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Design of Temperature Smoke Alarm Based on Single Chip Computer

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Abstract: This paper presents an intelligent temperature and smoke monitoring and alarm system based on STC89C52 single chip computer. The system uses STC89C52 single chip microcomputer as the core controller, integrates DS18B20 temperature sensor and MQ-2 smoke sensor, and can continuously monitor the ambient temperature and smoke concentration in real time. In addition, the system is equipped with a Bluetooth communication module, which enables it to transmit the monitored temperature and smoke data to the mobile device in real time, thus improving the dynamic and interactive monitoring. When the monitoring data exceeds the preset safety threshold, the system will not only immediately start the audible and visual alarm to warn the field personnel to take prompt action, but also send the alarm information to the preset mobile device through the Bluetooth communication module to ensure that the relevant personnel can timely understand the situation and take the necessary preventive measures, enhancing the timeliness and effectiveness of the system. The simulation and real debugging results show that the system can run normally, which has a certain significance for environmental safety monitoring.

Keywords: Alarm system; STC89C52 MCU; Temperature sensor; Smoke sensor;

1. INTRODUCTION

Modern society attaches great importance to the safety of people's lives and property. With the acceleration of industrialization and urbanization, the residential density continues to increase, the complexity of office environment and living place increases, and the fire risk increases accordingly. It is very important to develop a temperature smoke alarm system with high precision, all-round monitoring ability and modern remote communication technology to detect fire hazards in advance and reduce fire accident losses.

In addition, with the continuous development of microelectronics technology, sensor technology and network communication technology, the performance of intelligent fire detection and early warning system has been greatly improved, which can more effectively strengthen fire safety management and ensure the safety of public life and property. In particular, the extensive application of single-chip technology makes electronic equipment more intelligent and miniaturized, and promotes the upgrading of fire detection system. Because of its advantages of low price, small size, low power consumption and high integration, SCM has become the preferred core control unit for designing modern temperature smoke alarms.[1]

This paper aims to design and develop a temperature smoke alarm system based on single chip microcomputer, which integrates high precision temperature and smoke monitoring technology and Bluetooth communication module. This design not only pursues high integration, strong dynamic monitoring ability and friendly user interaction, but also pays attention to cost efficiency, so as to meet the growing demand of intelligent alarm equipment in the market. By combining modern electronics and information technology, this project greatly improves the efficiency and intelligence level of fire detection, and broadens the application range of fire warning system. The innovation and promotion of this technology not only effectively improves the social security, reduces the casualties and property losses caused by fire, but also produces significant economic benefits, reduces the economic losses caused by fire, and contributes to social stability and the effective use of resources.

2. OVERALL SCHEME DESIGN

The overall scheme design is a key step in the development of temperature smoke alarms, which determines the core structure and function of the system. The scheme is designed around six main links of smoke monitoring, alarm, temperature monitoring, data display, Bluetooth communication and control keys to ensure the reliability and stability of the system. The design scheme integrates functional modules such as smoke monitoring, temperature monitoring, MCU control, character display and sound and light alarm into a complete system.

Temperature smoke alarm can be divided into single-chip microcomputer minimum system, temperature monitoring module, smoke concentration monitoring module, keying module, Bluetooth module, audible and visual alarm module and display module. Among them, the core control module is the smallest single-chip microcomputer system, which collects real-time information of external temperature and smoke concentration together with the smoke concentration monitoring module and temperature monitoring module, and then collaborates with other modules to complete threshold setting, sound and light alarm function, remote threshold setting, and real-time monitoring of external environment temperature and smoke concentration.

