Temperature and Humidity Monitoring System for Archive Warehouse Based on Microcontroller

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Abstract: ***Based on the temperature and humidity requirements of the archive warehouse, this paper designs an archive warehouse monitoring system based on the STC89C52 microcontroller to monitor the temperature and humidity of the archive warehouse in real time. When the real-time temperature and humidity exceed the set corresponding threshold, the system will alarm. The designed system is composed of sensor module, microcontroller module, liquid crystal display module, sound and light alarm module. STC80C52 microcontroller is the control core of the system, using temperature and humidity sensors to collect temperature and humidity data in the warehouse. The temperature and humidity sensor sends the collected data to the microcontroller for processing, and displays the temperature and humidity on the LCD screen. The system uses Keil software to write programs, and uses Proteus software to perform simulation tests to realize the real-time display of temperature and humidity, and realize the alarm function when the temperature and humidity exceed the set threshold.***

Keywords: Microcontroller, Archive warehouse, Temperature and humidity monitoring, Alarm

1. Introduction

Archives play an indispensable role in the development of human society. Because paper archives need to be preserved for a long time, they have extremely high requirements on the storage environment. If real-time temperature and humidity monitoring of the archive storage environment is not possible, it will cause the loss of paper archives[1][2]. Therefore, it is necessary to strengthen the reasonable monitoring of the temperature and humidity parameters of the archive warehouse environment, so as to help the staff adjust the warehouse temperature and humidity in time to ensure the long-term preservation of the archives.

Archive warehouse management, mainly including ambient air detection, fire prevention and anti-theft, personnel entry and exit records, etc., can help improve the archive warehouse environment and realize a humanized, intelligent, and scientific management model[3][4][5]. At present, many archive warehouses have been equipped with related temperature and humidity measuring instruments, ventilation fans, dehumidifiers and other equipment, but only relying on the consciousness and management experience of managers to maintain the temperature and humidity of the warehouse, resulting in the warehouse environment cannot be effectively protected.

This article studies the temperature and humidity detection technology of archive warehouses, and designs a warehouse temperature and humidity monitoring system based on STC89C52 microcontroller. The current environmental data is collected by the temperature and humidity sensor, and the data is processed by the single-chip microcomputer, and the warehouse is monitored by manual regulation. The system combines traditional manual control methods with intelligent control to realize temperature and humidity management of the archive warehouse environment.

2. System Design

2.1 Design Requirements

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

(1) Real-time and accurate collection of temperature and humidity in the warehouse, and comparison with the set temperature range (14±2℃～24±2℃) and humidity range (45 ± 5% ～ 60 ± 5%) by the single-chip microcomputer Processing and comparison of collected data.

(2) If the set limit is exceeded, the buzzer will continue to alarm, and the corresponding indicator will light up so that the administrator can take timely treatment.

(3) The liquid crystal display can show the temperature and humidity values and alarm parameters at the same time.

(4) When the temperature and humidity of the warehouse are manually adjusted, it can be reset manually.

(5) The required technical specifications of the system: use 3~5V alternating current to supply power through USB. Work in an environment of -30～80° C and <95%RH.

2.2 System Block Diagram

This system uses STC89C52 microcontroller [6][7] as the core control element to complete the processing of temperature and humidity data and transmit it to the LCD for easy viewing. At the same time, it completes the comparison between the current temperature and the set value. If it exceeds the limit, an audible and visual alarm will be performed until it returns to the set range.

The system structure is shown in Figure 1. The DHT11 digital temperature and humidity sensor [8] is used to collect the data of the current environment regularly, and hand it over to the microcontroller to complete the analysis and comparison. Using LCD1602 as the display module, the screen is divided into two lines, the first line is used to display temperature-related information, and the second line is used to display humidity-related information. The button module is used to set the temperature and humidity alarm range, circuit reset and power switch. The alarm module uses a triode amplifier circuit, which turns on the sound and light alarm under over-temperature and over-humidity conditions.

