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Design of Intelligent Greenhouse Monitoring and Control System based on PLC

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Abstract*:* Modern agriculture is developing more and more towards refinement and scale. It is very important to design an intelligent greenhouse automatic monitoring and control system. The automatic control system based on PLC realizes real-time monitoring of illumination intensity, temperature, carbon dioxide concentration and other parameters. Data transmission and control are realized based on ethernet. The system has simple structure and stable operation. Through field application test, the system can meet the needs of users and greatly improve the management efficiency of greenhouse.

Keywords Ethernet; PLC; Intelligent Greenhouse; Automatic Control

INTRODUCTION

Modern agriculture is developing more and more towards refinement and scale. Cloud platform monitoring technology is an important support for realizing agricultural intensive, high yield, high quality, high efficiency, ecology and security. At present, it is mainly applied to the perception and regulation of field information. It provides a basis for scientific management of agriculture, so as to take appropriate management measures in time, adjust production factors, make them meet the needs of efficient crop growth, and improve the efficiency of agricultural production. The intelligent agricultural greenhouse monitoring system supporting multi-platform application is designed in document 1. The system realizes remote data acquisition, but the control of production parameters in greenhouse is inadequate. The emphasis is on a monitoring role in greenhouse. In Document 2, an intelligent agricultural greenhouse system based on Internet of Things cloud platform is designed. The disadvantage is that it can only send alerts to users through short messages on mobile phones. This paper designs a monitoring and control system of Intelligent Greenhouse Based on PLC, which can detect production factors such as temperature, humidity, light, moisture, carbon dioxide concentration, and obtain image information of crop growth, so as to understand crops in time.

Growth status, soil fertility and pest and disease status provide the basis for scientific management of agriculture, so as to timely adjust production factors and meet the growth needs of crops. It also realizes high-scale, intensive and industrialized agricultural production, improves the ability of agricultural production to cope with natural environmental risks, and makes the disadvantaged traditional agriculture a modern industry with high efficiency.

The Intelligent Greenhouse Monitoring and control system based on PLC consists of three parts: information-acquisition-system, information processing system and regulation system. Firstly, the information acquisition system collects the parameters in greenhouse, uploads the information to the information processing system equipped with PLC, sets the specific range of relevant parameters on the information processing system, when the parameters of production factors in greenhouse exceed the range, the information processing system uploads to the regulation system to adjust the parameters that need to be adjusted.

MODULE DESIGN

Design of Information Acquisition

Information acquisition system. The main parameters determining crop production status are atmospheric temperature and humidity, illumination and soil temperature and humidity. The information acquisition system collects temperature, humidity, illumination intensity, soil temperature and humidity information in greenhouse through the sensors of atmospheric temperature and humidity, illumination intensity and soil temperature and humidity in greenhouse, and transmits real-time production factors information to PLC. Real-time information is displayed by touch screen and PC. The RS-485 bus mode is used to collect the information of production factors such as temperature and humidity, illumination, soil temperature and humidity in greenhouse. It does not occupy the control point of the controller, and I/O points are all from the control of the regulating equipment.

Crop breeding is the most common and common planting technology in agricultural production. It has remarkable effect in improving crop yield and immunity. The application of seedling technology is

to cultivate fruits and vegetables in Greenhouse in advance, shorten their growth cycle, obtain the excellent species needed in seasonal market, and increase the added value of products. Sensors have also been widely used in the process of seedling cultivation. Its main function is to collect and detect various parameters in the environment of seedling cultivation, including temperature, humidity, illumination, carbon dioxide content and other major data, and then transmit them to the main control computer instrument, thereby realizing the adjustment of various environmental conditions. [Yang Jianmin, Yang Qingmei 2005.10]

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Information Processing Design

Information processing system. The controller is mainly responsible for monitoring greenhouse temperature, humidity, illumination, soil temperature, humidity and other environmental indicators. Its parameter adjustment mainly provides communication interface for remote control system through field control and adjustment of fan, water pump and humidifier connected with the control system. Because of the bus mode of information acquisition and the need for remote control, the controller must have bus and Ethernet communication interface. Considering the control points and communication requirements, the controller chooses Siemens S7-200 series 224XP and Ethernet expansion module CP243-1, which provide two serial ports. The development of intelligent sensor networks is the key to achieve successful and sustainable control. This paper presents a method to develop this kind of network by using the possibility of programmable logic controller. [Atanas N. Iovev,Peter 2015.4.8]

Considering the complexity of field control, two control modes, automatic and manual, are designed. Manual control is realized by manual touch screen and upper computer. The automatic mode is controlled by controller according to the setting values of atmospheric temperature and humidity, illumination and soil temperature and humidity, so as to realize automatic control of production factors.

The RS-485 bus mode is used to collect the information of production factors such as temperature and humidity, illumination, soil temperature and humidity in greenhouse. It does not occupy the control point of the controller, and I/O points are all from the control of the regulating equipment.

The air switch and fuse are set, and the fuse is set for the output of DC power supply, so as to ensure the safety and stability of power supply.

