Design on the Wireless Detection of Soil Temperature and Humidity

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Keywords: single chip computer; sensor; wireless transmission; alarm; display.

Abstract: This design is mainly divided into two parts: collecting data on soil temperature and humidity through the machine part. Relevant equipment includes the DS18B20 temperature sensor and the YL-69 humidity sensor. Afterwards, the A/D converter transforms the analog quantity collected and sends out detected data to the receiver at the same time. The host machine mainly receives data sent by the sender and displays information on the LCD1602 screen. It also needs to judge and analyze whether the data exceeds the set range, so as to realize the alarm function. Meanwhile, keys can be used to set different temperature and humidity ranges for diversified environments. In this design, the main controller is a STC89C52 single chip computer; data transfer is achieved through wireless transmission mode and NRF24L01 communication. The ordinary mode of direct arrangement of wires is complex, unsafe and easy to be disturbed. Moreover, the instrument which integrates temperature and humidity measurement can neither provide data in real time nor receive data from a long distance. This design mainly takes the single chip computer as the core to realize various functions; data receiving and sending are realized through the wireless module. It is a feasible scheme for the measurement of temperature and humidity, and for the wireless transmission. It satisfied the requirements of this task.

1. Introduction

Temperature and humidity data are information used everywhere in life and production of various industries. The rapid progress of science and technology in agricultural and industrial applications puts higher requirements on temperature and humidity in the process of commodity production. Temperature detection and humidity measurement have become an essential issue. It is very important in ensuring commodity quality, increasing commodity outputs, saving energy and resources, and ensuring production safety. Therefore, fast, economical and effective temperature and humidity measurement technology and related devices have attracted wide attention. Because of the development of science and technology and the progress of industries, temperature and humidity are not only reflected in above aspects; they also affect people's basic life all the time. Therefore, it is particularly important to achieve accurate and reliable measurement of temperature and humidity. In recent years, the use of intelligent temperature sensors, humidity sensors and online measurement of temperature and humidity information have become a trend of development for temperature and humidity detection technology. In the case of inconvenient operation, wireless measurement is also needed urgently. How to cultivate good varieties of plants has been the subject of continuous research. Therefore, the wireless temperature and humidity detection system based on single-chip computer is urgently needed to solve these problems.

2. The Designing Scheme

2.1 Selection of control chips

The main control chips of this design are single-chips, including 51 single-chip computer and 52 single-chip computer. But in fact, the two single-chip computers are exactly the same; the only difference lines in the size of their internal memories. The internal program memory of 51 single chip computers is 4KB; the data memory is 128. The memory of 52 single chip computers is twice as big as that of 51 single-chip computers. It also has a timer; the baud rate can be a little higher than the set. Therefore, 52 single chip computers are enhanced versions of 51.

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2.2 Selection of sensors

Based on the subject, two kinds of sensors are needed: temperature sensors and humidity sensors.

The temperature sensor is a sensor that can receive temperature information and convert it into available signal output. The temperature sensor is one of the core components of temperature detectors. There are many kinds of temperature sensors.

One of the features of the thermal resistance is, it is mostly made up of negative temperature coefficients. It uses semiconductor components, so the changes of temperature can have a great impact on the resistance value. At the same time, it is small in size and fast in reaction. But the sensitivity is in ordinary level and not very reliable. It can only detect the change of temperature from 6 to 10 degrees centigrade, and it needs an A/D converter to send the information to the single chip computer, which leads to complex structure of the temperature measurement equipment. Moreover, the algorithm of this method is complex, which makes the design of software program even more difficult. Thermocouple is widely used in temperature measurement. It has a wide temperature range and is suiTable for different environmental conditions. The economical and practical component is very convenient and widely used, but it is not suiTable for high precision measurement.

2.3 Selection of the wireless communication module

There are three kinds of wireless communication modules. When leaves the factory, the wireless data transmission module has already made a single chip computer, and completed a part of the wireless communication program. It can receive and send data directly through the serial port. It is simple to use, but relatively expensive. Wireless data transmission module needs the single chip computer to control wireless data transmission and reception.

The NRF24L01 module is selected to communicate in this design. It has advantages of high-speed transmission, low energy consumption, reliability, stability, low price, long transmission distance, simple circuit, easy to use and wireless data transmission. It can work normally in low voltage environment. It also has the functions of automatically retransmit, automatically detect and retransmitting lost data packets, which makes it convenient for design and usage.

3. Main Hardware of the System

3.1 STC89C52 microcontroller

STC89C52 (STC89C52RC) single chip computer has very powerful functions, which makes it the first choice of most users.

The minimal system circuit of a single chip computer is the combination of simplest components with a single chip computer. It is a workable circuit that includes crystal oscillator (clock) circuits and reset circuits.

3.2 Temperature and humidity sensors

3.2.1 DS18B20 temperature sensor

The DS18B20 temperature sensor is a digital sensor; it can show the measured temperature directly. Writing and reading can be accomplished with only one interface line. Its data bus can supply power for the DS18B20 temperature sensor. It is also small in size, cheap in price, and has various products. It can be used in various occasions, since it is small in shape and convenient in use.

Main characteristics of the DS18B20 temperature sensor are as follows.

(1) The single-wire connection mode is used to connect with the single-chip computer. Only one connection line is needed to communicate with the single-chip computer and achieve data exchange.

(2) The detection range is wide and the accuracy is high. The temperature range is - 55 to 125 degrees.

(3) Several DS18B20 components can be arranged in parallel connection in the only single line; multi-point temperature detection can be realized.

(4) The sensor resolution rate can be set as 9-12 bits, which can be realized through the program setting.

