Research on the Application of Wireless Sensor in the Design of Curtain Automatic Adjustment System

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Abstract. With the development of science and technology and the progress of wireless sensor network technology, a variety of intelligent electronic products are used more and more widely in people's lives. High technology and intelligent technology have entered residential home users from intelligent buildings, and home intelligent technology has become a cutting-edge technology topic. The development of mobile Internet provides a new platform for home decoration, which is of great significance in promoting the formation of smart families and smart communities. Curtain is an important element in interior decoration design. It is of great practical value to develop a mobile virtual display system that can manage curtains and provide curtain decoration effects. The design idea of modularization is adopted, and the design process of wireless communication module, relay module, key module, power protection and level conversion module of the system is emphatically analyzed. The basic working principle and operation method of the system are introduced, and the server and client software based on TCP communication protocol are designed to realize the remote control of curtains through the Internet or personal mobile devices. The actual results show that the scheme can be applied to the home or office environment, and has the characteristics of high stability and simple operation.

Keywords: Wireless Sensor; Automatic Curtain Adjustment; System Design; Intelligent Home Furnishing.

1. Introduction

With the growth of the world economy and the progress of science and technology, people's material living standard has been gradually improved, and housing is not only a living environment, but also a place to enjoy life. People begin to pursue a safe, comfortable, convenient and intelligent living environment [1]. The development of technology continues to push the smart home industry forward. After recent years' development, the dream of intelligent life is gradually moving towards reality. It integrates modern information, automatic control system, network communication and intelligent computer technology to design [2]. Different from the traditional home style, it provides users with the most convenient, efficient and comfortable intelligent lifestyle. With the rapid development of smart home system, more and more smart home products are widely used in our life. The development of intelligent home system provides great convenience for people's life, and gradually becomes a new way of life, which has great development prospects [3]. As far as the current market form is concerned, smart home has become more and more perfect, and the price tends to be popular. It will be introduced by more and more families, with huge market potential. Therefore, the future development of smart home will largely depend on the needs of ordinary families. In order to deal with these problems, it is necessary to develop a comprehensive, efficient and scalable home information management system, collect home information and data, set up a complete database, query and process information through computers, networks and remote devices, so that users can instantly understand and process complete information data, complete the function of monitoring and controlling home equipment, thereby enhancing user experience and solving problems [4]. The Internet of Things makes full use of the new generation of IT technology in all walks of life. Specifically, it embeds sensors into various objects and combines them with the existing Internet to achieve the integration of human society and physical systems, enabling people to monitor and manage machines, equipment and facilities to achieve a "smart" state [5].

It is of great significance to remotely control household appliances through the Internet in smart home and smart office. Curtains are widely used in home and office environments, so it is of great practical significance to study how to realize automation and intelligence of curtain control [6]. Curtains play an important role in the design of indoor soft clothes. They not only have the functions of blocking light, preventing dust, blocking wind and reducing noise, but also have strong expressive force, such as improving the form of indoor space, softening the stiff lines of indoor space, enriching indoor colors and setting off indoor atmosphere. Different colors and styles of curtains with different indoor decoration styles will produce different visual effects. There are many kinds of curtains and their styles are extremely diverse. For dealers, it is obviously unrealistic to show the decorative effects of all curtains in kind [7]. Usually, dealers only show a few classic scenes of curtain decoration, but the curtains displayed in this way are just the tip of the iceberg, and it is difficult to meet the needs of consumers [8]. The software technology and hardware facilities in mobile terminals are constantly developing, and the equipment performance is steadily improving, such as the computing power of CPU and the graphics processing capacity of GPU. The unique hardware devices of mobile terminals, such as sensors and touch screens, are not available on PCs. Reasonable use of these hardware can produce excellent interaction effects. Therefore, the curtain virtual display system based on mobile terminal can better meet the needs of users and has higher practical value.

