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Design of Smoke Alarm Device Based on STM32C8T6 Single-chip Microcomputer

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Abstract: At present, with the popularization of high-power electrical equipment, more and more fires occurred. In order to protect the safety of people's lives and property, the prevention and monitoring of fires has become an urgent problem in today's society. The system is a single-chip microcomputer smoke alarm system designed for schools, families, hotels, cinemas, office buildings and public places. It uses STM32C8T6 single-chip microcomputer as the controller. When the device detects signals through the MQ-2 smoke sensor, then inputs the signals to the single-chip microcomputer after A/D conversion. And the buzzer is also controlled through the single-chip microcomputer to realize the smoke alarm. The system has the characteristics of high reliability, low cost, and easy maintenance.

Keywords: STM32F103 microcontroller, smoke sensor, alarm

I. INTRODUCTION

Beginning in the 1930s, the developed countries start to research and develop smoke sensor products, and made great achievements. According to statistics, before the beginning of the 20th century, the average growth rate of production and consumption of smoke sensor products in the United States was 27% to 30%, which was significantly ahead of other countries. China began to develop smoke alarms in the early 1970s. From the initial oil refining system to alarms suitable for various dangerous industries, it has formed an alarm industry with diversified models and complete varieties.

Of course, gratifying the number of alarms has also increased substantially. The development method of this industry in China is to first learn from foreign advanced technology and production technology, and then research and play on its own, so that the products also have distinctive Chinese characteristics.

This article introduces a smoke alarm system that is based on STM32C8T6 single-chip microcomputer

The smoke concentration is monitored by a smoke sensor, and the analog quantity is converted into a digital quantity through the DA (digital-to-analog) conversion module, and then sent to the single-chip microcomputer. The LCD1602 liquid crystal display shows the current detected data. For the smoke concentration value, the upper limit of the smoke concentration alarm can be set by pressing the button. When the smoke concentration exceeds the upper limit, the buzzer will alarm.

II. MODULARIZATION OF THE ENTIRE DEVICE HARDWARE SYSTEM

The smart car can be divided into the power circuit module, alarm circuit module, LCD1602 liquid crystal circuit display module, esp8266 module circuit, smoke sensor circuit module.

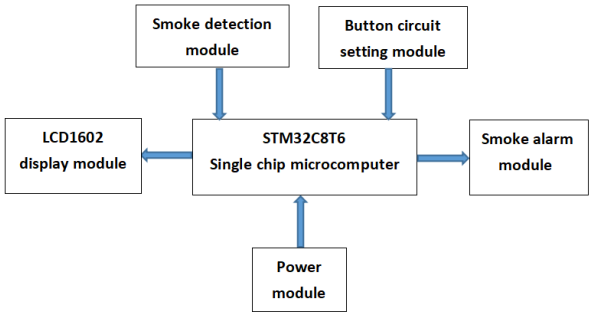

Fig.1. The hardware system structure diagram

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This device can realize functions such as smoke density detection, liquid crystal display, upper limit setting of smoke density, and alarm. The smoke alarm system uses STM32C8T6 microcontroller as the main control chip. The hardware system structure diagram is shown in Figure 1.

2.1 STM32C8T6 Single Chip Microcomputer Module

The STM32F103C8T6 microcontroller is chosen as the controller. This single-chip microcomputer comes with 2 AD conversions, which is convenient for us to avoid the need to add an external ADC for conversion when designing smoke and CO. STM32 has very powerful communication and control functions, and has 5 serial ports for communication, so for some modules that require serial communication and do not need to be converted by dual serial modules such as CD4052, this is widely used in the market.

The STM32 single-chip microcomputers can work with a variety of different clock module, so occupy a place in products with stricter power consumption requirements. The starting crystal part of the STM32C8T6 series adopts RTC, a low-load method, and does not have the traditional cheaper cylindrical crystal oscillator. The number of pins is 48. The working frequency is 72MHZ. The one-chip computer has 3 ordinary timers and 1 advanced timer. The microcontroller has two 2-bit/16-channel ADC analog-to-digital conversions. Using 3.3V voltage regulator chip, can guarantee the maximum output current of 300MA. Support ST-LINK and JTAG debug download. The storage resources are 64kb byte FLASH and 20byte Sram.The physical object of TM32C8T6 microcontroller is shown in Figure 2.

