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Research on Grain Drying Control System based on Microcontroller

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Abstract

The automatic drying technology of grain can reduce the loss efficiency of grain, which is of great significance to improve the storage efficiency of grain. This paper studies the grain drying control system based on the microcontroller AT89C51. The temperature and humidity sensor is used to collect the grain temperature and humidity in real time, and then the value of the temperature and humidity is displayed on the LCD through the single-chip processing. The system also includes a serial communication module and an alarm module, which respectively complete the setting of the optimal temperature and humidity value and the processing of over-limit alarms. Keil software and Porteus software are used for simulation and the hardware circuit is tested. The simulation and test results prove the reliability of the design system.

Keywords

Grain Drying; Microcontroller; Temperature and Humidity; Alarm Module.

1. INTRODUCTION

Drying grains is an important part of ensuring grain quality and yield. The grain harvested across the country every year due to many irresistible reasons such as regions, seasons, weather, etc., causes the stored grain to become moldy and fester, and the loss is as high as about one-tenth. Therefore, controlling the temperature and humidity of grains and designing a system that can monitor the temperature and humidity environment of grains in real time can remind the staff to improve the grain storage environment in time to achieve the purpose of ensuring grain drying [1]-[3]. In the automatic control process of grain drying, the key to the whole drying process is to measure the temperature and humidity of the grain environment quickly and accurately.

This paper studies the grain drying system with single-chip microcomputer as the control core, and monitors the grain environment in real time through temperature and humidity sensors. Part 2 mainly describes the main design requirements and schemes of grain drying technology. Part 3 introduces the design of the main control circuit, sensor circuit, display circuit and alarm circuit. Part 4 gives the software simulation and hardware test results, and part 5 gives conclusions.

2. SYSTEM OVERALL DESIGN

2.1. Design Requirements

The design requirements of the grain drying control system studied in this paper are as follows.

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(1) Use the temperature and humidity sensor to collect the temperature and humidity in real time in the environment of the grain.

(2) Transmit the real-time data collected by the temperature and humidity sensor to the microcontroller.

(3) Setting the optimal value of the ambient temperature and humidity of the grain.

(4) The single-chip microcomputer processes and analyzes the received signal to determine whether the real-time environmental data exceeds the set threshold.

(5) The microcontroller displays the received real-time temperature and humidity data on the LCD screen.

(6) When the real-time temperature and humidity of the environment where the grain is located exceeds the threshold, an alarm program is started.

2.2. Design Program

The overall design block diagram is shown in Figure 1. The core of the grain drying control system is AT89C51. After the system is turned on, the temperature and humidity sensor first collects environmental data, converts the collected data into digital signals, and transmits them to the microcontroller. After the microcontroller processes the collected data, the data is displayed on the LCD 1602. Set the optimum value of grain temperature and humidity through the operation of the host computer, and then use RS-485 to exchange the data between the control circuit and the PC. When the real-time temperature and humidity value of the grain exceeds the set tissue, different diode lights and buzzers will send out alarm signals through the alarm circuit.

