Design and Implementation of Intelligent Home Management System Based on Wireless Control Module

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Abstract. To solve the problem of "difficulty of control" in smart home, this paper proposes the design of smart home management system based on wireless control module. Users can use mobile phones to control household appliances in real time on the Internet, so as to achieve remote control and real-time monitoring, timely handling of emergencies and other functions. Therefore, home life, safety and convenience can be effectively improved.

1. Introduction
The global market of the intelligent home has reached US$48.5 billion in 2015, but then the growth rate slowed down gradually. It is expected to maintain an annual growth rate of about US$8 billion and reach US$71 billion in 2018. According to the survey data of the smart home industry in the United States, the smart home market capacity in the United States in 2016 was 9.715 billion US dollars, which has become the largest country in the global smart home market capacity. The top five countries in the global smart home market are the United States, Japan, Germany, China and the United Kingdom. Among them, the intelligent home market in the United States has a capacity of 9,915 million US dollars; Japan has a capacity of 1,128.9 billion US dollars; Germany has a capacity of 925.6 million US dollars; China has a capacity of 520 million US dollars and Britain has a capacity of 477.5 million US dollars.

The history and present situation of the smart home industry in China is that according to the Research Report on the Development Analysis and Investment Potential of Smart Home Industry in China from 2016 to 2021 issued by China Report Hall, it is estimated that the potential market size of Smart Home in China is about 5.8 trillion yuan, and the total market size of Smart Home in China is expected to reach 225 trillion yuan in 2018, with huge development space. Among them, household appliances of smart home have the highest market share. It is estimated that the overall growth rate of smart home market in China will be about 13% in the next 3-5 years, and the time of market outbreak has not yet arrived.

From the social basis, more and more residential areas have realized broadband access information highway and have been laid to the residential area and entered the family. The basic conditions for the construction and operation of smart home have been rudimentarily met.

From a technical point of view, the technology development of smart community has developed from decentralized control stage, field-bus stage to the stage of TCP/IP network technology. It solves the problem of centralized management of distributed control of each device in smart community and regional networking in smart community.

From the market point of view, with the increasingly fierce market competition, more and more real estate developers actively put high-end home intelligent system into the development of the
building as a new selling point. Soaring housing prices is already within the acceptable range, while investment costs of the smart home have not increased much. With the layout of large real estate groups in the country, new ideas also spread.

2. System Function Analysis

The smart home management system in the basis of the wireless control module makes the control of household goods intelligent and humanized through modern management methods, and achieves the following functions:

- Networking to share data. The information island is broken and the intelligent parking Internet of things platform is built, which use ZigBee technology and USB OTG technology to complete the monitoring of wireless devices and meter reading data query and record.
- Intelligent management of house lighting. It can use remote control and other intelligent control methods to realize the remote control switch, dimming, switching on and off of the whole house lighting and the effect of many kinds of one-button lighting scenes such as "meeting guests, cinema". It can also use timing control, telephone remote control, computer local and Internet remote control and other control methods to realize functions, so as to achieve energy-saving, environmental protection, comfort and square of intelligent lighting.
- Electrical control. It is safe and intelligent to use weak current to control strong current. Intelligent control of water dispenser, socket, air conditioner, floor heating, projector and fresh air system can be realized by remote control, timing and other intelligent control modes. It can avoid the influence of repeated heating of water dispenser on water quality at night. It can disconnect and drain electricity to avoid potential safety hazards caused by heating of electrical appliances when nobody is at home. The floor heating can be controlled regularly or remotely so that you can enjoy comfortable temperature and fresh air immediately after you get home.
- Family entertainment. Background music and videos can be shared in the house. It is in any house of the family, such as garden, living room, bedroom, bar, kitchen or bathroom, that music and video can be shared to achieve the purpose of physical and mental pleasure.
- A variety of security measures. Through the door magnetic switch, emergency help, smoke detection alarm, gas leakage alarm, broken glass detection alarm, infrared microwave detection alarm and other functions to prevent burglary.

3. Thoughts and Framework of System Implementation

Wireless communication transceiver module is the core part of smart home management system in the basis of wireless control module, which has wireless and wired control function, wireless communication and network communication function, sensor signal acquisition function. Among them, this system uses wireless communication module to communicate with the external network server and the local smart phone terminal in real time, and uploads the collected data in real time. It accepts the control commands of the server or mobile terminal to control the local machine and the extension-controlled equipment; 433MHz wireless communication with the extension is used to transmit the commands of the server and the mobile terminal to the extension, and reads the sensor information of the extension.

