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Design of Temperature-controlled Fan System Based on Single Chip Microcomputer

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Abstract

For the problems in traditional fan applications and combined with the actual application requirements, a more intuitive and humanized temperature control fan control system based on single chip microcomputer is designed. The design adopts AT89C52 single-chip microcomputer as the main controller, DS18B20 temperature sensor as the temperature detection unit, using PWM speed regulation mode to control the fan to start and stop, and finally through the program based on Keil C51 to improve accuracy of the fan system. After that simulation and debugging of the design is carried out. The results show that the fan can not only change its speed according to the surrounding environment, but also change the upper and lower limits of temperature manually. The design has the characteristics of good stability, high control precision and has wide application prospect.

Keywords

Temperature-controlled fan; AT89C52 Single-chip microcomputer; Temperature sensor; Automation.

1. INTRODUCTION

With the development of industrialization, various industries have emerged, and new technologies have been applied to all aspects of life. People use single-chip microcomputer and thermal sensors to design a smart fan. While achieving smart temperature control, it also uses a digital tube circuit to display text and digital information.

In order to improve the accuracy of the temperature collected by the system and make the control system more accurate, this design has made certain improvements to the fan's working system. The single-chip microcomputer is used as the main controller to control the fan speed accordingly, and the DS18B20 is the digital temperature sensor which is used to collect the ambient temperature, can display the temperature and has an independent button. After the fan works, when there is no human intervention, the fan starts and stops and outputs the corresponding speed under the action of the temperature sensor and the single-chip microcomputer; the greater the difference between the ambient temperature and the initial temperature setting, the faster the fan speed; the temperature exceeds the initial maximum After the temperature is set, the fan runs at maximum power and runs at maximum wind speed. You can also manually change the two temperature limit values of the initial control node through two buttons; by reducing and increasing the initial temperature value, the fan speed can be made more reasonable and more user-friendly according to work needs.

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2. OVERALL DESIGN

2.1. The Composition of the System

According to the expected functions of the system, this design includes: temperature acquisition circuit, power supply circuit, independent button circuit, reset circuit, crystal oscillator circuit, single-chip microcomputer, display circuit, drive circuit, etc. The block diagram of this system is shown in Figure 1:

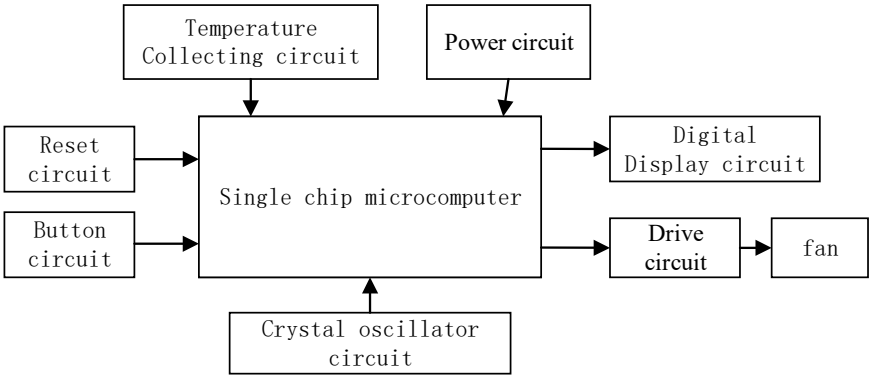

Figure 1. Block diagram of the system design

2.2. The Working Principle

The working process of the system is as follows: the temperature sensor detects the analog signal from the surrounding environment and converts it into a digital signal after processing, and then transmits it to the single-chip microcomputer for processing; at the same time, the eight-segment digital tube displays the fan speed gear and the ambient temperature value in real time. The current value of the displayed temperature does not contain a decimal part and is accurate to 1 degree; the initial value of the temperature setting is displayed in the form of an integer on the eight-segment digital tube display. The speed of the fan speed depends on the difference between the initial temperature setting and the current ambient temperature; when the fan speed reaches the maximum, it continues to run at the maximum speed; the speed of the DC fan motor is controlled by PWM. You can also manually adjust the initial temperature value of the fan at the beginning of the work, which can be achieved through the button circuit, so that the manual control of the fan can be realized according to the work needs.

3. HARDWARE DESIGN

3.1. The Smallest System of Single-chip Microcomputer

The smallest system usually includes: crystal oscillator circuit, reset circuit, power supply circuit and single-chip microcomputer. Figure 2 is the smallest system of the single-chip microcomputer.

