

The Temperature and Humidity Control System of the Nursery Environment based on Microcontroller

Wei Wang^{1,a}, Mengmeng Zeng^{1,b} and Li Wang^{1,c}

¹Department of Electronic Engineering, Xi'an Aeronautical University, Xi'an Shaanxi 710077, China.

^aweiiwang@qq.com, ^b1726941168@qq.com, ^cwangli871016@163.com

Abstract

Temperature and humidity are important factors affecting the seedling environment. Too low or too high temperature and humidity will affect the success rate of seedlings. Therefore, designing a high-precision temperature and humidity control system is of great significance to agricultural production and scientific research. This article combines computer sensor monitoring and single-chip control to design and manufacture a temperature and humidity control system in the nursery environment that meets the actual conditions of farmers. The design system is composed of single chip microcomputer, liquid crystal display, sensor and buzzer. The sensor monitors the temperature and humidity of the external environment, and transmits the collected data to the single-chip microcomputer, and the single-chip microcomputer starts the display program or alarm program after the data is processed. After software simulation and hardware testing, the design system can meet the design requirements.

Keywords

MCU; temperature and humidity control; DHT11 sensor; LCD.

1. Introduction

Food production is of great significance for ensuring people's livelihood and promoting rapid economic development. If you want to increase food production, the key link is to ensure the success rate of breeding [1] [2]. Temperature and humidity are important factors that affect the breeding environment. If the temperature and humidity of the breeding environment cannot be grasped in real time, the success rate of seedling will be affected in the spring when the temperature and humidity are relatively different [3]-[5]. Therefore, it is very important to design a nursery environment control system that takes the humidity and temperature of the nursery environment as the control object.

This article uses a single-chip microcomputer to establish a temperature and humidity control system, which can monitor the temperature and humidity of the nursery environment in real time, promptly remind the staff to improve the nursery environment, and increase the success rate of breeding. First introduce the overall design of the system, then introduce the hardware circuit design of the system, and finally verify the function of the system through software simulation and hardware circuit testing.

2. System Overall Design

2.1. Design Requirements

Establish a collection system and a control system, measure and process the controlled factors, and implement automatic and manual control of the nursery environment temperature and

humidity control system through simulation software to complete the overall analysis and functional testing.

- (1) The temperature and humidity data is collected by the temperature and humidity sensor DHT11 and quickly transmitted to the single-chip microcomputer.
- (2) The MCU AT89C51 analyzes and processes the received data, and sends the collected temperature and humidity data to the LCD display in time.
- (3) Use LCD1602 to realize temperature and humidity data display;
- (4) Set the temperature and humidity threshold, when the collected data exceeds the threshold range, the buzzer will send out an alarm signal.

2.2. Overall Program

The temperature and humidity control system block diagram designed in this paper is shown in Fig. 1. The system includes temperature and humidity acquisition part, central processing unit, display module and alarm module part. We use AT89C51 [6] [7] as the central control part of the entire system, use DHT11 sensor [8] to collect the temperature and humidity of the environment, and transfer the collected data to the single-chip microcomputer, the processed data is displayed in the display module.

