Research on Smart Agriculture Big Data Platform Based on the Internet of Things

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Abstract. With the exponential advance of science and technology, Internet of Things technology is enjoying widespread applications. As a part of smart economy, smart agriculture plays an essential part in the digital transformation of agriculture. The combination of Internet of Things technology and smart agriculture not only provides a new perspective for agricultural modernization, but also contributes to rural revitalization and points out a new direction for its future research. This paper designs a smart agriculture big data platform built on the Internet of Things, designs the platform as four layers: infrastructure layer, network transport layer, platform support layer and application service layer, expounds the corresponding functional modules of the platform and conducts relevant tests, aiming at promoting agricultural intelligence.

Keywords: Internet of Things, Big data, Smart agriculture

1 Introduction

As an advanced stage of agricultural digital transformation, smart agriculture is a key trend of high-quality development of agriculture in our country in the future [1]. Smart agriculture is the application of technologies such as the Internet, the Internet of Things, and wireless communication to traditional agriculture, so as to realize remote control and smart management of agriculture. Since "smart agriculture" first appeared in the central No. 1 document in 2016, the state has introduced relevant policies to incentive to develop smart agriculture every year. In 2023, the Opinions of the Central Committee of the Communist Party of China and The State Council on Comprehensively Promoting the Key Work of Rural Revitalization in 2023 clearly put forward that it is vital to accelerate the application of big data in agriculture and rural areas and push for the development of smart agriculture. It is hard for traditional agriculture to comprehensively and systematically collect huge volume of data generated in the production process, but with the help of the Internet of Things technology, smart agriculture can timely and accurately collect information at all levels of agriculture [2]. The data in smart agriculture not only comes from the entire chain of agricultural production, but also involves cross-industry, cross-professional and cross-field data, with various types and large scale. The use of smart agriculture big data platform can

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screen out the truly valuable parts from the complex and massive data, so as to achieve the smart control of agricultural parks and promote the development of traditional agriculture to modern agriculture.

2 Research significance

Agriculture Agriculture is a basic industry related to the people's livelihood in China and occupies a very important place in the entire national economic system. To solve the problem of "agriculture, rural areas and farmers" is one of the key tasks of the Party and the state. Traditional agriculture has low production efficiency, high labor intensity and weak risk resistance [3]. The advance in science and technology has provided new opportunities for China's agricultural production, which can not only increase farmers' income, but also improve agricultural production efficiency and optimize agricultural production pattern [4]. For recent years, the country has always strongly supported development of science and technology innovation and science and technology industries in the field of agriculture. 2012 Central document No. 1 pointed out that agricultural science and technology to achieve sustainable and stable development of agriculture. The Notice of The State Council on Issuing the Action Outline for the Promotion of Big Data Development issued in 2015 clearly proposed the development of agricultural and rural big data and the construction of an integrated information service for agriculture and rural areas. As the big data, cloud computing and Internet of things of a new generation of information technology to mature, it is imperative to speed up the combination of new technologies into agriculture and rural areas [5]. Agricultural and rural big data is fully integrated with the development of agriculture and rural areas [6]. The building of agricultural and rural big data platform can facilitate the sharing and opening of agriculture-related data resources, raise the level of rural information service, promote the precision and wisdom of agricultural production, and breathe new life into the development of modern agriculture. With the Internet as the cornerstone, the Internet of Things is the inheritance and evolution of Internet technology application. The Internet is the core of the Internet of Things technology. Information between items can be connected on the basis of the Internet to achieve intelligent management and remote control [7]. Given the shortcomings faced by traditional agriculture, the Internet of Things combines with cloud computing, big data and other new technologies in depth to construct a smart agricultural big data management platform based on the Internet of Things, which can organically combine agricultural production technology and Internet of Things technology, strengthen the information perception ability of agricultural producers, and facilitate the collection of agricultural and rural data. Effective early warning and monitoring for production, sales and other related matters, and provide decision support for managers.

3 Platform architecture

Agricultural Internet of Things is an iot application system that runs through all aspects of agriculture, such as seedling selection, planting, fertilization, harvest, production, processing and circulation [8]. The smart agriculture big data platform is the center of agricultural and rural data processing and data analysis and application. It is characterized by many fields, a wide range of applications, and high management accuracy, and its construction should take into account the development trend of information technology and the actual situation of local agriculture. The overall architecture of the platform includes the infrastructure layer, the network transport layer, the platform support layer and the application service layer (see Fig1).

