Research on Precision Planting Management System Based on Agricultural Big Data

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Abstract. Through the use of agricultural intelligent sensing equipment and intelligent control equipment, the precision planting management system builds the Internet of Things monitoring network in the agricultural production site to realize real-time data collection, monitoring of the climate environment, soil conditions, crop growth, pests and diseases, and remote automation control of various agricultural facilities and equipment on the site. The collected agricultural big data is uploaded to the planting management cloud platform in real time, and statistical analysis is performed instantly, which addresses the staff's demand for data collection and analysis. Through data mining and analysis, the rules and expertise of high-quality and high-yield crops are obtained, which further guides the regulation of agricultural varieties and production environment, so as to achieve intelligent planting.

1. Introduction
With the development of information technology, intelligent agricultural technology, which combines Internet of Things and cloud platform, has been widely used in various fields of agricultural production, and has achieved obvious economic and social benefits. In the process of agricultural production and development, the Internet of things technology is to install high-performance intelligent sensors and high-performance integrated controllers in the planting area of crops, which can effectively collect more information data such as air humidity, soil humidity, sunlight intensity, needed for the growth of crops. Through data mining and analysis, the rules and expertise of high-quality and high-yield crops are obtained, which further guides the regulation of agricultural varieties and production environment, so as to achieve intelligent planting. Based on the above analysis, this paper proposes a precision planting management system based on big data analysis of agricultural planting to solve the problem of data analysis and intelligent control in agricultural planting.

2. Functions and principles of the precision planting management system
2.1. Functions of the precision planting management system
China has abundant agricultural resources. In traditional planting, the growth a large number of agricultural products is generally dependent on the continuous usage of pesticides and chemical fertilizers. However, most of the fertilizers and water resources have not been effectively utilized, resulting in a large amount of waste of water resources and other energy sources. In particular, the improper use of some fertilizers will also cause different degrees of pollution to the local ecological environment [1]. Through wireless sensors for light, temperature, humidity and sunshine hours, the precision planting application system collects and analyzes the environmental parameters of light intensity, air and soil temperature, air and soil humidity and sunshine hours of the planting
environment of crops in real time. According to the analysis results, the system can automatically turn on or off specified equipment (such as remote control irrigators, roller shutters). At the same time, cameras and other surveillance equipment are installed in the greenhouse to collect video signals in a timely manner. Through computers or 4G mobile phones, users can observe the site conditions, view the site temperature and humidity data, and realize remote control and intelligent adjustment of specified equipment whenever and wherever possible [2]. The main functions of the system are as follows:

2.1.1. On-site data monitoring of the planting environment. The information system collects and analyzes the sensor data collected in each plot, and analyzes and processes the parameters collected in real-time, including air temperature, air humidity, light intensity, soil temperature, soil humidity, and sunshine hours in the greenhouse, which are displayed to users in the form of intuitive charts and curves.

2.1.2. Early warning of planting. By setting thresholds of various sensor data in the system, such as temperature and humidity, the system can provide early warning when the thresholds are exceeded, and send the early warning information to users through various channels.

2.1.3. Planting video surveillance. In the system, the video surveillance images of the plots with video equipment can be viewed in real time, and the high-definition spherical camera can be rotated to capture multi-angle video images.

2.1.4. Equipment management. Through the information system, the current running status of all automation equipment can be monitored and remote automation control and management can be performed. Remote automation control of the planting equipment is realized through clicking on the system button and mouse operation, such as turning on the fan for ventilation and cooling, opening the roller blind for sunshade, unfolding the insulation film, etc.

2.1.5. Data query. The real-time planting data information can be viewed, including plot number, plant variety, air temperature and humidity, light intensity, soil temperature and humidity, and sunshine hours. The data can be queried, screened and filtered by plot number, planting variety, etc.

2.1.6. Planting analysis. Comparative analysis of the obtained planting data is carried out, including comparison of the growth rate and status of vegetables of the same plots in different time periods and analysis on the impact of environmental factors on the growth and yield of vegetables, so as to achieve scientific and cost efficient planting and increase the yield and quality of planting.

2.1.7. Tabulate statistics. The statistics are presented in the form of a report. The data related to planting is analyzed according to different dimensions, including greenhouse, variety, environmental parameters, etc., and is exported as an Excel file.

2.2. Working principles of precision planting management system

The system portal mainly consists of two parts. The first is a video management and surveillance module, which mainly monitors video images of each plot. On the one hand, it can meet the needs for day-to-day surveillance. On the other hand, it can connect with remote experts to provide guidance. The experts can view the growth of greenhouse vegetables and diseases and insect pests online in real time for remote diagnosis and decision-making. If rotary ball-head cameras are installed, the system can view the planting situation of each plot and area in real time through PTZ, and can also query the historical video information. The second is the intelligent management module of crop planting, which mainly collects and monitors the real-time sensor data of multiple environmental parameters of each plot, and these data parameters are analyzed for early warning. In the event that an early warning is
sent out, the staff will be informed by system messages or mobile phone messages to manually control the irrigation, ventilation and other automation equipment for environmental management, or the automation equipment will be triggered to adjust accordingly by the automation adjustment threshold set in the system. For example, if the maximum threshold of the greenhouse temperature is exceeded, the system will automatically start the fan for ventilation and cooling. The operating principle of the system is shown in Figure 1:

3. Architecture of precision planting management system for agricultural products

With the continuous and rapid development of Internet information technology, more and more sensor information technology, modern communication technology and computer information technology can be highly integrated to form wireless sensors. Among them, network information technology is an innovative technology, in which there are usually many low-power intelligent sensor nodes. To some extent, these nodes can perform real-time monitoring collaboratively, perceive the information of various environmental objects, and carry out comprehensive analysis and processing to obtain more accurate data information [3]. In order to ensure that the above functions can be achieved, this paper designs and proposes an integrated management system which is composed of a WSN sensing layer, a data transmission layer and an application layer. The functions of each layer are independent, and the layers are connected through software interfaces [4]. The architecture of the precision planting management system is shown in Figure 2.

