



HAL
open science

Research on the Internet of Things Platform Design for Agricultural Machinery Operation and Operation Management

Qian Zhou, Jiandong Jiang, Zhangfeng Zhao, Jiang Zhong, Bosong Pan, Xiao
Jin, Yuanfang Sun

► **To cite this version:**

Qian Zhou, Jiandong Jiang, Zhangfeng Zhao, Jiang Zhong, Bosong Pan, et al.. Research on the Internet of Things Platform Design for Agricultural Machinery Operation and Operation Management. 11th International Conference on Computer and Computing Technologies in Agriculture (CCTA), Aug 2017, Jilin, China. pp.400-410, 10.1007/978-3-030-06179-1_40 . hal-02111566

HAL Id: hal-02111566

<https://inria.hal.science/hal-02111566v1>

Submitted on 26 Apr 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

Research on The Internet of Things Platform Design for agricultural machinery operation and operation management

Qian Zhou¹, Jiandong Jiang^{1(✉)}, Zhangfeng Zhao, Jiang Zhong, Bosong Pan, Xiao Jin, Yuanfang Sun

(School of Mechanical Engineering, Zhejiang University of Technology, Hangzhou 310014, China)

Abstract: With the deepening of the agriculture and rural land reform, In China which is in the transition from traditional agriculture to modern agriculture, and the application of agricultural machinery networking technology is still in the preliminary application stage. This paper introduces the technology of Internet of things into the operation and operation and management of agricultural machinery, the technology integrates with Internet of things, cloud computing, and big data, then had optimized. So the managers can manage the agricultural machinery remotely, monitor the state of the machine at any time. The paper also discusses the core data management system of the platform, and gives the algorithm analysis of the rules such as the collection and excavation of the agricultural machinery operation and operation and maintenance process, and will improve the intelligent level of China's agricultural machinery to a certain extent.

Key words: agricultural machinery; Internet of things; operation and maintenance management; large data; cloud platform.

1 Introduction

The agricultural mechanization is an important part of agricultural production technology transform, and is an important manifestation of agricultural production technology progress. Since ancient times, agriculture is the first hand-operated, and then developed to semi-mechanized operations, and to the back of large-scale mechanized agriculture, The agricultural productivity has been improved. In recent years, with the relevant state-department attention on the agricultural mechanization development and the level of science and technology improved, the development of agricultural machinery has gradually become intelligent, saving, precision and large. However, there are still many shortcomings in the management of agricultural machinery in China, which have resulting in poor quality of operation, low efficiency and high operating costs. This specific performance is the low utilization rate of agricultural machinery, waiting for or the idle in the process of agricultural operation, and far away from the transportation of agricultural materials or agricultural products, the operating machine walking route is not economical, repetitive operations or excessive operations, and other non-value-added activities with

Zhejiang Province Science and Technology Project: R & D of portable multi-purpose tea machinery and equipment - intelligent testing of tea processing and equipment and quality decision-making control system integration research and production line application demonstration(2017C02027)

National Science Fund subsidized project (51375456)

Author: Zhou Qian, female, master graduate, now studying Zhejiang University of Technology, Research direction is the Internet of things cloud service platform. E-mail: 1151221032@qq.com

Corresponding author: Jiang Jiandong, male, born in 1974, professor, Ph.D. Mainly engaged in mechanical and electrical integration research. E-mail: jiangjd@zjut.edu.cn

resulting in loss of crop losses and other operations waste.

In Europe , the United States ,etc other developed countries, the agricultural machinery products not only to achieve the agricultural operations, the operation and maintenance of real-time monitoring, but also to have the gradual realization of intelligent control in some mainstream products. The foreign agricultural operations, agricultural production are base on the positive information and big data after the realization of the digital^[1]. Therefore, in this context, the development on Internet of Things provides an opportunity to improve intelligent agriculture. Agriculture is an important application area of Internet of Things technology. The deep integration of Internet of Things technology and agricultural production, management, management and service industry is of great significance to the transformation of the traditional agriculture and the promotion of agricultural modernization^[2]. With the use of Internet of things technology and the computer, Internet, cloud computing and other technologies, to establish a combination of agricultural operation and maintenance management platform to strengthen the management of agricultural operations, to reduce or eliminate the existence of waste in the operation process for improving China's farming industry crop mechanization process operation and maintenance management level and improving operational efficiency, is of great significance.