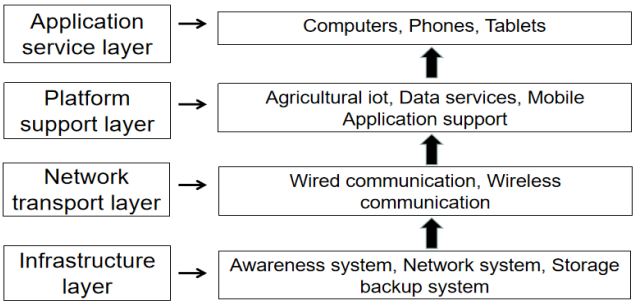

Fig. 1. Architecture of smart agriculture big data platform

3.1 Infrastructure Layer

Infrastructure is a prerequisite for the operation of smart agriculture big data platform, including awareness system, network system, storage backup system, etc. The awareness system consists of two parts: data acquisition layer and device control terminal. The data acquisition layer is the primary pathway for environmental big data collection for smart agriculture Internet of Things. Temperature and humidity sensors, soil moisture monitors, meteorological monitoring facilities (see Fig2) and other sensors can be used to collect temperature, soil moisture, strength of illumination, carbon dioxide concentration and other information in the agricultural production process [9], and then the collected information is used in the previously set data format. According to the requirements of the standard data output, so as to achieve the connection between the terminal and the platform. When the data monitored by the sensor exceeds the set threshold, the controlled device of the terminal will make intelligent adjustment. The network system provides basic network environment, network capacity, and network performance support for systems at all levels by means of gateways, routing devices, and switching devices. The storage backup system include shared storage devices and distributed storage devices that provide various storage capabilities.

3.2 Network Transport Layer

The communication network is an important component of the smart agriculture big data platform, which can provide the corresponding data transmission environment for the big data platform based on different application scenarios, and ensure the network stability of the device connection. The upload and management of the data collected by the data acquisition layer cannot be separated from the network transport layer, which constitutes the iot network of the smart agriculture big data platform. The Internet of Things can monitor farmland by means of wireless communication technology, establish multiple sensor nodes, collect information in time, and realize fast, convenient and safe data transmission and exchange [10]. Using Bluetooth technology can carry out short-range data and voice transmission, build a comprehensive wireless communication system, low cost and easy migration. The backbone network of the network transport layer is mainly wired communication, and its signal strength is relatively stable, which is not susceptible to the external environment, and can ensure the reliability of network transmission. The network transmission layer manages the whole process of data collection, classification, and processing, which is the key point to the data flow of the smart agriculture big data platform.

Temperature and humidity sensor

Soil moisture monitor

Meteorological monitoring facility

Fig. 2. Sensor device

3.3 Platform Support Layer

The platform support layer is responsible for the construction of the basic architecture of the smart agriculture big data platform, and provides global and unified support services for the application systems of the platform, so that the application systems can achieve effective integration and collaboration. The platform support layer includes agricultural iot, data services and mobile application support. The agricultural Internet of Things platform can effectively integrate monitoring data analysis, standardized planting, agricultural geographic information system, etc., and then pass the processed data into the application service layer to achieve real-time interaction from the infrastructure layer to the application service layer, providing effective AI decision-making and AI analysis for the platform. Data service consists of two parts: data application support and data opening support. Data application support improves data security and privacy through standardized data management, and provides data in-

formation retrieval and data content retrieval services; Data opening supports the provision of data opening and sharing services to relevant agricultural departments and users with access rights, and the traceability and manageability of open data. Mobile application support can create a unified development framework, supporting the rapid customization and construction of various applications on the platform and ensuring their quality.

