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CULTIVATING EFFICIENCY: HOW MECHANICAL AND ELECTRONIC ENGINEERING DRIVE SMART FARM EQUIPMENT

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Abstract:
In recent years, with the rapid development of new information technology, western countries have begun to implement precision agriculture, combining agricultural production with information technology, and agricultural informatization has entered a new era of development. China has also introduced a set of policies to promote the development of agricultural production and agricultural machinery service management in the direction of intelligence, digitization, and scientificity. This article explores the construction of an intelligent agricultural machinery comprehensive service system based on the 3S architecture. This article aims to study the establishment of a smart agricultural machinery integrated service system based on the 3S framework. The experimental results show that when the concurrency is 100, the average response time is 236ms, the maximum response time is 698ms, and the minimum response time is 178ms. Therefore, this system has improved the agricultural machinery information service management and decision support system, and strengthened the macro regulation and micro guidance of modern agricultural production.

Keywords: Control Engineering, Agricultural Machinery Integration, Mechanical and Electronic Engineering, 3S Integration Framework.

1. Introduction

The development of science and technology has accelerated the intelligent and automatic process of agricultural production, and also made machinery and Electronic engineering gradually develop in the direction of intelligence and automation, which makes the demand and demand for control technology constantly increase. There is a complementary relationship between Control engineering and mechanical Electronic engineering. The development of both can not only promote the rapid development of mechanical Electronic engineering, but also provide more possibilities and development directions for it. Therefore, this article conducts research on the implementation of intelligent agricultural machinery integration system, focusing on exploring the application methods of 3S integration framework, WebGIS and other related technologies in intelligent agricultural machinery, with the core of building 3S technology and the goal of building an agricultural machinery service management integration platform under WebGIS architecture. At the same time, in response to the newly proposed concepts in the computer field such as the Internet of Things, cloud computing, B2C e-commerce mode, how to apply them in intelligent agricultural machinery and integrate them into the 3s technology framework, in order to better utilize their own advantages, establish a series of technical framework models, and quickly develop a stable and powerful intelligent agricultural machinery integration system.

The innovative application of mechanical engineering in agricultural machinery integration is one of the current research hotspots, among which Sun Wei's goal is to focus on developing an integrated device for self-cleaning air filters of agricultural machinery air conditioning condensers, which can effectively solve the air cooling problem of agricultural machinery condensers caused by poor working conditions. Agricultural machinery and air conditioning condensers are prone to blockage by dust, pests, weeds, etc., resulting in poor heat dissipation and frequent malfunctions. To save resources, improve economic efficiency, adapt to agricultural structural adjustment, and improve the technical level of agricultural environmental protection equipment [1]. Pimonratanakan Sudarat's research adopts quantitative and qualitative research methods. Quantitative research was used to investigate the reasons and Relations of production of agricultural machinery business [2]. Abuselidze George proposed that the current situation requires manufacturers to focus their agricultural machinery activities on long-term profits and business efficiency [3]. Tian Hongkun believes that in the future, computer vision technology would be combined with intelligent technologies such as deep learning technology, applied to all aspects of agricultural production management based on large-scale datasets, and more widely applied to solve all aspects of agricultural production management. To solve current agricultural problems and better improve the economic, universal, and robust performance of agricultural automation systems, thereby promoting the development of agricultural automation equipment and systems towards a more intelligent direction [4]. However, due to insufficient data sources, the above research is only in the theoretical stage and lacks practical significance.

After consulting a large number of literatures, this paper studies and analyzes the Internet of Things, cloud computing, B2C mode and 3S (Integration Of Gps, Rs And Gis Technology) integration technology, and integrates these Technological convergence together, thus finding a basic framework model suitable for intelligent agricultural machinery integrated system [5-6]. Based on 3S technology and the software requirements of the system, the design of the system's structural system, functional modules, performance indicators, workflow, and database was ultimately achieved. The system's structural system, functional modules, performance indicators, workflow, and database were selected, and related software development techniques were used to carry out research and development work.

2. Design and Smart Electromechanical Systems in Agricultural Machinery Integration

2.1. Overall System Design

From the perspective of the data needs of the intelligent agricultural machinery integration system, the data involved in the system can be divided into three classes for data sharing and services on the intelligent agricultural machinery integration platform; Business data includes three categories: agricultural machinery service organization, inter data, business data, and resource data, including basic geographic data, remote sensing images of agricultural machinery, orders, and related information data of different users, providing data support for business systems. The resource data includes information related to data backup, resource management and maintenance, user role permissions, etc., providing data support for business applications [7].

