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Design of Wine Grape Mobile Terminal Scheduling Platform Architecture Based on IOT

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Abstract. At present, China is in the initial stage of the modernization of agriculture 4.0. How to use science and technology to improve the combination of agricultural machinery and agronomy, speeding up the construction of agricultural information technology is the core issue that agricultural production enterprises focus on at the present stage. Therefore, on the basis of analyzing the current situation of agricultural machinery operation in wine grape producing areas, this paper sorted out and studied the literature from three aspects: intelligent scheduling algorithm and intelligent scheduling platform of agricultural machinery equipment and the application of Internet of Things technology in scheduling platform, putting forward a kind of wine grape farm machinery equipment based on IOT moving with intelligent dispatching platform architecture design.

1. Introduction

China is a typical country of agricultural production. The construction of agricultural science and technology which is closely related to people's life has been attached great importance by the Chinese government. In recent years, with the rapid development of forestry and fruit industry, wine grapes, as raw materials for wine, have become a new direction of development and have great potential for the improvement of people's living standards. At present, the degree of mechanization in wine grape producing areas is relatively high, and the whole process of mechanization can be realized in production operations. However, there are still many problems in the production operation. For example, most of the agricultural machinery and equipment are mainly arranged by manual operation, the scheduling efficiency of agricultural machinery and equipment is low, and the resources of agricultural machinery and equipment are far from meeting the needs of farmer. In the process of wine grape cultivation, due to its large planting area and extensive mechanical operation methods, the operation quality is not high, and the evaluation standards of operation quality are different, so that it is difficult to have a unified regulation. The management and dispatching of wine-grape related agricultural machinery and equipment are mainly PC, which requires high technical requirements for dispatching personnel, and the operation of platform is not convenient enough. These problems have caused a large amount of unnecessary waste of resources in the production, so that it is difficult to achieve a breakthrough in industrial benefits, which seriously hinders the further development of China's wine industry.

In order to realize the industry informatization of wine grape, it is a new approach to build a mobile terminal scheduling platform for wine grape agricultural machinery equipment based on the IOT. In recent years, although many domestic and foreign scholars have carried out extensive research on the technical feasibility and scheme design of agricultural machinery and equipment dispatching platform, most of the scholars' research has been carried out in greenhouse rather than open-air field operation, and the research has great limitations. The scheduling platform proposed in this paper will combine IOT



technology to realize the intelligent scheduling of agricultural machinery in open-air fields. It is different from the research direction of previous scholars. The scheduling platform of open-air fields operation is applicable to a wider range, not only to the production of wine grapes, but also to the planting products in other open-air fields. In addition, the mobile platform is easier to learn than the traditional PC end, which is easy to operate and inexpensive, which is beneficial to the acceptance of farmers.

Therefore, this paper is intended to build the system framework of the mobile terminal control system of the farm machine equipment based on IOT. This platform can easily check the growth and development of wine grapes in the field through the mobile devices of the IOT terminal, finding the demand of wine grapes for agricultural activities such as raising and burying vines in time. After that, the platform will conduct real-time scheduling of agricultural machinery and equipment to ensure the survival rate and yield of wine grapes, so as to seek a breakthrough in industrial benefits. The system framework proposed in this paper will put forward a new direction for the application of the IOT technology in Smart Agriculture, providing a theoretical basis and reference experience for the combined design of IOT technology and the agricultural machinery scheduling platform. Thus, it can be promoted to a wider range of agricultural applications and contribute to the construction of China's modern agriculture 4.0.

2. Present Situation of Agricultural Machinery Application in Wine Grape Production

Nowadays, China is in agriculture 3.0 to agricultural 4.0 ahead of the modernization of the agricultural stage, how to enhance the level of agricultural machinery agronomic combined with modern science and technology, speeding up the agricultural informatization construction is one of the problems in present agricultural production enterprises to focus on. Wine grape fruit production in China as an important fruit and vegetable varieties, always attaches great importance to by the state government. China's grape-growing area of 855,000 hectares ranks second in the world, after Spain. At present, the whole region of Ningxia grape planting area of more than 600,000 acres, accounting for 1/4 of the country, is the country's largest concentrated wine grape production area^[1]. Among them, wine grapes are 370,000 acres, and the planting area is still rising steadily, accounting for 3.4% of the national grape planting area of 12.975 million acres. With the improvement of people's living quality, it is difficult to meet the domestic demand for wine, and the production of wine grapes is directly related to the production and quality of wine in China, so to accelerate the promotion of wine grape production in China is a top priority for the development of wine industry.

