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Design of Water Quality Monitoring System Based on Microcontroller

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Abstract: ***This paper designs a water quality monitoring system with STC89C52 microcontroller as the core controller. The system combines sensor technology, single-chip control technology, LCD display module and alarm circuit to monitor water quality in real time, and the overall design block diagram of the system is given. Through Protues software simulation and hardware testing, it is proved that the designed system can monitor the temperature in real time and display it on the LCD display; when the temperature exceeds the set threshold, the system can automatically alarm.***

Keywords: Microcontroller, STC89C52, Temperature sensor, LCD display, Alarm circuit

1. Introduction

With the development of social economy, human beings pay more and more attention to the quality of water resources, and are improving the quality of water resources through many ways and methods. Real-time monitoring of water quality can help us pay attention to the advantages and disadvantages of ecology and water resources in time [1]-[3]. Among them, the detected temperature, pH value, and dissolved oxygen characteristic parameters can accurately indicate the water body parameters and measuring the attribute parameters of the water body can effectively monitor the water quality.

This paper designs a water quality monitoring system based on a single-chip microcomputer. According to the design requirements, a block diagram of the overall system design is given, and the main functions of the single-chip microcomputer module, sensor module, sensor module, and display module are introduced. Through software simulation and hardware testing, the feasibility of the design system is proved.

2. System overall design

2.1 Overall program

According to the storage conditions of paper archives, the designed archive warehouse temperature and humidity monitoring system should meet the following requirements:

The entire control system can be divided into acquisition unit, control unit and alarm display unit according to functional requirements. Acquisition unit: It mainly includes temperature sensor and PH sensor, and transmits the collected data to the single-chip microcomputer. Control unit: Collect the acquisition signal of the sensor, analyze and get the result. Alarm display unit: real-time display of the current water quality temperature and PH value; when the water quality temperature and PH value exceed the set threshold index, the buzzer will give an alarm. The core of the design system is the smallest system of STC89C52 microcontroller. Other circuit modules are connected around the minimum system of the single-chip microcomputer, including: temperature sensors, pH sensor, A/D analog-to-digital converter, LCD display circuit, alarm circuit, etc. The overall design framework is shown in Figure 1.

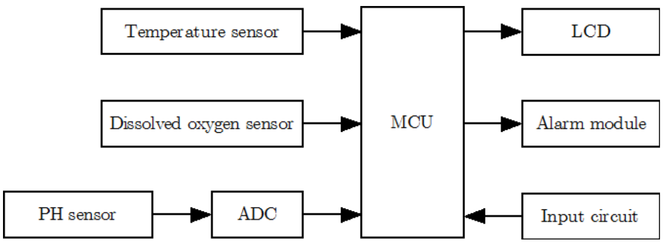

Figure 1: Block diagram of overall design

2.2 Hardware design

The main control circuit is the key of the whole system, which is composed of STC89C52 single-chip microcomputer, reset circuit and crystal oscillator circuit [4]. The frequency of the crystal oscillator determines the operating speed of the single-chip microcomputer. The reset circuit is composed of a polar capacitor and a resistor, which enables the single-chip microcomputer to be reset in time after finishing its work. STC89C52 single-chip microcomputer has the characteristics of high speed, low power consumption and super anti-interference. STC89C52 can finish the data processing independently; its circuit diagram is shown as in Fig. 2.

The design uses DS18B20 as the temperature sensor [5][6], its working power supply is 3.0～5.5V/DC, the resolution is 9～12, the temperature measurement range is -55℃～+125℃, and the resolution can reach 0.0625℃. The temperature sensor has 3 pins. Pin 1 is a data signal pin, which is pulled to a high level by a resistor, pin 2 is a 5V power input pin, and pin 3 is a ground pin, through which data is collected. Pin 1 is passed to the microcontroller for processing. The temperature sensor input circuit is shown as in Fig. 3.

This design adopts S8000 series PH value sensor [7], this sensor adopts differential five-wire electrode to form a double bridge structure. Because the sensor is equipped with a temperature compensation circuit and a pre-amplification circuit, the measurement data is more accurate, and the signal does not receive interference. The PH value measurement circuit is shown in Figure 4. Pin 6 is the signal output port, which can transmit the measured PH value to the AD acquisition module.