3.1. Sensing layer

The sensing layer is responsible for the collection of environmental information and irrigation control, and the sensor node composed of coordinator and router is responsible for the monitoring of air temperature and humidity, soil moisture, carbon dioxide, illumination and other agricultural information, which is collected and transmitted to the gateway. Through the Internet, producers and technical researchers can monitor the collected agricultural information whenever and wherever possible, and track the growth of crops in real time. Once there is a difference between the

![Figure 1 Schematic diagram of agricultural precision planting management system](image-url)
environmental data and the preset parameter values suitable for the growth of agricultural products, the system will automatically alert and turn on the corresponding equipment to adjust. For example, the shading equipment will be turned on when the light is too strong [5].

3.2. Transmission layer
The transmission layer is responsible for the transmission of various types of data, which consists of ZigBee module, GPRS and the Internet. The main function of this layer is to effectively and quickly transfer the collected information to the processing layer by using wireless sensor information technology and ZigBee technology. Under normal circumstances, the wireless sensor information network is composed of a large number of miniature sensors deployed within the detection range, and the function of network transmission is realized through wireless information technology.

3.3. Application layer
The application layer is responsible for data storage, statistics, analysis and graphical display, and carries out decision-making and automatic control according to farmland environmental information. It is mainly composed of a database and background data processing software. In the application layer, the production and development of crops and the change of the natural environment will be reflected in the user's operating terminal in the shortest possible time for the user to view at any time and place. In this way, users can respond correctly according to different situations, and then give proper instructions to the intelligent control and integrated information system through the decision-making layer, so as to realize the remote management and control of the entire process of crop growth [6].

Figure 2 Architecture of the precision management system for agricultural products

4. Big data processing mechanism in the planting management system
Traditional agricultural cultivation mainly relies on the past experience of fertilization and irrigation, which not only causes a lot of waste in human and material resources to a certain extent, but also poses a great threat to the ecological environment protection and the integrity of soil and water, and brings great pressure and challenge to the sustainable stability and development of agriculture. If the Internet of Things technology is introduced in the agricultural production process, more data related to crop
growth can be collected, and real-time monitoring and analysis of the information of various crops can be performed in a relatively short period of time. Intelligent irrigation, intelligent fertilization, and intelligent spraying of farmland can be effectively realized through data mining and construction of professional domain knowledge base, so as to effectively achieve intelligent agricultural production [7].

4.1. Data collection
The data to be collected by the planting management system mainly includes the data of agricultural natural resources and environment, and the data of agricultural planting production. Among them, the data of agricultural natural resources and environment mainly includes the data related to land resources, water resources, meteorological resources, biological resources and disasters, while the data of agricultural production mainly includes the information of improved varieties, historical information of plot cultivation, seedling information, sowing information, information of farm chemicals and fertilizers, information of agricultural film, irrigation information, information of farm machinery and information of crop conditions [8] [9].

4.2. Data preprocessing
The collected data should be pre-processed, which includes data update, analysis, cleaning, integration and storage. The original data collected through various channels is incomplete, inconsistent or noisy. Therefore, it is necessary to use algorithm engine to clean, integrate, transform and reduce the original data before data mining and analysis, which is because only high-quality data can ensure high-quality knowledge acquisition of the client. Through data preprocessing, two different subject-oriented data warehouses are formed, including a data warehouse of planting environment and a data warehouse of planting process.

4.3. Knowledge base construction
The construction of knowledge base is the core in the entire process of big data processing. The big data analysis includes the construction of key index systems for agricultural products cultivation, analysis of planting processes and algorithm implementation, and analysis of the impact of environmental data on the quality of agricultural products. Through the analysis of key data in the planting process, a preliminary index system for planting management is established. Mathematical statistics, artificial neural network, rough set and other algorithms are used to screen the indices, and then obtain a refined index system after dimension reduction. On this basis, data mining is performed on different subject-oriented data warehouses, and corresponding rules and knowledge are extracted to form an expert knowledge base, a domain knowledge base, an algorithm knowledge base, and a matching rule base.

4.4. Release of service application
In the service application release layer, various users can manage and control the planting process through the system portal. The expert knowledge base provides a clear knowledge map. Experts can perform remote diagnosis and propose scientific planting standards and schemes for specific planting scenarios. The system uses adaptive learning algorithms such as artificial neural network for data mining to obtain the corresponding relationship between quality and planting environment of specific varieties, and save the information in the knowledge base as specific rules and patterns. At the same time, the embedded hardware is used to realize the intervention of the planting process, so as to ensure the appropriate state of the planting environment. Data mining of the intelligent planting management system will cover the design of perceptron and the realization of adaptive learning algorithm.
5. Conclusion
Agricultural production is an integrated production process. Therefore, sufficient information should be collected for the determination of the optimal growth conditions. The Internet of Things information technology based on wireless sensor network technology serves to facilitate the informationization, intellectualization and networking of agriculture to some extent. The application of Internet of Things integrated information technology in intelligent agriculture can effectively promote the level of agricultural modernization and intelligence to a certain extent, and thus making the operation of agricultural system more intelligent, so that the competitiveness of agricultural products can be further enhanced, rural revitalization can be realized, and the goal for sustainable development of environmentally-friendly agriculture can be achieved.

Acknowledgments
This research was supported by Scientific Research Grant of Guangdong Province(2017A020208007) and Scientific Research Grant of Qingyuan City(2015A005).

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