2. Design of Automatic Curtain Adjustment System

2.1 Overall System Structure

Remote control of household appliances via the Internet is of great significance in smart home and smart office. For example, the utilization rate of sunlight and light in traditional laboratories is low and electric energy is wasted. The shading curtains and laboratory lighting are manually switched on and off, which are often shielded by shading curtains when the sunlight is not direct. At the same time, the laboratory lighting phenomenon causes unnecessary energy consumption waste [9]. When no one is using the laboratory, all the blackout curtains are shielded, all the lighting lights are turned off, the infrared monitoring alarm mode is turned on, and the remote monitoring mode is turned on by the administrator's computer or mobile phone; When students use the laboratory, open the automatic light control mode, and control the shading degree of the shading curtain and the number of laboratory lights opened according to the preset light intensity setting value, so as to maximize the use of sunlight and save electricity [10]. If the light control effect is not ideal, the manual operation mode can be adopted. With the help of the network, users can control the opening and closing of the curtains at home or office or inquire about the curtain status through clients such as computers or PADs. The system adopts modular design method, mainly including STM32F103 core processor module, Wi-Fi wireless communication module, memory module, key module, power protection and level conversion module, relay module, server and client, etc. The system structure is shown in Figure 1.

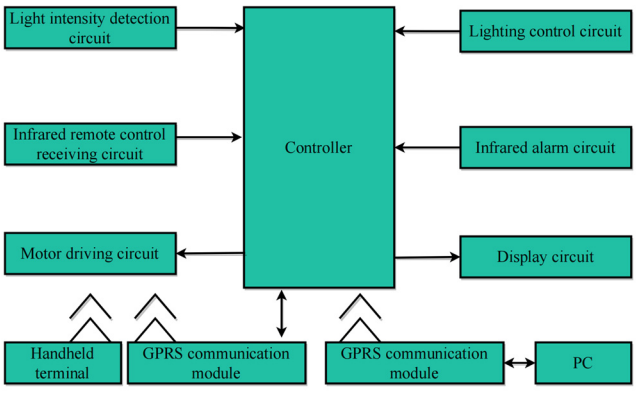

Figure 1. System structure diagram

This system takes STC89C52 as the control core device, which is used to complete the control functions such as detecting light intensity, relay switch control and motor drive control, LCD screen control output and remote monitoring. Photoresistor is used as the light intensity detection device, and the light intensity detection circuit is composed of photoresistor and A/D converter PCF8591. Through this connection mode, the remote control of smart home can be realized, which greatly facilitates users' use. Data are stored in the database, and different data are stored in different tables, which is convenient for users to query and manage data.

The main issues to be considered in the selection of wireless network are: 1. the functional characteristics of wireless network communication itself, network energy consumption, node communication energy consumption and distance, and network data communication rate; 2. Cost consumption caused by communication energy consumption of the network itself; 3. The user's own needs and experience are also a key technical factor. The reason is that the equipment is not in the same network and the system lacks a unified communication network. Therefore, the only way to build a smart home system is to let all devices join the same network. Only by realizing home networking, can we achieve home intelligence, and wireless communication is the ideal way to build a network. Wireless communication technology refers to the transmission of information through the propagation of electromagnetic waves in free space. Because there is no limit to the connection, the equipment can move freely within the family, which has practical significance in many cases.

2.2 System Hardware Design

This module is the core of the system's communication with the server and router, and its main function is to receive network data and send data outward. The module adopts WM-G-MR-09 chip, which is a Wi Fi wireless communication chip, supports IEEE802.11b/g wireless communication protocol, supports SPI and SDIO interface modes, and has the advantages of small size, low power consumption, wide wireless range, and fast transmission rate. The user opens the client software and clicks the corresponding button to control the opening and closing of the electric curtain. The client communicates with the GSM module by sending short messages. The reason for choosing the short message mode is that it is simple and reliable, and does not rely on the Internet and the General Packet Radio Service (GPRS) network, so it is more stable, there will be no problem that users can't control the curtain without Internet. PCF8591 is a A/D conversion chip with four analog inputs. It outputs the digital signal after A/D conversion through I2C bus. This design connects the SDA and SCL of the 9th pin of PCF8591 with the microcontroller, and the microcontroller completes the light intensity signal acquisition through this pin. The research and development of system design should be based on the daily needs and overall experience of home users, and should aim at meeting the requirements of home users. Therefore, before the overall design, it is necessary to analyze the market demand for users' functions and experiences.

