Design of Simulated Small Smart Home System

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Abstract. With the progress of science and technology and the improvement of economic level, people have a higher pursuit of the quality of life at home, thus promoting the rapid development of smart home industry. This paper mainly focuses on the research of smart home system. A smart home system which can provide people with comfortable, safe and convenient home environment is simulated and designed with STC89C52 MCU as the main control chip. The design and operation of the system are simple, convenient, low power consumption, stable performance and low cost, which has certain practical application value.

1. Introduction

With the rapid development of information age and the continuous development, renewal and application of high and new technology, people are surrounded by various scientific and technological products. Smart home is one of the technologies that have been invented and produced to provide services for people. Smart home provides people with a more secure, efficient and comfortable living and working environment for the original intention of continuous development and improvement. Nowadays, driven by the Internet industry, smart home is becoming more and more colorful, which can satisfy people's pursuit of high quality life to a great extent. In today's society and its future development, smart home will gradually become a common household equipment in people's homes.

Smart home is a research and development based on advanced modern electronic technology such as network communication and automation control. It realizes the monitoring and management of home environment, household appliances and the control of security and alarm system. This topic mainly studies the identification and monitoring of indoor environment temperature, humidity and smoke concentration in smart home system. Through the control of single chip computer, the household equipment is integrated for unified management, and the detected data of environmental factors and the working status of household equipment are displayed through the display module for users to understand. When abnormal phenomena occur in the environment, the user is prompted by the alarm system.

2. Overall Design Scheme of the System

The overall design of the system mainly takes the minimum system of single chip computer as the core control unit, and communicates with the temperature and humidity acquisition module, LCD display module, smoke detection module, buzzer alarm module, key control module and relay module, which constitute the peripheral circuit, and collects the temperature and humidity sensor to the home
environment. The values of degree and humidity are processed and displayed by LCD display module. Smoke sensor is used to monitor the information of smoke and gas in indoor environment.

When the information of temperature, humidity and smoke concentration exceeds the normal range, the buzzer alarm system is activated, and the indoor environment is controlled automatically by the switching state of the corresponding devices of heating, cooling, dehumidification, fan and window. The system uses relays to simulate the switches of various household appliances, and keys to set the range of temperature and humidity.

In addition, the LED lamp is used to simulate the indoor lighting, and the human infrared sensing module and keys are used to control the working status of the LED lamp. The overall design block diagram of the system is shown in Fig.1.

![Figure 1. Block diagram of overall scheme design of the system.](image)

3. **Hardware Circuit Design**

According to the overall design scheme, the appropriate hardware devices are selected to design the hardware circuit. This system mainly uses STC89C52 single chip computer, HC-SR501 human body induction module, DHT11 temperature and humidity module, MQ-2 smoke sensor module, LCD12864 LCD screen and other devices. Several key unit circuit designs are described in detail below.

3.1. **Minimum System of Single Chip Microcomputer**

The smallest system of single-chip computer is composed of single-chip computer, reset circuit and clock circuit. The design of the smallest system circuit is shown in Fig.2. The design of this system uses portable power supply as the power supply to provide a stable 5V voltage for the system, which can ensure the normal operation of the single-chip computer system.

![Figure 2. Design of Minimum System Circuit for Single Chip Microcomputer.](image)
The reset circuit, as shown in Fig.3, consists of a 1K resistor and a 10UF capacitor plus keys. It plays an important role in reset in the system. By resetting, the microcontroller can make mistakes in the process of operation, or return to the initial state of operation when the machine is dead and unable to run, and then start running again. The reset circuit designed by this system can reset the single chip computer by power-on or press the button to a high level on the RST pin.

![Figure 3. Reset Circuit.](image)

As shown in Fig.4, the clock oscillation circuit of the system is composed of a crystal oscillator (frequency is about 11 MHZ) and two capacitors (30pF) connected to the 18 pins (XTAL2) and 19 pins (XTAL1) of the single chip computer, which play a key role in controlling the working rhythm of the system. The clock circuit provides the MCU with a regular clock rhythm, which enables the MCU to execute various instructions in the clock rhythm. Only with the clock circuit can the normal work of the MCU be guaranteed. This clock rhythm can be controlled according to the need, but it can’t control the content of the work of the single-chip computer. We write a program to control the single-chip computer in the clock rhythm to achieve functional requirements.

3.2. Design of Temperature and Humidity Signal Acquisition Circuit

The connection circuit of DHT11 temperature and humidity acquisition circuit is designed as shown in Fig.5. A 4.7K pull-up resistor is connected in parallel between DHT11 sensor and MCU in the circuit. This has pull-up effect, improves the accuracy and stability of DHT11 data transmission, and plays a current limiting role, avoids burning out devices due to excessive current. Temperature and humidity sensor has four pins. It only need s three wires to connect with the outside world, namely VCC, GND and DATA. Among them, NC is not connected in suspension. The P1.0 port of MCU is connected to the DATA output port of the module to communicate, and the temperature and humidity data collected by the sensor are read.

![Figure 5. Design of Smoke Concentration Detection Circuit.](image)

3.3. Design of Smoke Concentration Detection Circuit

Among them, DO is the output port of digital signal and AO is the output port of analogue signal. If the output port of analog signal is used, AD conversion chip needs to be connected externally to convert analog signal into digital signal so that it can be read directly by single chip computer. Compared with the output port of DO digital signal, the design of hardware circuit and the compilation of software function program are relatively complex. So in this system, we choose the way of digital communication, adopt the DO digital signal output port which is more convenient to control, and
connect the DO digital signal output port with the PI.6 pin of the single chip computer to communicate. The design of smoke detection circuit is shown in Fig.6.

