

Design and implementation of Smart Home integrated control system

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Abstract: In order to design a convenient, intelligent, low intelligent home system. This paper is based on the STM32 microcontroller. TCP/IP communication protocol is used as the communication mode of Android application. At the same time, the Modbus communication protocol is used as the communication mode of the touch screen terminal and the host. With the infrared remote control module and the thermal sensing module as the auxiliary control, the comprehensive function of the intelligent home control system is realized. Experimental results show that the system is simple and reliable, and it has wide application and popularization value.

Introduction

In recent decades, the rapid development of computer technology in the field of application is also expanding, which is particularly prominent in the embedded field. ARM technology based on a variety of chips from scratch, so embedded in the life of the application becomes more and more widely. Among them, the smart home is a more typical example. At present, domestic smart home system usually is high cost, less application. Intelligent home control system research of practical and innovative, has become an important trend. Therefore, in order to meet the requirements of economic control, it is particularly important to study the practical and convenient smart home system.

This paper designs a kind of smart home control system based on STM32. The purpose is to seek a reasonable system to improve the practicality and economy of the control system^[1]. By selecting high cost of the temperature, video and thermal sensor to achieve the indoor monitoring and control. For different operations, the microcontroller can achieve the corresponding action, with the operation simple and use of flexible and other advantages.

Overall system design

The whole system mainly consists of two parts, the upper computer and the lower computer. The upper computer is composed of a mobile phone based on the Android application program and a communication function of the Modbus protocol, the lower computer is composed of a STM32 controller and various modules. The overall design of the system is shown in figure 1.

In order to realize the intelligent control, first we need to learn all the infrared control appliances infrared frequency encoding, then by the infrared module reuse household appliances infrared emission code, then control the home all the necessary appliances infrared control. The temperature and humidity and relay module are connected directly with the host, which is convenient for the data exchange between the host and the module. Video class modules need to connect to the Internet, and then interact with the APP on the phone.

The design of the upper computer takes into account the redundancy design. When at home, the control is mainly completed by the touch screen, touch screen and host interaction through the Modbus protocol; when the go out, the phone APP to achieve remote control. Running on the Android program based on TCP/IP communication protocol, through the wireless route to the host to send commands, the host receives the command, the analytical control of each extension and then control the electrical equipment or video communication.