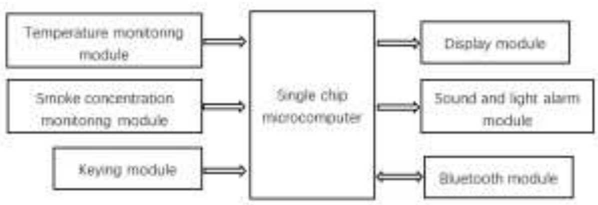

Figure. 1 System frame diagram

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3. SYSTEM HARDWARE CIRCUIT

3.1 Minimal System of Microcontroller

The minimal system of a microcontroller refers to a complete and fully functional working environment for the microcontroller, including the core microcontroller and the necessary peripheral circuits, enabling it to operate normally and perform the designated tasks. In this system, the STC89C52 serves as the core component, providing control and computing capabilities for the entire system. The STC89C52 microcontroller, with its high cost-effectiveness, good compatibility, ease of programming and development, extensive application support, stable and reliable performance, as well as a rich set of peripheral interfaces, makes it an ideal choice for the control unit of temperature and smoke alarm systems. As an 8-bit microcontroller based on the 8051 core, the STC89C52 not only inherits the core features of the 8051, but also enhances processing power and memory capacity by increasing the operating frequency and expanding functionality.[2] Additionally, it supports online programming and serial downloading, features that make it widely used in numerous embedded system projects.

3.2 Smoke Concentration Monitoring Module

Smoke sensors are widely used in firefighting, security, and monitoring fields to detect the concentration of smoke in the environment, providing timely alerts to protect people and property. The MQ-2 sensor, due to its high sensitivity, broad detection range, and low cost, has become an ideal choice for smoke detection in fire alarm systems. It is capable of detecting a variety of combustible gases and smoke, making it particularly suitable for early fire detection. The working principle of the MQ-2 sensor is based on a tin dioxide (SnO_2) semiconductor element, which changes its resistance when exposed to smoke or combustible gases. This change in resistance is converted into an electrical signal, which can be interfaced with a microcontroller, making it suitable for large-scale deployment and cost-effective applications.[3]

The core of the smoke monitoring module is the MQ-2 sensor, which is capable of real-time collection of smoke concentration data from the environment. The collected data is converted into voltage values at different concentrations using an ADC0832 analog-to-digital converter. Based on these voltage values, an ideal smoke concentration alarm threshold can be set, enabling real-time monitoring and alarm of smoke concentration..

3.3 Display Module Circuit Design

The core component of the display module is the 1602 LCD display, which is used to show the set threshold values as well as the monitored temperature and smoke concentration values from the external environment. The display circuit is shown in Figure 2.

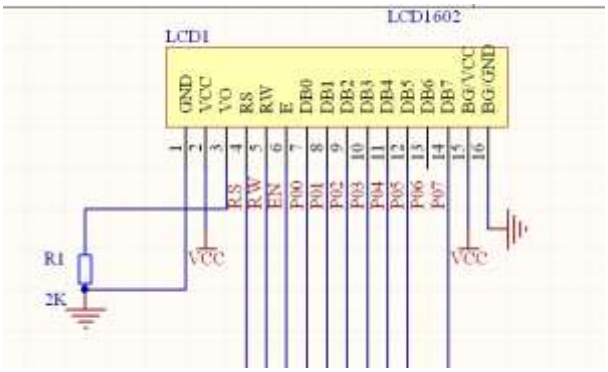

Figure .2 LCD1602 LCD

3.4 Sound and Light Alarm Module Circuit Design

In the circuit design, a resistor is placed in series between the base of the transistor and the microcontroller port, enabling control of the buzzer alarm and the on/off state of the LED. This configuration allows the microcontroller to directly control the transistor's conduction and cutoff by outputting signals, thereby achieving the switching function of the alarm or indicator light. The circuit diagram is shown in Figure 3.

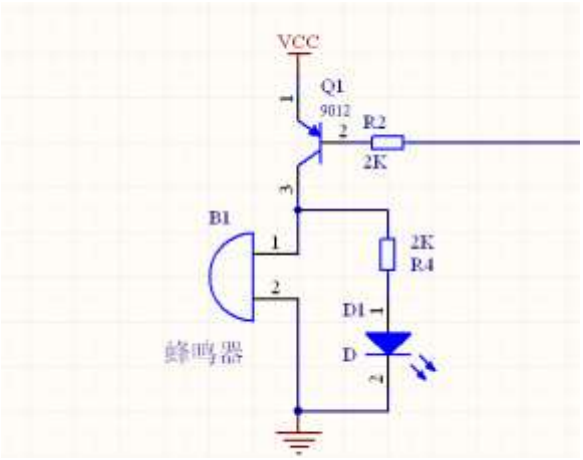

Figure.3 Audio alarm circuit diagram

3.5 Key Control Module Circuit Design

This module includes a set button, an alarm button, an increase button, and a decrease button. The set button allows the user to select whether to adjust the temperature threshold or the smoke concentration threshold. When the alarm button is pressed, the alarm will immediately trigger both sound and light warnings, which is crucial in emergency situations. The increase and decrease buttons are used to adjust the value of the threshold. The circuit diagram is shown in Figure 4.