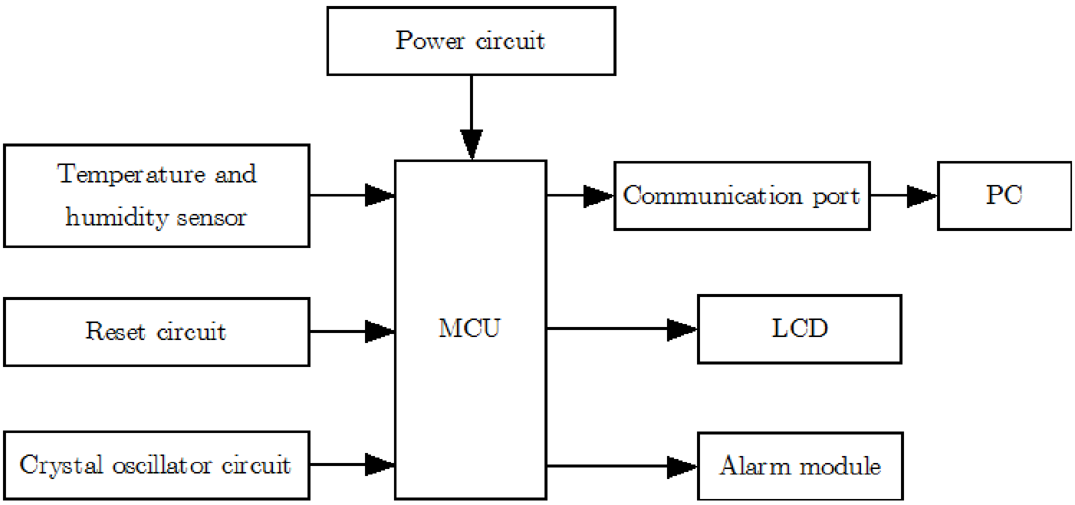

Figure 1. Block diagram of overall process design

3. HARDWARE DESIGN

3.1. Design Requirements

Use Proteus software [4] [5] to draw circuit diagrams, including single-chip microcomputer, reset circuit, clock circuit, buzzer, temperature and humidity sensor and LCD liquid crystal display, as shown in Figure 2. The upper left corner is the clock circuit and reset circuit, the lower left corner is the alarm circuit, buzzer, the upper right corner is the LCD display, and the lower right corner is the temperature and humidity sensor circuit. The clock circuit is composed of two crystals and two capacitors, which can provide standard working time for the system. The reset circuit can ensure that the circuit is restored to the initial state, and the circuit can be reset by pressing the button of the reset circuit. The sensor is responsible for transmitting the

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collected data to the single-chip microcomputer, and then the single-chip computer makes calculation and analysis, and then transmits it to the LCD liquid crystal display for display. The circuit studied in this paper can realize the measurement and collection of temperature and humidity real-time data, the setting of the optimal value of temperature and humidity, and the buzzer alarm function after exceeding the limit.

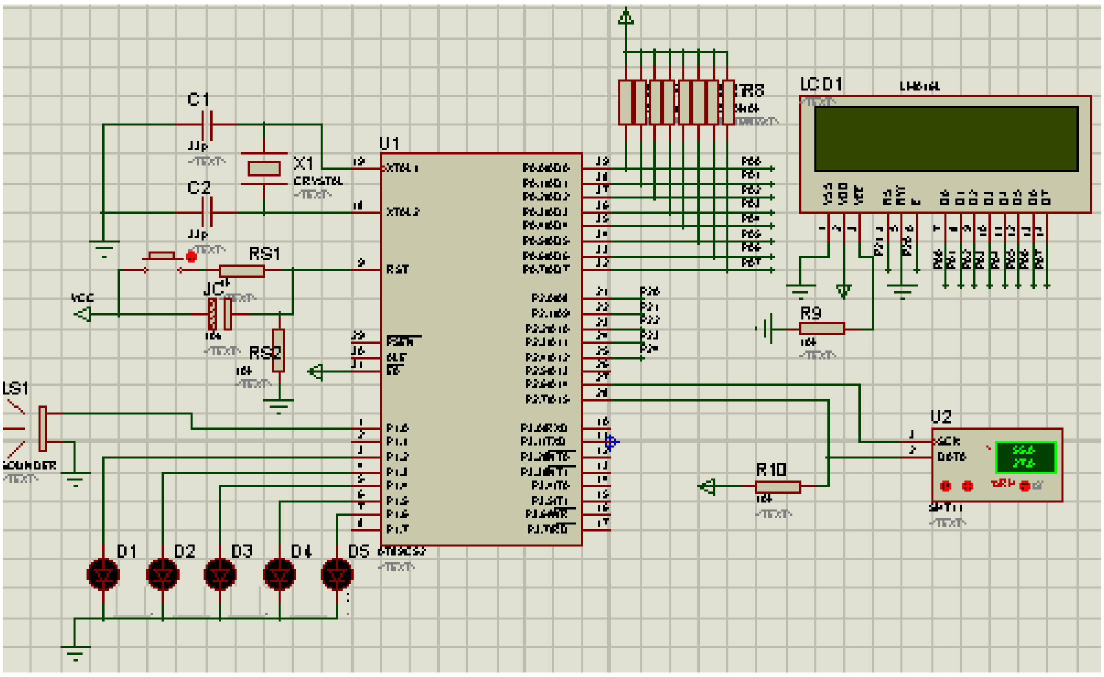

Figure 2. Overall circuit diagram

3.2. Sensor Circuit

The sensor module is responsible for the collection and preliminary processing of the entire circuit signal, including the temperature and humidity sensor DHT11 [6], as shown in Figure 3. It can monitor the temperature and humidity in the environment in a very short time and convert it into a signal that the single-chip microcomputer can receive. Pin 1 is the power supply, pin 4 is grounded, and pin 2 is connected to the power supply through a pull-up resistor.