The intelligent agricultural comprehensive management system is built on a network foundation, therefore it uses a browser/server architecture (B/S, Browser/Server) development method; J2ee with three-tier structure is divided into Presentation layer, middle layer, and data service layer; In order to ensure the universality, efficiency, portability, and security of the system, this article selects the Java platform for system development and deployment; Software system development is carried out through Java language and WEBGIS related technologies, and technologies such as the Internet of Things, cloud computing, and B2C e-commerce mode are introduced in the research and development. 3S technology is used for data collection, management, calculation, analysis, and display to achieve a smart agricultural machinery integration system [8-9]. Based on the principles of B/S design mode and j2ee three-tier architecture, and combined with the actual Functional requirement of the system, it is divided into three layers: user layer, application layer and data layer, as shown in Figure 1.

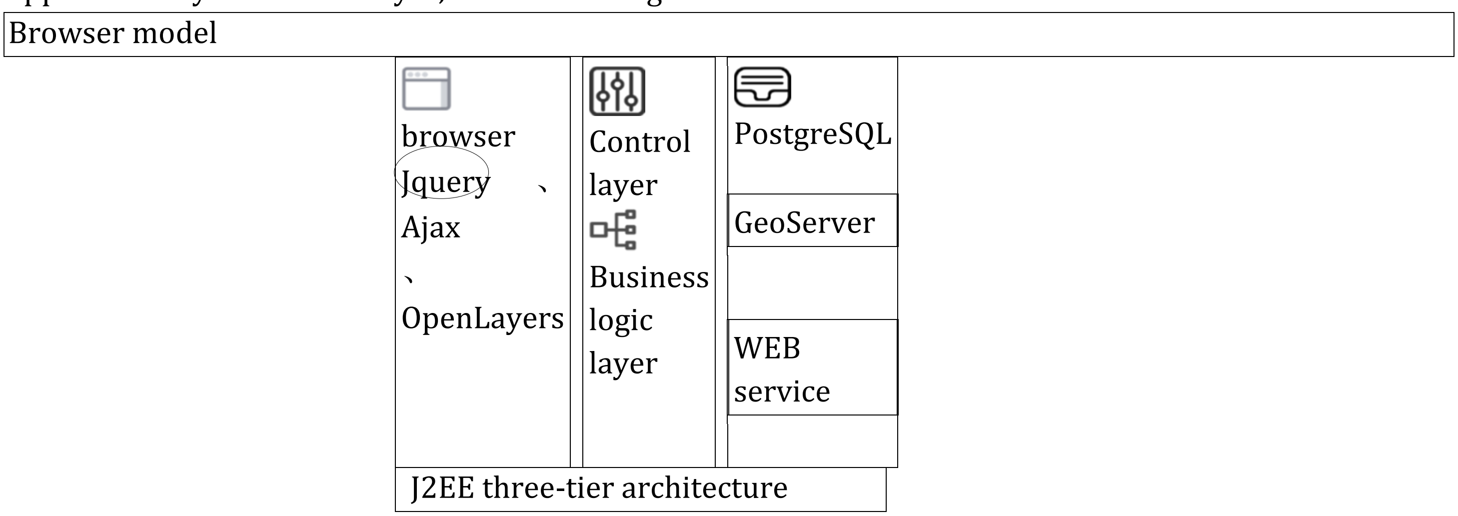


Figure 1. Structure diagram of intelligent agricultural machinery integration system