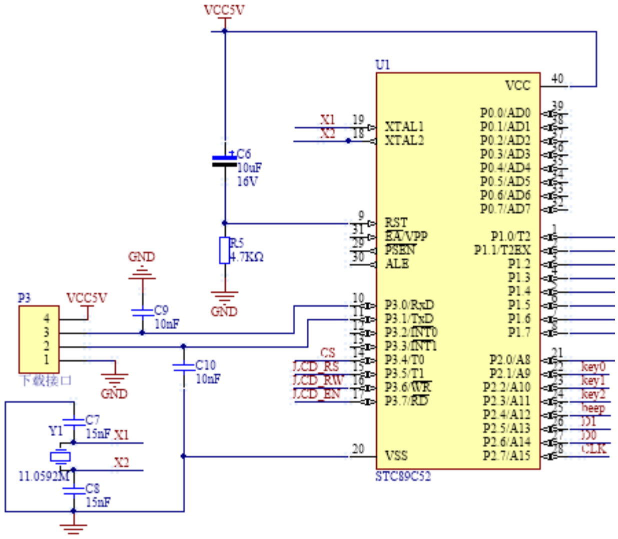

Figure 2: Main control circuit

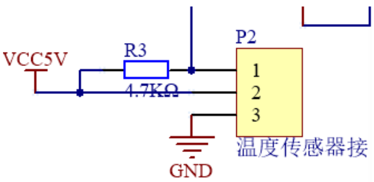

Figure 3: Temperature sensor input circuit

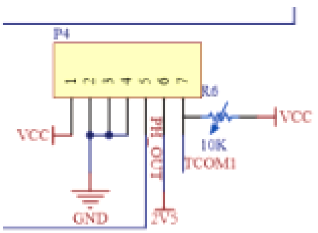

Figure 4: PH value measurement circuit

The display circuit is to allow people to directly and clearly obtain data. According to the design requirements of the water quality monitoring system, it is necessary to display the water temperature and PH value in real time. This system uses LCD1602 liquid crystal display [8], can display 2 lines of standard characters, each line has 16 characters. The LCD1602 display circuit is shown in Figure 5.

The alarm circuit is shown in Figure 6. This design uses an electromagnetic buzzer. After the power is turned on, the current flowing through the electromagnetic coil causes the electromagnetic coil to generate a magnetic field. When the temperature and PH value are higher than the alarm value set by the key input module, the microcontroller will send a low level to the triode SS8850, the triode will be turned on, and the buzzer will alarm.

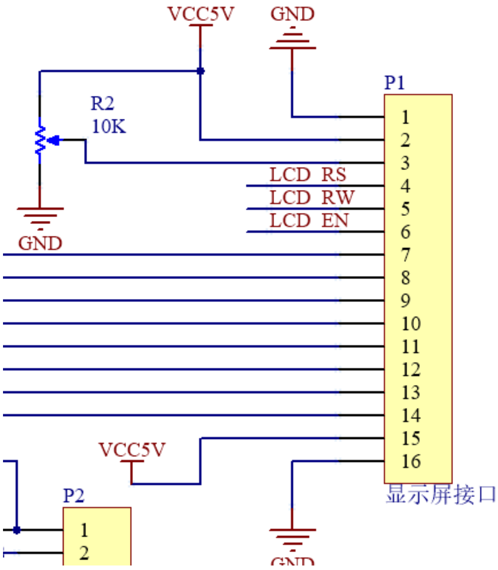

Figure 5: System composition structure

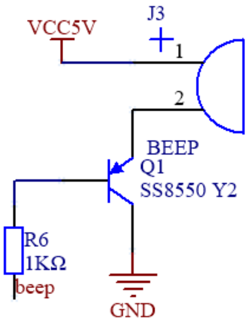

Figure 6: LED alarm circuit

3. Simulation and hardware test

3.1 Software simulation results

According to the design block diagram of the system, use Proteus software [9] to draw the schematic diagram, and use Keil to write the program. After editing the program, generate the .HEX file and add the .HEX file to the microcontroller. The simulation circuit includes the single-chip minimum circuit, temperature sensor, PH sensor, button circuit and alarm circuit. The simulation interface of the system is shown in Figure 7.

