Research on the Smart Home Design based on Single-chip Microcomputer

Hongbo Hao [1], Fengzhi Dai [1, 2]*, Haokang Wen [1], Jichao Zhao [1]

[1] Tianjin University of Science and Technology, China,

[2] Tianjin Tianke Intelligent and Manufacture Technology CO., LTD, China
*E-mail: * daifz@tust.edu.cn*
www.tust.edu.cn

Abstract

The research of the home is mainly reflected in the indoor environment temperature, humidity, smoke concentration and the human body to monitor. This indoor environment monitoring system takes the STC89C52 monolithic computer as the control core, using MQ-2 smoke sensor, temperature and humidity sensor, infrared sensor, buzzer and other modules, the main function is to detect the indoor environment temperature and humidity, smoke concentration exceeded the predetermined value, immediately for sound and light alarm; and when the body is detected, immediately to the sound and light alarm. This system can be used in shopping malls anti-theft, Warehouse anti-theft, bank anti-theft and other occasions. The device for the current people's daily life has a strong guiding significance.

Key words: 52 single-chip microcomputer, temperature and humidity detection, MQ-2 sensor

1. Introduction

1.1. Research background and significance

In recent years, with the advancement of science and technology, intelligent environmental monitoring has become a topic of common concern to mankind. Smart cities and smart homes bring together control systems such as lighting, fire detection, air conditioning, and security alarms via the Internet to implement intelligent temperature and humidity adjustment, appliance lighting control, fire and burglar alarm control, and environmental detection automatic adjustment functions[1]. Compared with the past and present, the biggest difference between smart homes and traditional homes lies in the intelligence of the home environment. The five most significant advantages of smart home are comfortable, safe and efficient.

This design first describes the development prospects of smart home in human life. Secondly it introduces the concept of the overall framework of this topic and the selection of circuit module components of each module, then it draws the circuit diagram of each module and analyzes the principle[1]. Then it writes the design of software program. Finally it summarizes and predicts the design of this system. This design enables the system to operate efficiently and reliably.

1.2. Function Overview

The design of this project mainly consists of five parts, namely temperature and humidity detection, smoke concentration detection, human infrared sensing, alarm information and display screen information[2].

- The DHT11 temperature and humidity sensor send the detected data to the LCD1602A LCD screen through a single-chip microcomputer. If the

detection result is not within the setting range, an audible and visual alarm is issued.

- The function of the smoke sensor can analyze and check the indoor carbon dioxide, methane and smoke concentrations. When the concentration of these gases exceeds a predetermined alarm value, the LED lights up and the buzzer sounds an alarm.
- When the owner leaves the house or rests, he can enter the password on the keyboard of the security system to arm, and the system will enter the arming state. When someone invades the room, the human body infrared sensor can quickly locate the human's range of motion and can send corresponding command signals along with the area where the human body moves.

2. Overall system design

2.1. Design scheme

This design topic is the design of an indoor environment monitoring system based on a single chip microcomputer. The target of the design service is the home of an ordinary family. The reference style chosen for this design is about 120 square meters, with three bedrooms, one living room and one bathroom[3].

2.2. System composition

This system is divided into several modules: the single chip microcomputer (STC89C52) contains a watchdog timer, which supports parallel editing and ISP reline editing[2]. Temperature and humidity sensor (DHT11), this chip has strong anti-interference ability, fast execution of instructions, cost-effective. Liquid crystal display module (LCD1602), MQ-2 smoke sensor, buzzer alarm. The anti-theft module uses a passive infrared sensor. This chip has high cost performance, high security, and strong detection.

3. Hardware circuit design

3.1. Main control circuit

STC89C52 is a low power, high performance CMOS 8-bit microcontroller with 8K system programmable flash memory. The minimum system includes a single-chip microcomputer and its required power, clock, reset, and other components, which can keep the single-chip microcomputer in a normal operating state at all times. Circuits such as power supply and clock are necessary conditions for the single chip microcomputer to operate. The minimum system can be taken as the core part of the application system. By performing memory expansion and A/D expansion, the single chip microcomputer can complete more complex functions.

3.1.1. Reset circuit

The reset operation selected in this design is performed manually. The capacitor in the circuit and the switch used are operated in parallel to meet the predetermined requirements. The resistor R1 plays a role of protecting the circuit. The schematic diagram of the reset circuit is shown in the Fig.1 below.

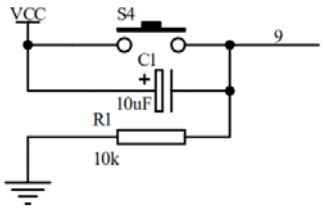

Fig1. Reset circuit schematic

3.1.2. Clock Circuit

This design uses an internal clock circuit, and the selected external crystal is 12MHz. C1 and C2 are load capacitors with a capacitance of 30pF. The function of the two capacitors is to improve the frequency stability and the quickness of oscillation. The selection range of the capacitor is 5-30pF, and the oscillation frequency selection range of the crystal is 1.2-12 MHz.