Adjustment design

1. Adjustment of temperature and light intensity. In order to improve the temperature and illumination intensity in greenhouse, the plane mirror is used to reflect sunlight, and the temperature and illumination intensity in greenhouse are adjusted by adjusting the angle of the plane mirror reflection. A plane mirror is installed outside the greenhouse. The axis of the plane mirror is connected with the stepping motor and the stepping motor is connected with the PLC. When the temperature drops, the information is uploaded to the PLC, which makes the stepper motor electrify, the stepper motor rotates, and changes the angle of the plane mirror, so that the temperature and light intensity in the greenhouse rise.

2. Adjustment of shading. Install the motor on the upper part of the greenhouse, roll the straw mat on the outside of the motor, control the motor forward and backward by PLC. When the motor is in positive rotation, the straw mat is put down to keep warm and shade the sun. When the motor is in reverse, the straw mat will be put away.

3. Humidity regulation. Pumps are installed in the greenhouse, and water pumps are connected with sprinklers through water pipes. When the humidity detected by humidity sensors in the greenhouse decreases, the PLC is uploaded to make the water pumped electrically and sprayed through the sprinkler head, which not only increases the humidity in the greenhouse, but also supplements the moisture of the soil.

4. Regulation of ventilation. When the concentration of carbon dioxide is lower than the compensation point of crops, the fans installed on both sides of the greenhouse begin to rotate and exchange with the outside gases. But when the outside temperature is lower than a certain temperature, the temperature sensor uploads the PLC, which cuts off the fan and stops ventilation. This is the supplement of carbon dioxide in the greenhouse.

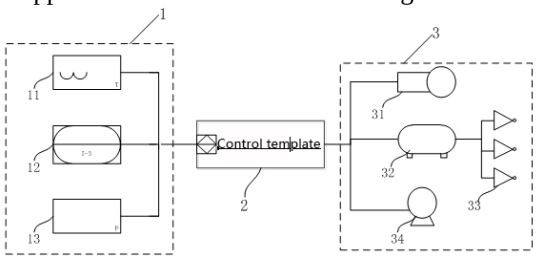

Fig 1 the control structure chart of greenhouse monitoring and control system

Fig. 1 is the control structure chart of greenhouse monitoring and control system.

Fig. 2 is the structure diagram of greenhouse control system.

Fig: 1-monitoring module; 11-temperature monitor; 12-humidity monitor; 13-illumination monitor; 2-control module; 3-regulating module; 31-motor; 32-

pump; 33-sprinkler; 34-fan; 35-plane mirror; 36-straw mat; 4-greenhouse.

A greenhouse monitoring and control system includes monitoring module 1, control module 2 and regulation module 3. Monitoring module 1 includes temperature monitor 11, humidity monitor 12 and illumination monitor 13. Regulation module 3 includes motor 31, water pump 32, sprinkler 33, fan 34, flat mirror 35 and straw mat 36. Control module 2 receives the monitoring information of monitoring module 1. Control module 2 analyses whether it meets the requirements according to the monitoring information and sends control signals to regulation module 3. Temperature monitor 11, humidity monitor 12 and illumination monitor 13 are distributed in greenhouses. The motor 31 drives the grass mat to rotate and retrieve. The grass mat 36 can set the top of the word greenhouse 4 to adjust the light transmission and heat preservation effect of the greenhouse 4. The motor 31 drives the plane mirror 35 to rotate, thus changing the illumination of the greenhouse. The pump 32 is connected with multiple sprinklers 33, which are arranged in the greenhouse 4 through a bracket. The top and side of the greenhouse 4 are equipped with a plane mirror 35, and the fan 34 is set on the side wall of the greenhouse 4. There are more than 35 planar mirrors. The motor 31 drives the planar mirror to rotate 360 degrees, so that the illumination in the greenhouse can be changed from many angles. In addition, a temperature monitor is set at the entrance of the fan, and an electric heating wire is set in the duct of the fan 34. In order to prevent the temperature of the greenhouse from being affected in the process of ventilation, the fan 34 with electric heating wire is used to ventilate the greenhouse by means of pressurized ventilation to ensure the concentration of CO2 in the room.

Example 2

On the basis of implementation example 1, the specific structure of greenhouse monitoring and control system is further explained.

Greenhouse monitoring and control system includes monitoring module 1, control module 2 and regulation module 3. The monitoring module includes temperature monitor 11, humidity monitor 12 and illumination monitor 13. The main parameters of temperature and humidity, illumination and soil temperature and humidity in greenhouse are determined. Through the humidity detector 12 in greenhouse, illumination detector 13 and soil temperature and humidity detector 11 buried in soil. The information of temperature, humidity, illumination intensity, soil temperature and humidity in greenhouse were collected, and the real-time production factor information was transmitted to PLC, and real-time information was displayed by touch screen and PC. The RS-485 bus mode is used to collect the information of production factors such as temperature and humidity, illumination, soil temperature and humidity in greenhouse. It does not occupy the control point of the controller, and I/O points are all from the control of the regulating equipment. When the parameters of factors of production in greenhouse exceed the scope, control module 2 sends out control signals to the regulation module to adjust the parameters that need to be adjusted.

