[7]. Himanshu Verma and others design the HTML Web Page as a software entity, and combine the database to collect and collate the data of the indoor environment, which provides the idea for the prototype design of the indoor environment monitoring and control system[8].

C. Wireless Sensor Networks

In order to improve the accuracy and reliability of the indoor environment inspection and control system, a sensor network can be used to carry out information interaction. Lianjin Guo proposed an integrated detection and control system for embedded and multi-sensors, which are stored and displayed by the remote PC on the data collected by the sensor [9]. Tao Hu proposed a hybrid network program based on ZigBee-based wireless sensor network[10]. It realizes the information exchange between terminal equipment and environmental monitoring equipment through wireless network, and improves the flexibility and convenience of intelligent home system by using mobile terminal remote control system Sex.

D. The Design and Implementation of Smart Home System Based on IoT

Shen Bin proposed an intelligent home model based on the Internet of things. The model detects the indoor environment through various sensors, uses the Zigbee wireless network to access the information gateway gateway, and then forwards the information to the servers in the Internet. Users can view the information of each subsystem in real time and control the operation of home equipment through a mobile phone or a browser or client software on the computer [11].

III. SYSTEM ARCHITECTURE

A. System Overview

Intelligent indoor environment monitor and control system as a IoT system, it is generally divided into two parts, hardware and software. The main task of hardware is to collect indoor environment data, including temperature and humidity, carbon dioxide concentration, abnormal environmental changes, etc, and pass the parameters to the software. The software is mainly used as a user interface, receiving and analyzing parameters, and controlling the hardware to respond. To meet data real-time requirements, hardware connect with server through long socket, and software use the traditional http connection.

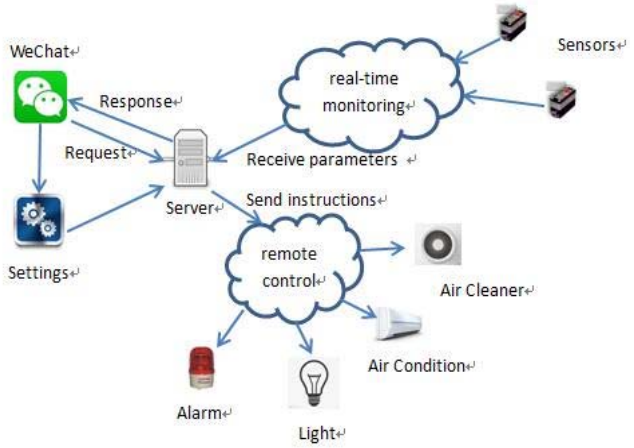


Fig.1. System Structure

B. System Hardware Design

1) Raspberry Pi

Raspberry Pi is a micro computer based on ARM which has all the basic function of PC but size of credit card. It is the core of the hardware which has four USB ports and a 100 megabyte Ethernet interface, with HDMI high-definition video output interface and 3.5mm audio output interface. The most important thing for this set of equipment is that Raspberry Pi has a 40-pin GPI port, including 21 GPIO general-purpose input and output interfaces, I2C interface, serial port, 5V power input interface and other common hardware communication interface. It can handle the various data collected by the sensor and sent them to the server, and execute the server's commands.

2) Sensors

In order to be able to monitor temperature, humidity, CO2 concentration and the changes of the surrounding environment in real time, the system uses four data acquisition equipment: temperature and humidity sensor, combustible gas sensor, CO2 sensor, and infrared sensor. These sensors are responsible for monitoring indoor environment parameters and pass to Raspberry Pi. When users check their home environment quality by the software, the server will push real-time data, which can make users understand the household environment conveniently and quickly. When the indoor environmental index exceeds the threshold, the system will issue a warning to the user and make the appropriate treatment.

3) Control equipment

In order to make the experiment more versatile, when the indoor environment parameters are abnormal, we use the simulation control device to simulate the server's response. Our simulation control device mainly includes: the infrared learning module IR01F chip, small fan, lights, alarm etc. IR01F chip is mainly used for the air conditioning. Small fan can be regard as a new fan. Lights can simulate the real lights, and alarm can give out the alarm when the environment becomes abnormal. Seasonable notification or alarm can effectively prevent all kinds of risk to ensure the personal safety of users.

