Design of temperature humidity and illumination control system for indoor flowers

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Abstract. In order to improve the automation of indoor flower environment monitoring, enable the flowers grow in the best environment, this paper designs an automatic control system of temperature, humidity and illumination based on STC89C52 single chip microcomputer. Temperature sensor DS18B20 is applied to sense indoor air temperature, meantime, YL-69 soil moisture sensor and photosensitive resistance are used to sense soil relative humidity and light intensity respectively. Temperature, humidity and light intensity are transmitted to single chip microcomputer for analysis and processing, and the results are displayed by OLED display module. The upper and lower limits of environmental parameters are manually preset through the keyboard. When the temperature and light intensity exceed the upper limit, the system can send out alarm signals and output control signals to drive the corresponding actuator to work; when the soil moisture is lower than the lower limit, the system will automatically alarm and water automatically; when the humidity reaches the upper limit, watering will be stopped to ensure the indoor environmental parameters in the best value suitable for flower growth. The system has been tested and debugged. The results show that the control system can effectively process and display the flower environment information, achieving the purpose of automatically adjusting and controlling the temperature, humidity and illumination of flowers, has strong promotion value.

1. Introduction

Temperature, humidity and light intensity have great impact on the growth of flowers and directly affect the economic benefits of flower planting[1-2]. According to the most suitable growth environment of flowers, combined with the information of temperature, humidity and light intensity obtained from environmental monitoring, it is particularly important to design a control system which can adapt the environmental parameters to the growth of flowers[3-4].

In recent years, there have been a lot of research results in the detection and control of indoor environmental parameters, but the control of single environmental parameters can not make flowers achieve the ideal growth state[5]. In this paper, we introduce the design of an automatic control system of indoor temperature, humidity and illumination of flowers, which is low cost, strong environmental adaptability, safe and reliable, and with multi- functions. The system has the advantages of low power consumption, stable function and economic benefits single chip microcomputer as the core, using temperature sensor DS18B20, humidity sensor YL-69 and photosensitive resistance to collect the temperature, humidity and illumination in the greenhouse, and transmit the collected data to the single-chip microcomputer, which makes corresponding analysis and processing, and displays the processing results on the LCD screen. At the same time, the temperature, humidity and illuminance parameters...
suitable for the growth of flowers can be set by pressing the key, so as to adjust the temperature, humidity and light intensity of the flower house and realize automatic control.

2. Working principle
The main control CPU of the automatic control system is STC89C52. In the peripheral circuit, the input devices are keyboard button, temperature sensor, humidity sensor and illuminance sensor. The output devices include exhaust fan, temperature compensation lamp, water pump, fill light, OLCD display, alarm system and etc. The overall frame structure of the system is shown in Figure 1.

The function flow of the system is as follows: DS18B20 temperature sensor converts the detected environmental temperature value into digital quantity and sends it to STC89C52 single chip microcomputer; YL-69 soil moisture sensor detects soil moisture value, photosensitive resistance detects environmental light intensity, humidity and illuminance signal are converted into digital signal through A/D converter XPT2046, and then transmitted to single chip microcomputer, OLED to display the current value. The single chip microcomputer can judge whether the environmental parameter value is higher or lower than the set "maximum value" or "minimum value". If the ambient temperature value is lower than the set "minimum value", turn on the warming lamp; if the ambient temperature value is higher than the set "maximum value", the single chip microcomputer output port sends a signal to the relay to make the coil energized, the normally open contact is closed, and the exhaust fan is opened for heat dissipation. If the soil moisture value is lower than the set "minimum value", the buzzer will send out an alarm to warn that the soil drying and needs watering. At this time, the single chip microcomputer output port drives the relay circuit to take corresponding action, and the water pump circuit is connected to realize the function of automatic flower watering. When the humidity value is larger than the "maximum value", the watering will be stopped. If the ambient light intensity is less than the preset "minimum value", turn on the fill light.

3. Hardware circuit design
The hardware circuit includes data acquisition module, display module, key input module, control module and reset module. Single chip microcomputer uses external power supply +5V for power supply.

3.1. Data acquisition module
The circuit of data acquisition part includes temperature sensor, humidity sensor, photoresistor and A/D conversion module.
3.1.1. Temperature acquisition module.
DS18B20 temperature sensor is used to collect the temperature signal. The sensor has a large measuring range and is not easily affected by the external environment. Its output is digital signal, which has the advantages of small volume, low price, strong anti-interference ability and high precision. The sensor has three ports, which are ground terminal, power supply terminal and DQ terminal. DQ terminal is directly connected with P3.7 port of MCU. The temperature acquisition circuit is shown in Figure 2.