As for the production operations of wine grapes, the whole mechanized production of wine grapes has been realized from seed transportation, farmland fertilization, weeding and pruning, vine raising and vine burying, etc. Among them, six types of large-scale agricultural machinery are mainly involved: tractor, rattan hoist, pruning machine, weeding machine, application machine and rattan burying machine, which basically cover four wine-grape planting processes: seed and product transportation, rattan hoist, weeding and pruning operation and plant protection operation. Although mechanized operation has been basically realized at the present stage, there are still three problems in the process of production and operation:

- (1) Low quality of operation: Wine grape planting area is large, and agricultural machinery equipment and machinery operation methods are mostly extensive, so the quality of operation is generally not high. More importantly, the assessment criteria for the quality of the work are different, and there is almost no post-evaluation of the grape work.
- (2) Low scheduling efficiency: Agricultural machinery and equipment dispatching still takes manual dispatching as the core, so the dispatching cycle is long. The technical level of the dispatcher is high, which leads to low scheduling efficiency, which seriously affects the completion speed of the work.
- (3) Difficulty in platform operation: The management and scheduling of wine-grape related agricultural machinery and equipment are mainly PC terminal, which makes it difficult for farmers to operate the platform.

3. Literature Review and Problem Identification of Wine Grape Agricultural Machinery Scheduling Platform

3.1. Research on the Application of Agricultural Machinery and Equipment Scheduling Algorithm

With the continuous development of science and technology, the technology of vehicle navigation and dispatching in China is becoming more and more mature, but the research and application development of agricultural machinery and equipment is still relatively slow. However, with the advent of the era of Agriculture 4.0, the continuous proposal of smart agriculture has led more and more domestic scholars to embark on the field of agricultural machinery and equipment scheduling and conduct a lot of exploration and research. Jawarneh S et al. (2015) established a path planning model with a time window for fleet service in their article "A Sequential Insertion Heuristic Algorithm for Adaptive Bee Colony Optimization for Vehicle Routing Problem with Time Windows" ^[2], used the colony optimization algorithm to solve the problem, and verified the effectiveness and robustness of the algorithm. Kang Kang et al. (2018) established a monitoring system for agricultural machinery and equipment based on the IOT in their article "Monitoring System for Mobile Agricultural Machinery and Equipment Based on the IOT" ^[3], issued scheduling orders for agricultural machinery and equipment through communication network, drawing running routes of agricultural machinery and equipment on the basis of monitoring. With the in-depth study of the algorithm, many domestic scholars began to use heuristic algorithm to solve the problem of agricultural machinery scheduling, trying to improve the existing algorithm to start the scheduling of agricultural equipment. Qiang Yao et al. (2018) established a mathematical model for the service cost and dynamic change of agricultural machinery based on 3S technology in the article "Design of Agricultural Machinery Scheduling Algorithm Based on 3S" ^[4], using genetic algorithm to solve the problem. It also improved the scheduling efficiency through continuous improvement and innovation.

3.2. Research on Agricultural Machinery and Equipment Scheduling Platform

The dispatching platform of agricultural machinery and equipment can manage agricultural machinery and equipment in a low cost and scientific way, match agricultural machinery and equipment and operations with high efficiency, and play a positive role in promoting agricultural mechanization and decision-making management of agricultural operations. The functions of the dispatching platform are generally divided into two levels: management and control. Management refers to the input and exit of equipment, location positioning, whether it works, etc., while control refers to the intelligent dispatching of agricultural machinery and equipment, reasonable arrangement of paths, and efficient operation. Domestic and foreign scholars and practical enterprises have carried out active research and exploration around the agricultural machinery and equipment scheduling platform. Sichonany O R D O, Schlosser J F et al. (2011) established a set of decision support platform in "Management of Computer System for Performance Monitoring of Agricultural Machinery Sensor" ^[5], which can monitor agricultural machinery performance, real-time access, dynamic storage data and other features in real time. IT can greatly help farmers and operators to make operation decisions and improve operation efficiency. In the design of cotton picker geographic location information service system based on Google Maps ^[6], Mengna Chen et al. (2013) developed a geographic location service platform for cotton picker by using Google Maps and combining GPS and database technology to carry out real-time positioning and path navigation of cotton picker. 2015 years later, the domestic scholars began to move the wisdom agriculture, agricultural research, appearing a number of typical agricultural machinery management software, such as agricultural machinery helper, farmer's housekeeper. These emergences of the Internet agricultural software to a certain extent, promoted the development of the domestic agricultural machinery equipment operation platform. However, on the platform of the scheduling control, such as intelligent scheduling and efficiency calculation, related research is less.

