Application of Micro Control Unit Technology in Intelligent Electronic Products

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Abstract. With the continuous development of science and technology in China, a variety of intelligent electronic products have emerged, and the level of intelligence is also getting higher and higher, providing people with better services. The reason is that micro control unit technology plays a key role. Therefore, this paper takes MCU technology as the research object, analyzes its application in intelligent electronic products, and elaborates the hardware and software design of smart-home smoke fire alarm based on STM32 MCU, so as to improve the effectiveness of intelligent equipment and products and meet the needs of economic construction and social development.

Keywords: Intelligent Electronic Products; Micro Control Unit; Smart Home; Fire Alarm

1 Introduction

With the continuous development of China's economy and science and technology, a large number of intelligent electronic products have emerged, which has completely changed people's lifestyles. It makes human life more convenient and interesting, and the key to intelligent electronic products is also the micro control chip (MCU) [1]. The application of MCU effectively improves the system architecture and operation mechanism of intelligent products, improves the intelligent level of products, and enables equipment and products to play their due functions and roles [2]. Due to the advantages of low power consumption, small size, high performance, low price, etc., MCU has been integrated with sensors, the Internet and other emerging technologies in recent years, making it widely used in industrial control, consumer electronics, medical electronics, automotive electronics, communications and other fields.

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2 Application of MUC in intelligent electronic products

2.1 Application of intelligent dimming

The searchlight is widely used on the stage, and its effect is getting better and better, which also makes people's life more beautiful. In the modern stage, the intensity and color of the searchlight, as well as the control and movement of the searchlight area, have great flexibility. It needs to change with the changing scene and atmosphere of the stage to reflect the artistic effect of the stage light, which has become an indispensable part of the performance and has a high market value [3]. Below, analyze the application of the MCS-51 series AT89C51 in searchlight. Its principle is to use ADCO832 analog-to-digital conversion chip to monitor the voltage change of the photoresist in real-time, and MCU makes it compare with the preset value and adjust the PWM ratio to control the current, so as to achieve the purpose of automatic dimming.

2.2 Application of Motor Energy Saving Control

Motors are widely used in industrial control and various electrical drive systems. In China, the energy consumption of motors account for 60% of the total domestic power generation, while the operating efficiency is lower than 30% in developed countries [4]. It cannot effectively improve production efficiency and restrict the development of China's productivity. At the same time, the electric energy utilization rate of motors is low, wasting electric energy resources and increasing industrial production costs. Therefore, in order to ensure the quality and efficiency of industrial production, it is of great significance to study the energy-saving control of motors. The following introduces a circuit for energy-saving control of an AC asynchronous motor based on MCU technology. In practical work, the power factor and efficiency of the AC asynchronous motor will change with the load’s change, especially in light load, the power factor and efficiency will be very low. Six thyristors are used to form a three-phase voltage-regulating circuit. When the motor is running, the six thyristors are contacted in turn at a certain angle. The trigger angle of the thyristors is controlled by the MCU, so that the power supply voltage can be changed to supply the motor according to a certain rule, thus keeping the power factor and efficiency of the motor in an optimal state, and achieving the purpose of energy-saving control.

2.3 Application of vehicle monitoring system

With the deepening of reform and opening up, people's living standards are constantly improving, and the number of cars is soaring. Congestion has become a major problem hindering the development of urbanization [5]. In order to alleviate this phenomenon, it is critical to improve the level of vehicle control system on the basis of strengthening the construction of public transport and urban planning management. Combining the development of MCU technology and vehicle control system is an important means to optimize the vehicle control system. The system mainly uses GPS

technology to upload the geographic location information of vehicles in real-time, and combines MCU technology with network technology to realize the information tracking of vehicles, improve the performance of the vehicle monitoring system, and realize human-computer interaction.

