Design of Temperature and Humidity Controller of Warehouse Based On Arduino

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Abstract. Temperature and Humidity controller of warehouse based on Arduino IDE is designed to measure and control the temperature and humidity more conveniently and easily. The controller is controlled by Arduino micro-controller, using a combination of temperature and humidity Sensor technology, Programmable Smart LCD touch-display terminal, bluetooth module communication technology and network module technology to finish the real time detection of temperature and humidity. The data of temperature and humidity were sent to networking platform by network module. User can use any browser or smart phone to read. Once unusual phenomena occur, the temperature and humidity control system is automatically activated. The controller is operated easily and at low cost, suitable for popularization. It offers some references for the application of Arduino IDE.

1. Introduction

Moisture-proof, mildew-proof, corrosion-proof and explosion-proof are the important contents of daily warehouse work and the important indexes to measure the quality of warehouse management. It directly affects the service life and working reliability of materials that are stored in the warehouse. The detection and control of temperature and humidity in the military materials warehouse should be strengthened. The traditional methods are time-consuming, laborious, inefficient and low accuracy. Therefore, there is an urgent need to develop a set of controllers that can automatically detect, alarm and control in real time, which can effectively reduce human resources and improve the efficiency of the warehouse.

A warehouse temperature and humidity controller based on Arduino new integrated development environment is designed [1-3]. The controller is controlled by Arduino micro-controller, using a combination of temperature and humidity Sensor technology, Programmable Smart LCD touch-display terminal, bluetooth module communication technology and network module technology to finish the real time detection of temperature and humidity. The data of temperature and humidity were sent to networking platform by network module. User can use any browser or smart phone to read. This system can automatically test the temperature and humidity of each warehouse in the reservoir area in real time. Once unusual phenomena occur, it is easy to deal with them in time. It can

automatically ventilate, dehumidify and heat warehouses that do not meet the requirements of temperature and humidity.

2. Total Design

The controller is mainly composed of temperature and humidity testing system, control and detection circuit, temperature and humidity control system, LCD module, Bluetooth module, network module, as shown in Figure 1.

2.1. Temperature and humidity testing system

2.1.1 Temperature and humidity sensor. DHT11 is a temperature and humidity composite sensor with calibrated digital signal output [4]. It uses special digital module acquisition technology and temperature and humidity sensing technology.

It can overcome the disadvantage of signal conditioning circuit and A/D converter when analog sensors are connected with microprocessors. It is widely used in various temperature and humidity

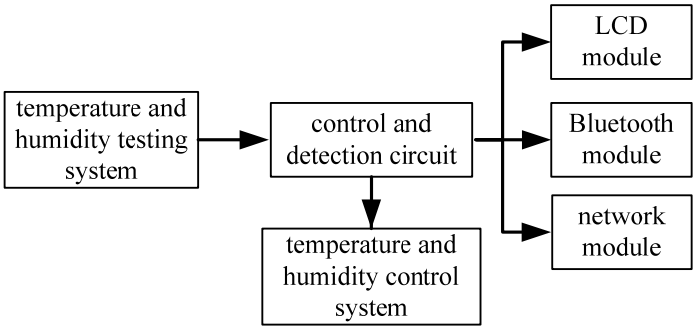

Fig. 1 system chart

Control systems. It consists of a NTC temperature measuring element and a resistive humidity sensing element. It is connected with a high-performance 8-bit single-chip computer. It uses single-wire serial communication mode to save IO resources. The range of measurement is 20% RH ~ 90% RH, the precision of measurement is (+5%) RH, and the range of temperature is 0 ~ 50 C, the precision of measurement is (+2%) and the resolution is 1. When connecting with the circuit of Arduino UNO control board, the VDD, GND and DATA pins of DHT11 temperature and humidity module are connected to the + 5V, GND and digital ports of Arduino UNO control board respectively, and a pull-up resistance of 5k between VDD and DATA

is also needed, as shown in Figure 2.

