

Design and Implementation of Intelligent Home Automatic Control and Monitoring System

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Abstract: With the development of social economy and science and technology in China, the performance and application range of microprocessor chips are constantly improving. In the current era, the development of home towards intelligence has become the main trend. Therefore, it is an urgent problem to explore the home control system with stable state, strong practicability and lower power consumption cost. This paper analyzes the current situation of smart home and discusses its automatic control system.

Keywords: Smart Home; Auto-Control; Detecting System

Introduction

Smart home is also called smart house, which belongs to a branch of Internet of things technology. Through the combination of network technology and automatic control technology, the household equipment used in daily life can be remotely monitored and controlled, so as to realize the effect of facilitating people's life. With the continuous improvement of people's living standards, people pay more and more attention to their family environment, which is the opportunity for the development of smart home. The intervention of smart home can greatly facilitate people's life and make people's daily life more intelligent. This technology has a very broad application scenario. With the expansion of urban construction in China, a large number of people gradually flow into the city from the surrounding villages and towns, resulting in the continuous improvement of urban population density and the increasing risk of people's living. How to eliminate fire and other hidden dangers of life safety is an urgent practical problem to be solved. This paper further discusses the control system of smart home, and eliminates the potential safety hazards in the family to the greatest extent through the automatic control and detection system of smart home. In the layout of the overall system, the temperature change is monitored in real time mainly through the temperature control sensor. In case of abnormal temperature, immediately control to cut off the household power supply and send a hazard report to the head of household. This function has strong practicability. For the first time, smart home can also realize the automatic detection of the concentration of natural gas in the air, provide people with a comfortable living environment and ensure people's property safety to a great extent ^[1].

1. Overall framework of automatic control and monitoring system

In the smart home automatic detection and control system, it is mainly divided into several modules, including detection module, control module, communication module, relay module and terminal module. Firstly, through sensor technology, the data parameters of each residence in the room are detected, such as temperature, humidity, concentration of a component in the air, etc. After the sensor completes the data acquisition, it will convert the data into digital quantity and transmit it to the single chip microcomputer for processing. The single chip microcomputer will send the processed information to the terminal through the wireless communication module. Here, the parameter indexes can be observed through app. In unconventional cases, the single chip microcomputer will cut off the power supply and other operations through relays, control the equipment to work or alarm, and send the abnormal situation to the terminal through the communication module. The overall structure block diagram is shown below.

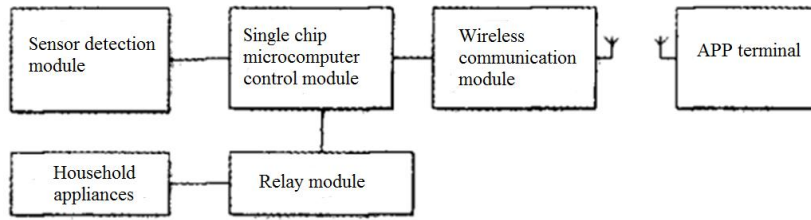


Figure 1. Smart home system structure block diagram.

In the whole control system, there are generally several main design functions. The first is to remotely control the home equipment through the mobile terminal. The relay is mainly used to realize the on-off and other operations to complete the management of the home equipment. The second is to open and close the door through mobile terminal or fingerprint. This part is mainly realized through intelligent lock. It is also a main function to adjust the home environment through the mobile terminal. Based on the function of sensor detection, it can observe and adjust the temperature and humidity of the family through the mobile phone. If the concentration of gas exceeds the standard, an alarm will be given. In family life, the current family safety is also a very important part. Based on the smart home system, it can also realize the supervision of regional safety. If outsiders break into key areas, the mobile terminal will automatically prompt the head of household. In this paper, STM32 microcontroller is used as the core control chip, and WIFI is used in the wireless communication part, so as to build a low-cost and low-power remote control system.

