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Design of Temperature Control System

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Abstract: *This thesis focuses on designing a temperature control system using the AT89C51 single chip microcomputer, which is widely used in production, scientific research, and daily life. The DS18B20 temperature sensor collects and converts real-time temperature data and transmits it to the single-chip microcomputer, which displays the current temperature on an external LCD1602 liquid crystal display screen. The single-chip microcomputer uses the PID algorithm to calculate the system deviation between the given and actual temperatures and controls the relay to heat and cool, achieving precise temperature control. The design principle, hardware, and software flow of the control system are discussed, and multiple simulation experiments demonstrate the system's high precision and stability. The research has significant implications for the development of intelligent control systems and has practical applications.*

Keywords: *AT89C51 single chip microcomputer, DS18B20 Temperature sensor, Control system based on PID algorithm*

1. Introduction

1.1 Background of research on temperature control systems

Temperature plays an extremely important role in human living environment. Especially in recent years, in all aspects of people's lives, the temperature control system has long been applied.

With the continuous development of society and the continuous progress of science and technology, the control system has been widely[1,2] used in production, scientific research and daily life. Among them, temperature control system is a very important control system. In industrial production, the temperature control system can ensure the quality and stability of the product; In the medical field, temperature control system can ensure the operating room and ward temperature comfort and cleanliness; In family life, temperature control system can improve the comfort of living environment and energy saving effect. Therefore, the research of temperature control system has very important significance[3-5].

1.2 Design Content

According to the needs of the system, it is divided into seven parts: the main control part, the temperature sensing part, the alarm circuit part, the operation button part, the LED display part, the digital signal processing part and the relay part.

In this paper, C language is used to write the system program, and Keil C51 development tool is used to compile and debug. In terms of hardware, a complete temperature control system is built by using single chip microcomputer, temperature sensor, digital tube, buzzer and other components. In order to test and verify the control effect, the method of temperature fluctuation test and temperature stability test is used to verify the system. The experimental results show that the system can control the temperature very accurately, and has high stability and reliability.

By using two different technologies, AT89C51 and DS18B20, these technologies can be used in different environments. Through PID algorithm and DS18B2 technology, the performance of the computer can be adjusted, and through these technologies, the computer can automatically adjust the voltage and current, in order to achieve the purpose of regulating voltage. The indicator light is green when working normally; If the temperature is higher than the set temperature, the indicator light will turn red and start the refrigeration switch, and there will be a buzzer to issue an alarm; If the temperature is lower than the set temperature, the indicator light will turn yellow and start the furnace temperature heating switch, and the buzzer will issue an alarm.

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This system can monitor and control the temperature in the room in real time, and can issue sound and light alarm.

2. Overall design of the system scheme

The system to achieve intelligent temperature control, that is, set a temperature value, can make the system temperature maintain near this temperature value, and finally gradually stabilize, so that the temperature reaches a constant. When the temperature changes, there will be a corresponding alarm. Whether the temperature is lower than the set value or higher than the set value, it should be judged by the LED flashing color; And through the PID control relay to work, low temperature heating, high temperature cooling.

2.1 Functional Requirements

(1) Can monitor the temperature in real time, with an accuracy of up to 0.1 degrees Celsius.

(2) Using DS18B20 as a temperature sensor, it can send the measured temperature information to AT89C51 in real time.

(3) LCD1602 LCD screen through MCU AT89C51 real-time temperature data acquisition, and after accurate analysis and processing, in order to better reflect the actual situation;

(4) Display temperature through LCD1602 LCD screen;

(5) Normally, the indicator is green.

(6) When the temperature drops, the yellow LED will light up, the buzzer will sound, and the heater will start to achieve warming.

(7) When the limit is reached, the red LED will light up, the buzzer will be excited, and the fan will be activated to achieve true cooling.

2.2 Scheme Selection

2.2.1 Sensor Selection

In order to better meet the emergency needs, a new technology is chosen to simulate the integrated sensor. This type of sensor is produced by silicon semiconductor integration technology, also known as silicon sensor or monolithic integrated sensor. Among them, the AD590 sensor can detect -voltage, which greatly enhances the tolerance and stability. However, the design of this circuit is very complex, and the gain of the AD590 must be considered at the same time, as well as the complexity of the A/D conversion circuit. This makes it necessary to constantly adjust in the actual circuit to improve the efficiency of its implementation.

By introducing digital single chip intelligent temperature sensor, real-time monitoring of ambient temperature can be realized. This kind of temperature sensor is composed of A/D converter, signal processor, storage device (or register), connection line, etc., its temperature control sensor has excellent performance, can provide -55℃~125℃ temperature data, and has the function of 16-bit digital quantity, can realize the real-time monitoring of environmental temperature, in addition, it also has an independent working power supply, Can be realized through the parasitic power supply, so as to achieve real-time monitoring of the environmental temperature. DS18B20 is a temperature control sensor with good performance, it can accurately detect the temperature change, so as to provide accurate temperature information. The DS18B20 is not limited to local use, but can be used across regions to achieve a wider range of connectivity. They are not just an I/O port, but a complete connection, making the port of the CPU more convenient to use, and easier to design and install.