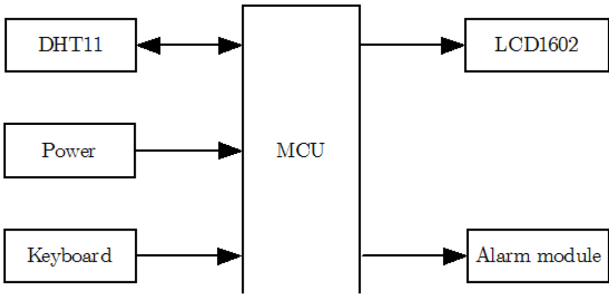

Figure 1: System composition structure

3. Hardware Circuit Design

3.1 Main Control Circuit

The main control circuit is the key of the whole system, which is composed of STC89C52 microcontroller, reset circuit and crystal oscillator circuit. The microcontroller has the characteristics of high speed, low power consumption and super anti-interference. STC89C52 can finish the processing to the data independently under the control of the procedure, its circuit diagram is shown as in Fig. 2. It has 4 bidirectional 8-bit input and output ports, among which P3 port can provide some control signals. The crystal oscillator circuit connected to pin 18 (XTAL1) and pin 19 (XTALA2) provides the operating frequency for the microcontroller. Pin 9 (RST) can initialize the entire system.

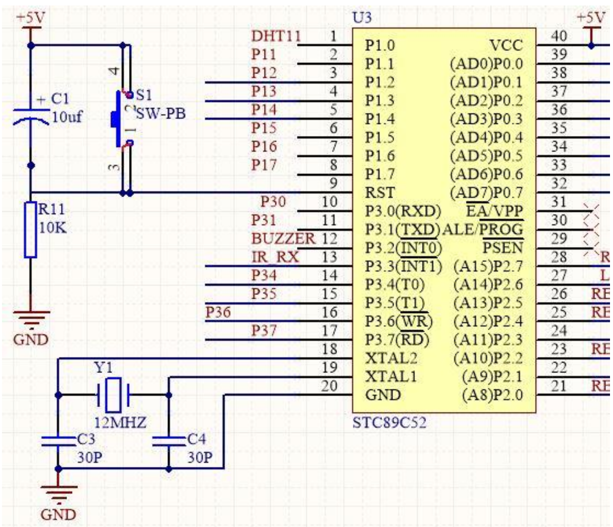

Figure 2: Main control circuit

3.2 Display Circuit

LCD1602 liquid crystal display can be divided into three parts: control, drive and display [9]. It is a dot matrix display that can be used to display a small number of characters, numbers and letters. LCD1602 is divided into two lines to display, each line can display 16 characters without affecting each other. LCD1602 displays clear and continuous light, no flickering screen appears in the screen, and has a digital interface, which can be directly connected to the single-chip microcomputer, making the operation more convenient and reliable. Its circuit diagram is shown as in Fig. 3.

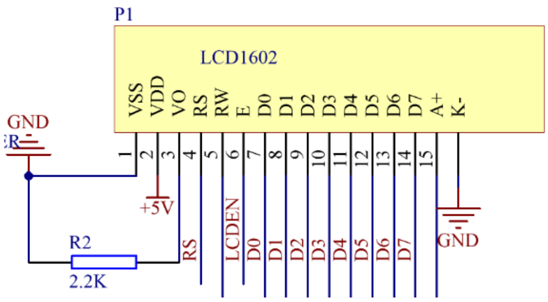

Figure 3: LCD1602 display circuit

3.3 Sensor Circuit

DHT11 is a digital sensor, which can directly convert the collected temperature and humidity data into electrical signals and send them to the single-chip microcomputer for processing. Its professional acquisition module can make the data collected by itself reliable, can be used for a long time, and has strong anti-interference ability. DHT11 is composed of resistive humidity sensing element and NTC temperature measuring element.

The parameters of DHT11 temperature and humidity sensor are: (1) Humidity measurement range: 20～95%RH, (2) Temperature measurement range: 0～50℃, (3) Humidity measurement accuracy: ±5%RH, (4) Temperature measurement Accuracy: ±0.5° C. The circuit diagram is shown as in Fig. 4.

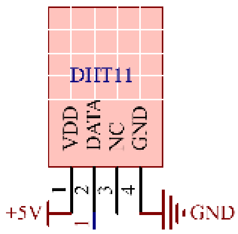

Figure 4: Sensor circuit

3.4 Alarm System

The alarm circuit is designed to give reminders to the management personnel to perform dehumidification and ventilation operations in time. This design uses a buzzer and LED lights to alarm. There are 4 LED lights, corresponding to the temperature is too low, the temperature is too high, the humidity is too low, and the humidity is too high. When the temperature and humidity threshold is exceeded, the buzzer will sound and the corresponding indicator will light up, so that the archives warehouse manager can take emergency protective measures in time.