Aiming at the disadvantages of previous home system design, most of them can't fully realize wireless communication transmission, including some intelligent residential and office equipment. Therefore, in the R&D and design of products, the overall experience of users should be taken into account on the premise of meeting the basic requirements and functions of products, and people-oriented operation should be intelligent and automatic. According to the analysis of users' needs, based on the different basic functional needs and experiences of each household user, several basic needs are proposed below. (1) Remote monitoring of home environment; (2) Audio real-time monitoring; (3) Home appliance automation; (4) Security monitoring; (5) The system is designed independently. At the same time, wireless network communication is also more in line with the characteristics of home intelligent communication. Wireless networking technology mainly includes Bluetooth, Wi Fi, ZigBee wireless technology, etc. Bluetooth technology is a wireless technology for short distance wireless connection between devices. One of the main ways of communication between devices in a short distance (generally within 10m) is to connect devices through Bluetooth. Wi-Fi connects computers with mobile devices such as mobile phones and tablets in a wireless way, and realizes communication. ZigBee technology is a set of standard wireless LAN protocols, which is

formulated according to IEEE802.15.4 standard. Table 1 shows the comparison of the main parameters of Bluetooth technology, Wi-Fi technology and ZigBee technology.

Table 1. Main parameters of wireless technology

Standard	Operating frequency band	Transmission mode	Safety measures
Bluetooth technology	2.4GHZ	Point to multiple power	1600 frequency hops per second, 128 bit key
Wi-Fi technology	2.4GHZ	Point to multiple power	Unable to set security key
ZigBee Technology	868/915MHz2.4GHz	Point to multiple power	32,64 128 bit key

In the internal network of smart home system, the main information transmitted in the network is control information and environmental information, and the data of these two kinds of information is not large. However, because there are a large number of nodes in the network, low power consumption and low cost become the primary consideration when choosing networking technology. Not only that, ZigBee technology has large network capacity, good stability and strong networking capability. Therefore, this system chooses ZigBee technology as the internal networking mode of smart home system.

3. System Design and Implementation

3.1 Software Design of Smart Home Gateway

As the core part of the system software design, the home gateway is mainly responsible for the communication between the system home and the external environment and the connection of one-to-many sensor nodes. While the system realizes the control of each functional sensor node, it is also responsible for the information monitoring of each sensor. In the process of network communication, not only the coordinator needs to work and communicate with the network, but also other sensor function nodes need to support the coordinator. There are many sensor nodes in the home network. Before working, the nodes should first join the selected network. Search the network in the communication environment of the node system, and then send a join request, and the requested network will choose whether to allow it to join. Its joining ways can be divided into joining the network through connection, rejoining the network, and isolating nodes. The restart function is carried out by the network layer and the application layer to send and receive the request signal. The restart of nodes can be divided into hot restart and cold restart according to their functional attributes and methods. The restart mode and whether the network address and its attributes are retained or reset after restart are determined by the parameter WarmStart. TRUE indicates hot restart and FALSE indicates cold restart. The software design program is designed according to the functions of various types of nodes. First, initialize the parameters corresponding to the node circuit after the node is connected to the network, and start the network access. After joining the network, according to the instructions issued by the home gateway coordinator, the instructions are processed and judged, and the corresponding functional operations are executed for data acquisition and processing. Then send the data required by the gateway to the coordinator, and then forward it to the home gateway to complete the corresponding functional operations.

The fluorescent lamp in the room acts as a router, which is mainly responsible for the transmission and forwarding of commands, and sending messages received from the gateway to other corresponding sub routes or terminal devices. The network terminal node is composed of intelligent devices in the smart home network, receives commands from the superior routing, and works according to the commands. Since the control terminal of the microcontroller uses DC 5V power supply, and the relay output terminal of the control lighting circuit is AC 220V, in order to avoid bringing the electromagnetic interference of the AC terminal into the DC circuit of the control

terminal, an optocoupler isolation circuit is added between the microcontroller and the relay. If the system is in the automatic mode, it will receive the indoor light intensity value measured by the BH1750 sensor, compare it with the threshold value set by the system in advance, and execute the corresponding opening and closing operation. For the selection of threshold value, it can be set arbitrarily according to the user's needs. It is suggested that when the light is too strong or it is dark, the curtains should be closed and opened the rest of the time. After repeated tests, it is more appropriate to open the curtains when the output light intensity is between 100 and 1 200 cd, and close the curtains in other cases. FCS 2.5-5-WES is a special rectifier module, which can convert 220V AC voltage to 5V DC voltage for output. It has the characteristics of small size, good stability and small error. The LM1117-3. 3 chips can reduce 5V voltage to 3. 3V voltage for output.