3.3. Research on the Application of IOT Technology in Scheduling Platform

Domestic and foreign scholars have made in-depth studies on the combination of the IOT and the scheduling platform of agricultural machinery and equipment, achieving good results. Abagissa A T (2018) in "intelligent agricultural equipment control system based on IOT" ^[7] proposed a kind of

intelligent agricultural equipment control platform based on IOT, using the Arduino Mega integrated agricultural knowledge and GSM module, monitor and control all necessary activities during cultivation administrator can obtain related Suggestions from the system, finally can scientific effectively guide agricultural production. However, most of the IOT technology is mainly used in greenhouses, such as Yuling Wan (2020) on the IOT of agriculture oil beans grown in the greenhouse technology analysis, the application of "[8]" in the specific analysis of the oil string beans growth stage, realized the IOT control of greenhouse environment on the basis of the corresponding oil beans growth stages of environmental factors on various aspects of adjustment are introduced, reflected on the IOT grow in the greenhouse resources utilization efficiency and accurate advantages, promote the application of the IOT in terms of farming. It is not difficult to see that most of the indicators in the greenhouse are controllable, and the equipment deployment is more convenient than that in the outdoor environment. Therefore, most of the researches of scholars start in the greenhouse, and there are few researches on the deployment of the IOT technology in the field operation. With the popularity of mobile terminal devices, it will be a new trend to set up a scheduling platform using mobile terminal. For example, Wenchao Ye (2019) designed an agricultural machinery scheduling and management platform based on Android in the article Design and Application of Agricultural Machinery Scheduling and Management Platform [9], which realized the data collection, management and scheduling of agricultural machinery and equipment. The platform provides data sharing and scheduling management for agricultural machinery, farmland owners and management departments, but lacking the design of intelligent scheduling path optimization for agricultural machinery and equipment, so there is still room for progress.

Through literature review, it can be found that many scholars have started to study the intelligent scheduling of agricultural machinery and equipment, mobile terminal scheduling platform and IOT scheduling platform, achieving remarkable results in these aspects. However, the application of IOT technology in agricultural machinery scheduling is not wide enough. There are few studies on the management of agricultural machinery and equipment of wine grape. Although the application of all aspects of the IOT has become mature, the application of advanced technologies and methods such as integrated IOT, cloud computing and big data processing technology in the intelligent agricultural mechanized scheduling platform of wine grape is still lacking. Researchers have paid more attention to the management functions of the dispatching platform, such as the information collection and storage of the equipment, while ignoring the control problems such as the intelligent dispatching path optimization of agricultural machinery and equipment. There are many methods to collect the position positioning, working state and body condition of agricultural machinery and equipment in the field. However, there is still much room for progress in how to use the information collected from the field to schedule agricultural machinery and equipment, arrange the moving path of agricultural machinery and equipment, and improve the time and space efficiency of equipment. In addition, the scheduling platform of wine grape agricultural machinery equipment is mainly PC terminal, and the development of mobile terminal platform will be a new idea. Compared with the traditional PC terminal, the mobile terminal operating platform is easy to operate and easy to learn. With the constant updating and iteration of mobile phones, the research and development and application of mobile terminal platform will be the development trend of scheduling platform, and will also be an important carrier for the next implementation of smart agriculture.

4. Preliminary Design of Wine Grape Agricultural Machinery Scheduling Platform Architecture Based on IOT

The completion of this intelligent dispatching platform design is based on the agricultural equipment scheduling platform on the functional architecture, mainly take the wine grape agricultural operation mechanism for scheduling platform design. Due to scheduling environment requirements and the agriculture in agricultural machinery scheduling tasks is different, the architecture of this platform design made the necessity of functional design, only in the vineyards of farm machinery equipment from the hangar to various fields of intelligent scheduling and between the various fields of agricultural equipment scheduling as the research core, specific design based on Internet of wine grape agricultural equipment mobile end scheduling platform architecture diagram, as shown in figure 1.

