Research on intelligent greenhouse based on Internet of Things

Lili Yao, Furui Dong, Chuankang Du
Shandong Vocational College of Science and Technology, Weifang 261053,China

Abstract: There are many drawbacks in the current traditional agricultural model, which consumes a lot of manpower, material resources and financial resources to solve the problem of crop growth environment. In order to change this situation, real-time detection and remote control of its environmental data, an intelligent greenhouse integrated system based on the Internet of Things was proposed. The system includes four modules: environment detection, gateway transmission, control execution and remote monitoring. The environment detection module detects the growth environment information in real time, and uploads real-time data with the help of the Internet of Things gateway. Users can remotely monitor the growing environment and growth state of crops in the greenhouse through mobile phone apps and computer web pages. At the same time, according to the growth environment data, control and implement equipment to adjust environmental factors in time to achieve accurate planting and improve crop yield and quality. Avoid the waste of agricultural resources.

Key words: Internet of Things; Intelligent greenhouse; Integrated system

At present, the greenhouse is developing in full swing in our country, planting technology is advancing by leaps and bounds, and the level of intelligent agriculture is gradually improving. At present, the communication mode of intelligent greenhouse is still basically using the wired connection method, which has many drawbacks, such as complex lines, high cost, difficult maintenance and so on. In this regard, a comprehensive system can be developed to solve the above problems through wireless communication, and give full play to its advantages of small size, low cost and low power consumption.

The Internet of Things technology is becoming more and more mature, and the application range is more and more wide, and the Internet of Things technology has begun to appear in the greenhouse. The intelligent greenhouse affects the growth state of crops through real-time detection and precise adjustment of the growing environment, preventing the waste of agricultural resources, creating favorable conditions for the growth of crops, so that it is no longer subject to environmental constraints. To provide people with more abundant and fresh agricultural products, to promote the transformation of agriculture, so that it to double high (high quality and high yield) modern agricultural development.

I. The overall design scheme of the system

Intelligent greenhouse can collect the environmental information in the greenhouse in real time, and upload the relevant data to the cloud platform, users can use the platform to understand the crop related information, such as growing environment, growth needs, etc., and combined with its needs to control the execution equipment, to create favorable conditions for its healthy growth. The overall structure of the system is shown in Figure 1. The system can be divided into 3 layers: ① Field layer, including sensing elements, implementation equipment, control cabinet composition, sensing elements include all kinds of sensors, responsible for obtaining environmental information in the greenhouse, such as temperature, humidity, light intensity and other parameters, implementation equipment including water pump, solenoid valve, fill light, etc. Controller according to the collected environmental data, operation control strategy, control implementation equipment to adjust environmental factors; ② Network transmission layer, mainly responsible for the collection of downlink data, back uplink data, by the Internet of Things gateway with the corresponding protocol to achieve the field layer, cloud platform, monitoring between the communication. ③ Monitoring layer, real-time monitoring of environmental data in the greenhouse, site status, remote control of the implementation equipment through mobile phone APP or computer web page.

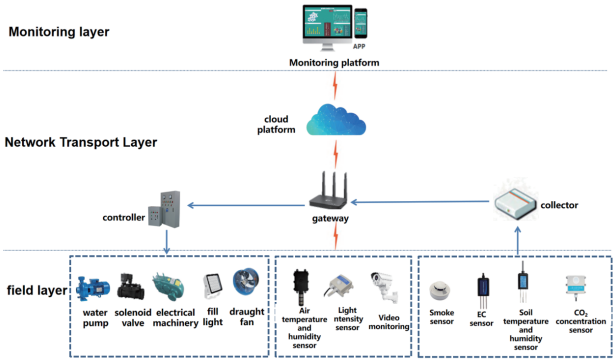

Figure 1 Overall structure of the system

The comprehensive system of intelligent greenhouse consists of four functional modules, which are environmental detection module, gateway transmission module, control execution module and remote monitoring module.

II. Environmental detection module

The module is mainly responsible for collecting information, and the information collected is related to the growing environment of crops in the greenhouse. The collection equipment includes cameras and a variety of sensors, such as air temperature and humidity sensors,

soil humidity sensors, CO2 concentration sensors, etc. These sensors are divided into wired and wireless sensor networks.