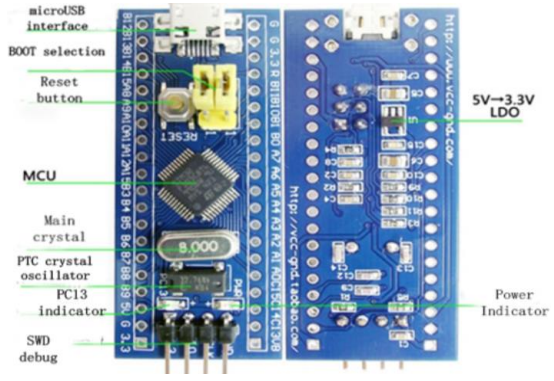

Fig.2. MCU physical picture

2.2 Power Circuit Module

The single-chip microcomputer adopts DC 5V power supply, and the power module includes a 3-pin power socket and a 6-pin power switch. The power socket is used to connect an external power plug, and the power switch is used to control the *on* and *off* of the entire single-chip circuit.

The port 2 pins of the power socket are grounded, and the port 3 pins are only used for fixing and have no special use. The port 1 pins are connected to the port 3 pins of the power switch, and the ports 1, 3 and 3 of the power switch are connected to the pins of the power switch. The pins of port 4 and port 6 have the same function and are used for the positive output of the power supply.

The pins of port 2 and port 5 of the power switch are used as the grounding pins of the single-chip microcomputer. When in use, the relative selection is adopted, that is, the pins of port 1 and port 3 are selected as the output, then the port 5 pins shall be selected as the grounding pins, and the selection 4 , 6 pins are used as output ports, and port 2 pins are used as ground pins.

This time, the voltage of the sensor and wireless transmission chip of the single-chip microcomputer is within 5V, so the voltage of 5V is sufficient. If there are sensors with 12V or other voltages, a boost module can be used to boost 5V to a higher voltage for power supply. The power circuit designed this time is shown in Figure 3.

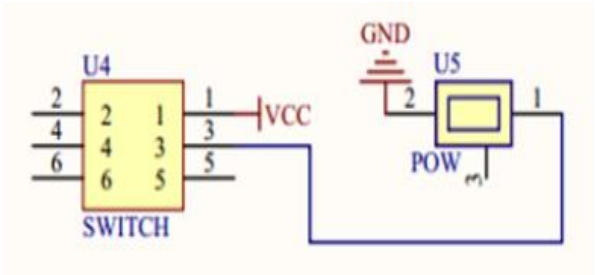

Fig.3. Power circuit diagram

2.3 Alarm Circuit Module

The alarm module designed this time uses a buzzer to give an alarm. When the smoke concentration is detected by the smoke sensor that exceeds the set temperature and humidity or the upper limit of the smoke alarm, the STM32F103 microcontroller controls the transistor to drive the buzzer to buzz and alarm [1].

One end of the buzzer is connected to the pin of the triode, and the other end is grounded. The transistor adopts

PNP transistor, its main function is to amplify the current and level characteristics, because the current of the single-chip circuit is very small, and it cannot provide the current required by the buzzer. After the driving current is amplified by the transistor, the current is amplified by 200 times to drive the buzzer call the police. At the same time, the pull-up resistor of the triode acts as a current limiter to prevent excessive current from breaking down the buzzer. The design power circuit of the alarm module is shown in Figure 4.