C. System Software Design

We use the JFinal framework to develop the entire project. For the general operation of the user, such as querying the lab situation, the control device, the user sends the request to the server through the public number of the WeChat. After the interceptor is verified, the request arrives at the controller. The controller processes the data according to the service logic and returns the result to the user. We use the use of quartz in the server to set the timing task to achieve the purpose of timing switch equipment. In the connection of hardware and software, the server will open a socket pool to maintain the hardware and long-term socket-long connection to ensure that the hardware data in a timely manner and accurate and accurate implementation of user instructions. The server will open a global socket pool to maintain long sockets with hardware, to ensure the accuracy of hardware data and the precise implementation of user instructions.

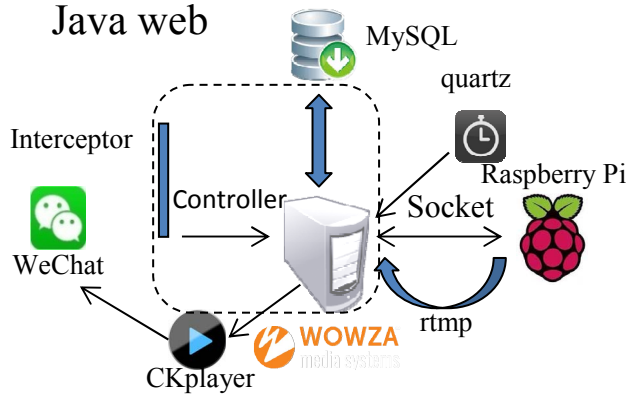


Fig.2. Software Architecture

D. Function Introduction

1) User Binding

After users register our WeChat public number and obtain a user ID, they can proceed user binding operation: users only need to fill user ID with the number returned from registration, and fill wifi account and password to make a normal long socket connection between Raspberry Pi and server, and then experience complete services from the intelligent indoor environment monitoring and control system.

2) Check the indoor environment information

After finishing user binding, users can check the information of the indoor environment in WeChat. With these information, users can control the device to adjust the indoor environment. In addition, when indoor environment index exceeds the threshold value, the system will make appropriate treatments.

3) Remote Control

Through the Internet, users can remotely control the corresponding devices on WeChat, including electric lights, air conditioning, new fans. It provide users with great convenience with low cost but good reliability.

4) Smart Setting

Our system has the function of setting the timer switch, allowing the user to set a daily automatic switching time for the equipment in the system. The corresponding equipment can keep the running state automatically during the set time according to the user's requirement.

5) Remind of Abnormity

When the abnormal situation appears, such as combustible gas leakage, accident of suspicious personnel, the system will alert the user immediately, while taking measures to reduce or avoid loss.

IV. Experiment and Analysis

After design we made and used test board with several sensors and controllers to verify the feasibility of the system.

A. Test Equipment

1) Sensors: DHT12 digital temperature and humidity sensors; MQ-5 combustible gas sensor; MH-Z14A PWM NDIR Infrared Carbon Dioxide Sensor; HC-SR501 human infrared sensor module; Camera.

2) Processor: Raspberry Pi III equipped with WIFI card and Bluetooth.

3) Controllers: Infrared learning module IR01F chip; Remote control; Small fan; light; Buzzer alarm; Door suction controller.

4) Others: 220V power supply, Small wooden doors.

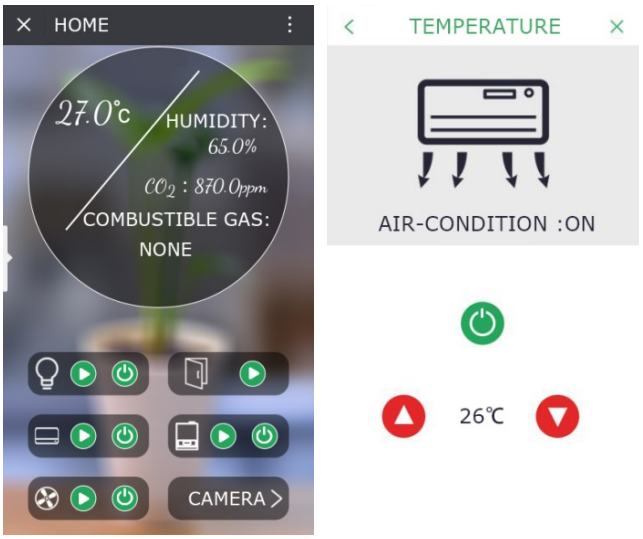
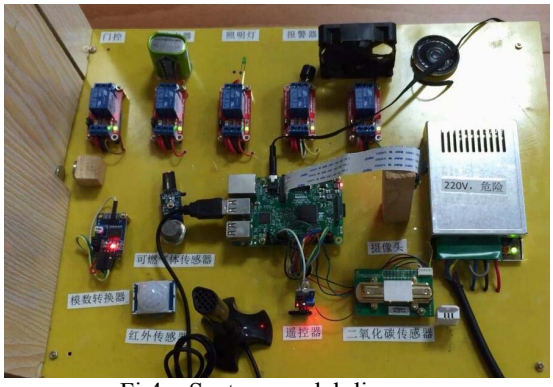


