Application Design of Intelligent Agricultural Greenhouse System based on Internet Plus

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Abstract*:* Household products, represented by Internet of things and intelligent equipment, are gradually entering the market in recent years promoted by the development of computer networks and the concept of Internet plus, which has greatly facilitating people's lives. The combination of smart home technology and greenhouse agricultural production will make the operation and management more convenient, realize the sharing of information resources, and greatly improve the degree of intelligence in the greenhouse planting process. By using Internet plus technology, sensors, Internet of Things, cloud computing, big data and so on are organically combined, and the information in agricultural production environment is collected in real time through the sensor nodes distributed in the greenhouse. The wireless sensor network is connected to the Internet, and the data acquired by the sensors are stored, displayed and analyzed by the cloud server, so that the growth environment inside the greenhouse is more guaranteed, and the whole greenhouse planting process is networked, intelligent and unmanned.

Keywords: Internet plus; smart agriculture; application design; big data; intelligence; wireless sensor

1. Introduction

China, as a large agricultural country, has a huge planting area of crops throughout the country, in which a considerable part of crops are planted by traditional agricultural means of production, which mainly rely on human, livestock and some simple machinery, with low production efficiency, difficulty to realize the accurate control of crop planting environment, and failure to make good use of water, electricity, land, fertilizer and other resources, which does not meet the requirements of energy conservation and environmental protection [1,2]. In this paper it is aimed at combining the Internet plus with the intelligent greenhouse, so as to obtain the information of air temperature and humidity, carbon dioxide concentration, light intensity and so on in real time through the remote terminal [3-5]. At the same time, the intelligent sensors in the greenhouse can also send real-time monitoring information and alarm information to the manager, give full play to the role of the internet technology in agricultural production, ensure that various factors in the greenhouse are more suitable for crop

growth, facilitate farmers to improve planting efficiency, reduce cost and increase revenue [6,7].

In the era of Internet plus, Liu Guangwei (2020) [8] thought that the intelligent development of agricultural industry has increasingly become one of the important directions of China's agricultural strategic development with the increasing demand for agricultural output in China, and the development of agricultural modernization and the integrated operation mode of modern intelligent technology will definitely improve the production quality of agriculture in China. Sheng Bin and Wang Shuwei (2020) [9] believed that the introduction of greenhouse planting system in traditional greenhouse mode can make the data among greenhouses interconnected and realize remote real-time control through wireless transmission technology, thus reducing manpower, increasing yield and finally realizing automation. Zhou Handa (2019) [10] et al. combined the intelligent agricultural greenhouse system based on the Internet of Things with computer control technology and drip irrigation technology, replacing the traditional artificial planting, which reduces the agricultural production cost and the labor force, and improve the yield, and promotes the development of agriculture to intelligent, unmanned, high-quality and high-yield production.

2. Comparative Analysis of Traditional and Intelligent Agricultural Greenhouses

2.1. The Characteristics of Traditional Agricultural Greenhouses

- **Local control only, centralized management not possible**: At present, most of the automatic control systems of greenhouses on the market are based on PLC, which can only realize local control but cannot summarize and analyze the data due to the limitations of the system architecture, let alone managing the internal environment of multiple planting greenhouses in a unified and centralized way.

- **High equipment cost, complicated installation process and high maintenance cost**: As the PLC-based automatic control system uses industrial field bus for communication, a large number of wiring operations are required inside the planting greenhouse, which is costly and complicated to construct, and has high installation, use and

maintenance costs, which is not conducive to large-scale promotion and use.

- **Inability to view the internal environment of the greenhouse in real time through the remote terminal**: To meet the requirements of rapid growth of agricultural crops, the interior of agricultural greenhouses is usually kept at a high temperature and humidity environment continuously, while the traditional automatic control system can only maintain the parameters such as temperature and humidity at preset control conditions and cannot feed back to users in real time. Users who want to understand the current crop growth conditions still need to go inside the greenhouses to view the sensor data, which greatly impacts the user experience.

- **Inability to trace the whole process of crop growth**: With the improvement of people's living standards, the planting process of many organic vegetables, fruits and other agricultural products needs to be traceable in the whole process. However, the traditional PLC control system can not save the real-time environmental parameter curve locally due to the limitation of storage space, so it can not meet the requirement of traceability in the whole process of agricultural product growth.