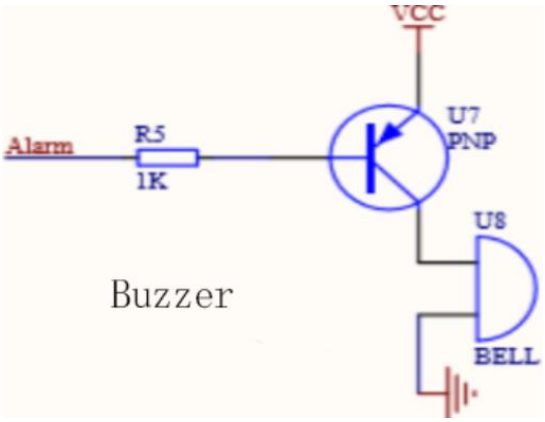

Fig.4. Alarm circuit diagram

2.4 LCD1602 Liquid Cristal Display Module

This design uses LCD1602 LCD (liquid crystal display) as the output display. LCD1602 is an industrial character liquid crystal. From its name, it can be known that the display has 2 lines of output, each line has 16 characters, which can display 16*2 at the same time (32 characters).

The LCD1602 screen uses the characteristics of liquid crystals to achieve the control area display by changing the voltage, and finally display the desired graphics or numbers.

Pin 1 is the power ground pin, which is connected to the GND of the microcontroller. Pin 2 is the VCC power input pin, and its working voltage is 5V. Pin 3-VO pin can adjust the display brightness of the display screen, pin 4-RS pin is used for register selection, when high level is used as data register, when low level is used as instruction register, pin 5 is RW read and write signal , Used for data reading and writing. Pin 6—EN pin is the enable terminal, high level reads information, low level executes instructions. Pins 7 to 14 are 8-bit bidirectional data segment ports, and pins 15 and 16 are the power supply pins for the backlight.

When communicating with the single-chip microcomputer, connect to port P0 with a pull-up resistor in the middle for connection. This design displays the detected temperature, humidity and smoke concentration values on the LCD1602 LCD screen, and displays the setting process of the upper limit value of temperature, humidity and smoke concentration. The pin connection diagram is shown in Figure 5.

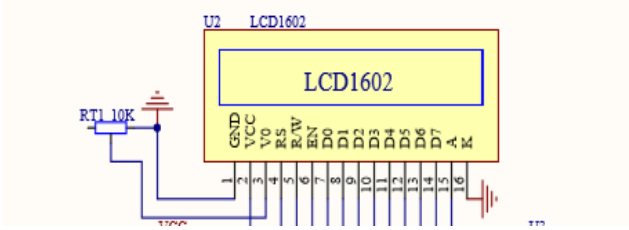

Fig.5. LCD1602 pin diagram

2.5 MQ-2 Circuit Module

This design uses a common gas-sensing smoke sensor. Its working principle is to use tin dioxide with low conductivity in clean air. When there is combustible gas in the environment where the sensor is located, the conductivity of the sensor and the gas concentration are the linearization ratio, through the AD0832 digital-to-analog conversion module, can convert the signal quantity into a digital quantity, output it to the single-chip microcomputer, and finally display it on the LCD1602 liquid crystal display. The schematic diagram of the circuit is shown in Figure 6.

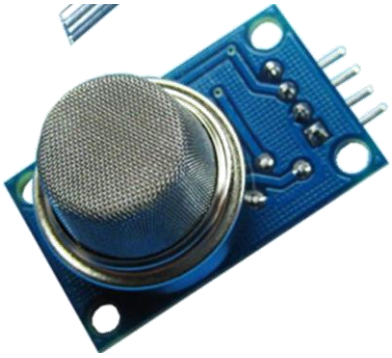

Fig.6.1. MQ-2 physical map

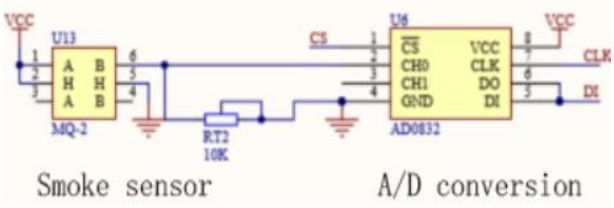

Fig.6.2. MQ-2 wiring diagram

2.6 Button Control Circuit Module

The button control circuit of the single-chip microcomputer is a circuit composed of three micro-switches in parallel. One section of the button is connected to the bidirectional I/O port of the single-chip microcomputer, and the other end is grounded .