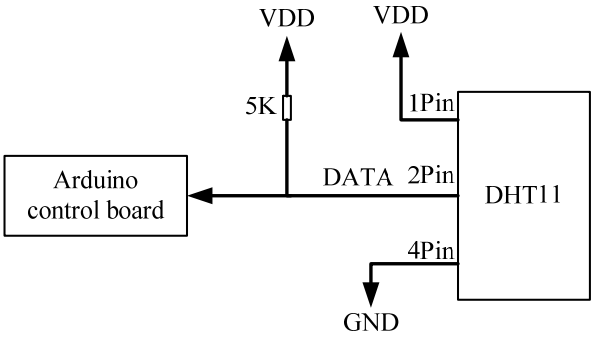

Fig. 2 circuit connection diagram of DHT11

2.1.2 Temperature and humidity acquisition subroutine. DHT11 uses single bus mode to transmit data with Arduino control board in control and detection circuit. The communication time is about 4ms. The data is divided into decimal part and integer part. The complete data transmission is 40bit at a time, and the high bit first out. Data format: 8 bit humidity integer data + 8 bit humidity decimal data + 8 Bi temperature integer data + 8 bit temperature decimal data + 8 bit checksum. DHT11 has a high requirement for timing. It is suggested that the data acquisition interval should be more than 1 s when writing the program, otherwise the acquisition will fail.

2.1.3 Control and detection circuit

(1) Arduino UNO control board. Arduino UNO R3 is the latest version of the Arduino USB interface series and serves as a reference standard template for the Arduino platform .The core of UNO processor is ATmega328, which has 14 digital input/output ports (6 of which can be used as PWM output), 6 analog inputs, a 16MHz crystal oscillator, a USB port, a USB port and A power outlet, a ICSP header and a reset button. At the AREF, two pins SDA and SCL are added to support I2C interface. The USB interface chip is replaced by ATmega16U2 instead of ATmega8U2 to increase IOREF and a reserved pin. Arduino UNO R3 development board has the ability to connect keyboard, mouse, rocker and other peripherals, and can be compatible with many peripheral modules, or through compatible expansion board, through the port of expansion board to adapt to the new peripheral module; the expansion performance is very strong.

(2) Main program flow. The software part of the controller adopts modular design [5-7]. The whole software consists of main program, temperature and humidity acquisition subroutine, temperature and humidity control subroutine, liquid crystal display control subroutine, Bluetooth module sending subroutine and network sending subroutine. The main program is the core of the whole system management and control. After the system is powered on, the temperature and humidity sensor is initialized first, and the temperature and humidity module is tested to determine whether the module is damaged or whether the error is larger. Arduino UNO main control board stores temperature and humidity collected by temperature and humidity sensors in registers to facilitate the reading and judgment of the main control board. Then it collects temperature and humidity data serially. Finally, the collected data is displayed on the LCD screen, transmitted to the mobile phone through Bluetooth, or transmitted to the computer or mobile phone through the network module for query. The main program flow is shown in Figure 3.

2.1.4 Temperature and humidity control system. When the temperature inside the warehouse is lower than the lower limit of the set value, higher than the upper limit of the set value or higher than the upper limit of the set value, the MCU will output the corresponding control signal to the temperature and humidity control system and start the heating (cooling) or dehumidification circuit. When the temperature and humidity meet the requirements, the temperature and humidity control system stops working. The core work of temperature and humidity control system is to control the action of relays to achieve circuit switching. Part of the control circuit diagram is shown in Figure 4.