1. Wired sensor networks. The sensor output signal is divided into digital signal and analog signal, the selected soil moisture sensor, soil EC sensor, CO2 concentration sensor and other output is analog signal, with the analog collector port of the sensor data collection is aggregated; Smoke sensor output is a digital signal, with the port of the digital quantity collector of the data collected by the sensor is aggregated.

2. Wireless sensor network. Air temperature and humidity sensor and light intensity sensor are wireless sensors, using ZigBee communication technology for data acquisition of these two sensors. ZigBee has the characteristics of AD hoc networking, is a low-power local area network protocol, as a wireless network technology has many advantages, such as close distance, low power consumption, low cost. It is composed of wireless sensor nodes, GPRS data transmission, sink nodes distributed system, the first sensor collected data uploaded to the GPRS network, and then by the central controller with the help of GPRS network and ZigBee node wireless data transmission, conversion.

III. Gateway transmission module

The module uses the Internet of Things gateway to realize the protocol conversion between the perception network and the communication network, as well as between different kinds of perception networks, so that the system realizes the local interconnection. It carries out a series of operations on the real-time data collected by the environmental detection module such as aggregation, processing, etc., and transmits these data to the cloud platform through Wi-Fi, GPRS, etc., and stores it in the system's database. Users can obtain relevant data in the form of remote access to the cloud platform, including historical information, the form of these sensing data is charts or curves. Digital quantity collector and analog quantity collector follow the Modbus protocol, output RS485 digital signal, the two kinds of collector data transmission port are D+, D-, the two ports and the Internet of Things gateway data transmission port RS485+, RS485- connection, upload the collected data. In the Internet of Things gateway embedded ZigBee coordinator module, collect ZigBee terminal node sensor related data information.

IV. Control the execution module

The module combines the collected relevant environmental information to effectively control the execution equipment, so as to realize the ventilation and light filling operations in the greenhouse. The control mode includes two modes, namely automatic mode and manual mode. Users can understand the crop-related information uploaded to the cloud platform through mobile phone App and computer web page, such as growth status and environmental information, etc. When abnormal conditions are found, manual mode can be adopted to control the execution equipment in the greenhouse. Under normal circumstances is the use of automatic mode, the controller chooses PLC, the controller according to the collected environmental information, operation control strategy, control implementation equipment, such as water pump, fan and so on. The common functions of this module are as follows:

1. Soil water and fertilizer management: The system uses the integrated system of water and fertilizer, according to the detected soil moisture, EC data, the use of fuzzy control algorithm, to determine whether the soil needs irrigation, fertilization, if necessary, then the control pump and fertilizer tank solenoid valve for fertilizer distribution, control fertilizer pump and regional sprinkler irrigation solenoid valve for irrigation, fertilization, to achieve accurate water and fertilizer management, water and fertilizer integrated system structure schematic diagram as shown in Figure 2.

2. Air temperature regulation:Temperature control is mainly divided into heating and cooling, with heating mainly in winter and cooling mainly in summer. When the temperature of the greenhouse is lower than the set temperature in winter, the controller controls the opening of the electromagnetic valve in the hot water pipeline to keep the temperature inside the appropriate temperature range. At night, the system starts the roller shutter motor to open the insulation quilt to provide insulation for the greenhouse; When the temperature inside the greenhouse is higher than the set temperature in summer, the system selects an appropriate control mode based on the temperature. The specific control mode is shown in Table 1, which controls the sunshade motor, sunroof motor, side window motor, and wet curtain water pump/fan to achieve multi device linkage control. The size of the sunroof opening and side window opening can be controlled. Adjusting the air temperature can also regulate the air humidity, maintaining a suitable growth environment in the greenhouse.

