Development of the Circuit System for Greenhouse Environment Regulation

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Abstract

Aiming at the demand of agricultural modernization, this paper proposes a circuit system for greenhouse environment regulation. For the greenhouse, due to the requirements of the crops for the stability of the growth environment, the cheap single-chip control system 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, regulate and control the environment through external equipment to keep the environment stable.

Keywords: STC89C52 microcontroller, DHT11 temperature and humidity sensor, light sensor

1. Introduction

With the development of automation technology and the gradual reduction of the number of people engaged in agricultural work, the method of agricultural production has begun to turn to automation and unmanned. Many new terms are beginning to be known by people, such as automatic harvesting, automatic cultivation and so on.

On greenhouse, the temperature, humidity and light intensity control three environmental factors, for crops grown in greenhouses of great importance. 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 control and calculation module of this system is a single chip microcomputer. 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

This system is mainly responsible for the collection of environmental data in the greenhouse and the control of the corresponding work modules. The system is mainly 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 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 [2]. The DHT11 module is shown in Fig.1.

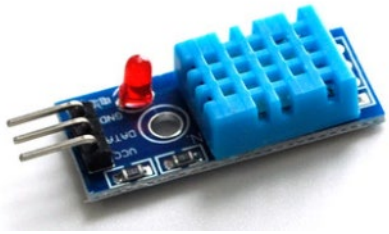

Fig.1. DHT11 module

2.2. BH1750FVI module

The BH1750FVI module (Fig.2) is a digital light intensity sensor for a two-wire serial bus interface, with a built-in 16-bit ADC. The module has the following characteristics: Wide brightness range: 0LX ~ 65535LX; Operating Voltage 3.0V ~ 5.0V.

Fig.2. BH1750FVI module

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 this design, the external MCU is the STC89C52RC.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 design

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 this system.

3.1. Design of connection circuit for temperature and humidity module

The IO pin of the DHT11 module for data exchange is connected with a 4.7K pull-up resistor in parallel with VCC pin to increase the pin level to transmit data. In addition, a capacitor is connected to the power supply for decoupling and filtering to improve voltage stability. Because the module's single-bus design greatly reduces the occupancy rate of circuit resources in actual use, the overall circuit looks very simple and clear.

3.2. Design of connection circuit for Illuminance module

The VCC pin and GND pin of the module can be connected to the positive and negative poles of the microcontroller. 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.

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.

4. Introduction of 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 on, each sensor will read the environmental data in the greenhouse in real time and send it to the processing unit.

4.2. Airkiss distribution network

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 Table2.

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

The control circuit system of the greenhouse environment regulation system controls the external equipment through the relay.

When the environmental data collected by the system is not in the preset range, it will control the relay to turn on the corresponding external equipment such as water pump, exhaust fan, fill light, etc. according to the type of value. This design method can replace different types of external equipment according to different environmental requirements, which has better practicability.

5. Conclusion

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

From the perspective of operation, it can save a lot of human resources and avoid some mistakes caused by manual operation. From the perspective of production, the system regulates various factors affecting the growth of crops in the greenhouses to keep them in an appropriate range, and the yield and crop quality of greenhouses have been improved to a certain extent. From the point of view of cost, the hardware cost of the system is very low, which is conducive to large-scale laying.

References

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