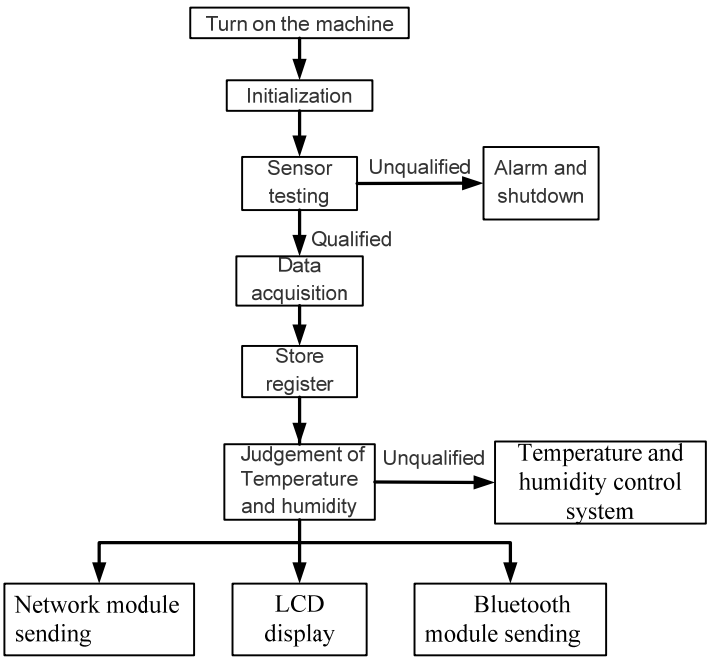

Fig. 3 flow chart of main program

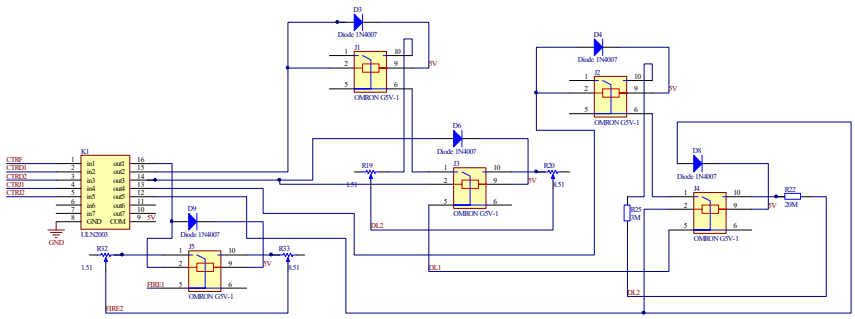

Fig. 4 a part of temperature and humidity control circuit diagram

The chip is driven by ULN2003 chip, which is a composite transistor array with high voltage and high current density. It is composed of seven silicon NPN composite transistors; each pair of Darlington is connected with a 2.7K base resistance in series. It can be directly connected with TTL and COMS circuits at 5V operating voltage, and can directly process data that originally required standard logic buffers to process. It uses collector open circuit output and large output current, which can directly drive relays or solid relays. For the safety and reliability of the system, the two level relay is adopted in the control system. The first stage uses OMRON G5V-1 relay for circuit switching and the second stage uses OMRON LY2J-AC220V relay.

2.1.5 LCD module

(1) LCD display circuit. Programmable Smart LCD (PS-LCD) developed in China is used in this design. PS-LCD is an intelligent display module which includes LCD display screen, LCD controller, touch screen, man-machine interface processing system and communication interface. It connects with external control unit (such as 51 MCU, ARM, DSP, PC, PLC, bus equipment) through optional communication interface to realize man-machine interface of the system. Traditional interactive interface development, from initialization device to drawing the final interface, involves many

technologies, such as what point, line, filling, coordinates, fonts, pictures, events and messages. So many concepts need to be used; the final realization is just a simple graphics or text display. With PS-LCD, you can select directly from the controls or your own pictures, and support various formats of picture display, bmp, jpg, tiff, png, gif animation, which greatly facilitates the user's development of human-computer interaction interface. PS-LCD uses JavaScript scripting language. JavaScript is the most popular scripting language on the Internet. It exists in all Web browsers all over the world and can enhance the interaction between users and Web sites and Web applications. The LCD display screen collects and judges the temperature and humidity sent by the controller in real time by scripting. As an advanced intelligent man-machine interface product, PS-LCD can easily and flexibly interact with external control unit through communication interface.

