Agricultural Greenhouse Crop Information System based on Big Data and Cloud Computing Technology

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Abstract. With the further promotion of urbanization in China, the arable land area in China is decreasing year by year, and it is very important to make full use of the existing land resources. At present, most areas in northern China have greenhouses. Since temperature, humidity, light, and CO2 concentration directly affect the yield of crops, how to provide a suitable environment for crops to grow in greenhouses is a topic worth investigating.

Keywords: Agricultural Greenhouse; Information System; Big Data.

1. Introduction

Intelligent agricultural management is the use of Internet information technology to achieve intelligent management of agricultural operations. Smart agriculture management not only can adjust the in and out of merchants at any time but also can improve the quality of agricultural products through unified scientific management[1]. Wisdom agriculture management runs through all aspects of the whole wisdom agriculture industry chain, including the monitoring platform for agricultural disasters and the B2B trading platform for agricultural products. An intelligent agricultural disaster monitoring platform can provide accurate weather service and disaster forecasts for agricultural planters, which is the fundamental guarantee for agricultural production. The agricultural disaster monitoring system monitors the planting environment 24 hours a day through the induction system. If the surrounding environment changes, the agricultural disaster system will provide direct feedback to the agricultural planters through mobile communication to make an early response. The B2B trading platform for agricultural products is an important platform to help buyers and sellers to complete the production and marketing of agricultural products[1]. The platform aims to use mobile Internet technology to complete online and offline service transaction docking through mobile client apps and provide customized services according to the different requirements of supply and demand sides. On the trading platform, the supplier can publish the yield, quality, and price of agricultural products online, while the demander can publish seeking information and request quotations online, and the platform will match the supply and demanders who meet the requirements and conditions through cloud computing technology, thus forming a complete transaction.

Smart agriculture will effectively manage agricultural production and improve output, labor efficiency, and resource utilization. Since Internet technology itself has many characteristics such as high efficiency, speed, and resource sharing, the "Internet and agriculture" smart agriculture development model will bring many benefits to the agricultural economy. Smart agriculture management systems include a wide range of digital management systems, remote monitoring systems, and Internet of Things systems.

First of all, the digital management system of smart agriculture can realize the precise nutrient management of agricultural production, maximize the input-output ratio of agricultural costs, target the crop growth conditions and nutrient conditions for regulation, and improve the yield per unit area. For example, the yield of rice production before the use of smart agriculture production was 9429.0 kg/hm2, while after the use of smart agriculture technology using precision fertilization, the yield increased by 973.5 kg/hm2, an increase of 10. 33%, a significant increase in production efficiency[2].

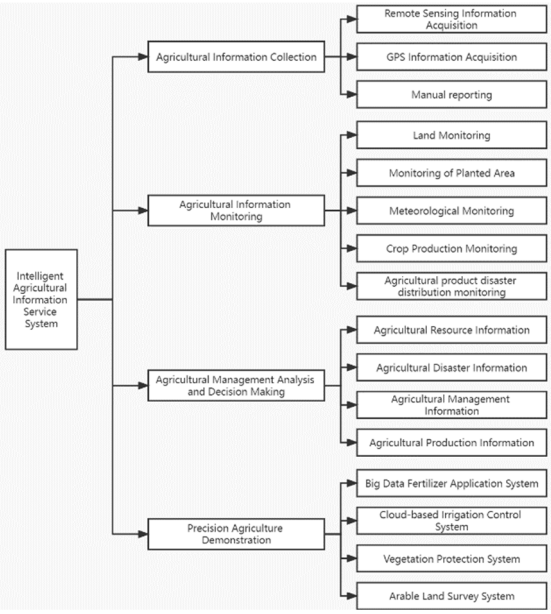

Fig 1. Functional architecture block diagram of data analysis management system

Secondly, the remote monitoring system of smart agriculture can achieve 360-degree monitoring of crops without any dead angle and can zoom in and out at will to give planters a comprehensive understanding of crop growth conditions[3]. Especially in the disease season, the monitoring system will also prompt the planters to apply fertilizer and medicine tips to prevent diseases. This intelligent management system liberates human capital and allows planters to take care of crops at any time even when they are not in the field.

Finally, the intelligent agricultural IOT system, as the most advanced intelligent agricultural management system, can record and trace agricultural affairs through big data technology and cloud computing technology, including information on planting, weeding, fertilizing, and harvesting of crops to ensure the quality and safety of agricultural products.

In addition, crops with this management mode have complete records from planting to table, so it can save a lot of manpower and money on food safety and supervision of sources, which not only reduces the cost of agricultural products but also improves the quality of agricultural products.