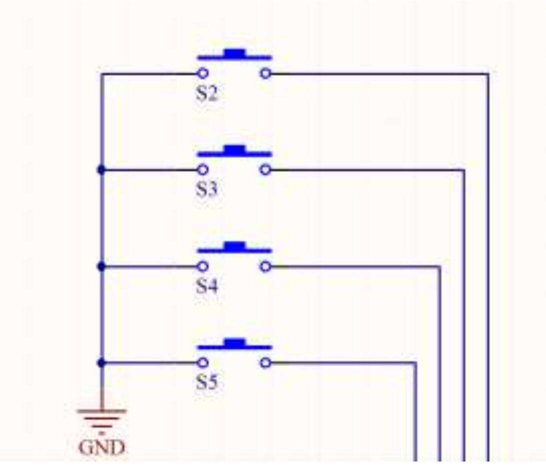

Figure.4 Key connection circuit diagram

3.6 Bluetooth module

Integrating a Bluetooth module (such as the HC-05 Bluetooth chip) into the system can significantly enhance the intelligence and convenience of the temperature and smoke alarm. It allows users to monitor the device status via a smartphone, perform remote operations (such as turning off the alarm or adjusting thresholds), and transmit and record data (such as temperature and smoke concentration). The HC-05 module offers excellent compatibility, a serial communication interface, and configurability, enabling wireless communication with microcontrollers and providing a better user experience and system scalability.[4]

The Vcc pin of the HC-05 is connected to the input power supply, the GND pin to ground, and the TX and RX pins of the HC-05 are connected to the P3.0 and P3.1 pins of the STC89C52, respectively, completing the serial communication between the Bluetooth module and the microprocessor.

3.7 Temperature monitoring module

The DS18B20 is chosen as the temperature sensor for the temperature monitoring module primarily because of its wide measurement range, high accuracy, and ability to directly interface with microcontrollers via a single-wire protocol. This simplifies system design while enhancing scalability. Its fast digital temperature conversion within 1 second and user-configurable temperature alarm settings make it particularly valuable in applications such as temperature control, industrial systems, and thermosensitive devices. The durability and stability of the DS18B20 are ensured even in complex environments, and its high cost-effectiveness makes it an ideal choice for cost-sensitive applications.

The interface circuit of the DS18B20 is very simple in design, mainly due to its unique single-wire communication method. In a typical DS18B20 interface circuit, the main components include the sensor itself, a pull-up resistor, the data line, and the microcontroller interface.[5] The data line is used both for data transmission and as a power supply line. The pull-up resistor plays a critical role in the DS18B20 interface circuit. The data line needs to be connected to a high voltage level through the pull-up resistor, which helps to ensure that the data line remains at a stable high level, allowing the DS18B20 to correctly receive and transmit signals. The circuit diagram is shown in Figure 5.