3.4 Application Service Layer

The application service layer is the terminal service provided by the smart agriculture big data platform, which is a part of the key system module, connecting the presentation module and the data module. The application service layer works on the basis of the data collection of the infrastructure layer and the integrated processing of the platform support layer to further analyze and mine the original data, so as to establish the corresponding model to guide the agricultural production decision. The application service layer can understand the user's requirements in real time when the user operates the data network, and transmit the requirements to the data information network. Users can view the environmental data and platform data of agricultural production through the display terminal of computer, mobile phone, tablet, etc., and make decisions according to the specific situation and their own needs. For example, users can understand the environmental information of greenhouses through the web page, and carry out remote control of lighting, water supply and other equipment according to different environments, so as to realize meteorological disaster monitoring, precise fertilization of crops and prevention and forecast of diseases and pests [11]. The application service layer extends the function of the web browser, supports a variety of user access methods, and provides services for agricultural production and agricultural product sales.

4 Function modules

4.1 User Management

The role of user management module is to manage the information related to users, including platform login function, rights management function and personalized customization function (see Fig3). The platform login function determines whether a user is eligible to log in according to the information about the user in the database and the user name and password entered by the user. A user's login goes through steps such as authentication, information matching, and error reporting. The rights management function verifies user rights during system operations and manages functions based on user requirements. The types of smart agriculture big data platform users are complex, and different user permissions are established and set for different users, and corresponding platform resources are opened. Personalized customization The Web-based management interface provides users with the information they care about by customizing views and contents, improving the efficiency of obtaining services and information.

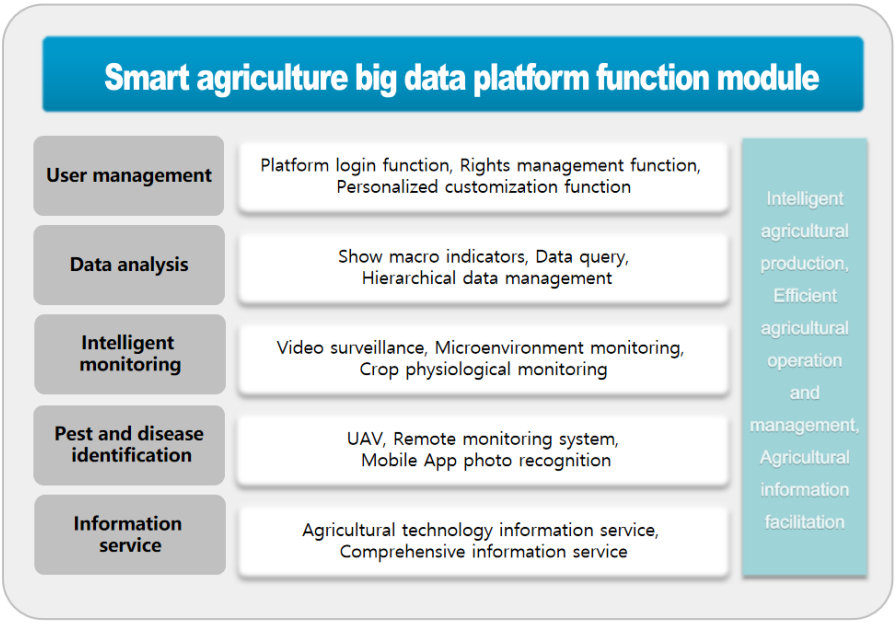

Fig. 3. Function module of smart agriculture big data platform

4.2 Data Analysis

All kinds of sensors and monitoring equipment will generate huge amounts of data when monitoring the agricultural production environment information in real time. The data analysis module builds on the visualization ability to collect and statistic the external temperature, humidity, soil moisture and insect situation of the region by means of data tables, graphs and column charts, providing data comparison function. In addition, the data analysis module will also display and classify the macro-important index parameters of each topic, such as agricultural population, agricultural natural resources, agricultural products related data, etc., and provide data holographic search query and timely query functions to show the collection and sharing output of all relevant data. Moreover, the data analysis module will be divided according to the sensitivity of the data content or the open scope of the data, build a sound data classification management system to ensure the data is used safely, and on the basis of integrating agricultural and rural big data resources, conduct data correlation analysis, monitoring and early warning analysis, etc., to provide managers with "one-stop" decision support.