By comparison, the DS18B20 has A complete core, including temperature sensor, signal amplifier, A/D switcher and interface, making it very easy to connect, and its performance is far beyond the AD590, so we decided to choose the DS18B20 as the final choice.

2.2.2 Singlechip selection

A new solution: using DSP (digital signal processor) as the controller of the system. The dsp is unique in that it can process a large amount of data, and its characteristics make it very resistant to external interference, such as temperature differences and other changes. In addition, DSP can be integrated

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quickly and can be reused in a short time, while also being able to self-regulate by adjusting the parameters of the processor, and can handle extremely weak signals. However, the hardware circuitry of a DSP is very complex and expensive because it is an energy-consuming active device rather than a trusted passive one.

The use of single chip microcomputer as a network control robot is a very good option, because of its high stability, high price, low current, low power consumption, so that it has been rapidly popularized in recent years, and is widely used in many fields. In addition, it also has excellent algorithm processing power, easy to operate, with a high degree of freedom, but also equipped with timers, counters, so that it can be timed to operate, but also to carry out accurate measurement, and its low power consumption, the size is smaller, and the cost is also lower.

After many comparisons and demonstration, the final decision to use AT89C51 single chip microcomputer as the central processing unit of the thermometer, so that it can meet the practical requirements, but also save costs.

3. System hardware design

The whole system takes AT89C51 single chip microcomputer as the core device, with resistance capacitance crystal vibration and other devices, to form the minimum system structure of single chip microcomputer. The other modules revolve around the minimum system of the single chip microcomputer. Including temperature sensor module, DS18B20 temperature sensor is responsible for collecting temperature data and transmitting it to the MCU; Key module, responsible for the setting of alarm pre-value; The alarm module uses the combination of buzzer and LED design, beyond the alarm range for sound and light alarm; LED display module shows the working state, the normal state shows the green light, if the low temperature then yellow light, if the high temperature then the red light; Relay module, controlled by PID, if the temperature is too high will start the refrigeration switch, if the temperature is too low will start the furnace temperature heating switch; At the same time, there is a digital tube display module, display set temperature and real-time temperature; The system schematic diagram is shown in Figure 1.

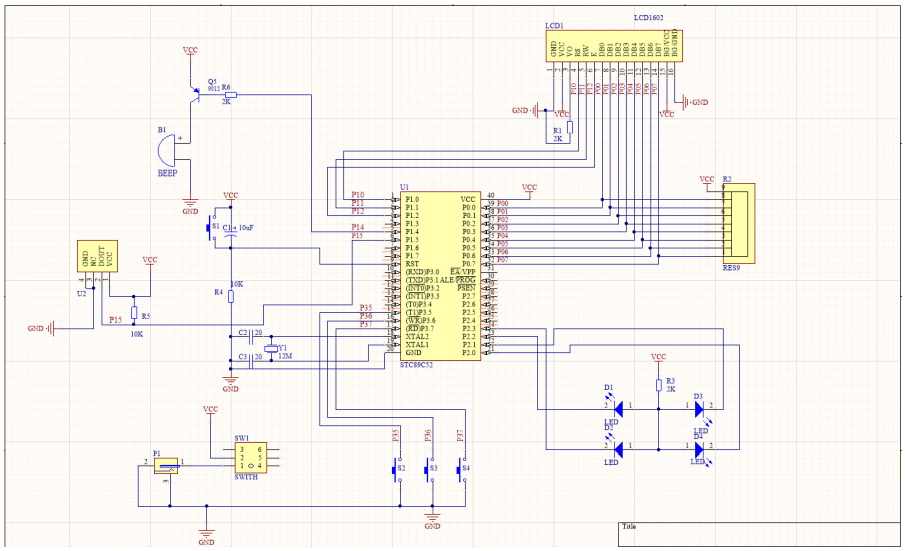

Figure 1: System schematic diagram

4. Software design

4.1 Programming language and development environment

C language is a powerful computer programming language, it can achieve complex functions, but also can support a variety of complex programming languages. It can not only meet the needs of workstation design, but also meet the needs of various aps, whether it is in hardware or software can play a good performance. Its application field is extremely wide, with excellent data processing capabilities.

Keil C51 is a 51 series Software operating system with MCU C programming language promoted by

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Keil Software Co., LTD. It has more powerful functions, higher flexibility, higher reliability and better operating experience, making it easier to be accepted and used by people.