3 Analysis of typical application cases

This paper takes the design of a smart home smoke fire alarm based on STM32 as a case, deeply analyzes the specific application of MCU technology, and provides a reference for the wide application of MCU in intelligent electronic products.

3.1 Overall scheme design

This system's block diagram is shown in Figure 1. The system consists of MCU, smoke sensor, temperature sensor, key-press circuit, alarm circuit, display circuit, water pump drive circuit and wireless communication module. First, set the alarm threshold value of temperature and smoke concentration by the key circuit or the mobile phone APP, and then compare the data transmitted by the temperature and smoke concentration sensor with the preset threshold value. Once the threshold value is exceeded, give an alarm, and start the water pump drive circuit to extinguish the fire.

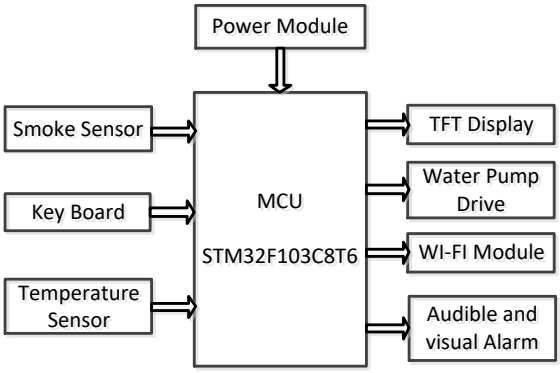

Fig. 1. Block diagram of fire alarm system

3.2 Hardware design

3.2.1 MCU.

This system is based on STM32F103C8T6 MCU. It is a 32-bit microcontroller based on an ARM Cortex-M3 core. It has 37 GPIO ports, two 12-bit AD converters, four 16-bit timers/counters, and is equipped with I2C, SPI, USART, CAN bus and other common communication interfaces [6]. It can be connected with various sensors and external control devices to meet the needs of most users.

3.2.2 Smoke sensor circuit.

The system uses the MQ135 chip to collect the indoor toxic gas. The gas sensing material used in the MQ135 gas sensor is tin dioxide (SnO2) with low conductivity in clean air, which is highly sensitive to ammonia, sulfide, and benzene vapor, and is ideal for monitoring smoke and other harmful gases. It and the dual voltage comparator LM393 form the smoke sensor module circuit, as shown in Figure 2. It has four interfaces, VCC, GND, DO and AO from top to bottom. VCC is connected to the positive pole of the 5Vpower supply, GND is connected to the negative pole of the power supply, DO is the TTL switch signal output, AO is the analog signal output, which is the voltage signal. If the voltage is 0.1-0.3V, it means there is no smoke, and the voltage at the highest concentration can reach about 4V. In this system, A0 analog signal output is used to connect to the PA1 port of the MCU through two 10K voltage-divider resistors, and the connection circuit is shown in Figure 3

Fig. 2. MQ-135 smoke module

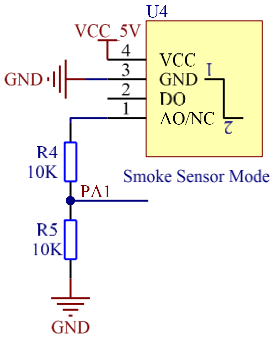

Fig. 3. Smoke module circuit

3.2.3 Temperature sensor circuit.

The system uses the DS18B20 chip to collect indoor temperature. It is a commonly used temperature sensor, which can directly output digital signals. It does not require A/D conversion when connected to a MCU. It has the characteristics of small size, low hardware, strong anti-interference ability, and high accuracy [7]. DS18B20 chip is simple in connection, and only a one-port line is needed to realize two-way communi-

cation when connecting with the microcontroller. It has three pins, DQ, GND and VCC. DG is connected to the PA0 port of the microcontroller, and the circuit is shown in Figure 4. It monitors the indoor temperature in real time and transmits the data to the MCU. The MCU compares the data with the preset value and sends out an alarm signal once it is higher than the preset value.