3.1.3. Interrupt System

Interrupt technology is mainly used for real-time monitoring and control. It is required that the single-chip microcomputer can respond to the service request made by the interrupt request source in time, and make a quick response and timely processing. This is achieved by the on-chip interrupt system. When the interrupt request source issues an interrupt request, if the interrupt request is enabled, the single-chip microcomputer temporarily suspends the main program currently being executed and transfers to the interrupt service handler to process the

interrupt service request. After the interrupt service handler has finished processing the interrupt service request .It returns to the original interrupted program (breakpoint) and continues to execute the interrupted main program[4].

3.1.4. Temperature and humidity detection

DHT11 is a temperature and humidity composite sensor with a calibrated digital signal output. It uses special digital module acquisition technology and temperature and humidity sensing technology[3]. The sensor includes a resistive humidity sensing element and an NTC temperature measuring element, and is connected to a high-performance 8-bit microcontroller. Therefore, this product has the advantages of excellent quality, ultra-fast response, strong anti-interference ability, and high cost performance. The actual sensor used this time is shown below. The physical picture of DHT11 sensor，as shown in the Fig.2 below.

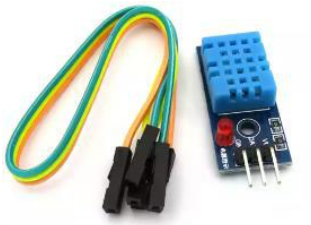

Fig.2 DHT11 sensor physical map

3.2. MQ-2 smoke module

The MQ-2 smoke detection module mainly uses the MQ-2 gas sensor to detect hydrogen in natural gas, liquefied petroleum gas, coal gas and other gas components. This chip has the advantages of strong anti-interference ability, high measurement accuracy and fast response. This chip is mainly composed of ceramic tubes, sensitive layers, measuring electrodes, heaters and other sensitive components[4].

3.3. Alarm module

Light-emitting diode is short for LED. It uses a semiconductor device to convert physical signals into electrical signals. In addition, the component uses tungsten wires and phosphors to emit different colors of light as alarm signals. This design scheme is to use LED lights to emit different colors of light as an alarm signal.

3.4. LCD Module Design

LCD1602A uses a digital liquid crystal display, which is easy to operate, small in size, fast in response, high in sensitivity, and clear in picture.

3.5. A/D conversion circuit

In this design, ADC0832 uses a single-channel analog signal input. The connection between ADC0832 and STC89C52 should be 4 data lines: chip select signal CS, clock signal CLK, data output DO, and data output DI. It is an 8-bit resolution operation and uses two channels using A/D conversion elements.

3.6. Button module design

The key design of this project uses a stand-alone keyboard. Because the different output and input pins in this type of key will be stringed together with a certain coded key. The other port is usually grounded. Generally, the single-chip microcomputer operates at a high-potential position in the initial state.

3.7. Design of human detection module

This design uses passive infrared detectors for human detection. Passive infrared sensing technology uses infrared light-sensitive devices to convert trace infrared rays emitted by living organisms into corresponding electrical signals, which are amplified and processed. It can distinguish moving organisms from falling objects[5]. At the same time, it also has the characteristics of large monitoring range, good concealment, strong anti-interference ability and low false alarm rate. This chip is suitable for home use, with low cost and high security.

4. Software design

After the control system powered on, it will reset to the initial state which is the system initialization[6]. This process includes initialization of smoke sensor MQ-2, ADC0809 initialization, temperature and humidity sensor initialization, and so on. If it exceeds the predetermined value, an audible and visual alarm will be issued. If not, it will continue to test the next cycle.

5. System testing and conclusion

5.1. Hardware testing

Before testing the hardware of this design, it makes sure that the welding of the good circuit is correct. The key1 is to set the temperature, humidity and smoke module. Key2 is the plus key, key3 is the minus key, and key4 is the arm disarm key. When key1 is pressed, you can set the upper and lower limits of temperature and humidity and the upper limit of smoke. When the detected humidity falls below the lower limit, the fifth LED turns red and alarms simultaneously. When the indoor smoke concentration is detected to be higher than the set value. The first LED light turns white and an alarm is issued. When the key4 is pressed, the sixth LED turns purple and the LCD screen displays the letter “Z”. After about 20 to 30 seconds, the system enters the armed state and the LCD screen displays the letter "B" The arming status LED is off.

5.2. Software testing

First the switch is turned in the lower left corner of the simulation software and the buzzer will keep alarming. This is because the AT89C52 single-chip computer in the simulation. Software does not have the function of saving data when power is off. When the indoor smoke concentration is lower than this value, the sound and light alarm will stop. For the human infrared sensor module, the LCD screen displays "Z", and the LCD screen displays "B" for about 20 to 30 seconds. The indoor smoke concentration value is shown in the Fig.3 below.

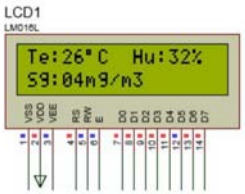

Fig.3 Indoor smoke concentration value

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