This design uses a transistor amplifying circuit, the circuit is shown in Figure 5, the power supply provides 5V voltage. The core idea is to transfer the data collected by DHT11 to the microcontroller, which performs data processing and digital filtering, and then compares the measured data with the threshold value [10]. If it is higher than the upper limit, the corresponding sound and light alarm will be issued, and if it is lower than the lower limit, the alarm will also be issued. The LED circuit is shown in Figure 6.

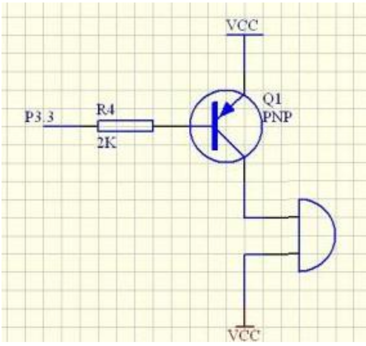

Figure 5: Buzzer alarm circuit

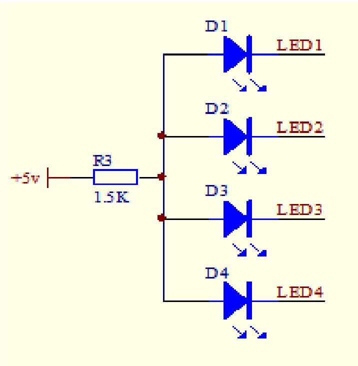

Figure 6:LED alarm circuit

4. Simulation and Testing

4.1 System Simulation

Use Proteus to simulate the circuit designed by the system and run it in Windows. Draw the schematic diagram through Proteus, and write the program with Keil. After editing the program, generate the .HEX file and add the .HEX file to the microcontroller.

Press the keyboard to adjust the temperature and humidity control range, and adjust the temperature range to 14～24℃ and humidity to 45～60% according to the management requirements of the archives warehouse. After the adjustment is complete, press S again to directly return to the normal measurement mode.

Figure 7 shows the simulation interface of the entire system. DHT11 can be manually adjusted to simulate the actual transmitted temperature and humidity data.

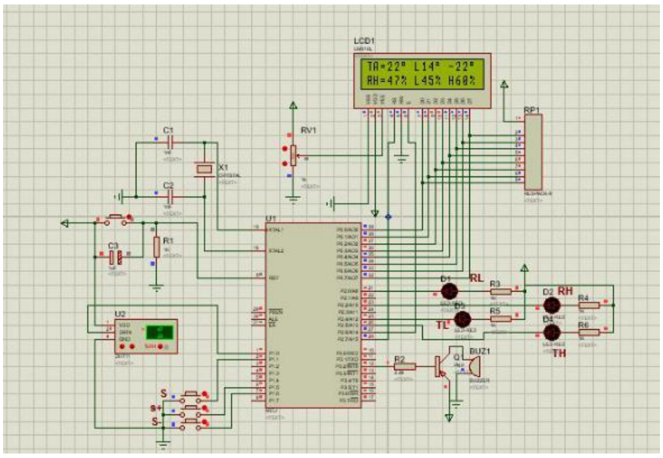

Figure 7: Simulation circuit

Adjust the humidity value of DHT11 to 34% (below 45% of the minimum setting range) to simulate low humidity alarm. At this time, the buzzer alarms and the left indicator lights up, the result is shown in Figure 8.

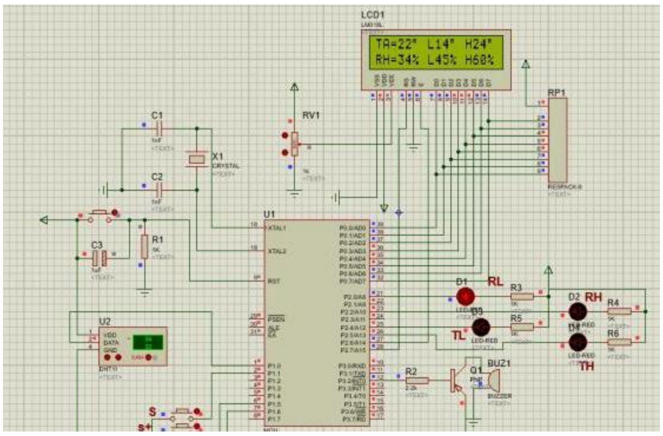

Figure 8: Low humidity alarm

Adjust the temperature value of DHT11 to 26°C (14°C higher than the highest setting range) to simulate high temperature alarm. At this time, the buzzer alarms and the second indicator light on the right lights up, as shown in Figure 9.