2. Hardware

In the whole hardware control part, STM32 chip is selected as the main controller, and the sensor circuit module is designed based on the control function requirements. In the information transmission, WIFI is used to transmit and receive the control information at the app end, and then after processing and analyzing the control instructions, STM32 chip sends corresponding control instructions to control the terminal to complete the operation.

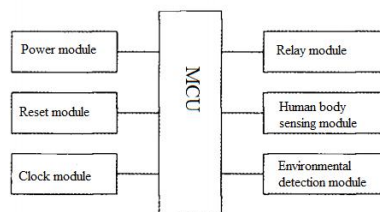


Figure 2. Hardware structure block diagram.

2.1 Core control module

The control module adopts STM32 chip. The working frequency of this chip can reach 72 mhz, and it has high-speed memory inside. There are rich enhanced I/O ports outside. Its functions and the number of ports can meet the control requirements. Based on the minimum control system based on single chip microcomputer, the detection data can be collected by adding sensor monitoring module. After that, connect the WIFI module with the MCU to transmit data wirelessly. In the control of equipment, some relay modules need to be connected to realize on-off control.

2.2 Sensor detection module

In the home sensor detection module, the temperature sensor and smoke sensor are mainly used. The selection shall be made in combination with the specific range and sensitivity of the sensor. In the current sensor module manufacturing, analog quantity is generally converted to digital output, and AD converter is provided in the integrated module. When connected, it can be directly connected with the I/O port of the single chip microcomputer, and the driving work can be realized through the program. Here, the following common sensors are introduced in detail.

2.3 Dhtll temperature and humidity sensor

The sensor can detect the digital signals of temperature and humidity at the same time, and transmit the signals to the microprocessor. Before each sensor leaves the factory, it will be calibrated, and the corresponding calibration coefficient will be derogatory in the module through the program, so as to improve the convenience in use. The digital module acquisition mode greatly improves the stability and anti-interference ability of the whole sensor. In the current application of dhtll temperature and humidity sensor, it has been widely used in automatic control fields such as medical treatment and household appliances^[2].

2.4 ADC and photoresist

Photoresistors are also called photoconductors. When a certain voltage is applied to both ends of the resistance, current will flow through the resistance element. Photosensitive resistance is generally made of aluminum sulfide and other materials, so it has photosensitive characteristics. In the case of illumination, the resistance value of photosensitive resistance will change dramatically, which is characterized by the decrease of resistance value with the intensity of illumination. Based on this characteristic, the photoelectric conversion effect can be realized through the photoconductor in use.

2.5 Wireless module nRF24L01

This is a single-chip wireless transceiver chip, which has the advantages of small size and strong performance. There are 125 optional RF channels in use. The transmission distance of chip signal is about 40m, and the maximum data transmission rate can reach 2Mb/s. its performance is very suitable for home system. When MCU is connected, it realizes data transmission and control through SPI bus, and the maximum rate of its interface can reach 8mbps. In addition, the chip has a standby mode. That is, in the standby mode, the chip will be in the power down mode, but this state is not the power down state. In this state, the contents of the register will be saved, and the average current of the chip will be greatly reduced to ensure the overall energy-saving effect. At the same time, when the instruction is transmitted, it can be activated quickly, which greatly shortens the start-up time.

2.6 Temperature sensor module

Temperature sensor is no stranger to people. This type of sensor is used in electronic thermometer and so on. The sensor model selected here is dsl8820. The sensor has the advantages of small volume, low hardware cost, wide voltage range and strong anti-interference ability. In specific use, users can adjust the temperature resolution of the sensor by programming, so as to meet the needs of different accuracy. The first mock exam is $-55^{\circ}\text{C}\sim+125^{\circ}\text{C}$, and the module integrates A/D converter into the same module. When the signal is output, it will directly output digital signals, and does not require the details of user A/D conversion. When in use, the sensor is a single bus device, so only one data line is needed in the connection to control it, and the connection operation is very simple and convenient.