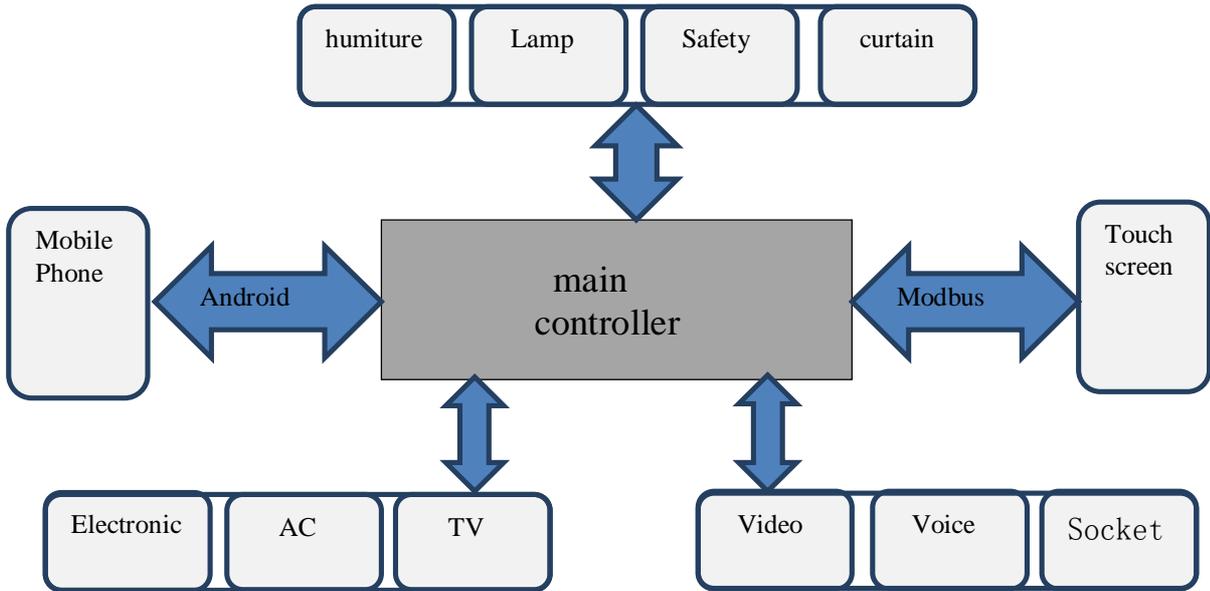


Fig.1 Design diagram of system

System hardware layer design

Infrared module design

Household appliances intelligent control is one of the smart home needs to solve the problem, makes the incompatibility between a variety of infrared remote control and control many household appliances become more troublesome, especially when the need to simultaneously control all the infrared device. Therefore, it is very important to design an infrared module which can control all the infrared control equipment.

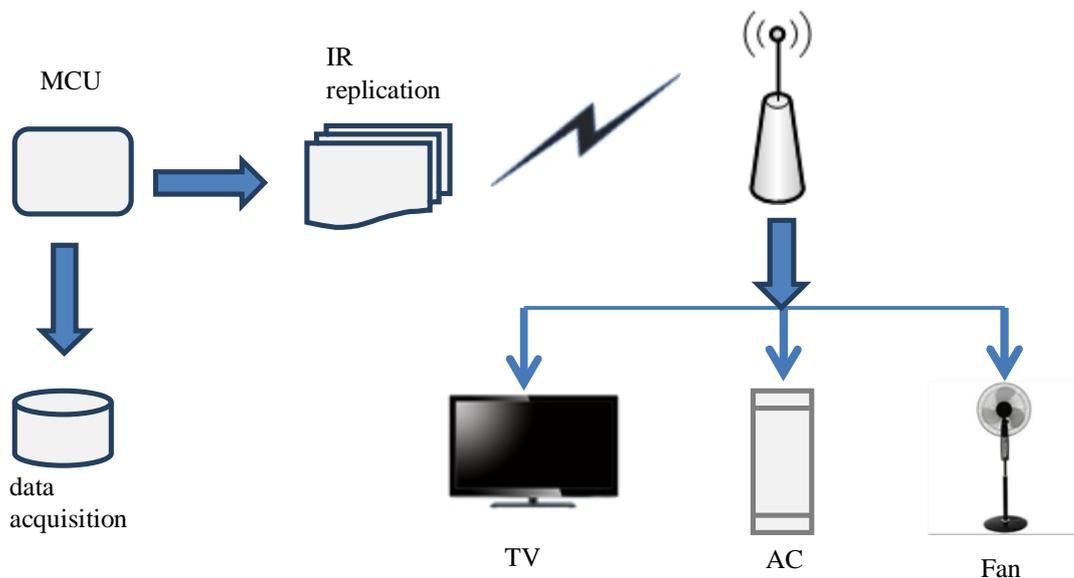


Fig.2 Design of Infrared module

Infrared remote control system is commonly used in coding mode FSK (shift keying), PPM (pulse position coding) and PWM (pulse width modulation) in three ways. On the market a large number of infrared remote control analysis shows that each of the remote control information is transmitted to a positive pulse and a negative pulse composition, followed by the device information and instruction information^[2]. As shown in Figure 3, as long as the record of the entire infrared emission of coded

information, through the MCU control module to be multiplexed infrared code, you can achieve the centralized intelligent control of household infrared equipment.