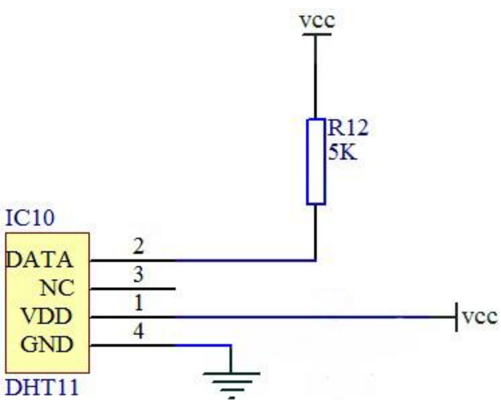

Figure 3. Sensor circuit

3.3. Display Circuit

The real-time temperature and humidity display circuit constitutes the chip of the temperature and humidity sensor. In the LCD1602 display [7], connect D0 -D7 to port P0 and

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connect RW to the ground through a two-line liquid crystal display that displays 16 characters per two lines. LCD1602 display circuit and its connection circuit are shown in Figure 4.

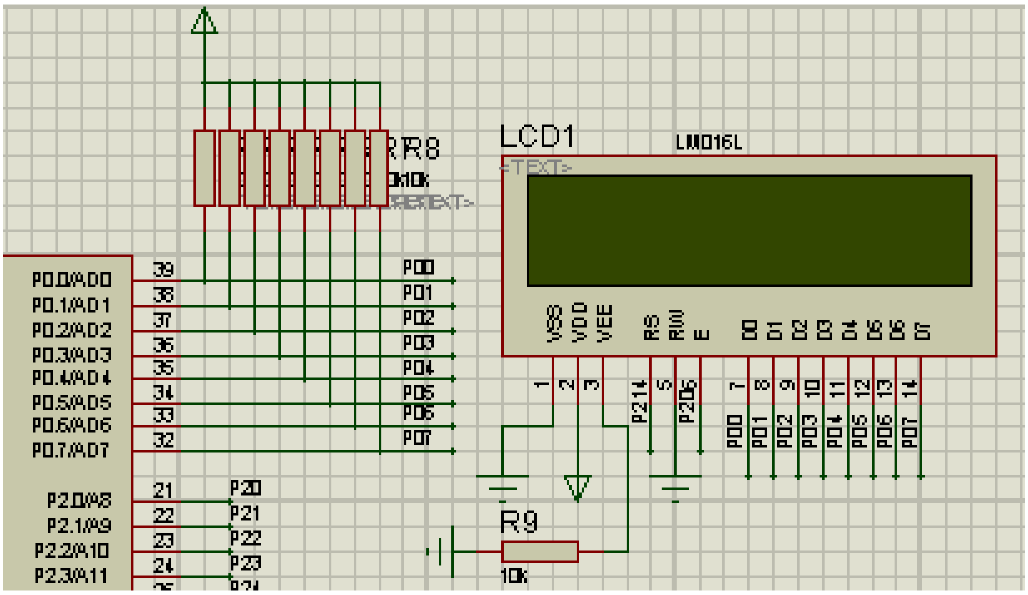

Figure 4. LCD1602 display circuit and its connection circuit

3.4. Alarm Circuit

The alarm circuit consists of 5 light-emitting diodes and a buzzer. The buzzer is connected to the P1.0 port on the microcontroller, and the connection of the light-emitting diode and the microcontroller is shown in Figure 5. D0 stands for light emission, D1 stands for cooling, D2 stands for heating, D4 stands for drying, and D5 stands for humidification. Once the data measured by the sensor exceeds the set threshold, different luminous signals will act as warnings, and at the same time, the buzzer alarm will also function. It will start and emit a continuous beep.