(2) LCD display control subroutine. At present, PS-LCD supports two communication protocols: CTP (Cooky Talking Protocol) protocol and User Define protocol. This Controller uses the first communication protocol CTP protocol. Because the serial communication protocol of PS-LCD is inconsistent with that of Arduino UNO microcontroller, it is necessary to transform and control in the process of communication. In order to cancel the automatic reply message of PS-LCD command execution result, in CTP communication mode, the automatic reply of PS-LCD is cancelled by calling ctpSet ("reply", 0) function. PS-LCD also sets the qualified temperature and humidity interval by serial port signal generated by communication protocol, which is sent to Arduino control board to realize the effect of human-computer interaction.

The interface of the controller PS-LCD is shown in Figure 5

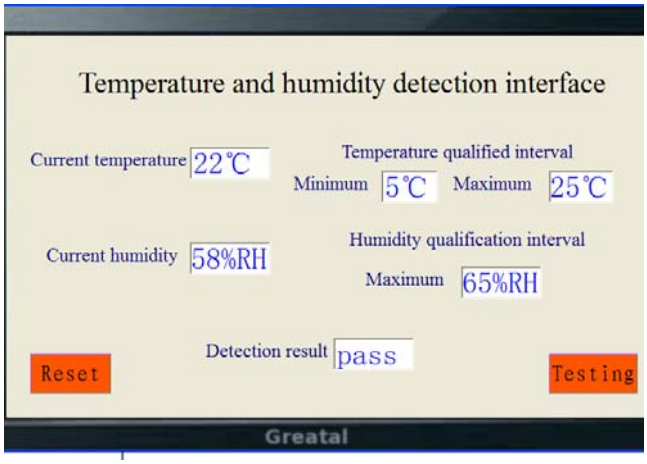

Fig. 5 detection interface

2.1.6 Bluetooth module

(1) HC-06 Bluetooth module. HC-06 Bluetooth module is used in this design. The main performance of the Bluetooth module is: Bluetooth 2.0 band EDR; standard HCI port (UART or USB); modulation degree is 2M bps-3M bps; volume is 27mm *13mm 2mm; built-in 2.4 GHz antenna; external 8Mbit FLASH, with adaptive frequency hopping technology, with low voltage 3.3V operation, small size and simple. The peripheral design circuit and other characteristics. Bluetooth module has six pins. We usually only need four wires. They are VCC, GND, TXD and RXD. We connect them to Arduino control board, VCC to 3.3V, GND to GND, RXD to RXD to control board.

(2) Bluetooth module sending subroutine. When in use, the AT instruction of Bluetooth module is used to test whether the communication is normal or not: send: AT (return to OK once a second), return: OK. The AT instruction of Bluetooth module is used to modify the name, password and baud rate of Bluetooth module. When the bandwidth requirement is not high, the baud rate can choose the default 9600. Finally, download the Bluetooth serial port assistant on the mobile phone and search for

the previously set Bluetooth device. Through this app, the measured temperature and humidity can be viewed in real time.

2.1.7 Network module. The electronic building block W5100 network module is adopted in the design. W5100 is a multi-functional monolithic network interface chip, which integrates 10/100Mbps Ethernet controller and integrates TCP/IP protocol, MAC and PHY. It supports direct bus interface, indirect bus interface and SPI bus. W5100 can realize Internet connection without operating system. W5100 is compatible with IEEE802.3 10BASE-T and 802.3u 100BASE-TX.

3. Conclusion

This paper introduces the design of warehouse temperature and humidity controller based on Arduino, realizes the communication control between Arduino microcontroller board and PS-LCD, HC-06 Bluetooth module and W5100 network module, and monitors the temperature and humidity in warehouse by screen display, mobile Bluetooth and network reception. It has the characteristics of simple hardware design, high reliability, convenient use and low price. When temperature and humidity control system is added, when the temperature and humidity exceed the warning value, the system can automatically control heating (cooling) and dehumidification, so that temperature and humidity tend to normal value, so as to truly achieve the goal of unattended warehouse.

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