Fig.3 Infrared remote control buttons encoding

Build infrared circuit composed of a triode and an infrared transmitting pipe, and the logic circuit to generate 38kHz carrier signal transmission, the command signal to through infrared carrier sent to the output circuit in order to achieve the control objective of the infrared device [3]. After testing, infrared encoding experimental design as shown in Figure 4, consistent with the expected goal.

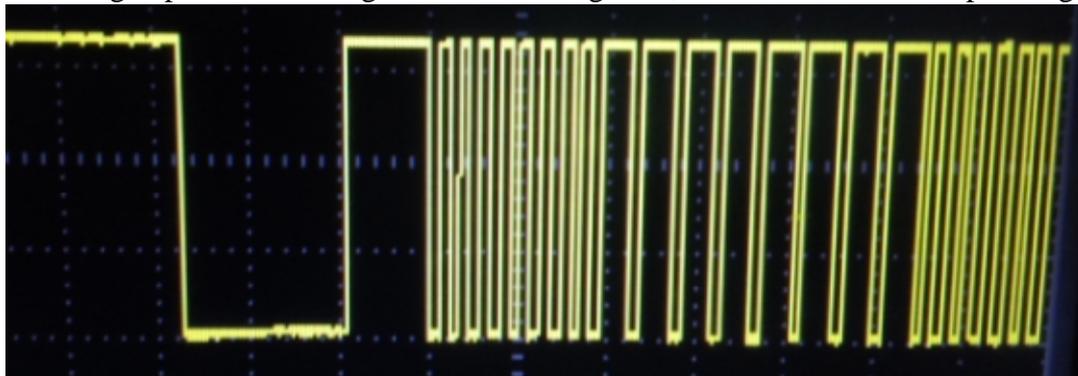


Fig.4 Experimental infrared encoding

Network card module design

STM32F103VET6 is a 32 bit processor based on Cortex-M3 kernel of ARM company. With high performance, low cost, low power consumption [4]. Working frequency of up to 72MHz, with a rich I/O interface, support for the advanced timer, ADC, DAC, SPI, IIC, UART and other peripherals. Through the SPI protocol and STM32 communication on the basis of Ethernet transmission data. Select ENC424J60 chip as the network adapter chip, HR911105A as a socket [5]. Schematic as shown below.

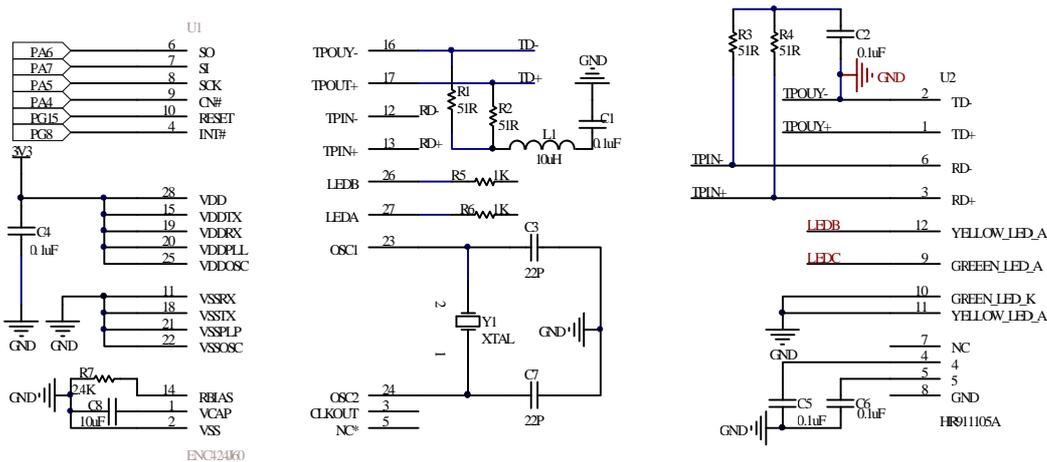


Fig.5 Peripheral hardware circuit

Other modules design

The automatic control of the curtain has three ways: (1)when the detected temperature and humidity limits, automatically open or close the curtains; (2) by infrared transceiver control relay module, so as to realize the automatic control of the curtain; (3) remote implementation of the curtain automatically open and close.