3.2 Experimental Verification

After the software is coded, it doesn't mean that the whole development work has been completed. Many other tasks still need to be completed, including software testing. The main purpose of software testing is to test software performance, detect vulnerabilities and performance in software code, prevent various problems such as software crash and inoperability during running, and constantly improve user experience. There are many methods of software testing, and different methods have different testing processes. After the modules are connected according to the above connection diagram, connect the motor of the electric curtain with the relay, that is, connect the forward and reverse lines of the motor with the live wire respectively. Pay special attention to the fact that the forward and reverse lines of the motor must not be connected together, otherwise the motor will be burned. Test the system. When the "Open" button is clicked, the relay will jump, the electric curtain will open automatically, and the reaction process will not exceed 10s. Considering the security of the system, a login interface can be set. Only when the user inputs the correct user’s name and password can he login to the system and control the electric curtains. The server software installation platform and curtain controller are connected to the same router, which can receive commands from the client and forward them to the curtain controller. The client software is connected to the server through the Internet. Users can place the equipment icon in the corresponding position of the house type drawing, and control the furniture equipment through the control icon. In the process of intelligent device control by operating software, users can also operate in different rooms. The user can first select the room to control. After entering the corresponding room page, the user can see the status and information of intelligent devices in the whole room.

Compared with static testing, dynamic testing is conducted during the process of program running. In the process of system operation, the tester checks what deficiencies exist in the system and how far away from the user's requirements. At the same time, the inspectors can conduct relevant operations on the software to find software code bugs and vulnerabilities. After the terminal node joins the network, the coordinator will assign the network address to the terminal node, and the network address will increase in sequence from 0x796F. In the serial port debugging assistant, you can see that the router node and terminal node have successfully joined the network, and that after they are assigned to the network address, the network is completed. After the terminal node is powered off, you can see the terminal node leaving the network in the serial port debugging assistant. When the power of the terminal node is turned on and the node returns to the network, the coordinator node will reallocate 0x796f to the node, indicating that the network has good self-healing performance. As long as the corresponding short message content (such as open, close, auto) is compiled and sent to the SIM card number loaded in the GSM module, the system can automatically recognize the short message after receiving it, and then complete the corresponding operation according to the instruction. Through the modular programming idea of subroutine call, the complexity of the program is reduced and the readability of the program is enhanced. The program design part consists of light intensity acquisition subroutine, motor drive subroutine, relay control subroutine, infrared decoding subroutine, serial port remote monitoring subroutine and main program.

4. Conclusion

In view of the shortcomings of the existing smart home system, such as complicated use, single function, poor compatibility, high cost and poor self-organizing ability, this paper analyzes people's daily smart home needs from reality, and designs a smart home system based on wireless sensor network, which integrates temperature and humidity, fire and gas, based on ZigBee wireless communication. The automatic curtain remote control system realizes the remote control of automatic curtains through Wi-Fi wireless communication technology and Internet technology. This design has designed the hardware and software for the intelligent control and management of the shading curtains and lights in the laboratory. This system has the characteristics of high detection accuracy, strong sensitivity, stable working performance, simple circuit design, low cost, convenient management and maintenance, and can be implemented as part of the intelligent and information transformation scheme of the laboratory. This system has good expansibility and can be transplanted to home facilities such as air conditioner, electric lamp, humidifier, etc., so as to establish a complete set of smart home system. The actual debugging proves that this method is suitable for most of the home and office use, and has a certain promotion and use value. The next step will be to design the light collection and light control module to combine the curtain with the light and other electrical equipment, so that the curtain has a higher intelligent processing capacity.

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