Reset system: reset the microcontroller to restart the system. The manual reset process is realized as follows: when the button is not pressed, there is no potential difference in the voltage of the RST port; when the button is pressed, the circuit starts to work and the two ends of the capacitor discharge charge, and the port is in a high-level reset state at this time. After the button is reset, the principle is the same as the ordinary reset button. At this time, both ends of the capacitor are charged normally, and then both ends are discharged. When the button is pressed, there must be a time delay, which is enough to reset the microcontroller. When the button is pressed, a 5V potential difference will be generated immediately, and this potential difference is not the voltage difference between the single-chip microcomputer and the ground terminal; at this time, a strong micro-current will be generated in the circuit immediately, which

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will be accompanied by a magnetic field. , Have an adverse effect on the circuit and the operation of the single-chip microcomputer. In order to avoid this unnecessary influence, we can add a resistance of 10kΩ when designing the reset circuit to eliminate this interference. The reset circuit is shown as in Figure 2.

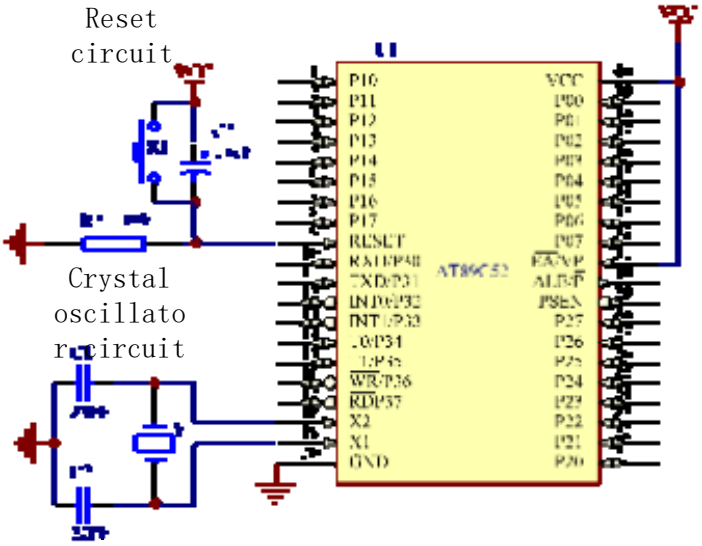

Figure 2. The smallest system of single-chip microcomputer

Clock system: Generate a clock signal for the microprocessor. The clock signal can be input by external components alone. The crystal oscillation frequency is 12MHz. The active crystal oscillator has a total of 4 ports, including a high-level pin VCC and a ground terminal, as well as an enable terminal. Passive crystal oscillators have relatively few pins. Some passive crystal oscillators have three pins. The two pins at the extreme edge have the same function. There is no need to distinguish between positive and negative when working. The port is used for grounding and is connected to the shell of the active crystal oscillator. For the active crystal oscillator, the output pin of the crystal oscillator port of the single-chip microcomputer is not involved when used, only the input part of the crystal oscillator port of the control chip is used; but for the passive crystal oscillator, it can be directly connected in parallel to the corresponding pins of the single-chip microcomputer. The crystal oscillator circuit used in this design is shown in Figure 2.

Power system: including the VCC pin connected to the high level and the GND pin used to ground, the working voltage is 5V.

Single-chip microcomputer: It is an integrated system used as a system control chip. The control unit of many portable electronic products uses a single-chip microcomputer. The various parts of the single-chip microcomputer are connected through the bus. The system can be modularized, with simple structure, high reliability, and can work for a long time with almost no problems; it has strong processing capacity, and it is difficult to be interfered by other unfavorable factors during work; the loss under normal working conditions is also small. The voltage is only 5V.

3.2. Fan Motor Drive and Speed Regulation Circuit

The speed regulation of the DC motor in this design is controlled by pulse width modulation technology. The fan has a total of four gears. The upper limit of the initial temperature is 35 degrees, and the lower limit is 25 degrees. When the temperature is 2 degrees higher than the lower limit, the fan can be increased by one gear. If the fan does not work after the current

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temperature is lower than the lower temperature limit, there is no corresponding signal output from the microcontroller at this time, and the duty cycle of the PWM pulse signal is zero. If the current temperature is higher than the initial lower limit temperature, the fan starts to work, and it can also output different control signals according to the ambient temperature in real time to adjust the duty cycle; if the temperature at this time is higher than the initial temperature upper limit, the fan rotates at the maximum speed . Therefore, the fan speed is more user-friendly and suitable for many occasions.

The speed control circuit is shown in Figure 3. The P3.7 port of the single-chip microcomputer outputs different control signals to adjust the speed of the DC motor.