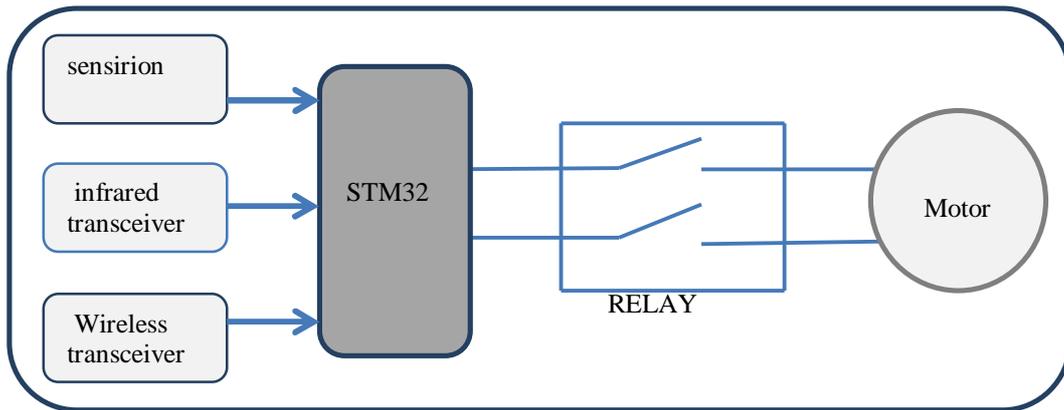


Fig.6 Design of Automatic curtain

Anti theft module design taking into account the doors and windows security two cases. Door anti-theft enable thermal sensor, window anti-theft using infrared sensor. When it detects a person to enable video monitoring, sounding room alarm device, push messages to the phone to remind open video remote viewing.

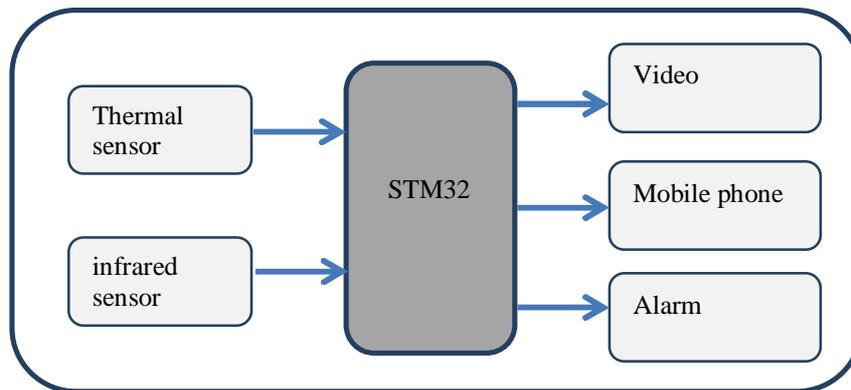


Fig.7 Design of Anti theft

Temperature and humidity detection using DHT11 temperature and humidity sensor module to detect the surrounding environment of the humidity and temperature. Its humidity measurement range: 20%~95% (0 degrees -50 degrees), humidity measurement error: + 5%; temperature measurement range: 0 degrees -50 degrees, temperature measurement error: + 2 degrees; working voltage 3.3V~5V, in the form of digital output.

There are two ways to control the energy saving lamp and the atmosphere light module. First, when the light is detected, the light is automatically turned on and the STM32 controller is used to adjust the atmosphere light.

System software design

Android Program design

TCP / IP protocol is a reliable communication protocol, it at both ends of the communication of the establishment of a socket, thus in the both ends of the communication formation virtual link, once the network link is established, both ends of the program can communicate^[6]. TCP protocol can provide a reliable communication link to the application, can automatically adapt to various changes in the network, as shown in figure 9.

