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Design and Application of Greenhouse Humidity Control System Based on Single-chip Microcomputer

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Abstract: Greenhouse planting is widely used, greenhouse humidity control automation has become people's urgent demand, automatic humidity control can reduce manual operation, improve management efficiency, and reduce operating costs through energy-saving means. In addition, such systems help to achieve a stable production environment, reduce the occurrence of pests and diseases, and improve the sustainability and economic efficiency of agricultural production. Referring to the design of greenhouse humidity control system in recent years, in view of the low degree of automation of greenhouse planting in China, a more reliable greenhouse humidity control system with AT89S51 single-chip microcomputer as the core was designed.

Keywords: Single-chip microcomputer; Greenhouse greenhouse; Humidity control

Introduction

With the development of science and technology, the application of humidity monitoring devices in life is becoming more and more mature. In order to meet people's daily needs, greenhouse planting is widely used. However, due to the lack of intelligent popularization in China, manual observation of humidity in the greenhouse often depends on the experience of the observer, in many cases because the observation is not accurate, resulting in a certain loss, the humidity control system can quickly measure the humidity in the greenhouse, and make corresponding measures, this method can greatly reduce the labor intensity of workers. However, in practice, the sensitivity of the instrument brings the problem of insufficient accuracy, resulting in poor system stability and often the consequences of economic losses. In recent years, with the rapid development of computers and a large number of applications of single-chip microcomputers, people's requirements for humidity control systems are getting higher and higher. On the basis of this problem, combined with the degree of automation of the humidity control system, a set of humidity control system with high accuracy and long-term use is designed.

1. Design ideas of humidity control system

The system in the process of collection, transmission, display data, alarm judgment to AT89S51 single-chip microcomputer as the core, by the humidity sensor AM2301 for data collection, the signal to the AT89S51 single-chip microcomputer, single-chip microcomputer for processing and sending control information, the implementation module automatic humidification or dehumidification, at the same time the detected humidity data with the LCD screen display, so that the operator timely understand the humidity in the shed, to ensure the growth of plants in the shed.

The humidity control device is divided into two modes: automatic control and manual control, the operation mode can be switched by a button, and the manual control mode can be controlled by the operator to control the humidification or dehumidification through the button. When the humidity in the shed is greater than the upper limit or less than the lower limit, the buzzer alarm will alarm the operator. In the automatic control mode, when the humidity exceeds the upper limit, the alarm will be given, and the single-chip microcomputer will control the dehumidification device to dehumidify, and it will automatically stop when it reaches the lower limit, on the contrary, when the humidity is lower than the lower limit, the alarm will be given, and the single-chip microcomputer will control the humidification device to humidify, and it will automatically stop when it reaches the upper limit. The schematic diagram of the automatic control design is shown in Figure 1.

2. Hardware design

2.1 The working principle and composition of the automatic control system

The main CPU of the humidity control system is AT89S51. In the external circuit, the input device is a button, the humidity sensor AM2301, the output device is an exhaust fan, a 1602LCD LCD screen, a stepper motor, a buzzer alarm, and the system hardware structure is shown in Figure 2.