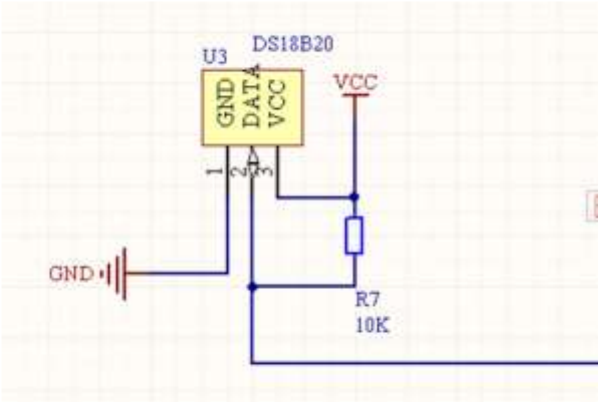

Figure.5 Circuit diagram of the temperature sensor port

4. SYSTEM SOFTWARE DESIGN

4.1 System Main Program Design and Flowchart

When the power is turned on and the switch is pressed to power the system, the system will initialize. During initialization, the temperature sensor and smoke sensor subroutines will be started to begin collecting environmental temperature and smoke concentration data. The system will transmit the collected data via the Bluetooth module to the connected device. Meanwhile, the collected temperature and smoke concentration data will be evaluated to check whether they exceed the preset thresholds. If the values exceed the thresholds, the system will activate the audible and visual alarm subroutine. If the values do not exceed the thresholds, the system will continue collecting data. The specific flowchart of the main program is shown in Figure 6.

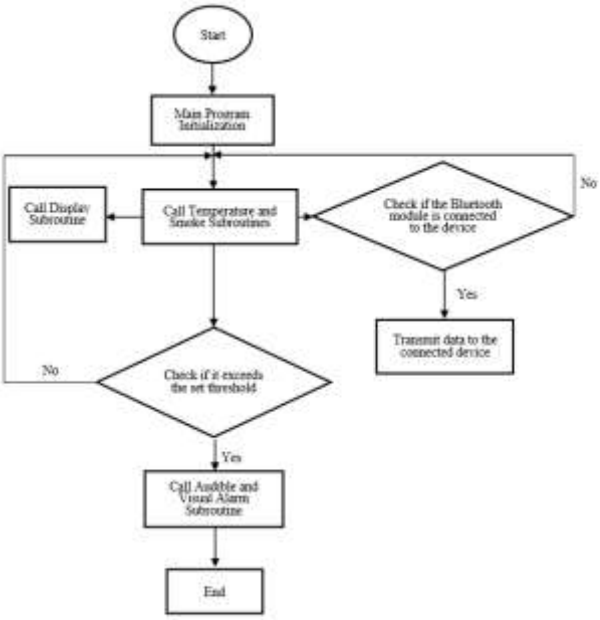

Figure.6 Flowchart of the main system program

4.2 System Core Module Subroutine Design and Flowchart

The system program consists of multiple subroutines, each responsible for completing a specific function. Among them, the most essential subroutines are the temperature sensor subroutine and the smoke sensor subroutine.

The temperature sensor subroutine is an essential component of the entire system program, as outlined below: First, a predefined temperature threshold needs to be set. Then, the temperature sensor continuously monitors the ambient temperature in real-time, comparing the detected temperature data with the preset temperature threshold. If the detected temperature exceeds the threshold, the audible and visual alarm subroutine is triggered to activate the alarm. The flowchart for the temperature sensor subroutine is shown in Figure 7.

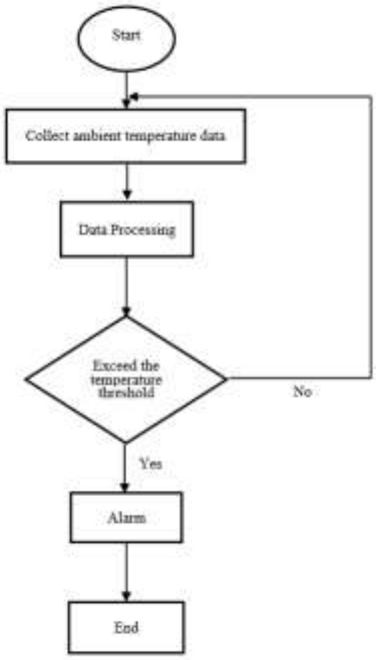

Figure.7 Flowchart of the temperature sensor subroutine

The smoke sensor subroutine is an indispensable part of the system program, as described below: First, a smoke concentration threshold is set. The system then calls the smoke sensor subroutine to control the smoke sensor to collect ambient smoke concentration data, which is compared with the preset smoke concentration threshold. If the detected concentration exceeds the threshold, the system enters the audible and visual alarm subroutine to trigger the alarm. Otherwise, it continues collecting ambient smoke concentration data. The specific flowchart for the smoke sensor subroutine is shown in Figure 8.