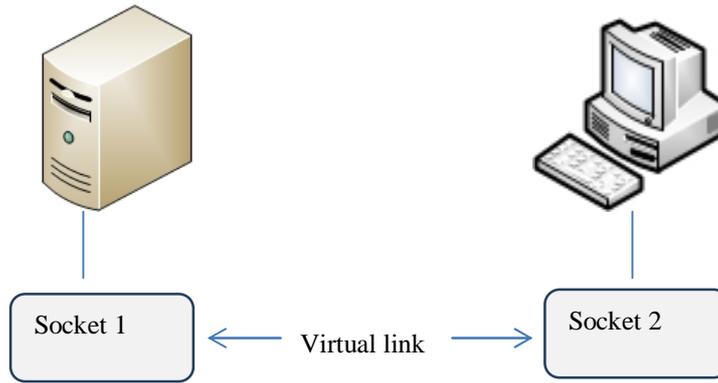


Fig.8 TCP protocol communication

Android (Android) is a kind of mobile phone operating system based on Linux open kernel design of Google company. PC phone APP is based on the Android operating system development. Eclipse development environment, ADT as the development environment, for the development of plug-ins, Java as an object-oriented development language to achieve the development of remote control terminal [7]. In this paper, based on the Android operating system, the main function of the smart phone terminal is video surveillance, intelligent socket control, TV air conditioning control and light control, the program interface as shown in figure 10.

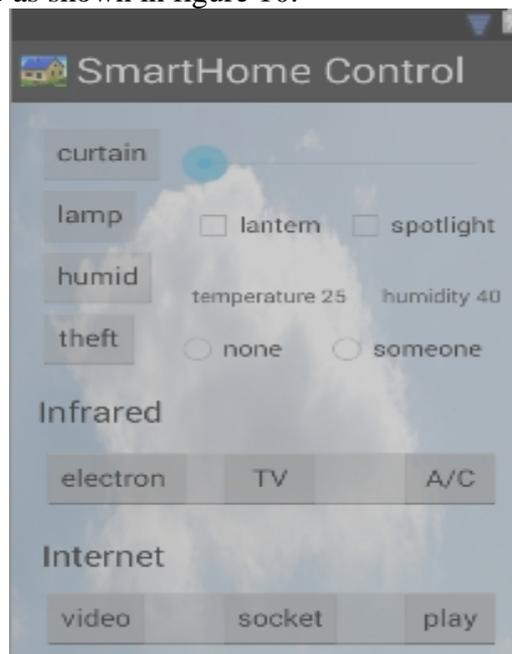


Fig.9 Android application interface

Modbus Program design

Modbus invented by Modicon in 1979, is the world's first real industrial field bus protocol used. Between the touch screen and STM32 using Modbus communication protocol, the protocol can ask from [8] using one of them. The transmission protocol of Modbus has two kinds of ASCLL and RTU. Touch screen using RTU type of PLC mode, communication type selection RS-232. When the controller is located in Modbus under the RTU mode, each complete data frame contains: address code, function code, data, CRC, CRC high low byte byte.

Tab.1 Message frame format of Modbus RTU

| Slave address | Function number | Data address | Data | CRC |
|---------------|-----------------|--------------|-------|-------|
| 01 | 05 | 00 04 | 00 00 | 8C 0B |

When using the RTU mode, there are at least 3.5 bytes between two data frames. And the two bytes in each frame can not be more than 1.5 bytes, otherwise the message frame may be considered wrong.