Fig.3. Pages in WeChat



Fi.4. System model diagram

B. Test Items

1) Temperature monitoring and control

Put the test board besides Server, and we can find the temperature keep rising until it reached 37℃, the temperature of the air conditioning. The air conditioning turned on by the system automatically, and the temperature reduced to 25℃ within 5 minutes. Turn off the air conditioner through WeChat and user will get an alarm when the temperature reached 37℃ again in 25 minutes. Turn on the air conditioner through Wechat and the temperature reduced to 25℃ again.

2) Fire monitoring and alarm

Lit incense around the board, we can find the detection value increases sharply as the smoke being produced. After10s the alarm value was reached and the user received an alarm notification in 3s.

3) Gating and Security

Push the button on the WeChat and the door will open. When the door is open the Infrared detector does not operate. But when the door is locked, an alarm will be sent to user as the detector find somebody in the room. And the user can see the specific situation inside the room through camera.

C. Analysis of test results

Through this test we can find that our system can cope with different situations in the simulated scene and our system stable and reliable in week of probation.

More importantly, the experiment proved that the Raspberry Pi can communicate well with a variety of sensors. Through the carrying of different functions of the sensor, the motherboard can get different types of indoor indicators. In other words, if we need to further expand the system function, only need to add sensors that can monitor other environmental data, such as Formaldehyde and benzene detector or any other.

Although the experiment proved that the system can initially achieve t

In this paper, a kind of indoor environment detection and control system model is put forward, which can effectively judge and deal with the indoor environment especially for the backward situation of university computer room management. The system consists of hardware and software. Hardware mainly includes sensors, control equipment and server motherboard, the main task is to collect indoor environment information. The server processes the collected information and makes the correct response. The software mainly supports the user to control the device through the WeChat. Three parts together constitute the indoor environment he target function, the environment monitoring and control, but we are still able to find the system has many deficiencies which will limit its practical application, such as we need to replace the sensor more in line with the actual situation requirements, and take into account the synergies between the sensors.

V. Conclusion

monitoring and control model.

The advantages of this model are as follows:

- Friendly user interface which changes according to environmental.
- Simple and compact structure, stable and reliable.
- Automatic adjustment combined with remote control of user.

- High scalability. More sensors more data, better sensors better control.

Due to environmental and capacity constraints, we still have many shortcomings, which are our future research direction:

- The scope of indoor environmental testing and control is limited, user's other requirements will possibly leading to the bottlenecks of the application of system. Therefore, we need to increase the system function to effectively reflect the application value of the system.
- The system interface needs to be further adjusted later.
- With the changes in the environment of the engine room, the collection and processing of relevant data may be difficult, so we need to further develop hardware and software.

The future development of the indoor environment monitoring and control system solutions can be concentrated in more areas. On the one hand it can integrate more types of electronic equipment for environmental monitoring and control, on the other hand, it can also adapt to more different types of indoor environment, automatically set the scene and theme. Therefore, studying and designing an environmental monitoring and control model which can meet the specific needs is of great significance to the practical use and future development of indoor environment monitoring and control system.

Acknowledgment

We suggest that you use a text box to insert a graphic (which is ideally a 300 dpi resolution TIFF or EPS file with all fonts embedded) because this method is somewhat more stable than directly inserting a picture.

To have non-visible rules on your frame, use the MSWord "Format" pull-down menu, select Text Box > Colors and Lines to choose No Fill and No Line.

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