2 Status and problems of operation and maintenance of agricultural machinery at home and abroad

With the development of the agricultural machinery and equipment in foreign advanced industrialized countries ,In the 1970s, the foreign advanced agricultural machinery and equipment has begun to integrate with the modern microelectronics technology, the instrumentation and control technology, the information and communication technology, and have the rapid development in the direction about the digital, information, automation. Intelligent.

Globally, American agriculture is leading the way in using the Internet of things technology. In 1995, the United States began to equip the united harvester with a global positioning system, in which using electronic sensors and satellites for precise positioning. As the world's agricultural machinery industry leading enterprises, John Deere of the United States, advocates JDLINK system, has many functions, such as online querying working location, working data, working efficiency and working costs of agricultural machinery. the managers can monitor online in the office to manage the work of agricultural machinery, to do the precision management of agricultural machinery work. John Deere's 60 Series harvester has been using the Green-Star system, equipped with the relevant sensors and control system, achieving the automatic control of feed quantity and automatically drawing the yield and grain moisture graphs, the terrain and other high-map ,etc on. At present, some large farms, in Europe and the United States, have also begun to establish and use the management information system for data exchange through the wireless communication between the computer and mobile operating machinery in the agricultural production office. Through the management information system for data exchange through wireless communication the managers can enable to monitor and manage agricultural machinery, to work in field with the computers in the farm management center. The field working data can be remotely recalled and stored directly in the corresponding database, greatly

improving the efficiency of data collection, the analysis and application; when the mechanical failure, the mechanical users can also make use of the computer techniques to analysis and diagnostic ,or to take targeting processing procedures of precision agriculture, which is basing on GPS, GIS, RS Technology for urging on the agricultural production to be changed more scientific and refined.^[3,4]

In China, the overall situation of agricultural equipment' s development is: small agricultural machinery occupies the dominant position with a large number and a single function; the large and medium-sized mechanical costs are higher, and their degree of intelligence are low; the agricultural machinery product surplus and shortage of coexist, traditional farming machinery market is almost saturated, the product structure is irrational, the number of cultivated and harvested machinery about some new crops is little and the level is low. There are also many problems, such as the system is imperfect in the agricultural management, the managers are not professional and so on^[5]. And "island-style" information technology investment of the current Chinese agricultural machinery networking cannot form a network model, and cannot have economies of scale effect. Therefore, it is better to study the advanced management and operation technology of the agricultural machinery, and to build a national advanced, low-cost, easy-to-use and dynamic agricultural data platform for improving the operating and managing level of the crop mechanization process in China's farming industry, then can greatly play the effectiveness of agricultural machinery, which is of great significance for serving the country.^[6]

3 The overall system architecture

The system model integrates many technologies such as the Internet, the mobile Internet, the cloud computing and the Internet of Things, and deeply integrates the Internet of things with the cloud computing big data. The cloud computing can help the intelligent cloud platform to realize the distributed storage of information storage resources and computing power. The information processing capacity of big data will provide support for the massive information processing and utilization, and rely on a variety of the sensor nodes and network environment, through the agricultural intelligence cloud platform operations large data information, environmental information, geographic information, soil information, crop information and other big data mining ,it establishes decision-making system to achieve the intelligent perception of agricultural operations environment, intelligent early warning, intelligent decision-making, intelligent data analysis, quality control and so on, to provides visualization and precision management to agricultural operations and operation and maintenance, for reducing human operations, improves agricultural efficiency, and timely having complete operation and maintenance fault detection and diagnosis. The following figure shows the intelligent agricultural management system map.