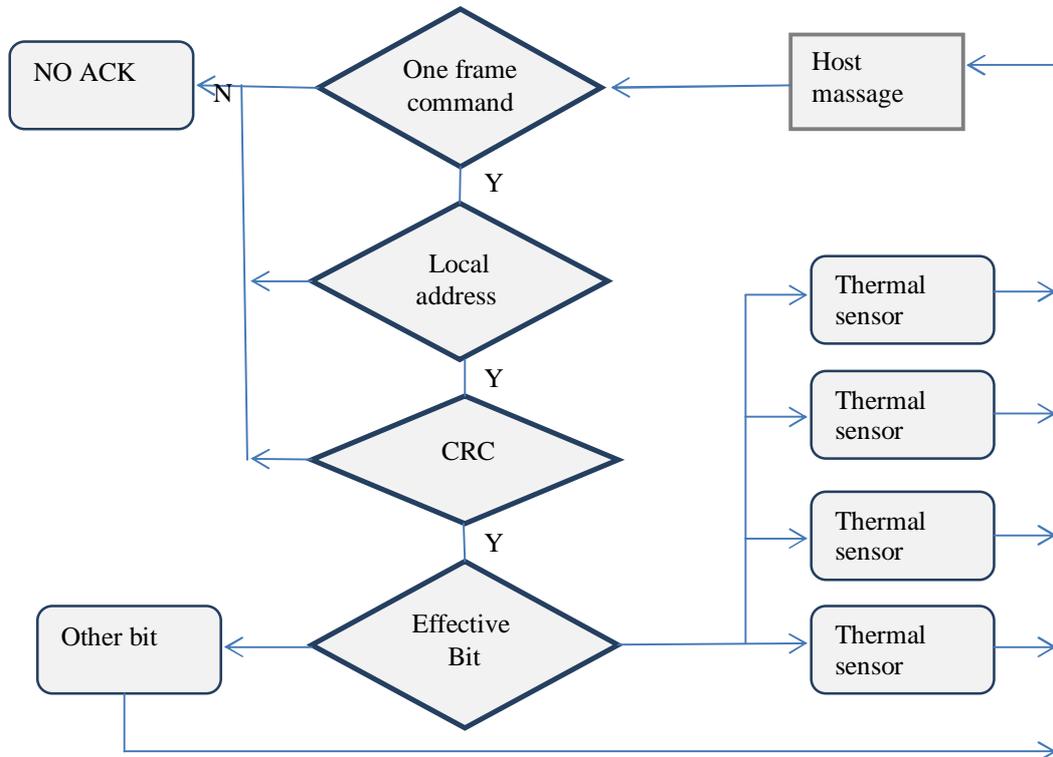


Fig.10 Program flow chart of Modbus

This program will be written to STM32, and then use the serial debugging tools for testing, the results are shown in figure 12.