2.2. Advantages of Intelligent Agricultural Greenhouse

In order to solve the above problems and deficiencies, in this paper, starting from improving user experience and aiming at improving the ease of use of equipment, an intelligent agricultural greenhouse management system based on Internet plus is designed, which can realize the real-time and automatic control of the growth conditions of crops in the greenhouse, and provide a friendly user interface, so that farmers can complete the previous work of inspecting the greenhouse without leaving home, thus improving production efficiency and saving labor cost.

This design has the following characteristics:

- **Networked and intelligent**: Based on the design concept of Internet plus, the industrial field bus sensors in the traditional greenhouse control system and actuators such as pumps and ventilation fans connected with the control cabinet are upgraded to intelligent wireless sensors and control terminals, which are connected to the cloud platform through the Internet, thus realizing the cloud centralized management of the greenhouse internal environment. The cloud computing technology is applied to the intelligent management system, which replaces the traditional PLC to realize the monitoring and management of the internal environment of the planting greenhouse, can intelligently adjust the conditions of temperature and humidity, illumination, and ventilation in the greenhouse according to the external environment and the growth requirements of crops, and can realize the operations such as automatic fertilization and the

like, thus solving the problem that the traditional PLC control system is not flexible because it can only control according to a preset control strategy.

- **Lightweight and environmentally friendly**: Benefiting from the sufficient illumination inside the planting greenhouse, the wireless sensor nodes can realize the energy supply by adopting the mode of combined power supply of the solar battery and the lithium battery, and the system can realize the real-time acquisition of the environmental parameters without wiring. On one hand, this design solves the problems of high installation cost, complicated wiring and long construction period of traditional PLC control system; on the other hand, it uses clean solar energy as source, which meets the requirements of energy conservation and environmental protection in the world today.

- **Unmanned and traceable**: With the introduction of Internet+ and cloud computing technology, this system has the ability of unattended management. Users, relying on the powerful Internet of Things cloud platform, can monitor the environmental conditions inside the greenhouse in real time without leaving home, and automatically regulate and remotely manage the environment inside the greenhouse according to the crop planting environment set by users and matched with the cloud. Especially when the key parameters are abnormal, the user can receive the abnormal alarm information through a mobile phone, a computer or an intelligent bracelet, which greatly reduces the workload of the user in daily inspection of the greenhouse. The intelligent sensor and the intelligent actuator based on the Internet plus make it possible for the comprehensive unmanned agricultural planting greenhouse, under the monitoring of which the user only needs to plant and harvest crops, as other planting processes can be automatically completed through the Internet plus cloud platform. Meanwhile, relying on the big data analysis function of the cloud platform, the system can completely achieve the comprehensive traceability of the greenhouse planting process, so that the planting process of agricultural products can be documented, and the system can provide big data support for the regulation and control of the planting production environment in the next year while reassuring consumers, thereby realizing the continuous optimization of the greenhouse planting process.

2.3. The Innovation of Intelligent Agricultural Greenhouses

The core research content of this paper is carried out around the work of information acquisition, internet plus platform construction and autonomous control decision-making.

The main innovation lies in:

- **Reducing the wiring of sensor nodes in the greenhouse, and realizing the convenience of plug & play installation.**
- **Connecting sensors and actuators to the cloud platform, thus realizing remote management of multiple terminals such as mobile phones and computers.**
- **Achieving complete traceability of crop growth process through big data acquisition and analysis.**

At present, the intelligent agricultural control system with the above advantages has not yet appeared in the market, which is an innovative research content, because this intelligent agricultural greenhouse management system based on internet plus technology, which is energy-saving, environment-friendly, convenient and easy to use, and supports the whole process traceability, is bound to show great practical value.

3. Design of Intelligent Agricultural Greenhouse System Based on Internet Plus

The research goal of this paper is to design a set of intelligent agricultural greenhouse management system based on internet plus, which should realize convenient installation, remote viewing, remote management, data tracing and other functions on the basis of realizing all functions of the existing PLC control system, so as to greatly enhance the user experience. The structure of this system is shown in Fig. 1.
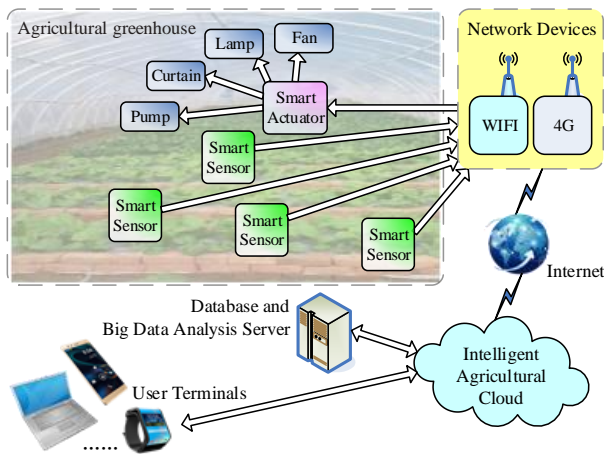