2.7 Intelligent relay module

In some of current equipment control, the old equipment has good functions. Its disadvantage is that the airport intelligent control module is not available in the original circuit board, so it will cause problems such as failure to connect to the network, resulting in the failure of intelligent control of the equipment. If all the original old equipment is eliminated, it is bound to cause huge cost waste. Therefore, in the design of smart home detection and control system, a part of intelligent control relay module is supplemented and linked with MCU through corresponding ways, so as to realize the control of the equipment through the terminal and achieve the function of intelligent control^[3].

3. Software part

The software design of smart home mainly includes two aspects. They are the design of APP end program and circuit end program. In the whole control port, in order to ensure a good interpersonal interaction experience, the input information and remote control interface also need to be optimized to reflect the remote control information and function options on the mobile terminal. During operation, the control circuit will judge the information by receiving the signal from the mobile terminal, and send corresponding control instructions, and operate the electrical terminal to complete the corresponding operation. The functional block diagram of the software part is as follows [4].

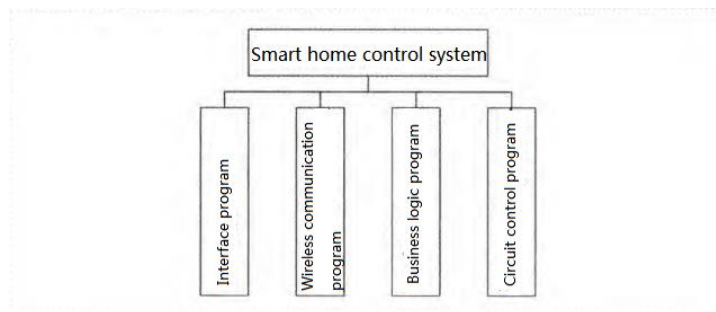


Figure 3. Functional block diagram of software part.

3.1 Single chip microcomputer control program

In the control program of single chip microcomputer in the system, the first link is power on initialization, and ready to receive the data sent by the mobile terminal. After that, make corresponding judgments and actions according to the instructions of the mobile terminal. The overall flow chart is as follows.

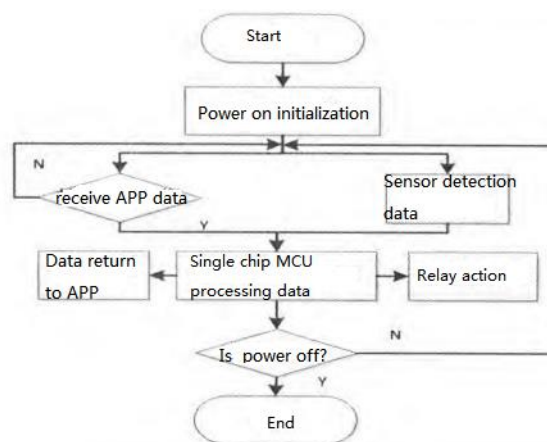


Figure 4. Flow chart of single chip microcomputer control program.

3.2 App control procedure

In the preparation of APP interface in the system, it should be associated with MCU control program to ensure the interaction of instructions and data between them. In the APP program page, the management information of various current smart home devices shall be displayed. At the same time, the remote control of home devices can be realized through the mobile port to ensure the overall convenience. For example, the on-off state of the electrical equipment is controlled through the terminal, or the switch of the lamp is remotely controlled, etc. At the same time, the mobile terminal displays the ambient temperature and humidity, and the environment can be adjusted through the corresponding household equipment. In the page design, switch buttons, labels and other spaces shall be designed for different functions to ensure the simplicity of the overall layout and convenient operation[5].

4. Conclusion

In the smart home automatic control and monitoring system, it can realize the state control of power on and power off of electrical equipment through the mobile terminal. At the same time, based on the page of the mobile terminal, it can observe the state parameters of the environment in real time. In case of gas leakage or other circumstances in family life, the system also has the function of automatic alarm, i.e., sending strong explosion to the head of household through APP. In the test and production of smart home system, we should first divide the modules in combination with the specific functions, and then select, assemble, manufacture and debug the hardware of the modules, so as to ensure that the external equipment can fully meet the requirements.

References

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