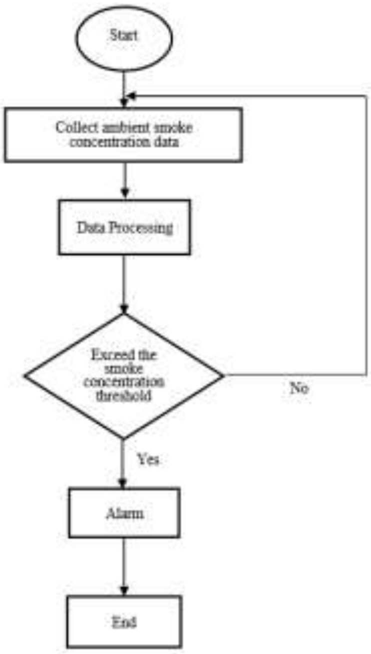

Figure.8 Flowchart of the smoke sensor subroutine

5. SYSTEM DEBUGGING

In the debugging process of alarm system, it mainly involves the verification of temperature monitoring module, smoke concentration monitoring module and Bluetooth communication module. When debugging the temperature monitoring module, touch the temperature sensor to simulate the ambient temperature change and observe whether the system can send an alarm signal in time when the temperature exceeds the set threshold. The debugging of the smoke concentration monitoring module simulates the gas environment of different concentrations by using combustible gases (such as propane, butane, etc.) instead of smoke. Observe whether the system triggers an alarm when the gas concentration exceeds the threshold. When debugging the Bluetooth module, ensure that the alarm can be successfully paired with the mobile device and verify the consistency of the data. By adjusting the threshold and observing the change on the alarm display, confirm the normal operation of the Bluetooth communication module. In addition, data synchronization is performed repeatedly to ensure stable communication. Through repeated debugging, the results show that the system can timely and stably complete various tasks, the system can accurately respond to environmental changes, trigger corresponding alarms, and maintain data consistency in Bluetooth communication.

6. CONCLUSION

This thesis aims to design and implement a temperature and smoke alarm system centered around the STC89C52 microcontroller. The thesis comprehensively presents the entire process from theoretical exploration, system design to final implementation. The system effectively integrates temperature and smoke concentration monitoring, significantly enhancing the timeliness and accuracy of fire hazard warnings. Through an in-depth analysis of existing fire warning technologies and leveraging the functional advantages of the STC89C52 microcontroller, the proposed design demonstrates efficiency, cost-effectiveness, and stability in both hardware selection and software design.

After rigorous testing and optimization, the designed temperature and smoke alarm system has shown excellent environmental adaptability and reliability. It can effectively provide early warnings in the event of a fire, offering valuable time for evacuation and firefighting efforts. However, the system still has certain limitations. For example, the Bluetooth module's data transmission distance limits the range of remote monitoring. To address this issue, the adoption of a Wi-Fi module could be considered, given its longer transmission range and higher data transfer rate.

7. REFERENCES

[1] Bu Yaqun, Guo Junmei, Liu Haiying. Design and Implementation of Intelligent Fire Alarm System Based on 51 Microcontroller [J]. Journal of Qilu University of Technology, 2021, 35(04): 53-58.

[2] Hao H B, Dai F Z, Wen H K, et al. Research on the Smart Home Design based on Single-chip Microcomputer [C]. Proceedings of the 2020 International Conference on Artificial Life and Robotics (Icarob2020), Beppu, Japan. 2020: 13-16.

[3] Yancheng C, Liheng W. Design and Implementation of Fire Monitoring and Warning User Terminal System [C]. 2022 International Conference on Artificial Intelligence and Computer Information Technology (AICIT). IEEE, 2022: 1-5.

[4] Wang X, Yun H, Cui P, et al. Design of thermometer based on STM32 and Bluetooth [J]. Journal of Computational Methods in Sciences and Engineering, 2021, 21(5): 1417-1432.

[5] Guo W, Feng X. Remote multipoint temperature detection based on single chip microcomputer system design [C]. Third International Conference on Machine Learning and Computer Application (ICMLCA 2022). SPIE, 2023, 12636: 976-980.