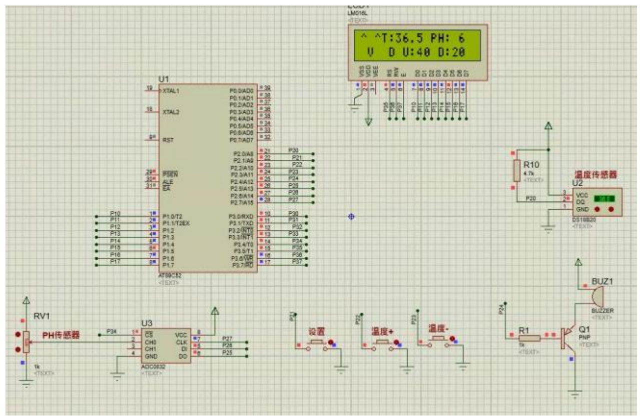

Figure 7: Circuit simulation

The upper and lower limits of temperature are set as shown in Figure 8. 1 The upper limit of temperature is 44℃, and the lower limit is 17℃. When the measured temperature is 16.4 ° C, which is lower than the lower limit of the temperature, P2.4 outputs a low level to drive the buzzer to alarm, as shown in Figure 9. Adjust the PH sensor, the liquid crystal displays the real-time change of the PH value, as shown in Figure 10, the currently measured PH value is 8.

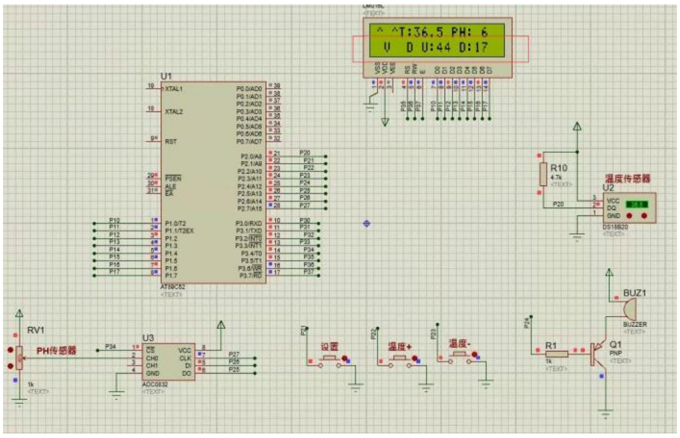

Figure 8: Temperature setting display

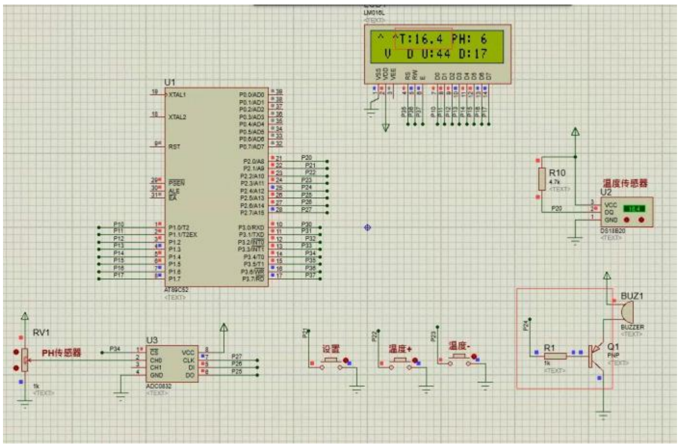

Figure 9: Temperature overrun alarm

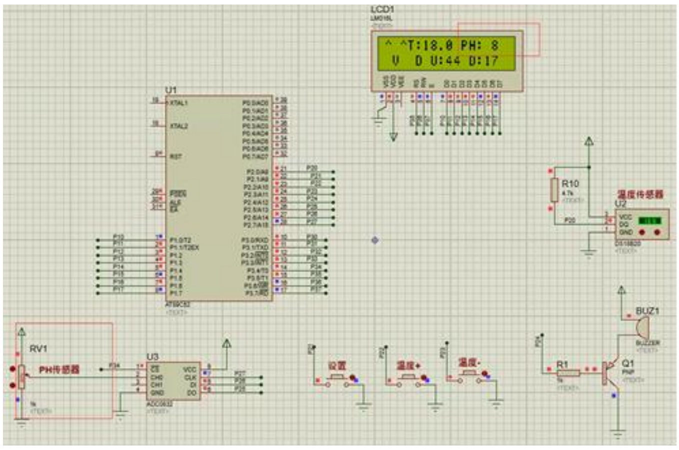

Figure 10: PH value setting display

3.2 Hardware test results

The minimum system operation of the single-chip microcomputer requires the cooperation of power reset circuit and crystal oscillator circuit. The normal operation of the system should first confirm that the power supply circuit is normal. Use a tester to measure the voltage between the ground and the power supply to confirm whether the power supply voltage is 5V. According to the circuit diagram designed in the simulation software, use a multimeter to carefully check the wiring in a certain order and repeat the test to make the hardware meet the design requirements. Figure 11 shows the boot initialization interface. After booting, the green LED is on and the power is normal, indicating that the circuit is connected correctly.