Table 1 Control mode

mode	control plan
mode1	Open the sunshade
mode2	Open the sunshade+sunroof with a 50% opening angle
mode3	Open the sunshade+sunroof with a 100% opening angle
mode4	Open the sunshade+sunroof opening at 100%+side window opening at 50%
mode5	Open the sunshade+sunroof opening at 100%+side window opening at 100%
mode6	Open sunshade+sunroof opening 100%+side window opening 100%+wet curtain

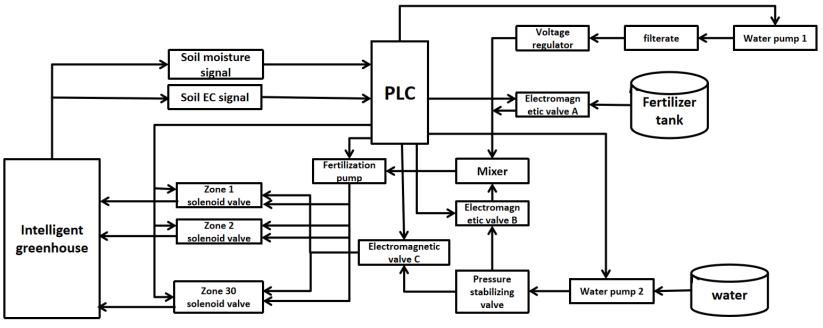

Figure 2 Schematic diagram of water and fertilizer integrated system structure

3. Light control: When the light intensity in the greenhouse is lower than the threshold, the controller turns on the fill light lamp, adjusts the intensity of the fill light lamp according to the indoor light intensity, and sets the light duration; When the light intensity in the greenhouse exceeds the threshold, the system starts the rolling curtain motor 2 open the shade curtain to reduce the light intensity in the

greenhouse. Through light control, to ensure the photosynthesis of crops, and does not affect the photoperiod regulation mechanism of crops, while avoiding excessive light damage to crops.

4. CO2 concentration control: When the concentration of CO2 in the greenhouse is higher than the set threshold, the system controls to open the ventilator for ventilation, and when the concentration of CO2 falls to the normal value, the ventilator is closed to ensure that the concentration of CO2 in the greenhouse is controlled within the appropriate range.

5. Pest monitoring: The system can automatically identify crop diseases and pests through multiple cameras and use convolutional neural network algorithm, and send alarm information in time to remind users to take preventive and control measures in time to ensure crop health. The principle diagram of self-identification of pests and diseases by neural network technology is shown in Figure 3.

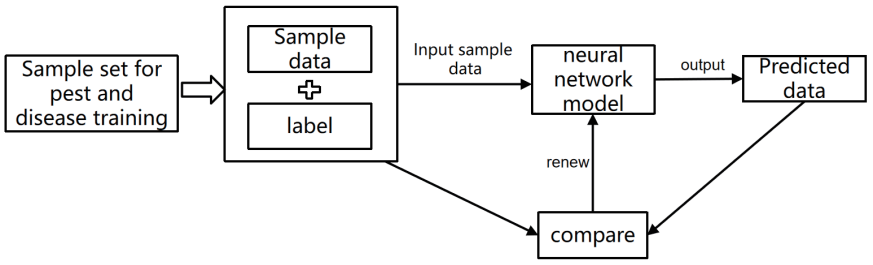

Figure 3 Self-identification of pests and diseases schematic diagram

V. Remote monitoring module

The user can view the crop growth environment status information transmitted by the cloud platform in real time through the mobile phone App or the computer web page. The specific form is a chart or curve, and the historical data can be queried. Control parameters can be set and modified through the human-computer interface. Through multiple cameras, the user can remotely monitor the growth of crops in real time, the operating status of the execution equipment, the labor status of workers, etc., and take measures in time when anomalies are found. For example, if the execution equipment does not execute automatic control instructions, it can be directly controlled manually.

VI. End

This paper focuses on the construction of intelligent greenhouse system based on the Internet of Things, and constructs four modules: Environmental detection module, gateway transmission module, control and execution module and remote monitoring module, to realize the real-time understanding of the intelligent greenhouse in the air, soil, light, pests and other environmental information, and timely adjustment of environmental factors, so that environmental factors self-adapt to the growth of crops, to achieve accurate planting. The research of intelligent greenhouse technology can effectively help the development of smart agriculture.

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