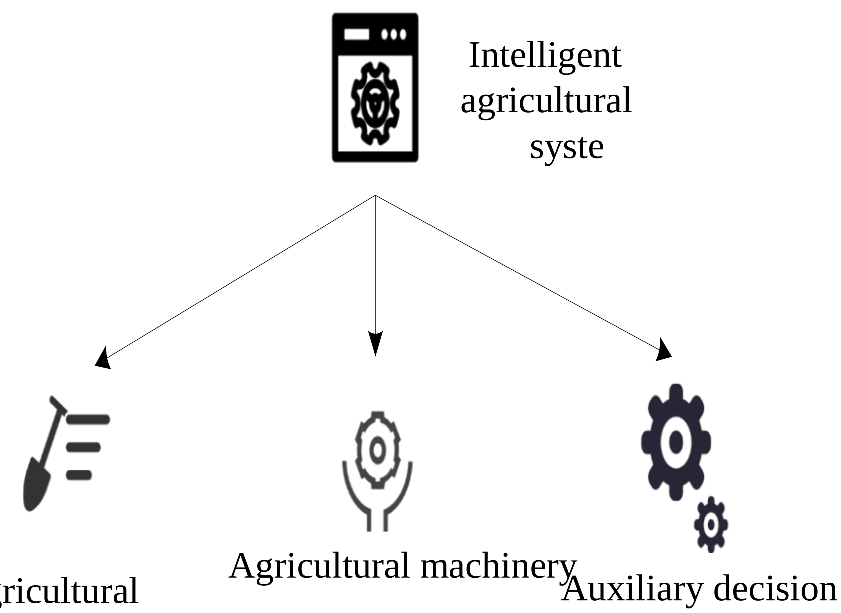
From Figure 1, it can be seen that the user layer is a place for in machine interaction, where various functional pages of the system can be displayed in different browsers. This article adopts the Jquery framework and Ajax technology to develop web page interaction functions. With the help of OpenLayers technology, various map functions of WEBGIS are completed. Users can send request instructions to the application layer through HTTP (Hyper Text Transfer Protocol) requests in the browser, using the Internet's transmission protocol. After the system processes these requests, the required data results are returned to complete the user's operation function.

OpenLayers is a JavaScript package used to develop WebGIS clients, with an application layer deployed on a WEB server, consisting of two parts: the control layer and the business logic layer. The control layer is managed by Struts, which ensures interaction between the user layer and the business logic layer. The role of spring can be extended to the entire application layer. It can be accessed through the combination of Struts and spring, using Java functional code to access data services in the data layer. Finally, the application layer searches for data based on user request instructions and returns it to the user layer, allowing users to perform operations.

In the data layer, it includes GeoServer servers and PostgreSQL databases, as well as some distributed web services and map services. The application layer utilizes access to the GeoServer server and PostgreSQL database to obtain basic geographic information data and business data. The Java functional code in the application layer can directly call the agricultural machinery terminal monitoring data service published by the data center, or use the internet to call the slicing service of published remote sensing images and vector maps, and feedback the data to the user's hands in the application layer. The data layer provides sufficient data support for the entire system's work [10-11].

2.2. System Module Design

The intelligent agricultural machinery integration system is mainly used by farmers, agricultural machinery service organizations and governments. Each user would have different Functional requirement, and there would be certain data logical relationships between different users [12-13]. Therefore, when designing the system modules, it should design each functional module of the system based on the user's Functional requirement and the relationship between them. The intelligent agricultural machinery integration system mainly includes three subsystems, namely the agricultural machinery operation service system, the agricultural machinery operation scheduling and supervision management system, and the agricultural machinery operation auxiliary decision-making system. Each subsystem is composed of different functional modules [14]. The overall module design of the intelligent agricultural machinery integration system is shown in Figure 2:



Scheduling and monitoring operation service system agricultural machinery operation management system

Figure 2. Intelligent Agricultural Machinery Integrated System

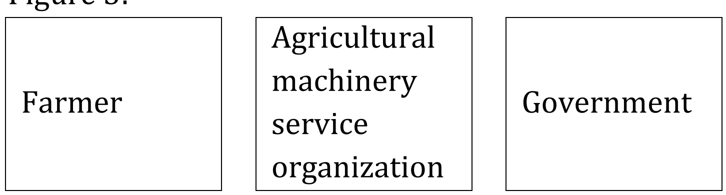
The agricultural machinery operation service system mainly includes four modules: homepage, supply information, order management, and job allocation. It provides farmers with functions such as agricultural machinery service organization retrieval, map display operation, order management (adding, deleting, modifying, querying), and assigning agricultural machinery service organizations to orders.

The agricultural machinery job scheduling and monitoring management system consists of modules such as homepage, order management, job scheduling, job supervision, job analysis, information management, trajectory point management, etc., enabling users of agricultural machinery service organizations to manage orders, schedule jobs, monitor agricultural machinery and operators, and manage relevant information under the organization.