When the key switch is in the open state, the I/O pin is disconnected from the ground, and the I/O pin is in a high level state at this time. When the button is pressed, the I/O pin is grounded, and the high level is set to the low level at this time, and a low level signal is returned to the microcontroller.

The principle of key switch detection is the detection of high and low levels [3]. The upper limit of the smoke alarm in this design is set by the button. Button 1 represents increase, and button 2 represents decrease. Figure 7 is a schematic diagram of the button control circuit.

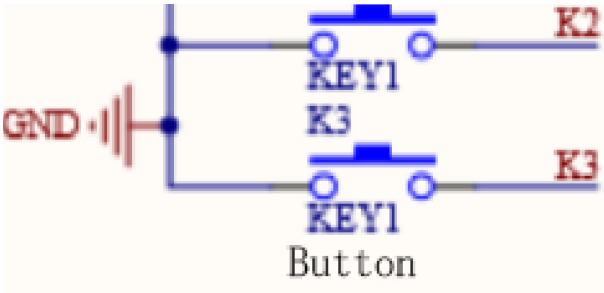

Fig.7. Button circuit diagram

III. SYSTEM SOFTWARE DESIGN

All modules are initialized, the smoke concentration sensor detects the current smoke concentration, and the key is pressed to set the upper limit of the smoke concentration alarm [2]. When the temperature or humidity or the upper limit of the smoke alarm is exceeded, the single-chip microcomputer drives the triode to control the buzzer to alarm. In addition, the single-chip microcomputer transmits the detected smoke concentration value data to the LCD1602 for display. The entire main flow chart is shown in Figure 8.

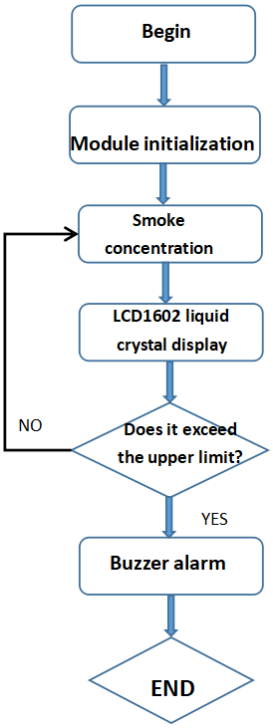

Fig.8. Program flow chart

IV. EXPERIMENTAL TEST RESULTS AND ANALYSIS

The overall appearance of the hardware is shown in Figure 9.

Fig.9. Device physical map

Set the smoke density to 25%, just as shown in Figure 10, the current smoke density to 20%. The alarm concentration has not been reached, and the alarm device has not issued an alarm message.

Fig.10. LCD1602 display when there is no smoke

Set the alarm concentration to 25%. When the MQ-2 sensor detects that the current smoke concentration exceeds the set value (just as shown in Figure 11, the smoke concentration is 31%), the indicator light will light up (Figure 12) and the buzzer will sound an alarm.

Fig.11. LCD1602 displays when there is smoke

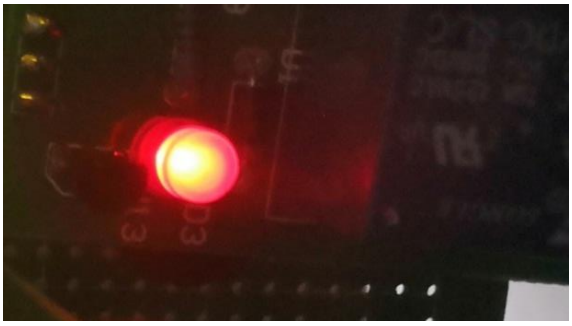

Fig.12. The indicator lights up when there is smoke

V. CONCLUSION

This article describes a smoke alarm system based on the STM32C8T6 microcontroller chip. The design effect of smoke detection and alarm is realized by the MQ-2 smoke sensor. In the design process, the quality of the sensor has an occasional impact on the smoke detection. A smoke sensor with higher accuracy can be used to improve the detection accuracy.

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