4.2 Program flow chart design

As shown in Figure 2, the timer is used for dynamic scanning of the digital tube, so as to achieve a dead cycle. The dead cycle includes: 1) read out the current temperature data; 2) display the detected temperature; 3) Evaluate whether the temperature has reached the temperature warning line, once it reaches the threshold, it will initiate the sound and thermostat (analog thermostat device); 4) Periodically scan the thermostat and automatically adjust it to the highest or lowest temperature set by the thermostat once it is found that someone has pressed it.

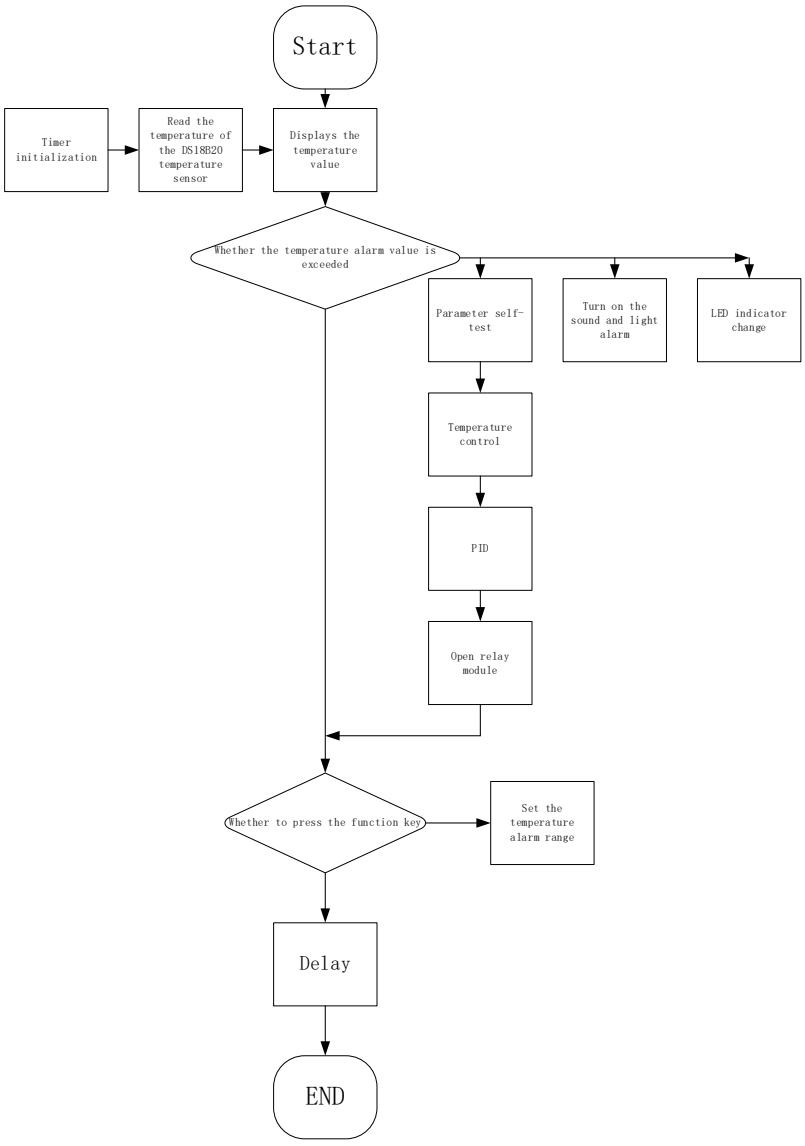

Figure 2: Program flow chart

5. Conclusions

This thesis focuses on designing a temperature control system using the AT89C51 single chip microcomputer, which is widely used in production, scientific research, and daily life. The DS18B20 temperature sensor collects and converts real-time temperature data and transmits it to the single-chip microcomputer, which displays the current temperature on an external LCD1602 liquid crystal display screen. The single-chip microcomputer uses the PID algorithm to calculate the system deviation between the given and actual temperatures and controls the relay to heat and cool, achieving precise temperature

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control. The design principle, hardware, and software flow of the control system are discussed, and multiple simulation experiments demonstrate the system's high precision and stability. The research has significant implications for the development of intelligent control systems and has practical applications.

References

[1] Huang Hai-Yu. Development of residual current protector based on MSP430 single chip microcomputer [D]. Huazhong University of Science and Technology, 2007.
[2] Wang Bin, Yu Yan. Warehouse Temperature control System based on S7-300PLC and touch screen [J]. Automation Application, 2018, (02):46+51.
[3] Li Fan. Tool Wear State Monitoring Based on Workpiece Surface Image [D]. Xi 'an University of Technology, 2007.
[4] Wang Xiaohua, WANG Jian. Design of Temperature Control for Warm Box [J]. Electronic Technique, 2012, 39(08):47-50.
[5] Qin Honglang. Design and Implementation of Control System of Resistance Furnace based on single Chip Microcomputer [J]. Industrial Heating, 2023, 52(04):18-21.