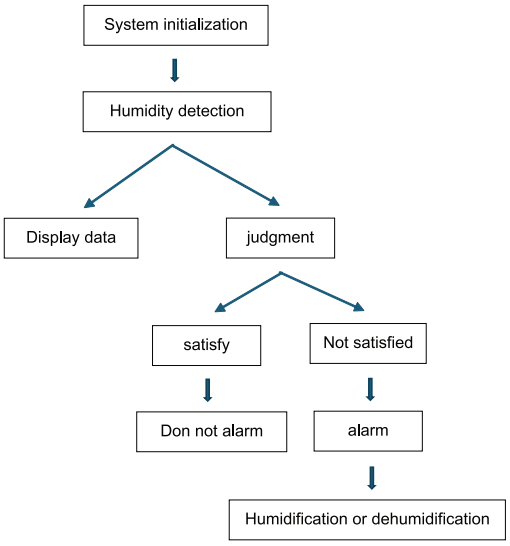

Figure 1. Schematic diagram of automatic control design

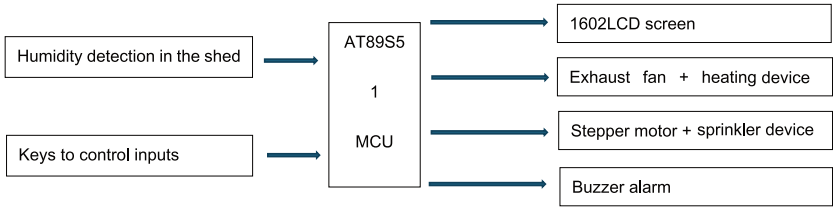

Figure 2. System hardware structure

2.2 Circuits of each part of the system

2.2.1 Button control input

The key control input takes two buttons of "dehumidification" and "humidification", as well as a knob to control power and three gears, which are divided into low, medium and high. Set the upper and lower humidity limits so that they will automatically turn off when they reach the upper or lower limits when they are turned on. Works in conjunction with the 1602LCD display to adjust the humidity in real time, showing real-time external humidity and in-room humidity when not in operation.

2.2.2 Exhaust fan device

When the internal humidity is greater than the external humidity and the humidity is greater than the upper limit, turn on the exhaust fan to discharge the water vapor in time, and two or more high-power axial flow circulating fans can be used to achieve the effect of rapid dehumidification.

2.2.3 Heating device

When the humidity in the shed exceeds the upper limit, it will be started together with the exhaust fan to heat the air and dehumidify it in time. Close it in time after dehumidification to avoid low humidity in the shed due to residual heat.

2.2.4 Sprinkler device

When the humidity in the shed is lower than the lower limit, open the sprinkler to provide timely water replenishment to the plants in the shed, and set up one or more spray devices according to the area of the greenhouse and the amount of spray water to achieve the effect of rapid humidification.

2.2.5 Humidity display device

The humidity display device adopts 1602LCD liquid crystal display, the display price is low, the performance is good, it is composed of two lines of 16 columns of characters, the display has the characteristics of low power consumption, high contrast, wide viewing angle, etc., is widely used.

2.2.6 Buzzer alarm device

In actual use, when the humidity is higher than the upper limit or lower than the lower limit, the buzzer will alarm when it receives the signal to remind the operator to pay attention to the change in ambient humidity.

2.2.7 Humidity detection device

The humidity detection device adopts AM2301, in order to avoid too much deviation of the humidity measurement value in the shed, several more humidity sensors can be installed in the shed.

3. Software design scheme

In this humidity control system, the corresponding software design is also very important, including humidity detection steps, CPU processing steps, LCD display steps, "dehumidification" and "humidification" steps. The designed software scheme is downloaded to the microcontroller to form a simple control system.

When using the system, the operator can choose two modes of manual control and automatic control according to actual needs. In manual control mode, adjust the "Humidify", "Dehumidify" buttons, as well as the power knob, to meet the operator's needs. In the automatic operation mode, the C language is used as the computer language used for program writing, and the automatic control system will monitor the humidity in the shed every once in a while under normal circumstances, and compare whether the humidity in the shed is within the normal range. If the humidity exceeds the upper limit or the humidity is lower than the lower limit, the alarm will alarm in time, and the corresponding execution module will be started at the same time, until the corresponding humidity is met to stop running, and the system will realize the automatic humidity. While adjusting the humidity in the shed, the automatic control system will reflect the real-time humidity on the LCD screen, so that the operator can observe and adjust it in time.

The main program is shown in Figure 3.