3.1.2. Humidity collection module.
The measurement of soil moisture selects the YL-69 humidity sensor, which has four ports, namely: VCC terminal, GND terminal, D0 terminal and A0 terminal. The DO terminal is a digital output port (0 and 1); the AO terminal is a voltage analog output port. The sensor can measure the humidity of the soil in a wide range. The potentiometer adjusts and controls the corresponding threshold. When the humidity is lower than the set value, the DO outputs a high level; when it is higher than the set value, the DO outputs a low level. The digital output DO can be directly connected to the single chip microcomputer, and the high and low levels are detected by the single chip microcomputer, thereby detecting the soil moisture. The analog output port AO can be connected to the A/D module. Through A/D conversion, more accurate soil moisture values can be obtained. This design uses the analog output port AO, and the output value of AO enters the XPT2046 A/D conversion chip. The soil moisture acquisition circuit is shown in Figure 3.

3.1.3. Light intensity collection module.
The measurement of light intensity uses a photoresistor, utilizing the characteristic that the resistance value of the photoresistor decreases with the increase of the light intensity [6]. The circuit schematic of the photoresistor is shown in Figure 4. Similarly, the analog signal of the light intensity collected by the photoresistor is converted into a digital signal by XPT2046 and sent to the microcontroller.

3.2. Display module
In this design, OLED liquid crystal display is used as the display element of the system to display the preset and measured values of air temperature, soil moisture and light intensity. The schematic diagram of OLED circuit is shown in Figure 5.

3.3. Key input module
The system uses the key as the input element of preset value, and the key circuit is realized by low-level scanning. One end of the key is connected with the I/O port of the single chip microcomputer, and the other end is grounded. This connection method is simple and stable, which is suitable for circuit design with fewer buttons. The key circuit is composed of three buttons, which are connected with the three ports of p3.0-3.2. The key circuit is shown in Figure 6.
3.4. Control module
The control part includes single chip microcomputer, relay, temperature lamp, exhaust fan, water pump and fill light lamp. The control system has two modes: automatic and manual.

3.5. Reset module
The reset pin of the STC89C52 microcontroller is a high-level reset, so when the button is pressed, the RESET pin is given a high level and maintained for 2 or more cycles to reset the system.

4. System software design

4.1. Main program design
The system reads the temperature, humidity and illuminance values through the sensor, and transmits the values to the single-chip microcomputer. The single-chip microcomputer analyzes the received information and can display the current parameter values on the display screen and determine whether it is necessary to drive the alarm circuit and the relay circuit to work or not, the main program flow chart is shown in Figure 7.

4.2. Subprogram design
According to the functional requirements, the system should have the functions of detection, display, key input, actuator and alarm. Therefore, the temperature and humidity and light reading subprogram, AD conversion subprogram, data processing subprogram, display subprogram, keyboard subprogram and overrun alarm subprogram.

In the control subprogram, the environment parameter value is detected by the sensor and the key is set to the target parameter. The single-chip microcomputer is used to control the normally open and normally closed contacts of the relay to control external devices, and the environmental parameters in the system are adjusted through these external devices. You can also choose manual mode for control.

5. Physical debugging
Copy the program of each part into the single-chip microcomputer, connect the physical objects, insert the humidity sensor into the soil, connect the power to turn on the system, the OLED screen will display the current air temperature, soil humidity, light intensity value, the bottom line shows the air temperature, preset values for soil humidity and light intensity. As shown in Figure 8, the measured current ambient temperature is 24°C, the soil humidity is 54%, and the light intensity is 58lx; the preset values are set by the buttons: 27°C, 29%, 208lx, after clicking the confirm button, the theory test results should be LED26 (warming light on), LED25 (fill light on), LED22 (watering system off), and a buzzer to sound an alarm. The actual test results are consistent with the theoretical results.
6. Conclusion
This system uses STC89C52 single-chip microcomputer as the core control unit, adapts DS18B20 temperature sensor as the ambient temperature collection element, YL-69 humidity sensor as the soil humidity collection element, photoresistor as the illuminance collection element, and OLED as the data display element. Through each component to regulate the indoor temperature and humidity control system of flowers, so as to realize the information collection and automatic adjustment function of temperature, humidity and light intensity. The physical debugging achieves the expected effect, achieves the purpose of intelligent detection and automatic control, has strong practical value.
References

[1] Lu, X.A. (2018) Design of Temperature, Humidity and Illumination Control System Based on AT89C52 Single Chip. Software Guide, 17: 125–128.

[2] Cheng, M.X., Zhang, W.W. (2013) Design and Realization of Multi-channel Temperature Monitoring System Based on AT89S52 Single Chip. China Medical Devices, 28: 46–49.

[3] Yuan, D.M. (2018) Design of Temperature and Humidity Automatic Control System for Greenhouse Based on Single Chip. Agricultural Engineering, 8: 32–34.

[4] Wu, B. (2018) Design of Automatic Watering System Based on Single Chip Microcomputer. Modern Information Technology, 2: 39–43.

[5] Fan, W., Cheng, Y.R. (2018) Design of the Intelligent LED Illumination Control System Based on Plant Expert System. Process Automation Instrumentation, 39: 26-29.

[6] Zhang, W., Yang, S. L. (2018) Design of Intelligent street lamp control system based on SCM control. Modern Electronics Technique, 41: 110-113.