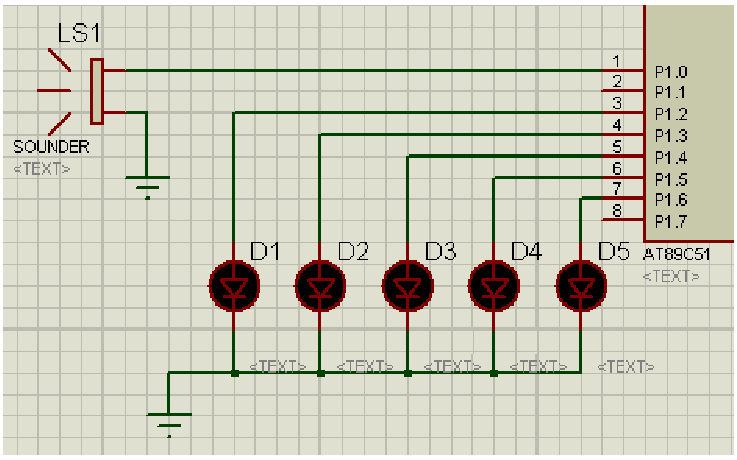

Figure 5. Alarm circuit

4. SOFTWARE SIMULATION AND HARDWARE TESTING

4.1. Software Simulation

According to the overall design, Proteus software is used for circuit simulation, as shown in Figure 6. When the system is connected to the power source, the LCD starts normally and starts

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to measure the temperature and humidity of the current environment. The four buttons in the upper left corner are the lifting buttons of temperature and humidity in the simulated environment. From top to bottom, they are: real-time humidity value increase button, real-time humidity value decrease button, real-time temperature value increase button, and real-time temperature value Decrease button. When the detected temperature and humidity exceed the threshold value, the buzzer at the bottom of Figure 5 will start to sound a long "tick" alarm, then lower the temperature value, and the alarm sound will disappear immediately. The same verification is done for humidity, and the result is the same as that for temperature.

