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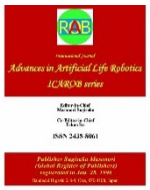

Research Article

Design of Greenhouse Environment Control System

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ABSTRACT

In order to meet the automatic management of greenhouses in agricultural modernization, this paper proposes a circuit system for greenhouse environment regulation. For greenhouses, maintaining the stability of the growth environment of crops is an important requirement. In order to properly control the greenhouse environment, low-cost single-chip microcomputers and some sensors can be used to complete this work well. The system can obtain the current environmental data in the greenhouse through the DHT11 sensor and the light sensor, and send control instructions to the relay through the single-chip microcomputer to control the external equipment to adjust the relevant environmental parameters in the greenhouse to maintain the stability of the environment.

1. Introduction

With the development of automation technology, the efficiency of automated operation has been applied in many scenarios, and many farms have begun to use automation technology to assist production and reduce labor costs. The mode of agricultural production has shifted from intensive farming at the beginning to mechanized operation and then to automated and unmanned operation. Many new terms are beginning to be known by people, such as automatic harvesting, automatic cultivation and so on.

For crops grown in greenhouses, temperature, humidity and light intensity have a greater impact on their growth process, except for a small number of crops that have special requirements for the growth environment. Closely related to the development and environmental changes in greenhouse crops, from sowing a seed to germinate and then pull back strain results, optimal plant growth environment in different growth period the demand is not the same. Most direct impact is the temperature, humidity, and in light of these factors [1].

Based on the above discussion, this circuit system mainly focuses on the collection and automatic adjustment of relevant data in the greenhouse. The system uses STC89C52 single-chip microcomputer as the center of data processing and command transmission. The system to achieve data collection work by DHT11 temperature and humidity sensor and an illumination sensor can be real-time monitoring of temperature, humidity, light intensity in the greenhouse. The system will be on the sensor data collected in real time comparison, if the preset threshold is reached, then the corresponding module will start work in order to achieve the purpose of the environment within the greenhouse to be regulated.

2. The Hardware Structure

The design purpose of this system is to collect the monitored environmental factors in the greenhouse through sensors and analyze these data through the single-chip microcomputer and issue control instructions. Environmental control is operated by the relevant peripherals connected to the relay. The system is mainly

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divided into three parts. The first part is the calculation and control part composed of single-chip microcomputers, the second part is the sensing part composed of sensors, and the third part is the external equipment controlled by the relay.

2.1. DHT11 temperature and humidity sensor

DHT11 digital temperature and humidity sensor is a temperature and humidity composite sensor with calibrated digital signal output. It contains a resistive humidity sensing element and an NTC temperature measuring element [2]. It uses dedicated digital module acquisition technology and temperature and humidity sensing technology to ensure that the product has extremely high reliability and excellent long-term stability. The DHT11 module is shown in Fig. 1.

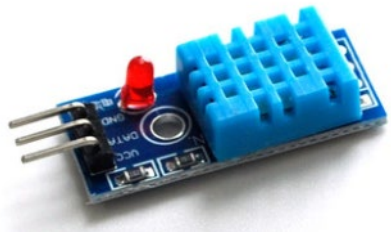

Fig.1. DHT11 module

2.2. BH1750FVI module

The BH1750FVI module (Fig.2) is a light intensity sensor that can be used to adjust the brightness of display in mobiles and LCD displays. The sensor uses I2C communication protocol so as to make it super easy to be used with microcontrollers. The SCL and SDA pins are for I2C.

Fig.2. BH1750FVI module

There is no calculation needed to measure the LUX value because the sensor directly gives the lux value. Actually, it measures the intensity according to the amount of light hitting on it. It operates on a voltage range of 2.4V-3.6V and consumes really small current of 0.12mA. The results of the sensor do not depend upon the light source used and the influence of IR radiation is very less. There are very few chances of any error because the variation in measurement is as low as +/-20%. The module has the following characteristics: Wide brightness range: 0LX ~ 65535LX; Highly responsive near to human eye.

2.3. LCD1602 liquid crystal display

LCD1602 liquid crystal display is a dot matrix liquid crystal module used to display letters, numbers, symbols and other characters. The liquid crystal display consists of multiple 5X7 or 5X11 dot matrix character bits to form a dot matrix character display module, which is shown in Fig.3.

Fig.3. STM32F103ZET6 chip

2.4. Main control chip

In order to meet the operational requirements of the system and reduce costs, the design uses STC89C52RC MCU as the control unit. The chip has 8KB flash memory and 512B RAM. And it has more than 30 general-purpose IO ports, multiple timers, which fully meet the design of the required pin and memory requirements. The main control chip is shown in Fig.4, and it has the following characteristics:

Operating Voltage 3.3V ~ 5.5V.

Operating temperature range: 0 ºC ~ 75ºC.

Fig.4. STC89C52RC chip

3. System Circuit Module

In the circuit design, this system uses temperature and humidity data acquisition module, light data acquisition module and relay control module. These modules play a vital role in the system.