The main content of agricultural machinery operation assistance decision-making includes: agricultural machinery dynamics and theme dynamics on the homepage, operation analysis, emergency management of emergency and temporary orders and emergencies, operation quality monitoring, service organization management, and user management. These can be utilized by government users to monitor and manage agricultural machinery service organizations, work quality, and emergency events, help farmers expand orders, and conduct statistics and analysis on various data of agricultural production and agricultural machinery service organizations in Beijing, providing data support for local agricultural production, economic development, and policy formulation [17].

2.3 Process Design

According to the main Functional requirement of users, the business process of the intelligent agricultural machinery integration system can be divided into six aspects: demand service, order scheduling, agricultural machinery operation, dynamic management, statistical analysis and auxiliary decision-making, as shown in Figure 3:



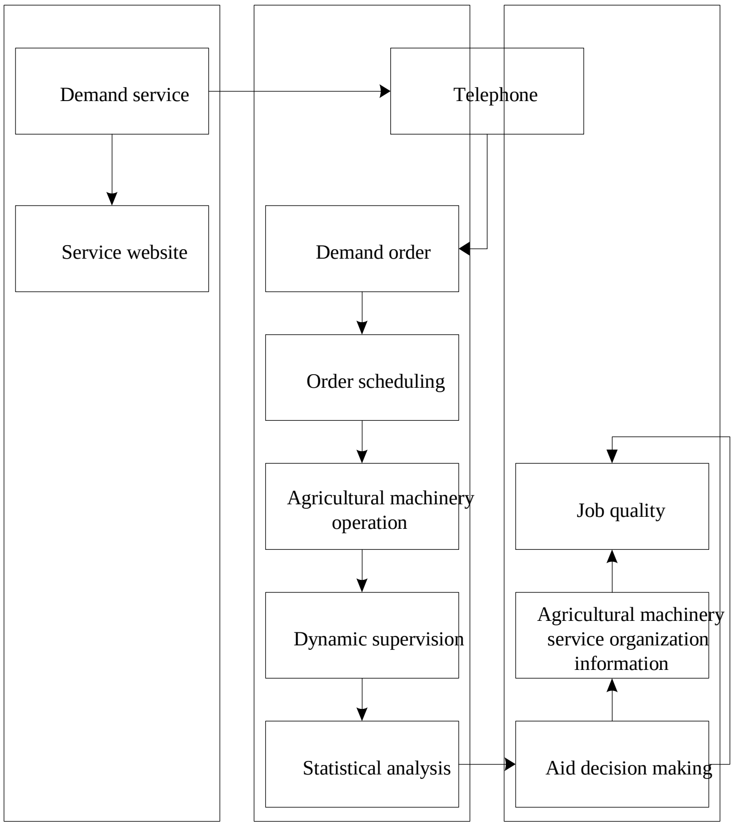


Figure 3. Business Process of Intelligent Agricultural Machinery Integration System

From Figure 3, it can be seen that:

Demand service: Farmers can find agricultural machinery service institutions on this service site and submit their service needs. They can also request their needs from agricultural machinery service institutions and relevant government departments by phone, and then the agricultural machinery institutions and government department staff would complete the filling of the order, and finally inform the farmers of the processing results of the order.

Order delivery: The agricultural technology promotion agency shall deliver the required machinery and machinery personnel to the designated locations according to the requirements in the order, and carry out agricultural technology promotion for farmers.

Agricultural machinery operation: The agricultural machinery service agency informs the operator through SMS on their mobile phones. The operator drives the agricultural machinery to the work site according to the requirements of the order, carries out agricultural work, and timely transmits work tasks and status information to the system [18].

Dynamic supervision: Through the data transmitted by the agricultural machinery mobile terminal, the operation path and status of the agricultural machinery are controlled, and real-time positioning of the agricultural machinery and manipulator is carried out. The agricultural machinery operation trajectory points can be replayed, and the operation area can be estimated [19].

Statistical analysis: According to the situation of agricultural machinery, machinery operators, and operation time, agricultural machinery service agencies have conducted statistics and analysis on the operation area, crop types, and operation types.

Assistance in decision-making: The government has conducted real-time understanding of agricultural machinery service institutions, number of agricultural machinery, agricultural machinery operation area, crop types, operation quality, operation time, and other information, providing scientific, comprehensive, and direct data support for the formulation of various agricultural production plans and support subsidy policies in Beijing.