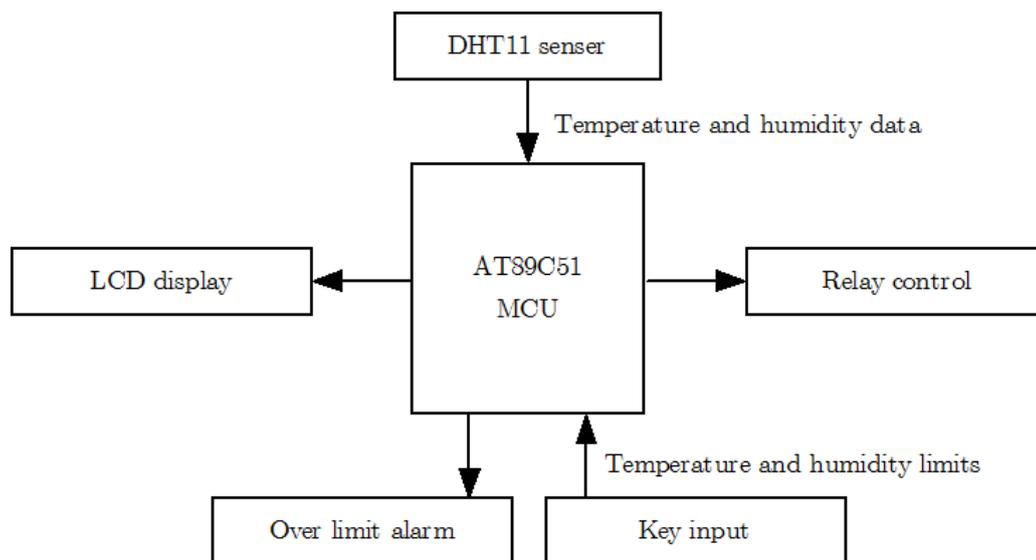


Fig 1. Block diagram of system design

3. System Hardware Design

3.1. Main Control Circuit Design

In the main control circuit, a sensor is used to monitor the temperature and humidity, and a single-chip microcomputer is used as the core component of the entire control. The collected temperature and humidity data are processed and displayed on the display screen. At the same time, the collected data is compared with the threshold, and when the collected data exceeds the threshold range, the alarm circuit is activated to give an alarm. The main control circuit is shown as in Fig. 2.

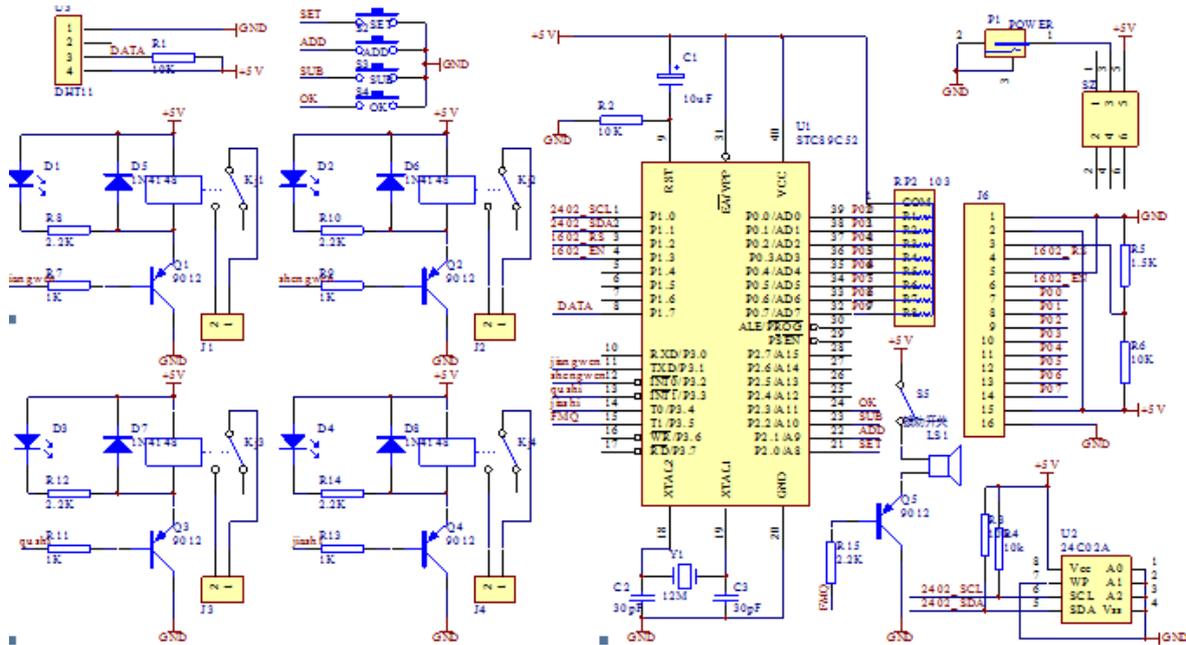


Fig 2. Main control circuit design

3.2. Sensor Circuit Design

The DHT11 sensor is used to measure temperature and humidity data, which has high measurement accuracy and can meet the requirements of real-time collection. When the range of the measurement environment is greater than 20 meters, a 5K pull-up resistor needs to be connected to the circuit to ensure the accuracy of the measurement data. The sensor circuit is shown as in Fig. 3.