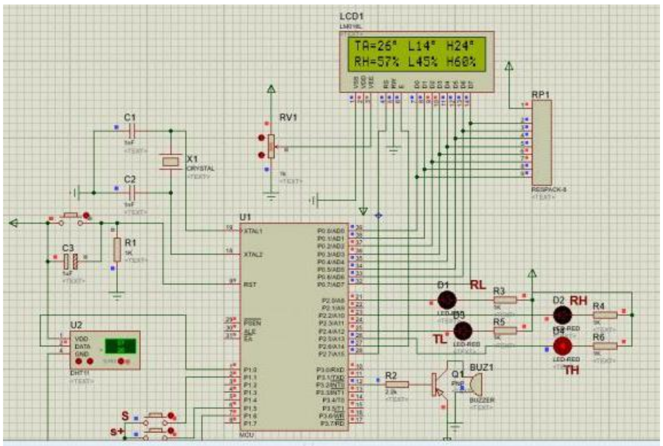

Figure 9: High temperature alarm

4.2 Hardware Test

The hardware circuit board of the designed monitoring system is shown in Figure 10.

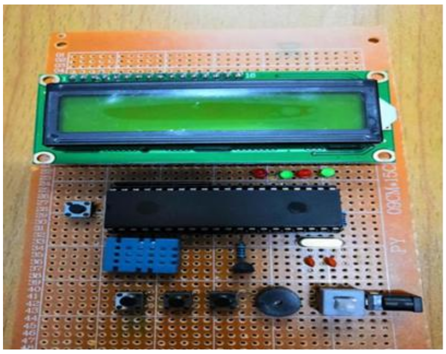

Figure 10: Designed monitoring system circuit board

Press the setting key, the setting value mark starts to flash. Use the buttons to adjust the temperature and humidity alarm threshold, as shown in Figure 11.

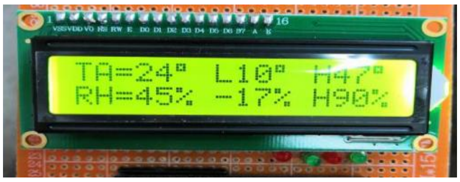

Figure 11: Button to adjust the threshold

Set the temperature to 15～30℃ and the humidity to 30～80% to test the system function. The water supply cup is connected to hot water and contacts the DHT11 temperature and humidity sensor to trigger a high temperature alarm. At this time, the buzzer sounds and the high temperature alarm indicator lights up, as shown in Figure 12.

Figure 12: High temperature alarm

Blow air to the DHT11 temperature and humidity sensor to increase the humidity and trigger an alarm that exceeds the upper limit of humidity. At this time, the buzzer sounds continuously and the response indicator lights up. As shown in Figure 13.

After testing, it is found that the system can normally display temperature and humidity values throughout the day, which is not much different from the values of physical temperature and humidity measurement devices placed indoors. It can perform over-limit sound and light alarms and realize functions such as button adjustment. Therefore, the system can be applied to archive warehouse management, real-time environmental monitoring, and over-limit alarm.

Figure 13: Alarm outside the humidity range

5. Conclusion

This paper designs a temperature and humidity monitoring system for archive warehouses with STC89C52 microcontroller as the control center. The composition of the system is introduced in detail, including sensor module, single-chip processing module, liquid crystal display module and sound and light alarm module. Proteus software is used for simulation test, real-time display of temperature and humidity, and alarm function when temperature and humidity exceed the set threshold. The hardware circuit diagram was tested, and it was found that the designed system can display the temperature and humidity of the environment in real time, and give an alarm when the temperature and humidity exceed the threshold. The software simulation and hardware test results fully proved the rationality of the design system.

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Author Profile

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