3.1. Design of connection circuit for temperature and humidity module

In the circuit design, the IO pin of the DHT11 module for data exchange is connected with a 4.7K pull-up resistor in parallel with VCC. In addition, a capacitor is connected to the power supply for decoupling and filtering to improve voltage stability. The single-bus design of the module greatly reduces the occupancy rate of circuit resources in actual use, and the overall circuit looks very concise and clear. The design of connection circuit for temperature and humidity module is shown in Fig.5.

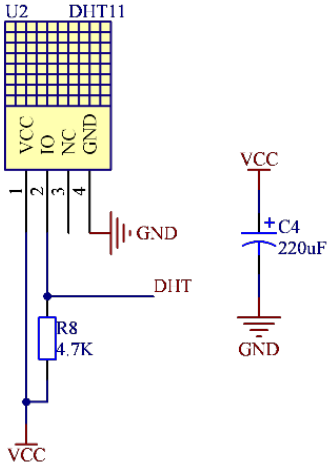

Fig.5. The connection circuit for temperature and humidity module

3.2. Design of connection circuit for Illuminance module

The voltage of the light intensity acquisition module is 3.0V~5.0V, and the single-chip microcomputer can be directly used for power supply. ADD is the address pin to zero. SCL and SDA are the clock and data lines in the I2C bus respectively. SCL is connected to the P10 pin of the microcontroller. The SDA pin is connected to the P11 pin of the microcontroller. The design of connection circuit for illuminance module is shown in Fig.6.

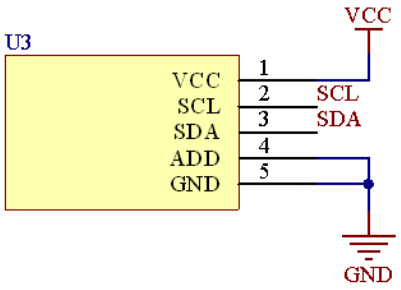

Fig.6. The connection circuit for illuminance module

3.3. Relay module control circuit

Relay is a circuit control element, which is triggered at high level. The input terminal is generally provided with three pins, GND, VCC, and IN. What we use in this system is two dynamic close type relay modules, controlled by the single-chip P7 pin and P8 pin. The design of relay module control circuit is shown in Fig.7.

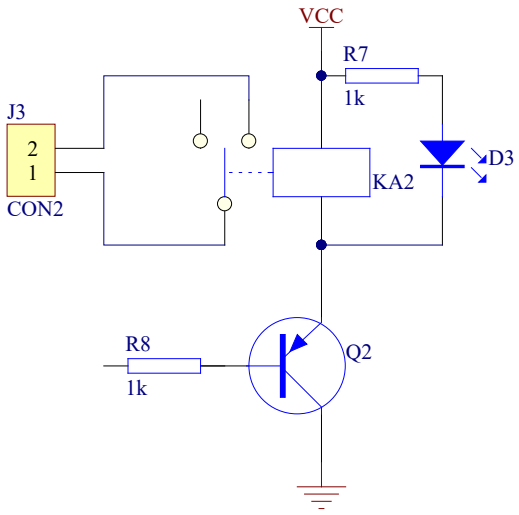

Fig.7. The relay module control circuit

4. Functional Module

Through the work of each functional module, the greenhouse environment control circuit system can well complete the set work.

4.1. Data collection module

The data acquisition module of this system is composed of DHT11 temperature and humidity sensor and light sensor. When the system is powered up, the sensor will be initialized first, and then the control unit will send an initial signal to the information acquisition module, and the sensor will start to work, collect real-time data and return it to the SCM.

4.2. System parameter setting module

The system can adjust the threshold of environmental parameters by pressing the buttons. The functions of each button are shown in Table 1.

Table 1. Introduction to key functions

Button	Function
Key1	reset
Key2	selection
Key3	value up
Key4	value down

The adjustable parameters of the system are shown in Table 2.

Table 2. System adjustable parameters

Name	Nun1	Num2
Temperature	upper limit	lower limit
Humidity	upper limit	lower limit
Light	upper limit	lower limit

4.3. Environmental Control Module

Greenhouse environment control system controlled by relay control circuit system external devices.

When the environmental data collected by the system is not in the preset range, the control relay turn on the corresponding external equipment such as water pump, exhaust fan, filling lamp, etc. This design method can connect different external functional equipment according to the growing environment requirements of crops planted in the greenhouse, which has higher practicability.

5. Conclusion

This design integrates the environmental information in the greenhouse and manages it uniformly.

From the perspective of operation, the system requires less manpower, and the operation mode is simple, so as to avoid the mistakes that may be caused by complex operation. From a production point of view, the system adjusts various factors that affect the growth of greenhouse crops, so that greenhouse crops grow in an appropriate range, and greenhouse yield and crop quality have been improved to a certain extent. From the point of view of cost, the production cost of the system is controlled in a lower range, which is beneficial for large-scale deployment.

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Authors Introduction

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He is a first-year master student in Tianjin University of Science and Technology. His research is about embedded system.

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