Figure 1. Structure block diagram of intelligent agricultural greenhouse management system based on internet plus

3.1. Sensor Power Management Module

In this system, a clean and environment-friendly power supply mode combining solar cells and lithium batteries is adopted, which can meet the all-weather data acquisition work without wiring and replacing batteries in the whole planting cycle of crops. To achieve this goal, a complete power management module needs to be designed. In addition, the output voltage and internal resistance of the solar cell change dramatically because the illumination intensity in a day changes greatly with time and weather, which can not be directly used to supply power to the sensor assembly. In view of this

characteristic of solar cells, the sensor power management module proposed in this paper aims to realize the collection and storage of solar energy, and to provide stable energy supply to the intelligent sensors to ensure the all-weather stable operation of the intelligent sensor nodes. The structure of the sensor power management module is shown in Fig. 2.
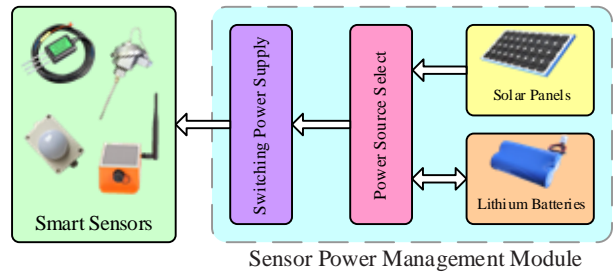

Figure 2. Structure block diagram of sensor power management module

3.2. Intelligent Sensor and Intelligent Actuator Module

The data needed by the intelligent agricultural greenhouse management system to complete the automatic control process are all acquired by the intelligent sensor module, which is the core component of the system for detecting and sensing the internal environment of the greenhouse, and is also one of the research focuses of this paper. Intelligent sensor module needs to complete two functions of data acquisition and data transmission, in which the former obtains raw data through various sensors such as temperature and humidity, illumination, CO_2, soil pH, ammonia nitrogen, etc., and forms data sequence through lightweight filtering algorithm, while the latter submits the data sequence obtained from data acquisition to network access equipment through wireless sensor network technology, and uploads it to the cloud platform through the Internet. Another research focus of this paper is the intelligent actuator module, which is used to replace manual operation to realize automatic control of the inner environment of the greenhouse. When the cloud platform needs to control the actuator, it will send the control decision data to the intelligent actuator through the Internet, so that it can automatically control the electromechanical equipment in the greenhouse according to the received decision data. The structural block diagram of intelligent sensor and intelligent actuator module is shown in Fig. 3.
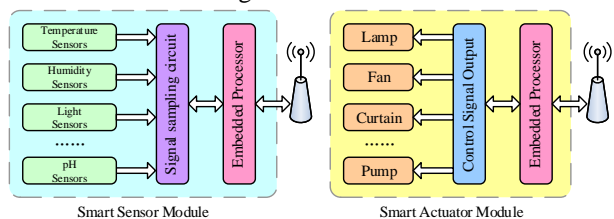

Figure 3. Structure block diagram of intelligent sensor and intelligent actuator module

3.3. Deployment of Cloud Platform Based on Internet Plus

Internet plus is an upgraded version of the integration of industrialization and informatization, with the core significance of taking the Internet as the core feature of the current informatization development to realize its comprehensive integration with industry, commerce and finance. In this paper, based on the thinking of Internet plus, the intelligent agricultural management cloud platform is constructed to realize the interconnection of intelligent sensors, intelligent actuators, databases, big data analysis servers and user terminals, and the intelligent decision-making and regulation of greenhouse planting conditions are realized according to climatic conditions and crop species through artificial intelligence algorithm.

3.4. Optimized Design of Human-Computer Interaction Interface

The traditional PLC automatic control system has poor user experience because of cumbersome programming and the need to view control status data on the spot. To solve this problem, in this paper, from the perspective of improving user experience, it is necessary to design a set of man-machine interaction interface suitable for smart phones, computers and other multi-platforms, so that users can easily control the use of intelligent agricultural greenhouse management system and realize remote operation of multi-terminal platforms without any professional knowledge of PLC programming.

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