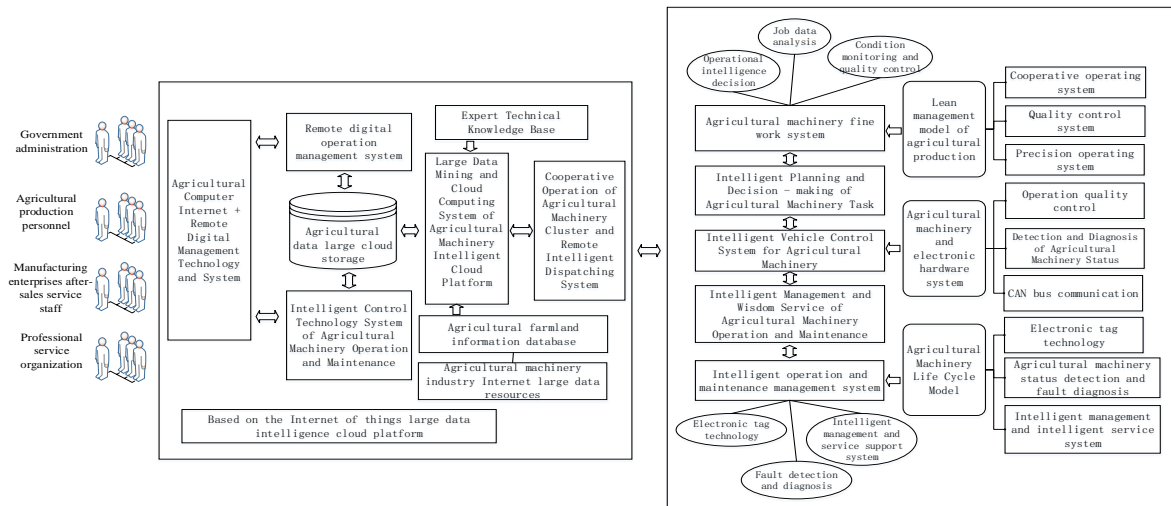


Fig.1. Intelligent agricultural management system map

The subsystems of the intelligent agricultural machine management system :

(1) Agricultural machinery Internet digital management system

The intelligent monitoring terminal acquires the agricultural working environment temperature and humidity, agricultural fuel consumption, operating normally or abnormally and the information of location through collecting the signal of the sensor output. The intelligent monitoring terminal makes a reasonable analysis and judgment through the data processing, data operations, Data analysis, and conveys to the government official, agricultural production personnel, production and after-sales staff and professional organization service personnel by the monitoring side (client). Meanwhile real-time, the field monitoring terminal have uploading the data stably and quickly ,which is collected in to the server to achieve data sharing and agricultural intelligence.

(2) Cooperative operation and remote intelligent dispatching technology and system of agricultural machinery group

The sub-modules in cooperative operation and remote intelligent dispatching system of the agricultural machinery group including the agricultural remote control system, the big data cloud storage system, the remote operation and maintenance control technical support, the expert technical service library, the remote collaborative operating system and the information base. The system needs big data and the support of decision-making system, first we need to establish data mining models and algorithms in the wisdom cloud platform big data mining system. According to the real-time monitoring and reporting of agricultural working location, crop category, working area, working speed, working conditions and other parameters, and combining with the matching knowledge base among the agricultural machinery, through the agricultural intelligence cloud platform's extraction of big data, model provides decision-making data. Meanwhile, we study the multi-device concurrent access control technology and database service technology to formulate the plan of the cooperative work and remote intelligent scheduling scheme for the agricultural machinery cluster. To research and develop the agricultural operations scheduling system, to release agricultural scheduling information facing to the agricultural operations management personnel, to achieve agricultural machinery cluster operations and remote intelligent scheduling.

(3) The fine management technology and system of agricultural machinery work

The sub-modules is made up the system including the fine operating system, the intelligent planning and decision-making of task, intelligent vehicle control system, intelligent management, intelligent service and intelligent operation and maintenance management system. The system integrates the key technologies such as mobile communication, Internet technology, global positioning system and detection sensor and so on. It obtains the information such as the geographical position, operation information, fault information, running trajectory, bulletin information, transmitter status, work statistics and so on. Then it use mobile network technology to send data to the data management center to the implement data processing and analysis to achieve the target machine identification, location determination, voice communications, network information query, data transmission, the realization of agricultural operations remote monitoring and agricultural scheduling management. Users and agricultural management departments can monitor the platform or the mobile client APP to monitor and understand the operation of the agricultural machinery, query the area of agricultural operations, and monitor the status of agricultural machinery and other operations' quality condition.

4 Agricultural machinery operation and maintenance management technology road the map and the core of the two model design

4.1 Key technical solutions and implementation methods

The technical route of the agricultural machine operation, based on the big data intelligent cloud platform, and the operation and maintenance intelligent management on Internet platform is shown in the figure below.