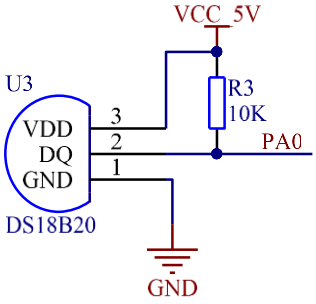

Fig. 4. Temperature sensor circuit

3.2.4 Key-press circuit.

In this system, a total of 4 keys, S1, S2, S3 and S4, are designed, which are respectively connected to the PB0, PB1, PB3 and PB4 interfaces of the microcontroller. The circuit connection is shown in Figure 5. Press S4 to set the automatic or manual working modes of the system. In the automatic mode, press S1 to switch between the temperature and the concentration threshold, press S2 to decrease the value, and press S3 to increase the value. In the manual mode, press S2 to turn on or off the water pump, and press 3 to turn on or off the alarm.

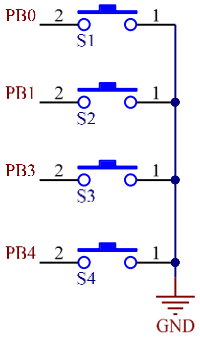

Fig. 5. Key-press circuit

3.2.5 Water pump control circuit.

The 5V water pump is used in this design. Since the water pump is a high-power device, the microcontroller cannot directly drive it, so the triode 8050 is selected to

amplify the current to drive the water pump. When the pin PA6 of the MCU is high, the triode is on and the water pump works normally. The function of the electrolytic capacitor is to filter the low-frequency signal in the power supply of the water pump so that the water pump can work more stably. The circuit is shown in Figure 6.

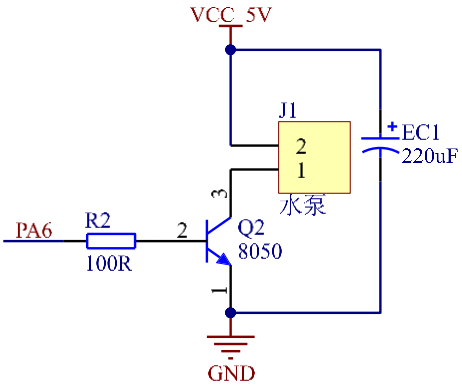

Fig. 6. Water pump control circuit

3.2.6 Buzzer alarm circuit.

The system uses a 5V active buzzer as the alarm circuit, which is connected to the PA5 port of the MCU. The circuit connection is shown in Figure 7. In the figure, the triode 8050 is used to drive the buzzer. As long as the MCU control pin is high, the buzzer will sound an alarm.

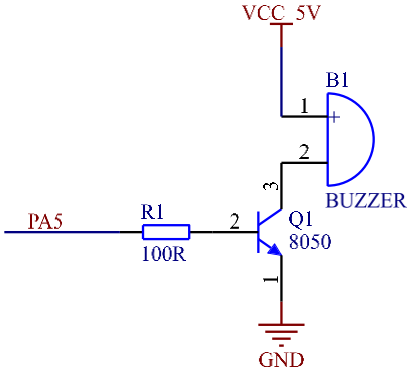

Fig. 7. Buzzer alarm circuit

3.2.7 Display circuit.

The display circuit of the system adopts a 1.44-inch TFT touch LCD color screen, which is characterized by good brightness, high contrast, a strong sense of hierarchy,

bright color, and a resolution of 128 × 128. It has 8 pins, and the definition of each pin is shown in Table 1. The connection with the microcontroller is shown in Figure 8.

