Automatic Temperature and Humidity Detection and Alarm System for Greenhouse

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Abstract. With the continuous development of agricultural production technology, greenhouses have been widely used in the production of agricultural products. Temperature and humidity are important parameters in greenhouses. The real-time detection and regulation of temperature and humidity in greenhouses plays an important role in crop cultivation. This paper designs an automatic detection and alarm system for greenhouse temperature and humidity based on STM32. The system uses STM32F103C8T6 single chip core module as the microcontroller, uses temperature and humidity sensor DHT11 to obtain temperature value and humidity value, and uses LCD1602 liquid crystal module to display monitoring data and Bluetooth module. Together form a temperature and humidity detection system. Through system function testing, the system can operate stably according to the expected requirements and meet the expected requirements. Finally, an intelligent temperature and humidity monitoring and alarming system that can monitor the temperature and humidity in the greenhouse in real time is realized. The system has the advantages of good stability, high precision and convenient operation, which is of great significance for improving the monitoring and management of temperature and humidity and agricultural production.

1. Introduction
In the era of digital intelligence, we are required to use the least labour to create maximum work efficiency. The popularity of greenhouses makes it a new development trend for intelligent functions to be injected into greenhouses. In today's rapidly developing society, how to use intelligent technology to optimize agricultural greenhouses has become particularly important. Through single-chip technology, agricultural greenhouses can effectively improve production efficiency and reduce the error rate and loss caused by weak manual supervision, to ensure the orderly progress of agricultural production.

2. Introduction Research content
In this design, by fully investigating the structure, layout and needs of the greenhouse, inquiring related information, the temperature and humidity automatic detection and alarm system of the greenhouse are rationally planned and designed, and related feasibility analysis is carried out. This design completes the overall design of the automatic temperature and humidity detection and alarm system of the greenhouse in various forms such as text, data, drawings, and pictures. Ensure that the proposed scheme can be easily adjusted, safe and feasible, and stable operation [1].

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The main research contents of this paper are:

1. Design an automatic temperature and humidity detection and alarm system, select the appropriate wireless communication module and sensor module to monitor the temperature and humidity in the greenhouse;

2. Program and design a temperature and humidity control system based on STM32. The system obtains ambient temperature and humidity data by collecting sensor output voltage signals and signal frequencies, and can perform corresponding actions according to the required temperature and humidity values;

3. Design and realize monitoring of temperature and humidity in the greenhouse, if it exceeds the set temperature and humidity range, the designed alarm function needs to be activated.

3. Scheme design and demonstration

3.1 Determination of design plan
This design takes the STM32 as the core, and the external device contains a 1602 LCD display module, temperature and humidity sensor, Bluetooth communication module, and power circuit.

3.2 Feasibility analysis

3.2.1 Technical feasibility
The system is mainly developed based on STM32 single chip microcomputer. It has components STM32 core board, LCD1602 liquid crystal, DHT11 temperature and humidity module, Bluetooth module and multi-purpose board, resistor, triode, USB cable, tin wire, etc. The device is complete. Using ARM as the control center, using STM32F103C8T6 chip, using KeiluVision5 development environment, using C language to write.

3.2.2 Economic feasibility
With the rapid development of science and technology, the design and use cost of the single-chip microcomputer has a downward trend, which is conducive to the development of this design. At the same time, greenhouse cultivation in agriculture has gradually gained popularity. The use of temperature and humidity monitoring and alarm equipment in greenhouses has greatly improved the intensity and efficiency of supervision, not only reducing manpower and material resources, but also greatly reducing costs. The circuit module selected by the design system has the characteristics of universal market use, high cost performance, low price and excellent performance. Therefore, the temperature and humidity monitoring and alarm system of the greenhouse is economically feasible.

4. Design of hardware circuit

4.1 Core circuit of STM32 microcontroller
Because of its unique real-time simulation, STM32 series processors have become a hot spot for the application of single chip microcomputers. The physical diagram of STM32 microcontroller is shown in Fig. 1 The core board mainly includes STM32ZET6 chip and crystal oscillator circuit.
4.2 LCD1602 liquid crystal display module
This design system uses LCD1602 as the display module. This module can display a total of 16 Chinese characters in 2 lines, which can meet the display requirements of this design. It has the characteristics of small size, low power consumption, and does not require external driving circuit. Fig. 2 is its specific circuit schematic.