2.4 Database Design

The Web mapping used in the intelligent agricultural machinery integration system mainly calls the WMTS map slicing service and remote sensing image slicing service issued by Tianmap.com. Remote sensing images are mainly used for the operation quality analysis module under the agricultural machinery operation assistant decision-making system. The WMTS (Western Main Transportation Services) remote sensing image slicing service released by GEOServer is called, and the image data provides real-time and reliable monitoring data for field area, crop types, crop yield estimation, crop maturity, harvesting range, etc., ensuring the statistical analysis and scientific decision-making work of government departments. Other spatial data, system business data, and resource data are all stored in the local PostgreSQL database. The system would obtain data uploaded by agricultural machinery mobile terminals from the data center in real-time through service requests, and save the data in the local database for quick use by the intelligent agricultural machinery integration system. The intelligent agricultural machinery integration system is composed of three subsystems, each independent and interrelated, composed of data in the database, separated from each other and not interfering with each other, but some data (such as spatial data) is shared. Identify the attribution of data through ID identification and grouping in the data table. When designing the database design, all data tables and fields ensure users of different types and permissions according to data, structure, logical relationship and certain data. There is no conflict between data to prevent system errors. The user information table and spatial information table are shown in Tables 1 and 2:

Table 1. User Information Table

Field Name	Model	Meaning
Lid	Character Varying	Usergroup Id
Luserid	Character Varying	User Id
Loginname	Character Varying	Username

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Password	Character Varying	Password
Login Title	Character Varying	Name
Lid Card	Character Varying	Id Number
Imobilephone	Character Varying	Contact Number

Table 2. Spatial Information Table

Field Name	Model	Meaning
Gdsid	Character Varying	Identification Id
Gdstitle	Character Varying	Place Name
Centerx	Numeric(10,2)	Longitude Of Center Point
Centery	Numeric(10,2)	Latitude Of Center Point
Gdstreelevel	Smallint	Layer Level

Among them, the user information table in Table 1 includes the user's personal identification ID and group ID, as well as the user name, password, name, contact number, ID number and other basic registered information. The spatial information table shown in Table 2 includes basic geographical information of the country and stores spatial information data such as place names, center point coordinates, layer levels, spatial dimensions, etc., at the provincial, municipal, county, township, and village levels, providing sufficient geographic information for displaying electronic maps.

2.5. System Data Platform Services

On the intelligent agricultural machinery Big data system, based on the analysis of historical data such as agricultural machinery distribution data, agricultural machinery operation data, and agricultural machinery purchase data, the development of agricultural machinery in various regions was analyzed [20]. The analysis of the development of agricultural machinery consists of six aspects, namely: analysis of the number of agricultural machinery owned, analysis of the number of newly purchased agricultural machinery, analysis of the proportion of imported agricultural machinery, ranking of agricultural machinery brands, analysis of agricultural machinery subsidy data, and analysis of agricultural machinery maintenance data. Introducing the annual average growth rate into the study of the ownership of agricultural machinery can better reflect the development of agricultural machinery. The year-on-year development rate refers to the relative development rate achieved in the current period compared to the same period last year. Its mode is:

$$v = \frac{l - u}{u} \quad (1)$$

v represents the year-on-year development speed, l represents the development level of the current period, and u represents the development level of the same period last year. The analysis of agricultural machinery ownership in this article adopts this indicator, such as the development speed calculated by comparing a certain year with the same period of the previous year. The month on month comparison is based on the current data as the reporting period, and the previous data as the base period. The comparison between the reporting period and the base period is the month on month comparison. The change in the number of agricultural machinery is represented by year-on-year growth and month on month growth rate, and the formula is:

m

$p =$ (2) n $r_b - r_s$

$q =$ (3)

r_b

Among them, p represents year-on-year growth, m represents the quantity of agricultural machinery last year, n represents the quantity this year, q represents the month on month growth rate, r_b represents the quantity of agricultural machinery this month, and r_s represents the quantity of agricultural machinery in the previous month [21-22].