4.3 Intelligent Monitoring

The intelligent monitoring module mainly includes video surveillance, microenvironment monitoring, crop physiological monitoring and so on. The video surveillance part collects farm scene image information through high-definition cameras [12] and

transmits the information to the Internet of Things cloud platform. The monitoring range of agricultural parks is large, and for more remote areas, the agricultural production environment can be comprehensively monitored in real time with 5G transmission technology, and at the same time, users can remotely view the situation on the spot through mobile phones and computers. The microenvironment monitoring part uses hardware facilities such as moisture sensors, insect monitoring lamps, and crop ecological monitors to help users timely grasp the growth of crops and cooperate with the pest identification module to monitor and warn the insect situation. The crop physiological monitoring part monitors the physiological indicators of crops for a long time to promote efficient and optimized management of agricultural production and improve crop quality.

4.4 Pest And Disease Identification

There are many kinds of diseases and pests, so the identification of diseases and pests is an important technology in crop planting, and early accurate identification of diseases and pests is the key to early warning and control. The pest and disease identification module collects image data by means of UAV, remote monitoring system, and mobile App photo recognition, and then compares the collected data with the relevant database of pest and disease information, and uploads it to the cloud server. When monitoring agricultural diseases and pests reach the control boundary point, the control system in the system will automatically start, while monitoring the control effect of diseases and pests, and close the prevention and control system when the control boundary point is stopped, so as to achieve continuous cyclic monitoring and control. With the help of the cloud image information base and AI analysis function of the module, combined with the remote diagnosis consultation of experts, it can not only accurately diagnose and identify diseases and pests, but also prevent diseases and pests in advance.

4.5 Information Service

The information service module includes agricultural technology information service and comprehensive information service. Agricultural technology information service aims to offer users various types of agricultural skills training information and knowledge exchange interactive information, including agricultural planting technology, breeding technology, agricultural engineering technology, biological technology for the agricultural pest and disease prediction and control, as well as all kinds of scientific research dynamic information, scientific research results information, literature database information. Users can also participate in relevant online courses, and carry out interactive questions and answers on agriculture-related knowledge through mobile networks and computer networks. The comprehensive information service includes all kinds of agricultural news information, national policies and regulations information, agricultural economic production information, crop variety information, agricultural market information, meteorological service information and agricultural life information.

5 Platform test and analysis

By testing the functions achieved by the smart agriculture big data platform, the reliability, stability and ease of use of the platform functions are verified. The typical functional tests are shown as follows (see Tables 1 to 3):

5.1 User management test

Table 1. User management test

Test module	User management
Test function	platform login
Test content	enter the correct and wrong account password respectively to log in; register a new user
Test results	enter the correct information to enter the platform normally, and any wrong account password can not log in; new users can successfully log in to the platform after registration
Test conclusion	The test result is consistent with the expected target, and the test passes.

5.2 Data analysis test

Table 2. Data analysis test

Test module	Data analysis
Test function	data query and data visualization
Test content	enter the region, time, indicators and other conditions, query the specified information; select the desired data and the corresponding chart style to present the results of the data analysis
Test results	required data successfully query, and real-time update; display the query data in bar chart form
Test conclusion	The test result is consistent with the expected target, and the test passes.

5.3 Intelligent monitoring test

Table 3. Intelligent monitoring test

Test module	Intelligent monitoring
Test function	video surveillance, crop physiological monitoring
Test content	remote monitoring of the agricultural park, view the on-site production; observe the growth of crops and check their physiological indicators
Test results	by clicking the system platform video monitoring button, you can remotely monitor the scene; through the platform page, you can view the collected crop pictures and analyze the growth information
Test conclusion	The test result is consistent with the expected target, and the test passes.

6 Conclusion

The rise of a new generation of information technology has triggered a new agricultural revolution, smart agriculture, which has a great influence to change in the way of agricultural production and is an essential driver to achieve high-quality agricultural development. The application of technologies such as the Internet of Things and cloud computing provides strong technical support for agricultural production, which not only helps promote rural revitalization, but also meets the needs of agricultural and rural modernization. The smart agriculture big data platform based on the Internet of Things can strengthen the deep integration of big data and rural revitalization, and promote intelligent agricultural production, efficient agricultural operation and management, and convenient agricultural information. On the basis of an analysis of the importance of agricultural big data and the Internet of Things, this paper discusses the framework of smart agricultural big data platform based on the Internet of Things, and designs the corresponding module functions, with a view to promoting rural economic development and social progress through the consolidation and sharing of agricultural and rural information data resources.

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