(5) When the polarity of the power supply is not connected correctly, the temperature measuring equipment will not be burned down. The only consequence is that it cannot work properly.

(6) The sensor chip is equipped with EEPROM, so it has the power-off protection ability. That is, in the case of power failure, relevant data can still be retained.

3.2.2 YL-69 humidity sensor

Humidity sensors can be used to collect data on humidness. Humidity sensors can detect moisture content in soil and obtain soil humidity information. The characteristic of rheostat can be regarded as a humidity sensor. When the moisture information is obtained, the resistance value will change accordingly. The output voltage of the circuit alters with the changes of resistance value. The probe of YL-69 humidity sensor has nickel plating, which prevents water damage, enlarges the sensing area, improves the conductivity and prolongs the service life. When there is little water in the soil, the resistance between the two inserts will become nearly infinitely great; when the soil moisture is large, the resistance between the inserts will be reduced to thousands of ohms, or possibly hundreds of ohms.

When the inductor of the soil moisture sensor is not inserted into the soil, the transistor Q1 is open. In that case, Q1 is cut off, and the output is 0. When it is inserted into the soil, the water resistance in the soil changes; the base of Q1 has break-over current. The conduction current between the collector and the emitter of Q1 is controlled by the base. The current will be converted into a voltage after passing through the R2resistance of the emitter; then the voltage will be processed by the converter.

3.3 NRF24L01 wireless module

Data transmission of NRF24L01 is realized through the wireless mode. It can be compatible with all kinds of microcontrollers, and has merits of low energy consumption, reliability and stability, low price, long transmission distance, simple circuit and easy to use. It can work normally under low voltage environment.

Main features of NRF24L01 are as follows.

(1) Data transmission rate supports 1Mbps and 2Mbps.

(2) It has the functions of automatically retransmitting, automatically detecting and retransmitting lost packets.

(3) There are 125 channels available, which can be compatible with other nRF24 models.

(4) The connection between NRF24L01 and MCU communicates through SPI interface.

(5) The working frequency range is 2.4 GHz to 2.5 GHz.

Because the high frequency circuit has very high design requirements, an existing integrated wireless module is directly used in this design, so the whole design idea becomes very concise.

3.4 A/D convertor

A/D converters can convert analog quantity to digital quantity. There are many ways of A/D conversions, which can be divided as direct and indirect from the perspective of conversion principles

ADC0832 converter is also an A/D converter chip, which can meet general conversion needs. The analog input voltage of ADC0832 converter is between 0V and 5V. With dual data output functions, it can be used for data verification, so as to reduce the error between data. The conversion is very fast and sTable. The convertor has its own enable input terminals, which makes it quite flexible to cooperate with other components. With DI pins, it is very convenient to select channel functions.

3.5 LCD 1602 display

Liquid crystal displays are called as liquid crystals because they are organic compounds between solid and liquid states. The molecular arrangement of liquid crystal is very regular. As long as an electric field is added to it, the molecular arrangement of liquid crystal will change. If a polarizer is added, the light transmission can be affected. When color filter is added and the voltage value is changed, the brightness of one color can be changed. So the screen can display different colors.

4. System Debugging

The inspection and debugging of hardware mean to check and debug welded objects so as to realize the required functions. Before welding, the functional quality of each component is checked and the components are reasonably laid out. Then we need to install and weld each component one by one according to the requirements of the circuit. When the circuit board is welded, check whether the physical object can work properly immediately. Afterwards, following steps should be followed before providing power supplies for the circuit board.

(1) Check whether the welding wiring is correct: it is important to check whether the nodes and the power supplies of chips are correctly connected. Attention should also be paid to check whether the nodes are stacked. Comparing the actual circuit with the circuit schematic diagram, the researcher took one component as the center to check one by one. All circuit sources should exist on the circuit diagram. In order to avoid missing detection, the checked components were marked on the circuit diagram.

(2) Check whether there are short circuits between pins, whether there are bad connection points, whether there are polarity misconnection of devices and other phenomena.

(3) Check whether there are short circuits in the power supply connection.

(4) Before installing the chip, the multimeter is used to test whether the power supply of each chip and the voltage of the grounding pin are in normal state. The chip can be installed only when everything is in good condition.

When above checks are over and no problems are found, the power can be turned on for debugging. Debugging is a necessary process to ensure the normal operation of the equipment. Practice has proved that even if a product is manufactured and installed according to the circuit parameters designed, it is often difficult to achieve the desired results. People can’t think if all kinds of complex problems thoroughly in design, such as errors in the numerical value of components, and problems in the coordination of components’ parameters. Researchers must find out deficiencies in the design process through testing and adjusting after installation, and then take measures to correct them in order to achieve the desired effect.

Power-on debugging: After power-on, the first step is not to measure the electrical indicators of the device, but to observe whether there are abnormal phenomena in the power-on circuit, such as abnormal smell, smokes and hot chips. If abnormal phenomena occur, the power supply should be switched off immediately. The power supply should be turned on after problems are eliminated.

Static check: It means to detect the DC operation without providing signal needed by the input circuit or only providing constant voltage. The multimeter can be used to measure the voltage of each point in the circuit. After comparing and analyzing with the theoretical value, it can be concluded whether the circuit operates normally in the DC state. If there are bad or critical operation components in the circuit, it is necessary to change components or adjust parameters to make the circuit meet the requirements.

5. Conclusion

This design uses STC89C52 as the main controller; the temperature and humidity of soil are measured by temperature and humidity sensors. The collected data are processed and transmitted; the temperature and humidity of soil can be observed in real time through data displayed on the LCD screen. The range of temperature and humidity can be set according to the characteristics of

different plants. When the data does not fall in the set range, the buzzer will set off the alarm.

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