3. Testing and Intelligent Agricultural Machinery Integration System

In the network environment, the network environment has a significant impact on the responsiveness of the network environment. The response rate experiment in this article aims to detect changes in the corresponding response time of the system as there are more and more concurrent requirements in the system. The calculation of response time is a request made from the client. After it arrives at the server, it undergoes a series of interactions (such as reading request files, querying relevant database information, etc.), and then returns to the client from the server to complete the response. In some testing tools, the response time is referred to as TTLB, as shown in Figure 4:

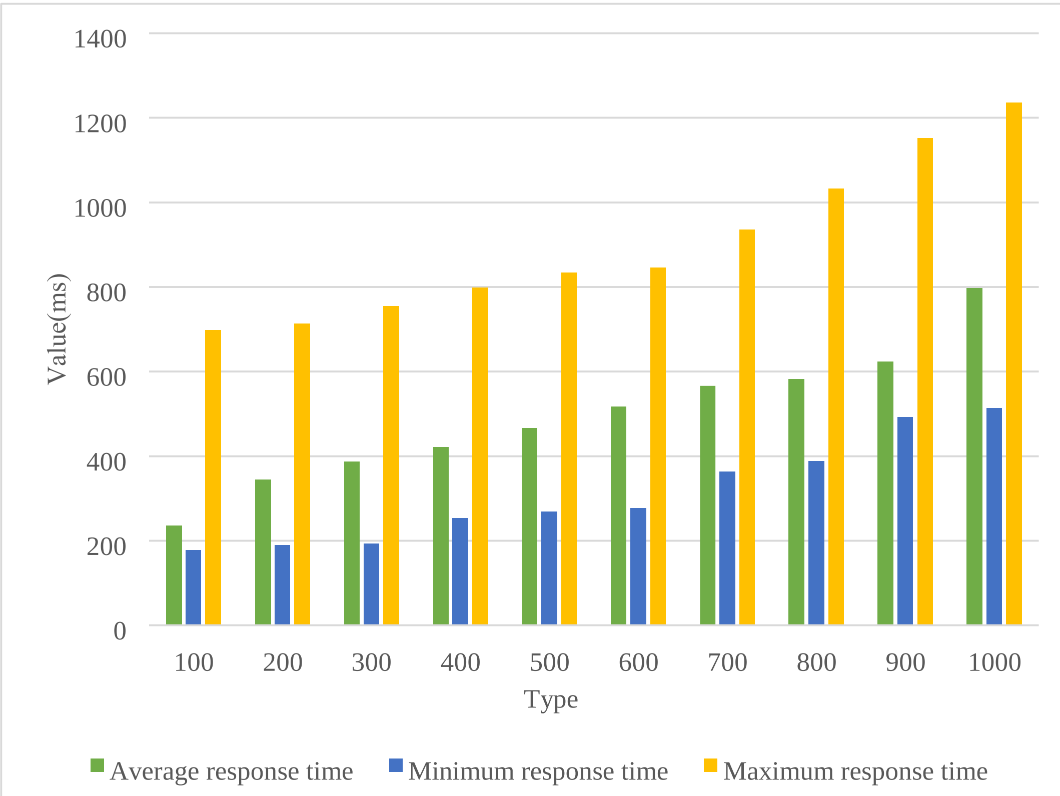

Figure 4. Response Time Statistics

As shown in Figure 4, the response time increases with the increase of concurrency, with an average response time of 236ms, a maximum response time of 698ms, and a minimum response time of 178ms when the concurrency is 100. When the concurrency is 1000, the average response time is 798ms, the maximum response time is 1236ms, and the minimum response time is 514ms.

4. Conclusions

Mechanised agriculture is a key indicator of agricultural modernization. In this process, modern computer technology should be brought into full play to build a set of agricultural machinery service management integration system suitable for the The Internet Age. This would help to improve the level of China's agricultural machinery informatization, strengthen the macro control of government departments on Mechanised agriculture, and promote the overall development of Mechanised agriculture and informatization. A set of agricultural machinery informatization service management system that matches the economic system can be constructed. This is a major method of combining agricultural production with information technology. In recent years, information technology has been increasingly applied in agricultural production, and digitalization of agricultural machinery service management is a representative example of the development of agricultural informatization. Building a new model of agricultural machinery service management can help agricultural machinery service organizations schedule orders in a timely manner during busy agricultural seasons, manage all agricultural machinery and operators under them, and quickly provide agricultural machinery services to farmers. This has completely transformed the traditional management methods of agricultural machinery services, making the intelligent and information-based development of agricultural machinery operation services possible.

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