1.1 System Function Analysis

The system provides services to the park management for the monitoring of the production process and the integrated management of the environmental system of agricultural greenhouses throughout the park. The system consists of a sensing layer, a transmission layer, a data storage center, and an application layer. The sensing layer relies on the sensor nodes deployed in the park to collect crop production information in the agricultural greenhouses and environmental and meteorological data such as temperature, humidity, light, carbon dioxide, PM2.5, PM10, etc [3]. in the field of the park. The data can be sent to the data storage center deployed with the MySQL database platform through the transmission layer network, and the data can be analyzed, monitored, stored, counted, and analyzed through the management and decision system software in the application layer.

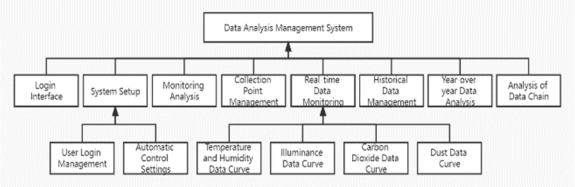

Fig 2. Functional architecture block diagram of data analysis management system

The implementation of the agricultural greenhouse production environment monitoring system is an extension of the Internet of Things from the desktop to the field, allowing agricultural greenhouses to be online in real-time, combining real-time collected sensor data and meteorological data with traditional planting experience, and realizing the integration of agricultural production with the digital world. The deployment of the agricultural greenhouse production environment monitoring system is of great importance in promoting the development of modern agricultural production technology in agricultural science and technology parks, enhancing the ecological and environmental protection capacity of the parks, and transforming scientific and technological achievements.

1.2 System Software Design

The intelligent agricultural greenhouse system is divided into three parts: wireless sensing network, gateway, and master control center, combining embedded technology, sensor detection technology, and wireless communication. The wireless sensing network consists of a coordinator, router, five data acquisition nodes (temperature sensor node, humidity sensor node, lightness sensor node security sensor node, soil moisture node), and a control node. The five data collection nodes are responsible for collecting temperature, humidity, illumination, soil moisture, security, and other information in the greenhouse, and transmitting the collected data to the coordinator. On the one hand, the coordinator and the gateway transmit various setting parameters, commands, and data in the greenhouse through the serial port; on the other hand, the coordinator sends control commands to the control nodes to control the switch of the fan, humidifier, and heater to adjust the environment in the greenhouse.

The intelligent agricultural greenhouse system can collect the temperature and humidity, light information, soil humidity, and security information in the greenhouse in real-time, and intelligently control the temperature, humidity, and ventilation conditions in the greenhouse by measuring the parameters in the production process of the greenhouse with high precision, and automatically realize the functions of heat preservation, moisturizing, and recording of historical data. The system also has remote access and control functions, users can remotely access the relevant data in the greenhouse through a PC, pay attention to the growth of plants in real-time, and remotely control the switch of the equipment inside the agricultural greenhouse and adjust the internal environment of the greenhouse.

1.3 Intelligent Shed Control

The facilities and equipment of several greenhouses, including fans, external shading, internal shading, sprinkler, and drip irrigation, side windows, water curtains, valves, and heating lights, can be manually controlled remotely from a cell phone. According to the time, meteorological data, soil data, etc., the system can automatically perform irrigation, ventilation, opening and closing of the skylight, etc. according to the set regulations.

1.4 Water and Fertilizer Integrated Automatic Irrigation System

Water supply and fertilizer supply through the controlled pipeline system, is the water and fertilizer blend through the pipeline, spray gun or nozzle for sprinkler irrigation, uniform, regular, quantitative spray again crop development and growth area, is the main development and growth area in vain always maintain loose and suitable water content, at the same time according to the different crop fertilizer needs characteristics, the vain environment, and nutrient content status, the water, nutrients, time and quantity, according to the proportion directly to the crop.

1.5 Pest Diagnosis and Control System

When the user finds that the crops are abnormal, they can take pictures of the leaves or fruits of the crops and upload them to the cloud platform, and they can identify whether the crops suffer from diseases and insect pests in milliseconds, and get the control measures, so that you can quickly diagnose and use accurate medicines. Avoid delays in treatment and cause losses. The system can realize automatic classification and counting of pest categories, and automatically conduct pollution-

free trapping and killing to reduce the use of pesticides; through high-definition cameras to collect insect images, it is possible to remotely check field insect conditions and formulate control measures.

1.6 Meteorological Environment Monitoring

Real-time monitoring of air temperature and humidity, light, rainfall, wind speed, wind direction, atmospheric pressure, gas concentration, and other data, and by setting relevant alarm thresholds, real-time alarms are realized, and planting environment indicators are accurately controlled. Based on satellite data, the system can forecast the weather for the next 72 hours, and give 24-hour early warning of abnormal weather such as extreme weather, precipitation probability, high winds, etc., reminding users to prepare for disaster prevention and risk prevention promptly.