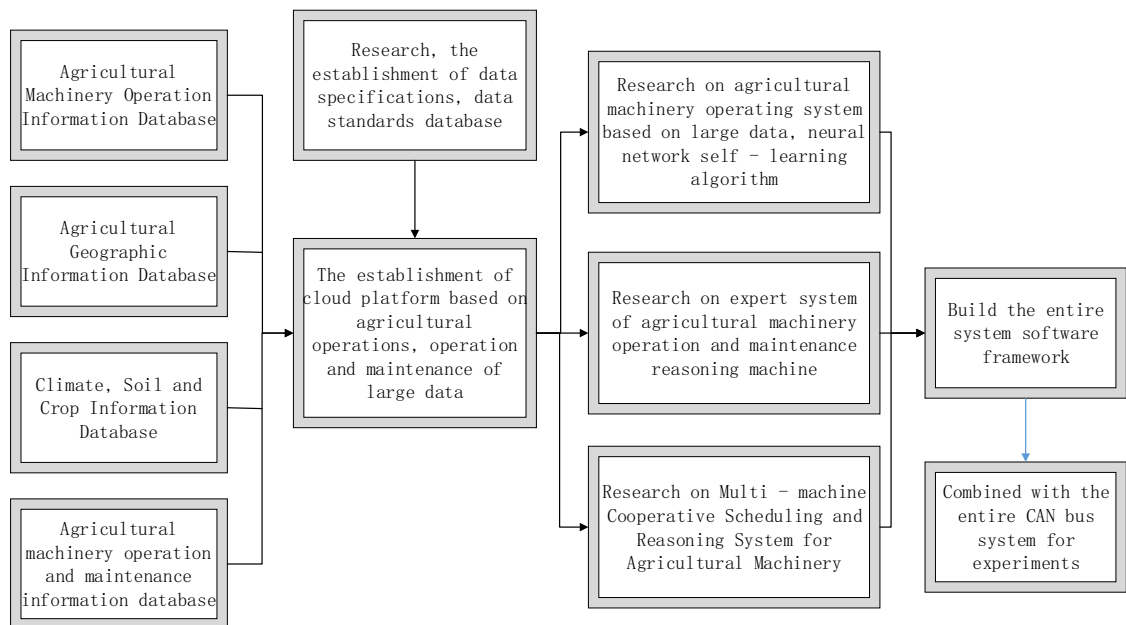


Fig.2.Intelligent Route of Agricultural Machinery Operation and Operation and Maintenance Based on Big Data Intelligent Cloud Platform

The technical roadmap builds up the scheduling model of the database, in the process of

agricultural machinery operation, and sets the target for the selection of hardware and software components and algorithms in the whole scheduling reasoning management organization, which lays the foundation for the design of the whole Internet of Things platform.

On the Internet of Things platform, the core technology is data processing, including three major parts : data collection, data analysis and mining, service of the data in the operation and maintenance, this instructions will be given in the design of the following core models^[7,8]

4.2 Design of monitoring platform for agricultural machinery

The agricultural big data intelligent cloud platform ,based on the Internet of things, which's construction need the help of the raw data acquisition and storage support, therefore the first thing need to be done is the constructions of the agricultural machinery networking Monitoring platform, and the Monitoring platform mainly consists of the positioning system, mobile client, Internet of Things monitoring center system , Data management storage center, cloud computing modules and other components. The core part of Monitoring platform is the airborne data management module, which includes the data collection, analysis and data applications. The system topology diagram of the Monitoring platform is shown at the following.