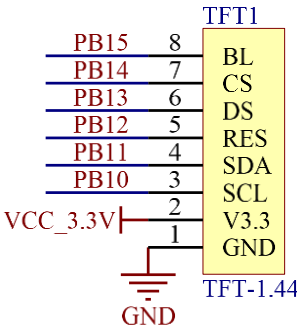

Fig. 8. Display circuit

Table 1. TFT touchscreen pin definition

Pin NO	Pin definition	Function description	Pin NO	Pin definition	Function description
1	GND	Grounding	5	RES	Screen Reset
2	VCC	Power Supply Positive	6	DC	Data/Command Selection
3	SCL	SPI Clock Input	7	CS	SPI Chip Select
4	SDA	SPI Data Input	8	BL	Backlight Control

3.2.8 WIFI communication module.

In order to achieve communication with the mobile phone APP, the system uses the ESP8266 WI-FI wireless communication module, which is an ultra-low power consumption UART WiFi transparent transmission module. It has a very competitive package size in the industry and is designed for mobile devices and Internet of Things applications. Its connection circuit is shown in Figure 9. Its TXD and RXD are respectively connected to the PA9 and PA10 ports of the microcontroller.

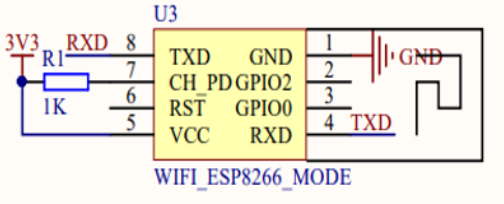

Fig. 9. WIFI communication module

3.3 Software design

This system can be divided into MCU and mobile phone APP software design. The software design of the MCU includes the programming of peripheral device drivers such as keys, displays and water pump control, the implementation of WIFI communication protocol and the main program code, in order to achieve the functions of data acquisition, display and wireless transmission. The software design of the mobile phone APP includes interface design, implementation of WIFI communication protocol, data display and main program to realize the functions of receiving and displaying sensor data information and sending commands to the microcontroller.

The overall software design process of the system is shown in Figure 10. When the system starts, the MCU and APP are in the initialization state. After that, the mobile phone APP is connected to the MCU through WIFI, and the alarm threshold and device status are set. The MCU receives the command sent by the APP, executes and displays it, compares the data monitored by the sensor with the preset value, and once the threshold value is exceeded, it immediately starts the alarm and turns on the water pump to extinguish the fire, and sends the alarm information to the mobile phone APP. The system has two threshold-setting methods, one is the button mode. Because the fire alarm system is generally installed at a high place, it is inconvenient to set. The second method is to use the mobile phone APP to set it.

3.3.1 MCU software design.

After the MCU is powered on and initialized, it starts to monitor the temperature and smoke concentration of the indoor environment, judge whether it exceeds the threshold, establish a WIFI connection with the mobile phone, and wait for the command issued by the APP and execute it. The process is shown in the left half of Figure 10.