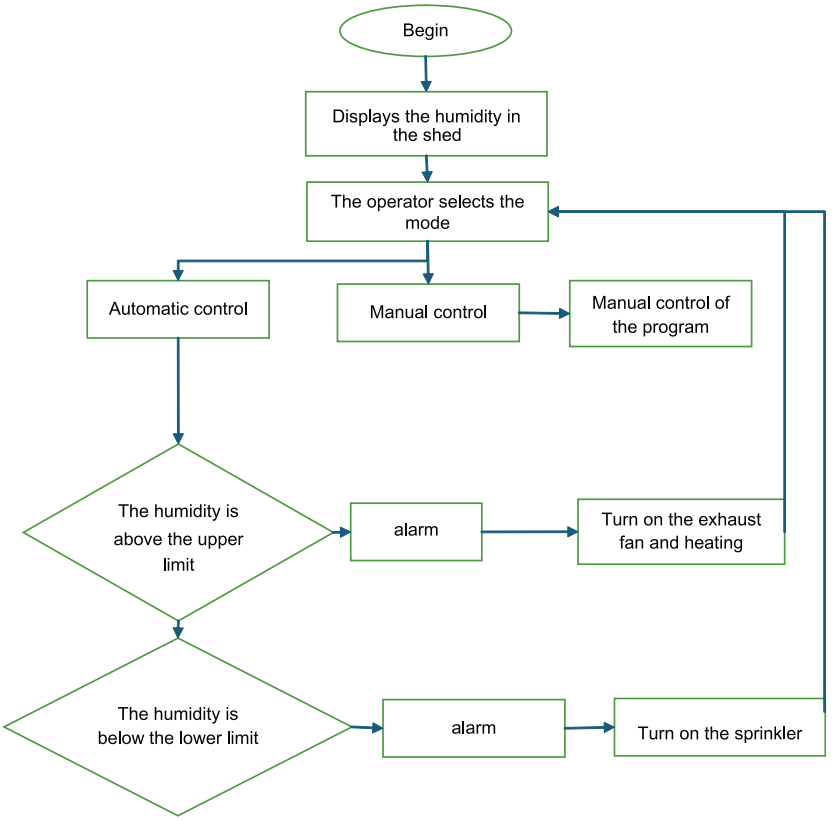

Figure 3. Software control flow chart

4. System debugging

The humidity monitoring and control system of the microcontroller was debugged, and the TINA-TI simulation software was used to test to confirm whether the design met the requirements. The software can simulate how the design system will behave in complex situations, and this process can quickly understand the defects and deficiencies in the design process. Conduct simulation of the hardware in the system design, and after confirming that there is no problem with the hardware, add the written code for debugging again, check the system simulation, and confirm that the system meets the design requirements.

5. Concluding remarks

The main reason for designing an automatic humidity control system in a greenhouse is to optimize the growing environment for crops.

The automatic control system precisely regulates the humidity level to prevent over-wetting or over-drying, thereby improving crop yield and quality. In addition, it can reduce manual operations, improve management efficiency, and reduce operating costs through energy-saving means. Ultimately, this system helps to achieve a stable production environment, reduce the occurrence of pests and diseases, and improve the sustainability and economic efficiency of agricultural production. The significance of controlling humidity in the greenhouse is to optimize the growing environment of the crops. Proper humidity levels promote healthy plant growth and prevent the growth of germs and molds, thereby reducing the occurrence of pests and diseases. In addition, stable humidity improves crop quality and yield, saves water and energy costs, and improves the efficiency and economic benefits of greenhouse management. Based on theoretical analysis, the AT89S51 microcontroller is used as the core to ensure the stability of the humidity in the shed.

However, there are still shortcomings in such high-automation products today, and the system components themselves are driven by electric energy, resulting in them not being able to work in the case of power loss or power failure, resulting in economic losses. In addition, the aging of the parts themselves and the errors brought by the appearance may also lead to errors in the humidity measurement, and the parts are exposed to air with high water vapor content for a long time, and the internal metal components are easy to age and rust. Solving these problems requires researchers to continue to develop new materials, and manufacturers need to make progress in their processing processes, with the goal of further improving the accuracy and automation of their instruments. Professionals should also conduct more experiments to obtain the most suitable humidity conditions for plant growth and provide a better growth environment for plants in the greenhouse.

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