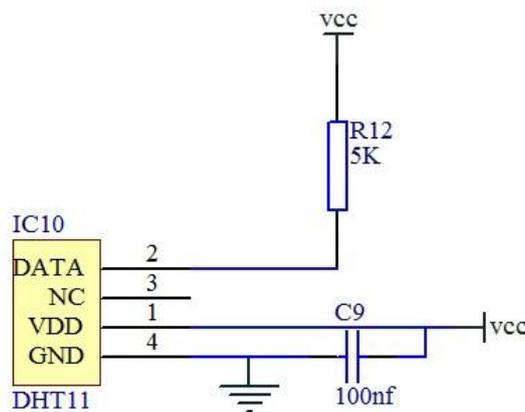


Fig 3. Sensor circuit

3.3. Display Circuit Design

The sensor transmits the monitored current temperature and humidity data to the single-chip microcomputer. After the single-chip uses the internal program to analyze it, it will be displayed on the LCD screen, and the upper and lower limits of the required temperature and humidity can be set on the display through external keys. The system adopts LCD1602 display screen, its circuit diagram is shown as in Fig. 4.

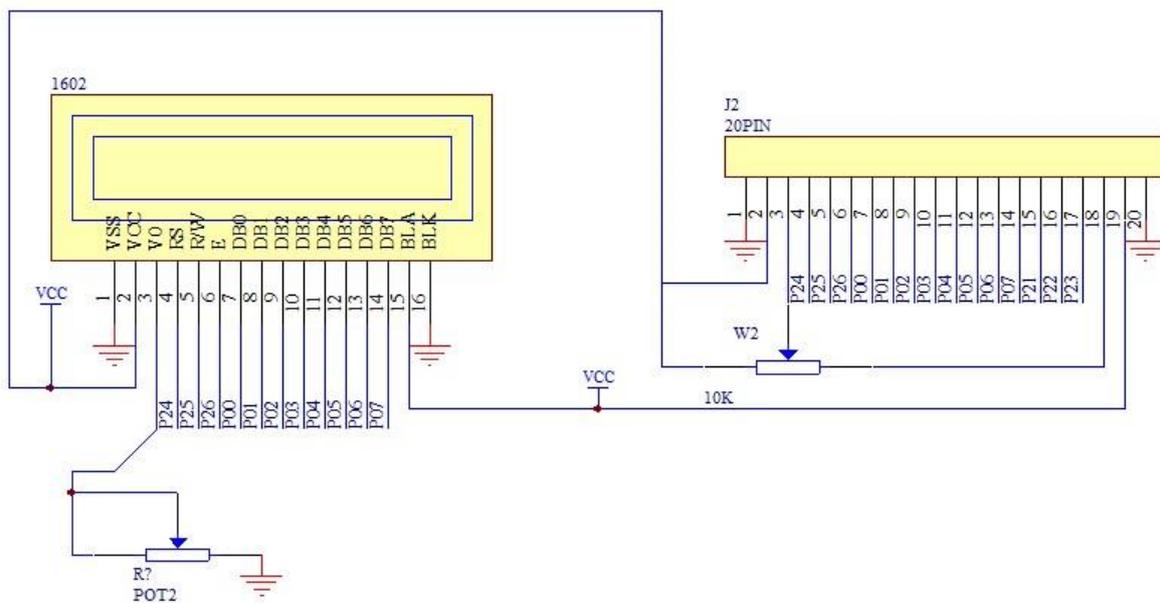


Fig 4. Display circuit

3.4. Alarm Circuit Design

After the temperature and humidity data monitored by the sensor are transmitted to the single-chip microcomputer, the single-chip microcomputer compares the collected data with the threshold data through an internal program. If the collected data exceeds the threshold range, the buzzer circuit is activated for alarm processing. The buzzer circuit is shown as in Fig. 5.