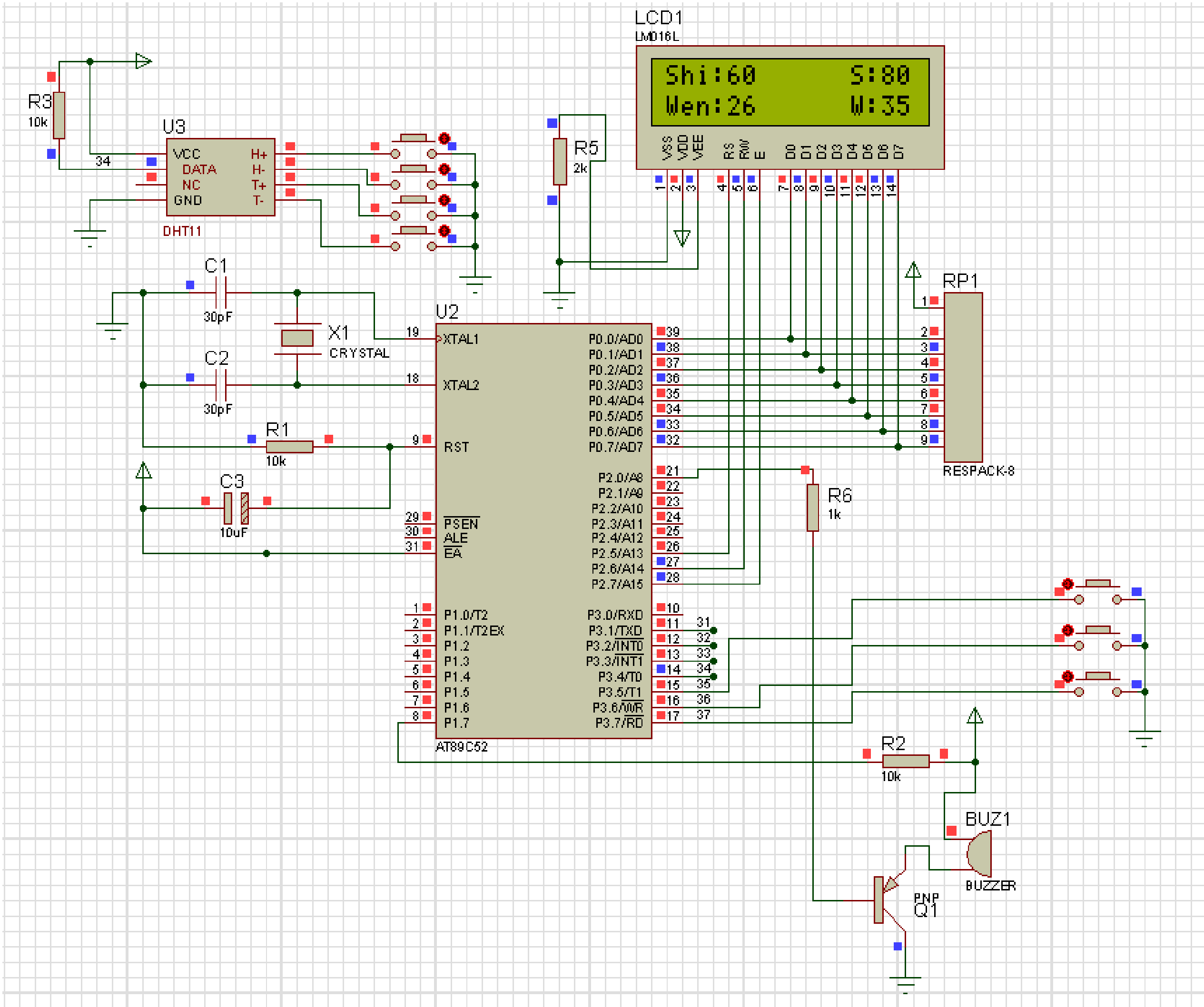

Figure 6. The overall simulation diagram of the system

4.2. Hardware Test

The welding process adopts manual welding, and the contact time of the solder joints must be less than 10s under the condition of the maximum temperature of 260°C. First solder the basic components on the circuit board, then connect the components of each module to the components according to the circuit diagram, and finally connect several modules together. The closer ones can be connected directly with solder, and the farther ones can be connected with wires. Pay attention to the positive and negative poles during the connection. The hardware circuit diagram is shown as in Figure 7.

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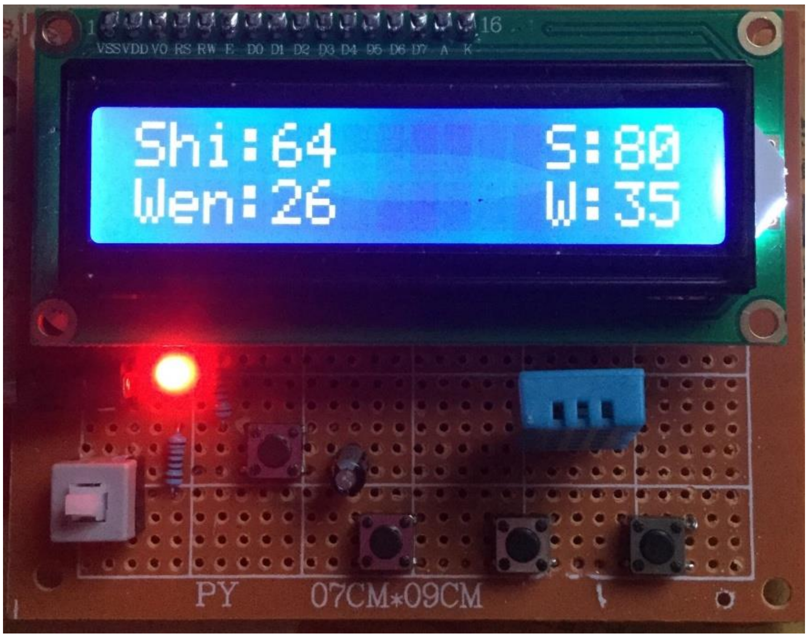

Figure 7. Hardware circuit connection diagram

At room temperature, connect the USB interface to the power supply, and press the power switch button, the USB interface starts to supply power. At this time, the temperature and humidity sensor will start to detect the temperature and humidity value of the environment where the current sensor is located in time, and the single-chip microcomputer will send the collected data to the LCD screen and display it, Wen: °C, Shi: RH. Adjust the upper temperature limit to 40°C; adjust the upper humidity limit to 82%RH, as shown in Figure 8.