MQ-2 smoke sensor transmits a TTL level digital signal to MCU according to the detected environmental information, and MCU controls other systems to do corresponding work according to the level signal read. The sensitivity of the sensor to smoke can be changed by adjusting the potentiometer knob in the module.

When MQ-2 smoke sensor is used, it is preheated after electrification for about 20 seconds. The purpose of this is to make the measured data more accurate. It should be noted that the sensor contains electric heating wire inside, so the sensor heating is normal after electrification, on the contrary, if it does not heat, the sensor may not work properly.

3.4. Design of Relay Circuit

Relay is an electric control switch. When the coil is electrified at both ends, the magnetic field generated by the coil pulls the dynamic and static contacts of the armature into the circuit. When the two ends of the coil are cut off, there is no gravitational effect, and the armature returns to its original position and then disconnects the circuit. According to the characteristics of the relay, it can be used as an automatic control switch for electronic devices such as remote control or automatic control. In the design of this system, relay is used to simulate the switch of household appliances, and the single chip computer is used to control the automatic switching of its working state.

Five relays are used in this system to simulate the control switches of heating, cooling, dehumidifying, fan and window of household appliances. The pins of the relay are IN, GND and VCC respectively. The connection mode between the module circuit and the MCU is shown in fig.7. The temperature rising device is controlled by the PI 1.2 pin of the MCU, the cooling device is controlled by the PI 1.3 pin, the dehumidifying device is controlled by the PI 1.4 pin, the fan is controlled by the PI 1.5 pin, and the window is controlled by the PI 1.7 pin, so that the devices can be opened. Automation control of customs. The working mode of the relay module is low level trigger.

3.5. Design of Display Circuit

LCD12864 LCD and MCU are connected as shown in Fig.8. The data terminal D0-D7 of LCD12864 is connected with the PC port, the RS port is connected with the PC 22.6 pin, the R/W port is connected with the P2.5 pin, the E port is connected with the PC 22.7 pin, the LED + is connected with the positive pole, the LED is connected with the negative pole, and the V0 port is connected with the potential. The device adjusts the clarity of its display, but not connected enough to clearly display the content, VO in the system design is suspended.
4. Design of System Software
In the design of software program, modular programming is adopted. The whole software system design is divided into three sub-program modules: main program and led12864.c, dht11.c and key.c. Then the whole system program is managed in main program and the functions of each sub-program are called. Its main program design flow chart is shown in Fig.9. Firstly, I/O port is initialized, then temperature, humidity and smoke concentration are detected by sensors, the data are transmitted back to the single chip computer, displayed by the display screen, and the temperature, humidity and smoke information in the environment are monitored in real time. When exceeding the prescribed value, buzzer alarm is activated.

5. Conclusion
According to the design principle introduced earlier in the article, the system physical production is completed. This section mainly uses the method of simulating the external environment changes to test the functions of the system, and analyses the test results data.

Taking temperature and humidity acquisition function test as an example, the indoor multi-point data were tested at different times. The location is the entrance of the dormitory (A), the middle of the room (B), and the indoor toilet (C). The time is 12 am and 8 pm. The temperature (°C) and humidity (%) test results are shown in Table 1.
According to the table data test results, for the same time temperature and humidity test data of different points in the dormitory room, the temperature difference is only 1 °C, the humidity difference is only 1%. For the same time temperature and humidity test in the dormitory room, the temperature difference is 1-3 °C, the humidity difference is 1-2%. In the dormitory room, the same point is shown by the mobile phone. Time data test showed that the difference of temperature and humidity was 1-3 °C and 1% at noon (12 o'clock), 1-4 °C and 1-2% at night (8 o'clock).

Because the indoor ventilation of dormitory is different and the humidity of toilet is relatively large, the errors of the data measured at different points are normal. For the test of day and night, the temperature at noon will be higher, the humidity is lower, the temperature will be lower at night, and the humidity will be higher, which is day and night. The temperature difference on the mobile phone causes, and the change tends to be in line with the normal phenomenon. Because the mobile phone shows the temperature of a region, its range is wide, and the temperature and humidity collected by the system in a small range are quite different, but the error between the two is within the allowable range.

**Table 1. Test Results of Temperature and humidity data.**

| Test time | Test place | 1  |  2  |  3  |  1  |  2  |  3  |
|----------|-----------|----|----|----|----|----|----|
| 12am     | A         | 25 | 86 | 25 | 87 | 26 | 87 |
|          | B         | 26 | 86 | 26 | 86 | 26 | 86 |
|          | C         | 25 | 87 | 26 | 87 | 26 | 88 |
| 12am     | Mobile Display | 23 | 87 | 23 | 87 | 23 | 87 |
|          | A         | 23 | 87 | 23 | 87 | 22 | 87 |
| 8 pm     | B         | 23 | 86 | 22 | 87 | 22 | 87 |
|          | C         | 24 | 88 | 23 | 88 | 23 | 89 |
| 8 pm     | Mobile Display | 20 | 88 | 20 | 88 | 20 | 88 |

Through data analysis, the temperature and humidity detection data of the system temperature acquisition module is accurate and stable, and the change of the detection data accords with the actual change of temperature and humidity, so that the temperature and humidity acquisition module can work normally.

Similarly, after debugging, the system achieves the task requirements of indoor lighting, temperature and humidity collection, smoke detection and automatic control of analog switches of household appliances, and achieves the expected functions.

The system has low design cost, stable performance, flexible and simple operation, and has certain practical application value.

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