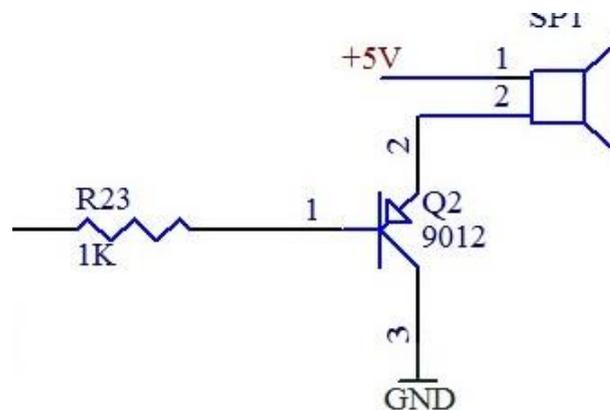


Fig 5. Buzzer circuit

4. Software Simulation and Hardware Test

4.1. Software Simulation

The design system is mainly used for the temperature and humidity control of the nursery environment. The main function is to measure the temperature and humidity of the nursery environment in real time, and display the temperature and humidity on the display screen; start an alarm when the temperature and humidity range exceeds the threshold. The core control component selects AT89C51, and the temperature and humidity of the external environment are collected using DHT11 digital temperature and humidity sensor. Protues software [9] [10] is used for circuit construction and simulation, and the simulation results are shown in Fig. 6.

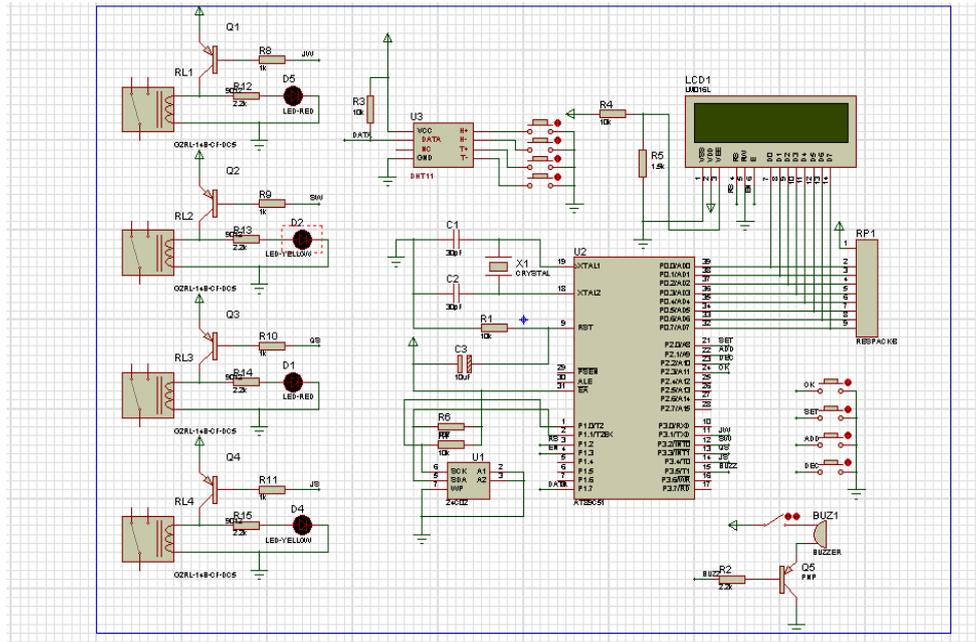


Fig 6. System simulation diagram

4.2. Hardware Test

Use Keil software to write the program, and burn the program into the single-chip microcomputer, let the single-chip microcomputer analyze and process the data. According to the software simulation diagram, build the hardware circuit, set the temperature and humidity threshold data through the button, the result is shown in Fig. 7.

Set the upper temperature limit to 25 degrees, the lower temperature limit to 24 degrees, the upper humidity limit to 70%, and the lower humidity limit to 28%. After power on, the sensor automatically starts to collect the temperature and humidity parameters of the current environment, as shown in Fig. 8. As can be seen from the figure, the current environment temperature is 23 degrees and the humidity is 65%. Because the temperature is lower than the threshold, the buzzer sends out an alarm signal to remind the staff to carry out the heating operation.