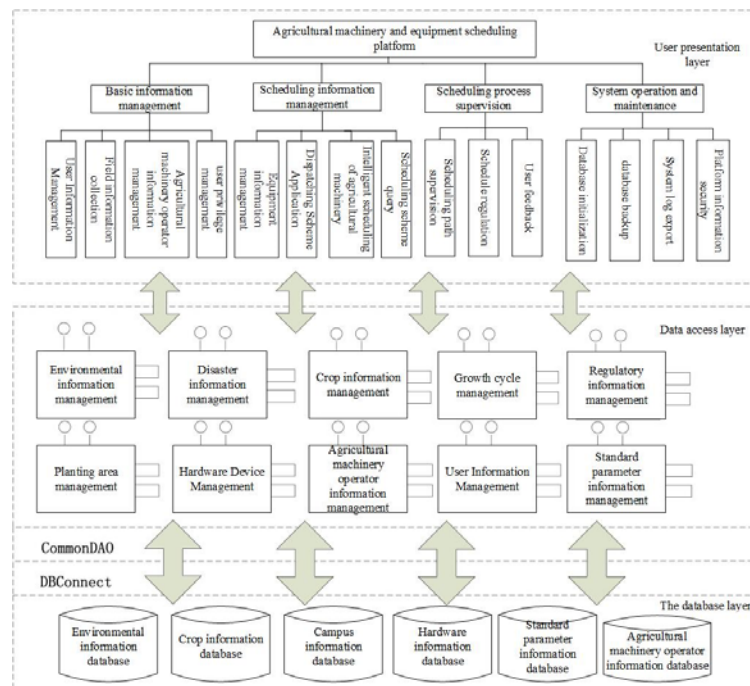


Figure 1. Platform architecture design diagram.

The intelligent dispatching platform of the mobile terminal of wine-grape agricultural machinery equipment is divided into three layers from top to bottom, among which the core of the system is the data access layer located in the centre. The platform uses ADO.NET component to access and operate the database data through SSM framework. The data information section involved in the system will be stored in 10 types of data information tables respectively.

Database layer is used to store data encapsulation, the key to the system according to the data acquisition module and categories, using good encapsulation of the MySQL database, summarize and design environmental information, crop information, campus information, hardware information, standard parameter information and operator information involved a total of six database storage system operation data.

The user presentation layer is the human-machine interface that the user interacts with the system, including the farmers, farm operators and platform administrators using the system. The user presentation layer realizes the intelligent scheduling of agricultural machinery and equipment through the system, and the communication between users, administrators and agricultural machinery operators. The platform adopts the visual interface realized by programming language and encapsulated into the mobile APP to realize convenient intelligent scheduling of agricultural machinery and equipment.

The main function of the system is divided into four modules, which are basic information management, scheduling information management, operation process supervision, system operation and maintenance. There are 15 functional sub-modules designed.

(1) Basic data management: The basic information management function in this module will store the user account, password, real name and other basic user information. The field information collection function can collect field information such as field humidity, temperature and number of weeds. Agricultural Machinery Information Management Store the basic information of agricultural machinery. The user rights management function is responsible for setting the rights of administrators and ordinary users.

(2) Dispatching information management: This module is responsible for collecting and storing agricultural machinery equipment information, such as brand and model, whether it can be used or not. Users can take the initiative to apply for scheduling of agricultural machinery and equipment in this module. The platform will intelligently generate the scheduling path of agricultural machinery equipment based on genetic algorithm. The administrator can query the historical scheduling information record and the backtracking scheduling scheme.

(3) Dispatching process supervision: This module will monitor the equipment scheduling path and give an early warning when the scheduling route of agricultural machinery equipment deviates. Users can give feedback in this module, and score and evaluate the implementation scheduling scheme.

(4) System operation: The function of this module can be roughly divided into three parts. The first is to initialize, backup the platform, export the system operation log and other daily maintenance functions. The second is to conduct visual report analysis on the data and make use of the feedback of users to timely improve the deficiencies of the platform. The third is to ensure data security. This module will store the verification function for user login. At the same time, the module will monitor the data in the database to prevent malicious tampering or information leakage.

The platform collects field information with the sensor of the IOT terminal and transmits data to the cloud platform through the 4G network. The cloud server determines the basic intelligent scheduling scheme through cloud computing, and then downloads it to the corresponding agricultural machinery and equipment to realize the intelligent scheduling. The system architecture is shown in figure 2.