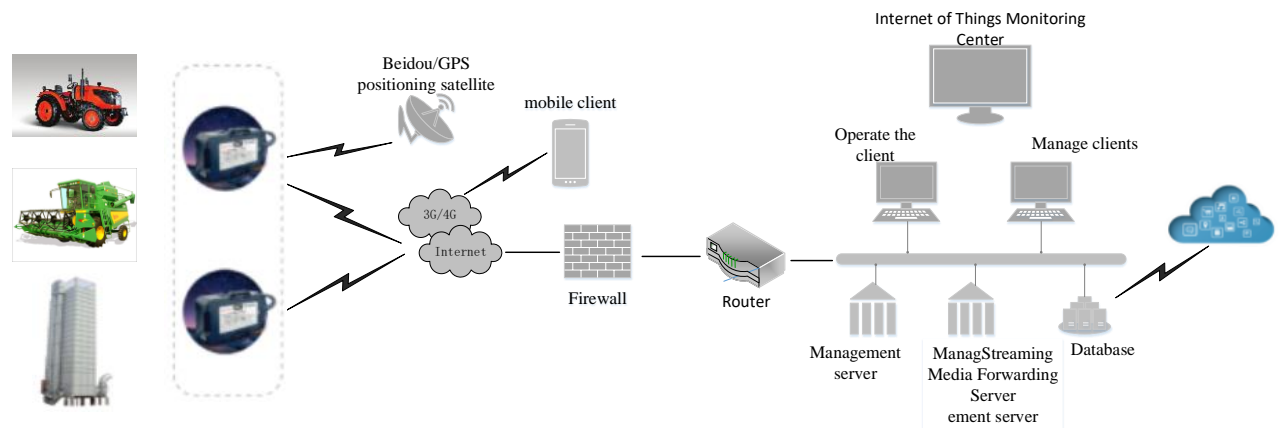


Fig.3.Agricultural machinery and equipment network monitoring system topology

The data collected by the monitoring system mainly includes the job location information , the job status information, the fault detection information and the trajectory of the agricultural machinery. After the corresponding information is obtained by the sensor, the mobile network technology is used to send the data to the data management center of the platform in real time ,to do the implement data Processing and analysis. The agricultural machinery data acquisition system should meet the needs of modern intelligent information management, effective management of historical data information, and can move towards the direction of development of higher precision, faster processing speed, more real-time, greater storage capacity and greater integration. The main acquisition technology included in the real-time data collection of agricultural machinery is shown in the following figure.

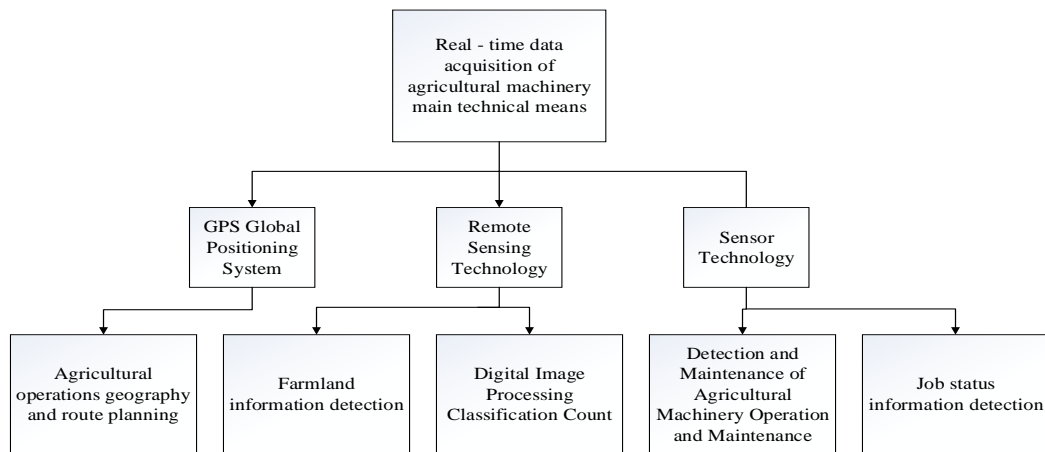


Fig.4.Real - time data acquisition of agricultural machinery main technical means

The monitoring system can receive the information produced in the operation process of agricultural machinery by using the Internet of things RFID technology and the wireless sensor technology together, which can achieve intelligent management of agricultural machinery and real-time monitoring.

4.3 Intelligent Management System for Agricultural Machinery Operation and Operation Based on Big Data Intelligent Cloud Platform

As an organic combination of big data technology, the big data platform have multiple functions such as data collection, data storage, data processing, data analysis and so on, which can provide a strong support for the applications of big data. Nowadays .In the aspects of big data processing, the general process method is distributed Map Reduce, and stored in the form of pair of key/value, which reading process is also different from the traditional way. By using the data mining technology ,the data mining in the agricultural operation and the maintenance management system can dig out the effective information from the agricultural work data ,thereby to guide the operation and maintenance of the agricultural machinery. In this paper, the data mining system function diagram is designed as follows.