Fig 7. Temperature and humidity threshold setting



Fig 8. Alarm when the temperature is below the threshold

Change the temperature and humidity threshold, set the upper temperature limit to 25 degrees, the lower temperature limit to 20 degrees, the upper humidity limit to 60%, and the lower humidity limit to 55%. Collect the ambient temperature again, the current ambient temperature is 23 degrees, and the humidity is 63%. Because the humidity is higher than the set threshold, the buzzer sends out an alarm signal to remind the staff to perform dehumidification work, as shown in Fig. 9.

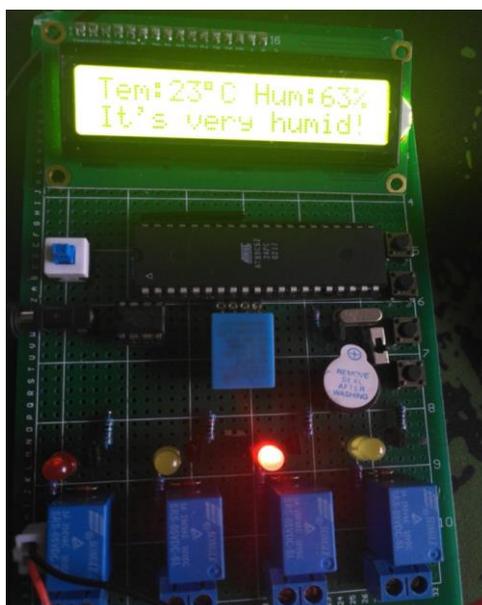


Fig 9. Alarm when humidity is higher than the threshold

5. Conclusion

This article discusses the design and implementation of a single-chip microcomputer-based temperature and humidity control system for nursery environment. The main function of the system is to monitor the temperature and humidity of the current environment in real time,

display the temperature and humidity on the display, and send an alarm signal when the temperature and humidity exceed the set threshold. The thesis gives the overall design of the system, hardware circuit design, software simulation and hardware circuit test results. The test results show that the system can collect and display the temperature and humidity of the current environment in real time, and send an alarm signal when the temperature and humidity do not meet the requirements, which fully prove that the design system can meet the design requirements.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (grant number 61901350); and Science Research Fund of Xi'an Aeronautics University (grant number 2019KY0208).

References

- [1] Zhang Wei. Design of basic environment monitoring system for wireless intelligent nursery shed[J]. Southern Agricultural Machinery, 2020, 51(13): 20-22.
- [2] Lu Daipeng, Zhang Duanxi, Xu Huachen, et al. Technical specifications for environmental management of greenhouse vegetable plug seedlings[J]. Shanghai Journal of Agriculture, 2019, 35(6): 118-122.
- [3] Wei Xing, Zhu Shiping, Huang Hua, et al. Design of wireless monitoring system for environmental parameters of tobacco seedling greenhouses based on ZigBee[J]. Jiangsu Agricultural Sciences, 2016, 44(2): 414-417.
- [4] Long Xing. Research and design of factory seedling germination room based on temperature and humidity control [D]. Hubei: Huazhong Agricultural University, 2014.
- [5] Chengdu Xinjin Muge Ecological Agriculture Development Co., Ltd. Nursery box with temperature and humidity adjustment function: CN201711098655.7 [P]. 2018-04-06.
- [6] Hu Chao, Wei Zhonghui. Design of greenhouse temperature and humidity control system based on AT89C51 microcontroller[J]. Science and Technology and Innovation, 2020, (13): 125-127.
- [7] Li Rui. Design of greenhouse temperature control system based on AT89C51 single-chip microcomputer [J]. Electronic Production, 2020, (2): 8-10.
- [8] Chen Jianxin. Application of DHT11 digital temperature and humidity sensor in greenhouse control system[J]. Shandong Industrial Technology, 2016, (18): 120-120.
- [9] Wang Xiangling. Practical teaching of Proteus simulated temperature, room temperature and humidity control system[J]. Laboratory Research and Exploration, 2020, 39(1): 120-124.
- [10] Li Delu, Liu Zhijian, Chen Hongzhen, et al. Exploration of MCU teaching reform based on Protues[J]. Electronic Testing, 2017, (18): 46-48, 33.