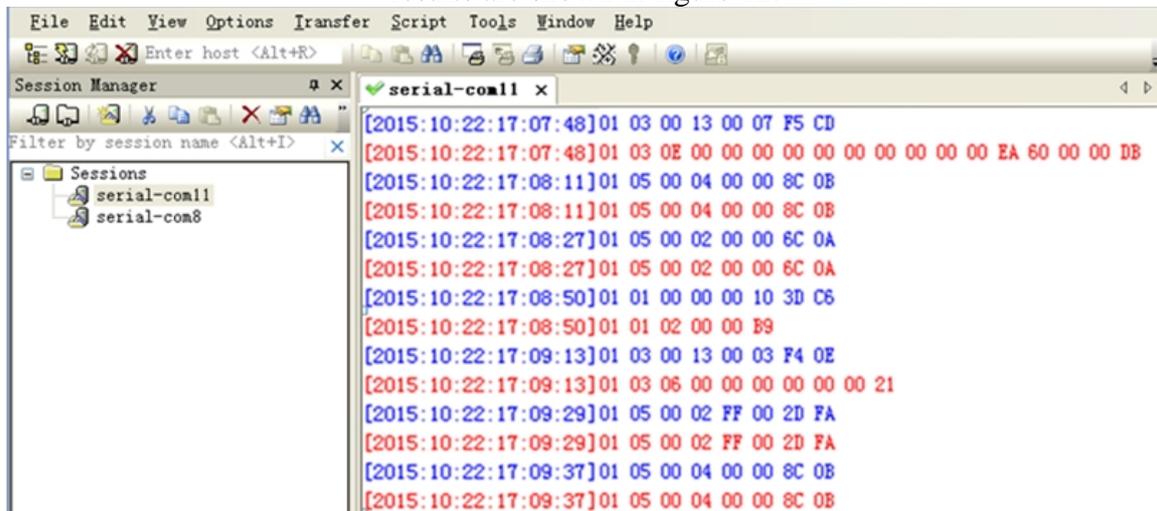


Fig.11 Test interface of Modbus

main controller program design

After the main controller begins to run, the system is initialized to a module. Then open the data listening mode, to get the data from the various modules. And sends the data to the touch screen and mobile phone terminal, so as to realize data collection and send. Mobile phone with touch screen terminal monitoring interactive state. When a button is pressed or when the need for data exchange, through the TCP/IP protocol and Modbus protocol to transmit data to the master controller, the main controller control module to achieve the corresponding functions. The flow chart shown below.

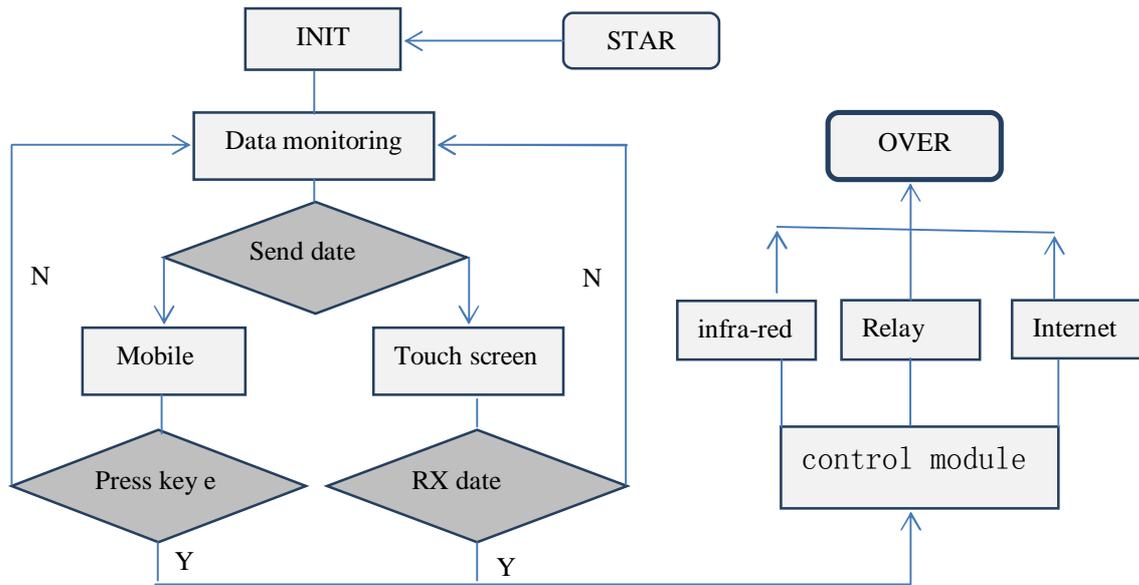


Fig.12 Main controller program flow chart

Conclusions

The flaws in the design of the smart home in the trouble of installation, and does not take into account the impact of housing construction, it became a reason that has been advertised "the future of science and technology", "villa" smart home delays in the popularity^[9]. Therefore, the domestic Internet companies actively explore the development of intelligent Home Furnishing module many, has made great contributions to the popularity of smart Home Furnishing. The future, every family will be Smart Home Furnishing standard, the development of science and technology will become a powerful driving force for the development of Smart Home Furnishing.

Thought tests, The system reliable operation, greatly reduces the cost of system design, to improve the reliability of the system, and formed many mature module, laid the foundation for the future smart home research and development.

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