Monitoring module 1 adopts bus connection mode and can realize remote control. Control module 2 must have bus and Ethernet communication interface. Considering the control point and communication requirements, control module 2 chooses Siemens S7-200 series 224XP and Ethernet expansion module CP243-1, which provide two serial ports.

In order to improve the temperature and illumination intensity in greenhouse, the plane mirror is used to reflect sunlight. The temperature and illumination intensity in greenhouse are adjusted by adjusting the angle of the plane mirror. A plane mirror is installed outside the greenhouse. The axis of the plane mirror 35 is connected with the stepping motor and the stepping motor is connected with the PLC. Plane mirror is used to adjust the width of daytime in the greenhouse so as to ensure the stability of illumination in the greenhouse. When the temperature or illumination decreases, the information is uploaded to PLC, which makes the stepper motor electrify, the stepper motor rotates, and changes the angle of the plane mirror, so as to increase the temperature and illumination intensity in the greenhouse. In addition, a motor is installed on the upper part of greenhouse 4, and the straw mat 36 is rolled on the outer part of the motor. The motor is controlled by PLC to turn forward and backward. When the motor rotates forward, the straw mat 36 is put down to keep warm and shade the sun. When the motor rotates backward, the straw mat will be put away.

The system adjusts the humidity by installing pumps in greenhouse. Pump 32 is connected with sprinkler 33 through water pipe. Sprinkler 33 is installed on the indoor bracket. When the humidity detected by humidity sensor in greenhouse 4 decreases, it is uploaded to PLC, so that pump 32 can be pumped by electricity and sprinkled out through sprinkler head, which not only increases the humidity in greenhouse, but also supplements the moisture of soil. Temperature, humidity and illumination in greenhouse are monitored by monitoring module. According to the monitoring results, control module 2 sends out control instructions, receives and puts grass mat or adjusts the angle of plane mirror, and adjusts sprinkler head to control humidity.

In addition, monitoring module 1 can also set up carbon dioxide concentration monitoring module. When the carbon dioxide concentration is lower than the compensation point of crops, the fans installed on both sides of the greenhouse begin to rotate and exchange with the outside gas. But when the outside temperature is lower than a certain temperature, the temperature sensor is uploaded to the PLC, which will turn on the hot wire in the fan duct to ensure the

temperature of the air, and make the temperature of the air flowing into the greenhouse. Carbon dioxide in greenhouses is replenished.

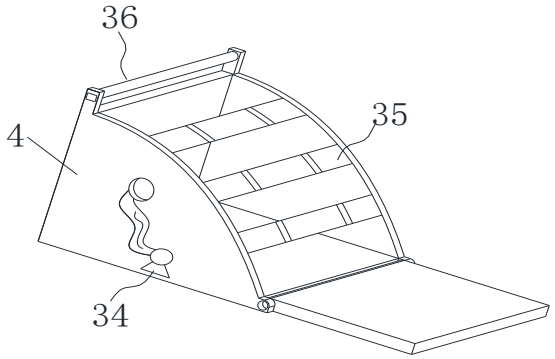

Fig 2 the structure diagram of greenhouse control system.

CONCLUSION

In view of the low popularization rate of Intelligent Greenhouse in China and the constraints of production cost, this research is seldom adopted by individual and general farmers. The greenhouse used by farmers is simple in structure, simple in equipment, difficult to achieve comprehensive environmental control, production management and operation level is relatively low and other conditions. Through the monitoring system of cloud platform, the detection of factors of production such as soil fertility, soil temperature and humidity, atmospheric temperature and humidity, light, water, carbon dioxide concentration and the acquisition of image information of crop growth are carried out. Through collecting environmental information and real-time monitoring of crop growth, the growth status of crops, soil fertility and pests and diseases can be timely understood, and scientific management for agriculture can be carried out. In order to adjust the production factors in time and meet the growth needs of crops, we have also realized the high-scale, intensive and industrialized agricultural production, improved the ability of agricultural production to cope with natural environmental risks, and made the disadvantaged traditional agriculture a modern industry with high efficiency.

REFERENCES

Atanas N. Iovev,Peter I. Yakimov. Application of PLC as a Gateway in a Network of Smart Power Transducers[J]. IFAC PapersOnLine,2015,48

Cui Jiadong, Qin Huibin, Xiao Zengrui,Design of Intelligent Agricultural Greenhouse System Based on Internet of Things Cloud Platform [J]. Internet of Things Technology, 2017, 7 (05): 68-71.

Fu Kangwei, Shen Lewei ,Shi You, and Zhang Chen, Zheng Yaping. Design of intelligent agricultural greenhouse monitoring system supporting multi-platform applications [J].Jiangsu Agricultural Science, 2018, 46 (12): 197-201.

Yang Jianmin, Yang Qingmei. Sensor technology []. Beijing: Tsinghua University Press, 2005, 10

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Tel:17860707287E-mail: f1877022835@qq.comAccording to the authorities, 15% of the Beijing's PM2.5 levels came from the pollution of the dust, and the pollution of the dust is the largest of all the pollution in Nanjing, reaching 37 percent [1]