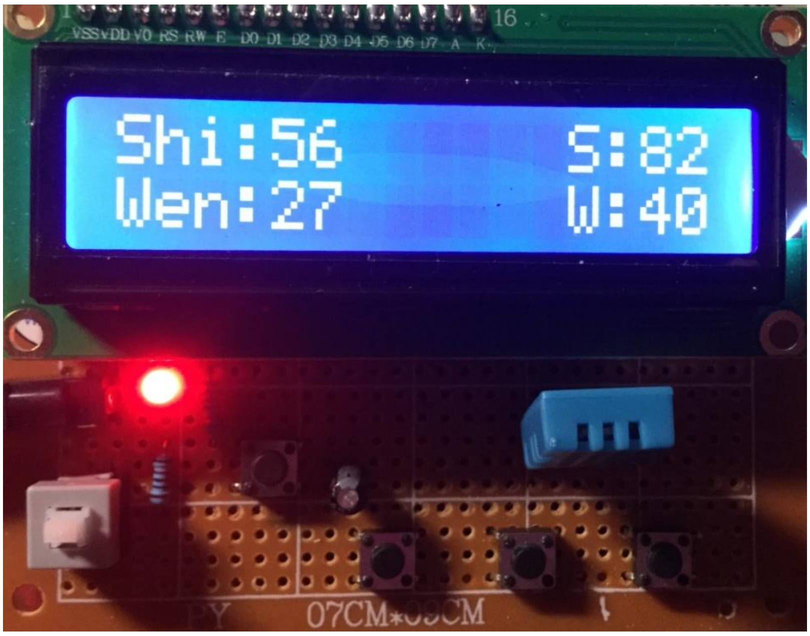

Figure 8. Setting the optimal value of temperature and humidity

Take a sigh of relief near the front of the temperature and humidity sensor DHT11, and then observe the data changes on the LCD screen, you can see that the humidity has risen from 64%RH to 95%RH, which is greater than the set upper limit 82 %RH, the alarm is activated at this time, and the buzzer emits a long and bright "di" prompt. The result is shown in Figure 9.

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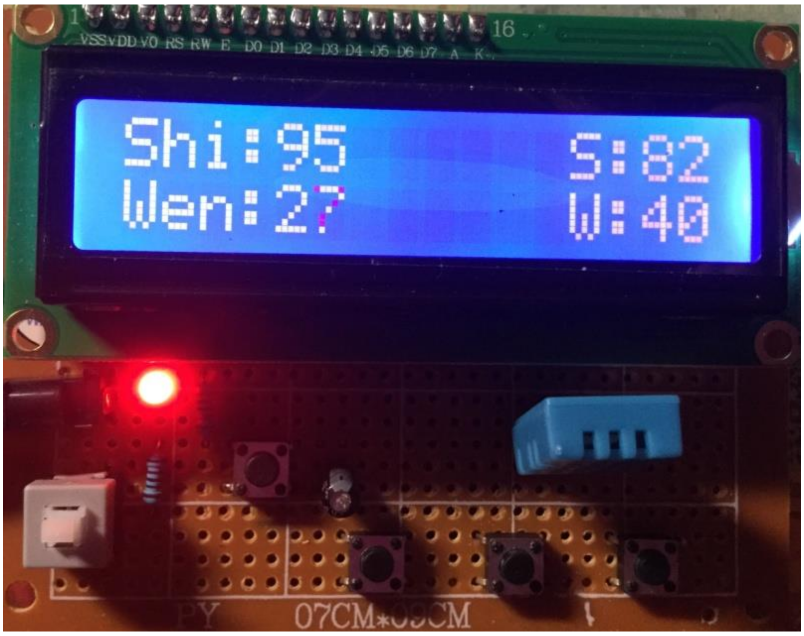

Figure 9. Alarm diagram when humidity exceeds the limit

When the data on the LCD screen is restored to the normal value of room temperature, and the buzzer no longer sounds, adjust the upper limit of humidity to 99%RH and the upper limit of temperature to 28°C. Move your hand to the front of the temperature and humidity sensor and stay there, and then observe the real-time temperature and humidity changes on the display. It can be seen that the temperature has risen from 26°C to 28°C on the display screen. At this time, the alarm is activated again, and the buzzer once again emits a long and loud "beep" alarm. The results is shown in Figure 10.

Figure 10. Temperature alarm diagram

5. CONCLUSIONS

In this paper, the background meaning of the grain drying system is explained. With the microcontroller AT89C51 as the control core, a system that can automatically monitor the

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environmental temperature and humidity is designed. The main control circuit, sensor circuit, display circuit and alarm circuit are introduced in detail, and the system functions are verified by software simulation and hardware testing. The experimental results show that the design system can monitor the temperature and humidity of the grain environment in real time, and send an alarm signal when the temperature and humidity exceed the threshold, which meets the design requirements.

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