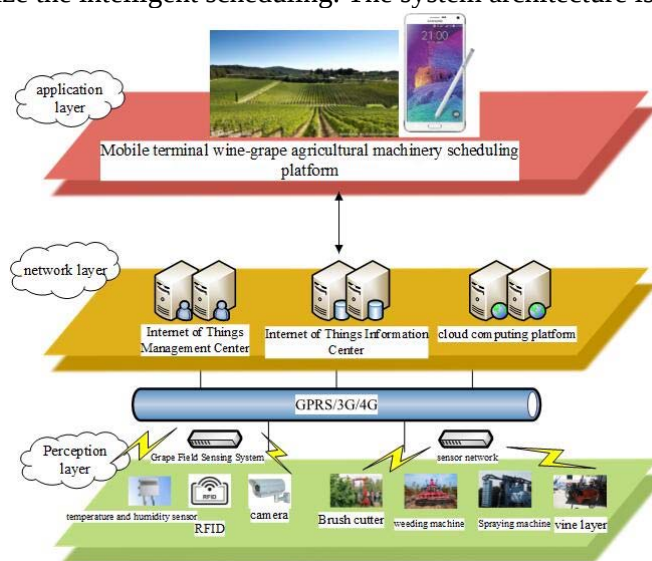


Figure 2. System architecture diagram.

Perception layer: this layer uses the basic sensor equipment of the Internet of Things, such as temperature and humidity sensor, monitoring camera, etc., to monitor the growth of wine grapes in the field in real time, and then uses the sensor array of agricultural machinery equipment to collect the position and state information of the equipment. Through GPRS, 3G and 4G mobile networks, such information is transmitted to the cloud server at the network layer.

Network layer: This layer will receive the information collected by the awareness layer, collect and uniformly manage it on the server side. After the cloud computing platform selects the appropriate scheduling scheme, the platform uses genetic algorithm and round-robin search algorithm to solve the scheduling problem of agricultural machinery, constructs the scheduling model of wine grape agricultural machinery and equipment, and plans the optimal path. The evaluation and supervision of agricultural machinery operation quality and capability through big data analysis can lay a foundation for further agricultural machinery and equipment scheduling. The platform uses the collected data to determine different priorities, determine the processing order of scheduling, and call up the remaining amount of agricultural machinery and equipment from the cloud database, so as to schedule appropriate equipment according to the distance, machine state, etc.

Application layer: this layer is responsible for classifying the scheduling information to the mobile terminal wine grape scheduling platform. The general plan of dispatching, type of agricultural machinery and equipment, operation of agricultural machinery and the current operation situation will be passed to User Port where the farmer is. The location and specific scheduling plan of agricultural machinery and equipment will be transmitted to the client where the agricultural machinery operator is located. At the same time, a dialog window is established to ensure the real-time communication

between the two parties. At the end of a production job, the evaluation and feedback functions will provide lessons learned for the next dispatch.

5. Application Prospects of Wine Grape Agricultural Machinery Scheduling Platform Based on IOT

The development of agricultural industry in Modern Agriculture 4.0 is based on the concept of diversified agricultural resource endowments, diversified industrial types and numerous agricultural practitioners in China. Starting from China's national conditions and agricultural conditions, agricultural industry has a bright future. It is very important for China's agricultural development to realize this point. Wine grape, as an important fruit and vegetable variety in China's forest and fruit industry, will become an opportunity to promote the wine industry, one of the characteristic industries in China, to the world. By building a wine grape farm machinery equipment based on IOT intelligent dispatching platform, can meet the farmers demand for wine grape agricultural equipment scheduling, strengthen the communication link between farmers and farm machinery operators, so as to improve the utilization efficiency of agricultural machinery equipment, the quality of operation of wine grape production, achieving the purpose of promoting the value of wine grape production.

The mobile terminal research and development of wine-grape agricultural machinery scheduling platform based on IOT will provide experience and ideas for the application of the IOT in agricultural machinery scheduling, so as to implement agricultural informatization and intelligent construction. Nevertheless, due to the particularity of the terrain in Ningxia wine grape producing area, the intelligent scheduling of agricultural machinery equipment under different operating conditions still has uncertainty and non-universality. Therefore, the following research still needs more in-depth analysis and targeted discussion, so as to promote this platform to a wider range of agricultural applications.

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