Figure 11: Interface diagram of boot initialization

The temperature upper and lower limit adjustment diagram is shown in Figure 12. Use the buttons to adjust the upper and lower temperature limits. The first letter in the second line is D, indicating that it is in the lower limit adjustment state. The figure shows that the lower limit is 34 and the upper limit is 44.

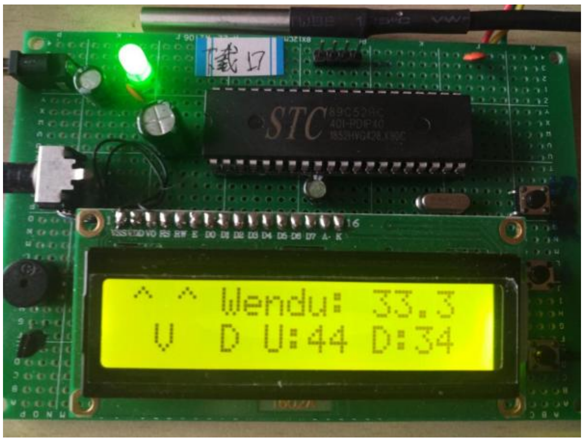

Figure 12: Temperature upper and lower limit adjustment

The result of the normal temperature measurement is shown in Figure 13, and the display temperature is 33.3 degrees.

When the temperature of 33.3 degrees is higher than the limit of 33 degrees, as shown in Figure 14, the buzzer will alarm.

4. Conclusion

This paper designs a water quality monitoring system based on STC89C51 single-chip microcomputer. The system includes main control circuit, sensor module circuit, analog-to-digital conversion circuit, display circuit and other auxiliary circuits. Software simulation and hardware test results show that the designed system can monitor the temperature and PH value of water in real time, and alarm when the temperature exceeds the threshold.

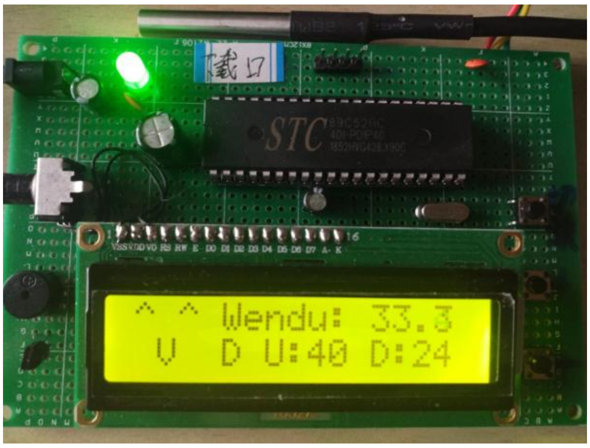

Figure 13: Results of normal temperature measurement

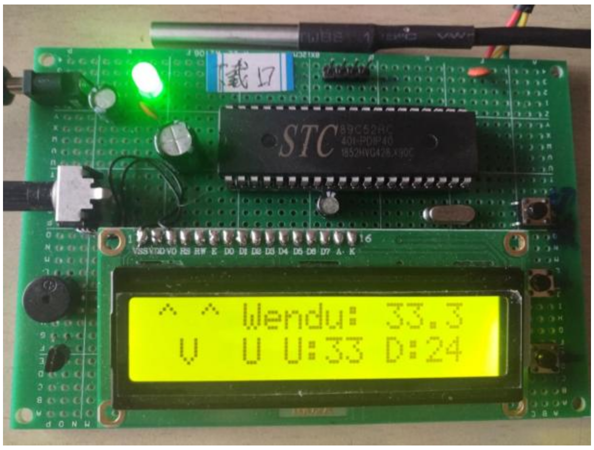

Figure 14: Alarm diagram for temperature higher than limit

5. Acknowledgements

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Author Profile

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