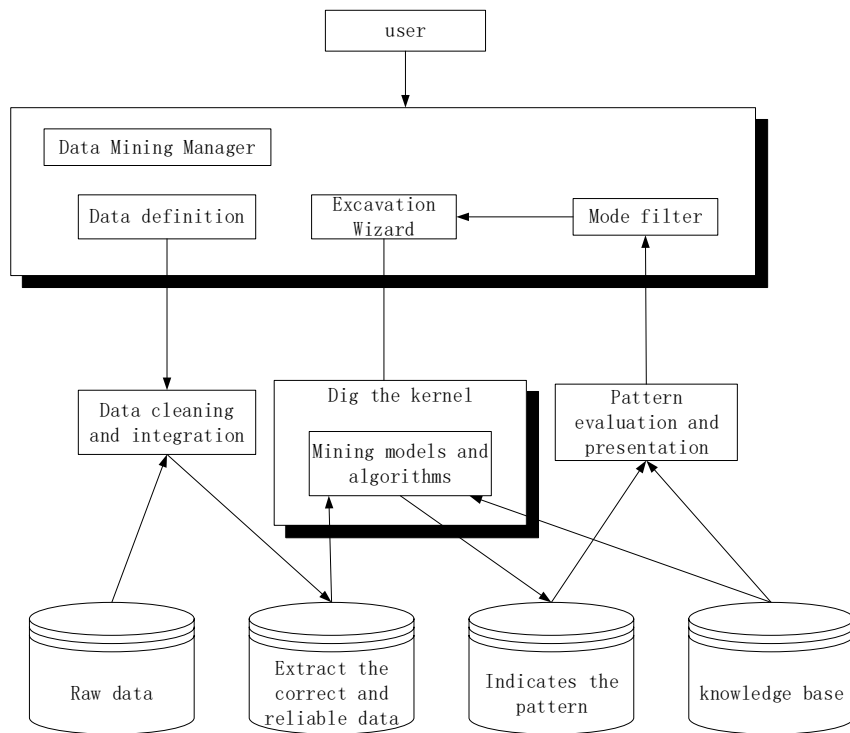


Fig.5.Data mining system function diagram

The core part of the data mining system is the establishment of mining models and algorithms. The data mining of massive data group, generated in the operation process of the agricultural machinery, which depends on the ability of mapping the real world and the ability of processing the data. The current mainstream distributed data mining platform is Hadoop, which use the distributed file system HDFS to save the file, and use the MapReduce to deal with the data of distributed file system, therefore can ensure the efficacy on the data analysis and processing.^[9,10]

HDFS can store the large files produced by the operation and maintenance, proceed the effectively access the mode of writing once and reading many times , and can carry out the streaming data access. The architecture of HDFS is shown below.

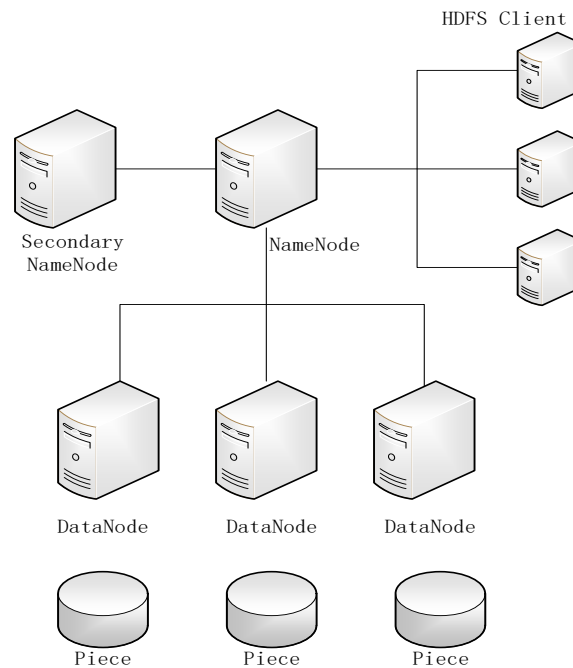


Fig.6.HDFS architecture

The computer cluster has achieved the mutual communication among the cluster and data transmission. As the brain of the cluster in the HDFS, NameNode is used to store the metadata of the entire file system, the real data is stored in the blocks of the DataNode. HDFS determines whether the data collected is corrupted by using the checksum technology, DataNode is responsible for verifying the checksum of the received data, and the HDFS client also verifies the checksum when it reads data from the DataNode and compares them with the checksum stored in the DataNode. Not only the client will verify the checksum when reading data and writing data. Each DataNode will also run a DataBlockScanner in a background thread to periodically validate all the data blocks stored in this DataNode. And HDFS can also repair damaged data blocks.^[11]