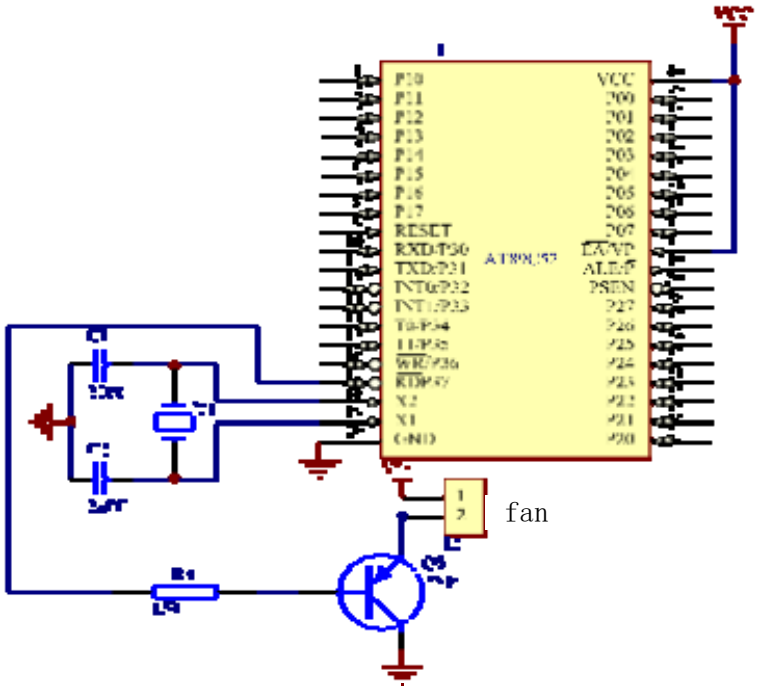

Figure 3. Drive and speed regulation circuit

3.3. Temperature Acquisition Circuit

The DS18B20 temperature sensor adopts a special production process in the design. It has a total of three pins, and is packaged in an integrated manner, which is economical and has obvious characteristics. The current temperature sensors are smaller in size, easy to install and design, and more convenient to use. The prices of such temperature sensors on the market are also lower.

When working, the DS18B20 digital temperature sensor "senses" the ambient temperature, and transmits this signal to the corresponding port P3.6 of the control chip after processing. A 10kΩ resistor is connected between the high potential pin and the signal pin; the signal is processed by the control chip After that, it is displayed on the digital tube in the form of temperature value. The circuit is shown in Figure 4.

3.4. Display Circuit

The display circuit of this design uses four digital tubes. The display content includes the wind speed gear and the ambient temperature value of the fan. The first digit is used to display the wind speed gear, the last two digital tubes display the ambient temperature, and the remaining digital tubes are used for connection. The wind speed gear and temperature value, and the display mode is an integer, which can clearly understand the fan's working gear. The display unit of this design adopts a common cathode connection, and the corresponding pins are connected to the P2.0 to P2.7 pins respectively, which can be used as segment selection signals;

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the output voltage of the P0 port is low level, and the external resistance of 10kΩ is connected to On port P0, P0.0 to P0.3 are connected to pins 12, 9, 8, and 6 through transistors as bit selection signals. The display circuit is shown in Figure 4.