4.3 5V fan control circuit design
It is easy to form a high-temperature environment in the greenhouse, and it is necessary to install a cooling fan in this design. The specific circuit schematic is shown in Fig. 3. The output voltage of the single-chip pin + 3V is too low to directly drive the fan. Here, the base voltage of the transistor is controlled by the pin, and the fan is controlled by the collector and transmitter voltage. Add a current-limiting resistor between the base and the input pin to prevent excessive current from damaging the microcontroller and protect the transistor.[3-4] When a single PB1 outputs a high level, the base and collector are in a short circuit state, the triode is turned on, and the fan works; when PB1 outputs 0, the fan does not rotate.
4.4 JDY-30 Bluetooth module circuit design

The Bluetooth module is used for wireless communication and is a chip with integrated Bluetooth function. This Bluetooth module is designed for wireless data transmission. It has the characteristics of low price, small size, and high receiving sensitivity. It only needs a few peripheral components to realize many high-scale functions.

The circuit diagram of the Bluetooth module interface is shown in Fig. 4. Pin 1 is connected to read register, pin 2 is connected to write register, pin 3 is grounded, and pin 4 is connected to +5V ground.

4.5 DHT11 temperature and humidity sensor module circuit design

DHT11 digital temperature and humidity sensor is a composite sensor that detects temperature and humidity at the same time[5]. In order to ensure high reliability and stability, DHT11 digital temperature and humidity sensor uses unique temperature and humidity sensing technology and digital module acquisition technology. This sensor is connected to a superb 8-bit microcontroller, including a resistance humidity sensor and an NTC temperature sensor. Because of this, this product exhibits fast response, high measurement accuracy, and reliable cost performance[6].

The internal circuit diagram of the DHT11 sensor module is shown in Fig. 5, where the R1 resistor is a pull-up resistor to ensure more stable data transmission. P2 is a single-row pin, R2 is a current limiting resistor, which can protect the D1 power indicator from burning out.
5. System software design

5.1 Software design and test
Kei1 uVision5 software is used for writing, debugging and management. It contains a large number of callable function libraries. The programming language is written in C language that is easy to read and easy to learn. The flow chart of the entire system operation is shown in Fig. 6. Initialize the system clock first, then initialize the definition of the input and output pins, as well as the clock and timer[7]. Next, the system enters the main program loop. The system judges whether the collection temperature and humidity are up. If the collection time is reached, the temperature and humidity are collected; if the collection time is not reached, the temperature and humidity are not collected, and the Bluetooth interaction is directly judged. If the Bluetooth interaction is successful, then the Bluetooth data is processed, and then the fan driver is processed; if it is determined that the Bluetooth data interaction fails, the comparison fan is directly driven for processing. Repeat in this way.
5.2 System Test

Before energizing the core board, check the hardware circuit again to avoid short circuit, circuit break and other hardware faults. Start the system and test the software functions one by one. If the program works properly, it passes the test. If there is a problem, continue debugging the program. After debugging, the system can work normally. As shown in the figure, temperature and humidity data are displayed on the LCD screen. In addition, mobile applications can also transmit data. The actual hardware is shown below.
6. Summary
This paper designs and implements the monitoring and alarm system of temperature and humidity of greenhouse. The core of this system is STM32 SCM. The system consists of temperature and humidity sensor circuit, 1602 LCD circuit, Bluetooth module circuit and other basic circuits. The system is based on STM32F103C8T6 chip, KeilVision5 development environment, and C language. The system has realized the monitoring of temperature and humidity in the greenhouse, if out of range, the alarm will be started. This paper realized the intelligent informatization and efficient and convenient management of agriculture. Through the analysis and design of the system and the realization of the final function of the system, the design of temperature and humidity monitoring and alarm of the greenhouse is completed.

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