The key about the operation and operational data of agricultural machinery is to excavate the relationship between the real-time status information of agricultural machinery and its operation and maintenance. Moreover the aim on improving the parallel algorithm is to get the information that the agricultural machinery manager and the producer can use it to know the running status and the fault detect of the agricultural machinery better, therefore can solve the problem timely. Because the amount of data is very large, and in the process of generating candidate items, the traditional parallel Apriority algorithm will lead to data processing in the calculation process is slow or lack of memory. Therefore, it is necessary to improve the algorithm of Apriority, improve the efficiency on the algorithm implementation, and can reduce the size of candidate items with the implementation of algorithms, also make the calculation nodes independently perform the mining of the items, thus solve the problem of insufficient memory.^[12]

On the design of the cloud platform the operation and operation and maintenance of the data management system is developed, which will provide the effectively support for the store and the mining of massive data produced in the operation process of agricultural machinery.

Conclusion

This paper aims at solving the problem on the backward development of the agricultural machinery, such as poor quality of operation ,low efficiency and high-difficulty of operation supervision, by comparing the development of agricultural machinery at home and abroad. and introducing the design of the agricultural machinery operation and operation and maintenance management network.

This paper gives the design framework of the intelligent agricultural management system map, the core is the design of the network monitoring platform for the agricultural machinery and the intelligent management system design on the agricultural machinery operation and operation and maintenance ,based on the large data intelligence cloud platform. The platform establishes the field locomotive database and the query System, as well as the data collection, mining, etc. So we can facilitate query, add, delete and save and other operations of varieties of agricultural machinery and equipment data. At the same time, it can improve the positioning accuracy and stability of agricultural machinery system, and can monitor and diagnose the failure of agricultural machinery in real time, not only can improve the efficiency of production operation, but also can promote the development of intelligent and the precise development of agricultural machinery.

Acknowledgements

This paper is accomplished under the guidance of careful of my mentor-professor Jiang Jiandong. His serious scientific attitude, rigorous scholarship, the work style of excellence has been inspired me to keep forward. From the choice of the subject of the topic and the overall idea to the final completion of the paper, Jiang teacher has been given my patient guidance and support, I would like to extend my sincerely thanks to the professor Jiang.Secondly, I would also like to thank the students in the process of completing the process to give me support and help students, because of your patient help and relentless support, I can continue to overcome the problems encountered and confused to complete this paper.Finally, I would like to express my sincerely thanks for experts and teachers who take times out of their busy schedule to review my paper .

Reference

1. Zheng Wenzhong. Development status of intelligent agricultural machinery and equipment at home and abroad [J]. Modern Agricultural Machinery,2015,(06):4-8.
2. Study on the Application of Internet of Things in Intelligent Agriculture[D].Zhengzhou University,2012.
3. Steven Archambault. Ecological modernization of the agriculture industry in southern Sweden: reducing emissions to the Baltic Sea. Journal of Cleaner Production, 2004, (12):491~503
4. Yukui Yokijiro, Veron Latan. Agricultural development of the international analysis. China Agriculture Press, 2005: 17
5. Liu Jinlong, Lu Xiang, Lu Kang. Intelligent and Development Trend of Agricultural Machinery [J]. Science & Technology & Innovation,2017,(07):123-124.
6. Mao Fei and Kong Xiangzhi. Overall Situation and Future Orientation of Agricultural Modernization in China. Reform, 2012 (10): 9 ~ 21
7. Technology of Crop Planting Environment Based on Mobile GIS [J]. Journal of Agricultural Mechanization,2015,(09):325-334.

8. Liang Pei.Design and implementation of real-time data acquisition system [D]. Southwest Jiaotong University,2015
9. Zhang Minghui.Study and research on data mining algorithm based on Hadoop [D]. Kunming University of Science and Technology,2012.
10. Qruganti S, Ding Q, Tabrizi N. Exploring Hadoop as a platform for Distributed Association Rule Mining[C]//FUTURE COMPUTING 2013, The Fifth International Conference on Future Computational Technologies and Applications. 2013: 62-67.
11. Yu H,Wang D. Mass log data processing and mining based on Dadoop and cloud computing[C]//Computer Science and Education(Iccse), 2012 7th International Conference on. IEEE,2012:197-202
12. Zhou Bin.Study on mining method of massive engineering data association planning based on Hadoop [D]. Beijing Jiaotong University,2016.