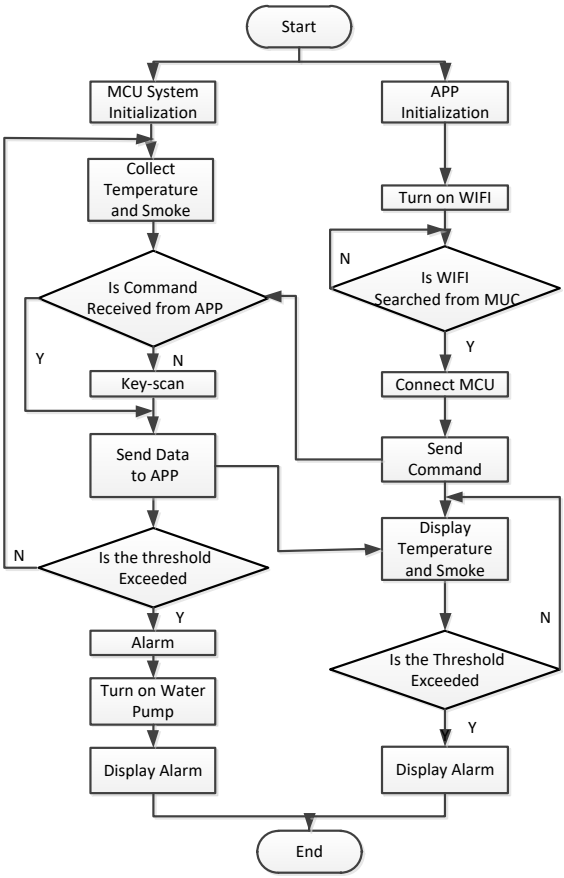

Fig. 10. System overall software design flow chart

3.3.2 Mobile APP design.

This system has designed a mobile phone APP using EasyAndroid software, and the interface is shown in Figure 11. The APP can display the temperature, smoke concentration of the current indoor environment, equipment (water pump) and alarm status, and can also set the threshold values of temperature and smoke concentration and the working mode of the alarm system. When the APP is just started, it has not yet established a connection with the MCU's WIFI, and all contents are only displayed as "*". At this time, you need to click the "Connect WIFI" button at the upper right corner of the APP to find the network of the microcontroller and connect it. When the temperature value and concentration value are displayed normally, it indicates that the connection is successful. When you need to change the threshold value of the system, just enter the value in the corresponding position, and then click the "Set Thre" button.

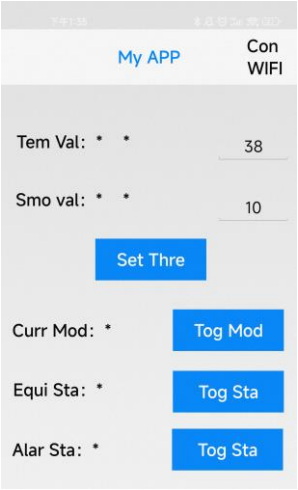

Fig. 11. Mobile APP interface

3.4 System debugging

3.4.1 Temperature sensor debugging.

The system modules are debugged below. The system is powered on. Figure 12 shows the normal working state. At this time, the font color displayed on the screen and APP is normal, and the equipment and alarm are off-state. First, check whether the temperature sensor is normal. Use an electric soldering iron to heat the DS18B20 chip to simulate a fire. The system detects a fire and gives an alarm, as shown in Figure 13. From the figure, you can see that the color of the temperature font displayed on the screen and APP at this time turns red, and the device and alarm status are displayed as "ON".

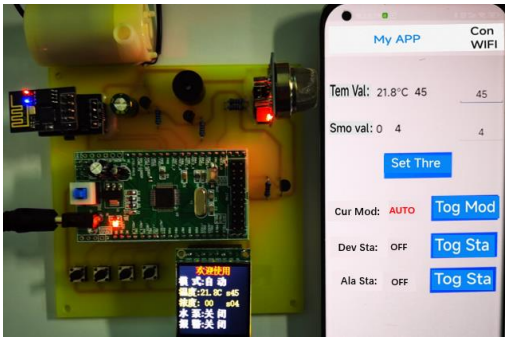

Fig. 12. Normal state

Fig. 13. Alarm due to temperature rise

3.4.2 Smoke sensor debugging.

Use burning paper to generate smoke to simulate a fire. Under normal conditions, the smoke concentration value is only about 0.5mg/L. In order to better test the alarm effect of the system, the smoke concentration threshold is set low, only 4mg/L. When the smoke concentration exceeds the threshold, the system will give an alarm, as shown in Figure 14. It can be seen from the figure that at this time, the font color of smoke concentration displayed on the screen and APP turns red, and the device and alarm status are displayed as "On".

Fig. 14. Alarm due to smoke

4 Conclusion

From the above analysis, it can be seen that the MCU has a high application value in intelligent electronic products, which makes electronic products develop in the direction of intelligence, information and modernization. In the future development, the MCU technology can also be combined with artificial intelligence technologies such as neural networks, expert systems and fuzzy algorithms to effectively improve the intelligent level of electronic products.

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5 References

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