1.7 Soil Moisture Monitoring

Accurate monitoring of soil moisture, rapid early warning of abnormal conditions; real-time monitoring of soil water tension, soil temperature, and humidity, water level, dissolved oxygen, pH, etc. Setting the alarm threshold, when the soil data is abnormal, such as the humidity is too high, the system will automatically send out a warning message to remind personnel.

1.8 Video Surveillance System

Precise surveying and mapping of drones, autonomous flight throughout the whole process, and any terrain operation at any time; locate the location of the plot, identify the boundary of the plot, and measure the plot area; draw the plot on the electronic map for visual display; through 720-degree high-definition camera, emergencies It can automatically turn to emergency recording to monitor crop growth; the high-definition camera can rotate 720 degrees, zoom in, and zoom out to check the real-time production situation in the park; when an early warning occurs, the camera can automatically turn to the early warning point for emergency recording, so as not to miss any abnormality; You can take screenshots of videos without having to install an additional camera for shooting.

1.9 Facility Remote Control System

Through the remote-control system, users can remotely view facility environmental data and equipment operation status, and can also analyze data for convenient and flexible management. It can automatically control the operation of heating, cooling, ventilation, irrigation, fertilization, and other equipment according to the preset planting conditions, meet the strict requirements of crop planting environmental conditions, reduce unnecessary losses, and save electricity and reduce production costs.

2. System Analysis

2.1 Greenhouse Management

The sunshade net, irrigation, fill light, fan, and airflow display can be manually switched on and off by operating on the page of the system. The smart greenhouse can automatically turn on/off the equipment according to the set rules according to time, weather data, soil data, etc. Greenhouse management is mainly divided into the following parts.

The shading net can control the intensity and duration of light and can adjust the intensity and duration of care according to the different growth stages of different crops. It can effectively ensure the healthy growth of crops, and can prolong the growth period of crops to achieve the effect of increasing production; after reading the temperature and humidity in the greenhouse, set the most suitable humidity according to the different requirements of different crops and soil moisture, and complete Automatic irrigation reduces manual labor and waste of water resources; greenhouse lighting is closely related to crop growth[4]. Capturing light energy to the maximum extent and giving full play to the potential of plant photosynthesis will be directly related to the benefits of agricultural production. The room fill light, also known as plant fill light, is by the natural law of plant growth

and the principle that plants use sunlight for photosynthesis, using light instead of sunlight to provide the light source required for the growth and development of greenhouse plants; the fan is the greenhouse[5]. An indispensable part of temperature control and automatic ventilation, the fan can intelligently control the air outlet and automatically adjust the temperature of the greenhouse. The most efficient use of temperature resources in the greenhouse improves the quality and yield of crops; the airflow display can help managers effectively see the state of airflow, which is convenient for managing the greenhouse.

2.2 Simulated Growth of Crops

In the system, the growth process of plants is simulated every 90s, and the state of seeds, germination, seedlings, small seedlings, middle seedlings, large seedlings, flowering, and mature and withered crops during the growth process of crops are displayed one by one, you can also manually control and display the growth status of crops.

3. Conclusion

The smart greenhouse is to apply intelligent control to greenhouse planting, obtains the environment and meteorological environment inside the greenhouse, compares the set environmental threshold and set the actual value, and takes corresponding measures when the actual value exceeds the environmental threshold).

The greenhouse system designed in this paper satisfies the user's monitoring of environmental parameters in the greenhouse under long-distance conditions. Using this system can automatically adjust the temperature and humidity, CO2 concentration, and other environmental variables in the greenhouse to adjust the range suitable for crop growth, and truly realize the greenhouse. Unmanned management of greenhouses.

References

[1] Kalyani, Y. and R. Collier, A Systematic Survey on the Role of Cloud, Fog, and Edge Computing Combination in Smart Agriculture. Sensors, 2021. 21(17): p. 5922.

[2] Amani, M., et al., Comprehensive review on dehumidification strategies for agricultural greenhouse applications. Applied Thermal Engineering, 2020. 181(1164).

[3] Abhishek, A., et al., Evaluating the Impacts of Drought on Rice Productivity over Cambodia in the Lower Mekong Basin. Journal of Hydrology, 2021: p. 126291.

[4] Das, S., S. Chatterjee, and J. Rajbanshi, Responses of soil organic carbon to conservation practices including climate-smart agriculture in tropical and subtropical regions: A meta-analysis. Science of The Total Environment, 2022. 805: p. 150428-.

[5] Liu, W., Smart sensors, sensing mechanisms and platforms of sustainable smart agriculture realized through the big data analysis. Cluster Computing, 2021(12).