As shown in Figure 1 below, the intelligent home management system based on wireless control module consists of four modules: ARM main control unit, information acquisition of extension room, equipment control of extension room and information receiving and receiving module.
4. Key Technologies of System Implementation

4.1. Infrared technology

Infrared technology studies the generation, transmission, transformation, measurement and application of infrared radiation. Usually, it is divided into three parts: near, medium and far infrared. Near infrared refers to the wavelength of 0.75-3.0 micron; mid-infrared refers to the wavelength of 3.0-20 micron, and far infrared refers to the wavelength of 20-1000 micron. In spectroscopy, the methods of band division are not uniform. Some people use 0.75-3.0 micron, 3.0-40 micron and 40-1000 micron as near infrared, mid-infrared and far-infrared bands. In addition, due to the absorption of infrared radiation by the atmosphere, only three important "window" areas are left, i.e. 1-3 micron, 3-5 micron and 8-13 micron, which allow infrared radiation to pass through. Therefore, in military applications, these three bands are called near infrared, mid-infrared and far-infrared respectively.

The infrared radiation characteristic of infrared technology is applied in intelligent home management system based on wireless control module. The equipment control module is divided into two categories: infrared emission module and relay output module. Among them, the infrared transmitter module uses infrared technology to capture and transmit signals. Then data is submitted to the device control module in real time.

4.2. Sensor technology

Sensor is a kind of detection device, which can sense the measured information and transform this information into electrical signals or other required forms of information output according to certain rules to meet the requirements of information transmission, processing, storage, display, recording and control.

The application of sensors in the intelligent home management system based on wireless control module
module is also a key module, which includes temperature sensor, humidity sensor, illumination sensor, air sensor and infrared sensor. A variety of sensors can transmit real-time information such as temperature, humidity, illumination, air and infrared ray to ARM main control board for processing. There are many types of sensor modules, thus the characteristics and practicability of various sensors should be taken into account in the selection. The selected sensors in the system are: dust sensor (SYHITECH dust sensor DSM501A in Korea), human infrared sensor (HC-SR501 human infrared induction module (pyroelectric sensor), illumination sensor (PO188), noise sensor (environmental noise detection module), temperature sensor (NTC thermal resistance 10K), etc.

4.3. Wireless control technology
The smart home management system based on wireless control module uses the mobile phone to control the wireless communication module to achieve the goal of controlling the information terminal. The smart home management system is also composed of three main functional modules: ARM main control board, sensor data acquisition module and equipment control module. The smart home management system is then interconnected by wireless local area network to achieve many control functions of transmitting data and controlling information. The structure diagram of the wireless transmission control unit of the system is shown in Figure 2.

![Diagram of Wireless Transmission Control Unit](image)

Fig. 2 Detailed Figure of Wireless Transmission Control Unit
The host address settings include host IP, host MAC, host sub-net mask, gateway, remote server IP and remote server TCP port. The name of the host is provided by the ID address of the host, and the control of mobile phone access is accomplished by the remote server in the external network and by wireless communication in the internal network.

5. System Solution
The specific solution of the smart home management system based on wireless control module is to take the control of wireless control module as the core, and interconnect the communication between host and mobile terminal, host and server, host and slave, host and equipment to realize the functions of information collection, data processing and command transmission.

5.1. Host and mobile terminal
Host and mobile terminal initiate TCP connection to host directly through WLAN under a wireless router and in the same LAN. After successful connection, mobile terminal communicates with host through WLAN. When there is no external server, the mobile phone can automatically find the host in the LAN.
5.2. Host and server
The host forwardly initiates TCP connection to the server. After successful connection, the server sends registration confirmation to the host and then the host sends back its own setup data. By comparing the corresponding setup data with the information in the database, the server can send out control information. Specific connectivity conditions are as follows:
- Host sends Ping package to server regularly to let server know the IP address of host. After the server knows the IP address of host, it accesses the host through browser.
- In addition to informing the IP address to the server regularly, the host is slave to the server and is always in the mode of reply, as opposed to the way of communication between the server and the mobile terminal.
- The control commands issued by the server include room number, device number, command coding information and others.

5.3. Master and slaves
The master and slaves use 433MHz wireless communication. The communication mode is the master-slave mode that the host polls the slave to obtain sensor data. When the mobile terminal or server sends the slave device control commands, the host transmits the command to the slave and controls the equipment in the slave room to run.

5.4. Host and equipment
After receiving commands from servers and mobile terminals, the host controls the operation of related devices through 315MHZ transmitter module, 433MHZ transmitter module and infrared transmitter unit.

6. Conclusion
In this paper, a smart home management system based on wireless control module is proposed to solve the difficulty of control of household appliances. With the application of infrared technology and sensor technology, the real-time control of household appliances is realized. In addition, users can also use the data acquisition information provided by the system to determine the use of household appliances and use safety, reduce waste of electricity, effectively remove the potential safety hazards caused by electricity, thereby enhancing social energy conservation and emission reduction, stability and harmony. What’s more, each module of the system can achieve more control functions through expansion, which plays a certain role in promoting the follow-up development of smart home technology.

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