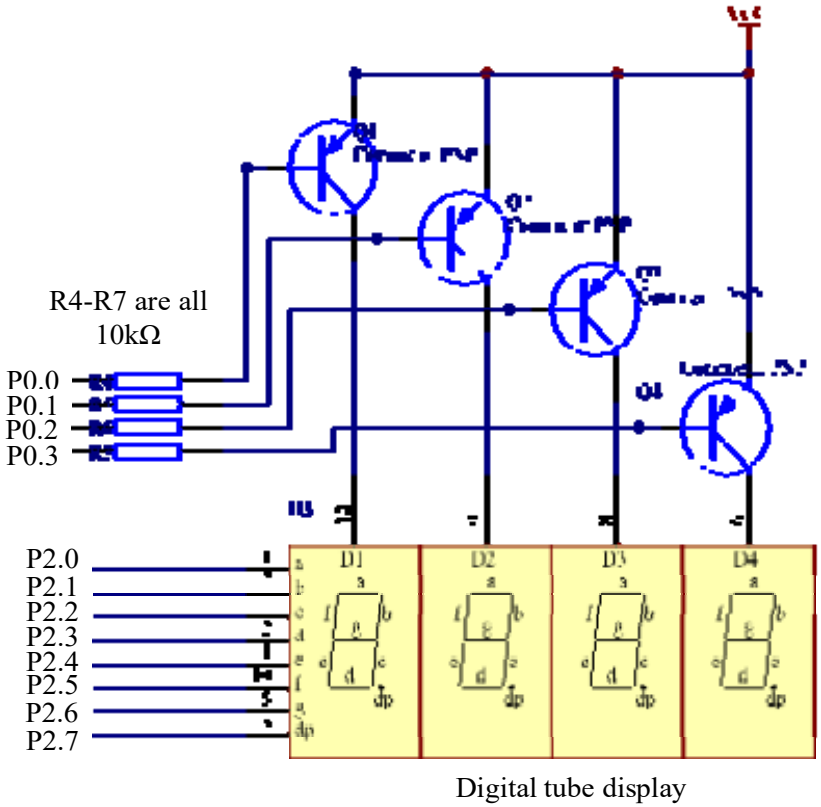

Figure 4. Temperature display circuit

3.5. The Button Circuit

This design requires three independent buttons K2, K3, K4 to set the initial temperature value. Press the button K2 to enter the menu mode to adjust the lower temperature limit. At this time, K4 is used to reduce the initial temperature value, and K3 is used to increase the initial temperature value. When K2 is pressed for the second time, it is used to adjust the upper limit of temperature. The adjustment method is the same as the above operation steps. The circuit is shown in Figure 5.

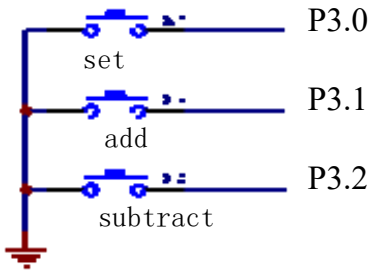

Figure 5. Button circuit

4. SYSTEM SOFTWARE DESIGN

The block diagram can be used to show how the program is executed and is a standard graphic symbol. It uses the flow chart design idea, through the block diagram, you can clearly

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see the content and steps of the computer program execution, and can also analyze the input and output data.

4.1. Software Design Flow Chart

The main flow chart of software design is shown as in Figure 6.

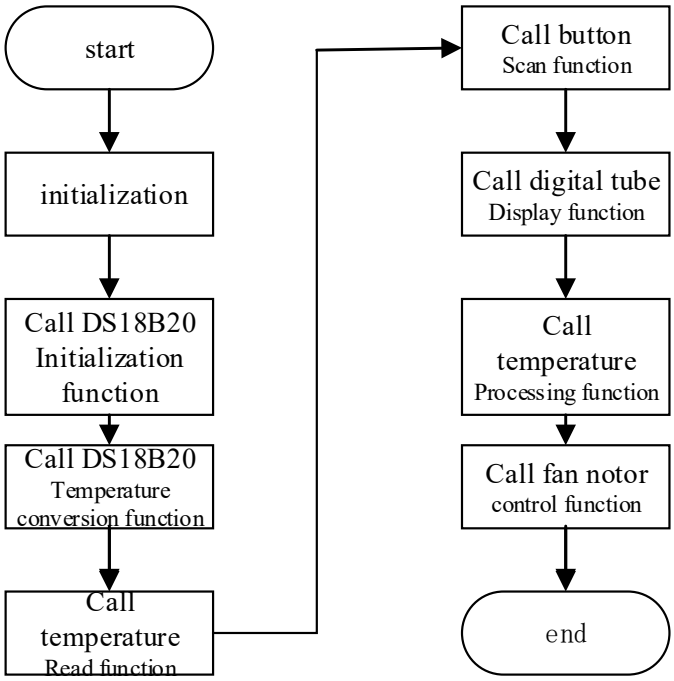

Figure 6. Main program flow chart

After the program is initialized, the temperature sensor collects the ambient temperature signal, and is processed and sent to the control chip. After the control chip is processed, it is displayed by the digital tube. When a button is pressed, the control chip runs the corresponding program segment, otherwise the current ambient temperature value T is compared with the set initial value T0. When the ambient temperature value is greater than the initial setting value, the corresponding gear is selected according to the temperature, the fan Rotate; otherwise the fan will not rotate.

The main program design includes temperature conversion program, temperature display program, scan button state program, PWM control motor speed program and other parts.

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5. SYSTEM DEBUGGING

This design can "sensing" the ambient temperature in real time according to the changes in the surrounding environment, and change the speed of the fan speed in real time; the speed adjustment adopts the PWM speed control method, which makes the speed control method convenient and reasonable, and the speed control result is timely and effective.

The temperature control fan system consists of an independent button module, a reset circuit module, a temperature detection module, and a temperature display module.

It is composed of block, PWM drive module and single chip microcomputer main control chip module. The circuit design of each part is reasonable and workability

The performance is excellent, so that the system can achieve the desired design results and meet the final design requirements.

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6. CONCLUSION

This paper has carried out a certain innovative design on the working system of the fan. The system has high detection accuracy, humanized design, and strong practicability. It can monitor the ambient temperature in real time and adjust the temperature through the fan speed. It uses a single-chip microcomputer as the control core and uses Reasonable speed regulation, good software and hardware matching effect, fulfill the design requirements, and can be promoted and used in many ways in life, which is more convenient for our lives. In addition, many features of the single-chip microcomputer need to be developed and utilized, and its design can be improved according to requirements to realize more functions.

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