

Research on Cooperative Operation Technology of Multiple Intelligent Agricultural Machines under the Internet of Things

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Abstract

In recent years, with the development of new information technologies such as the Internet of Things, 5G and artificial intelligence, more and more human-centered Internet of Things technologies have been gradually applied, especially with the large-scale production of farmland and the reduction of rural labor force, Internet of Things technologies have been gradually applied to agricultural environment to help agricultural production. The agricultural production using multi-intelligent agricultural machine cooperative operation mode has become an important part of smart agriculture in the future. The cooperative operation of multiple intelligent agricultural machines can work in different plots at the same time, greatly improving the efficiency of agricultural production, promoting the transformation and upgrading of agricultural production mode and the optimization and adjustment of agricultural industrial structure, and promoting the modernization and sustainable development of agricultural industry. The cooperative operation of multiple intelligent agricultural machines still faces problems such as field task sequence planning, changes in agricultural environment, and path conflicts of agricultural machines. Therefore, based on the analysis of relevant problems related to the cooperative operation of multiple agricultural machines, the cluster operation of multiple agricultural machines can achieve operation scale, while the operation can cover a larger field area and improve operation efficiency and production capacity. Reduce operation cost and optimize operation quality.

Keywords

Internet of Things; Multi-agricultural Machinery Coordination; 5G; Intelligent Device.

1. Introduction

During the first industrial revolution, the textile industry was the first to implement modern production technology, the automation era commenced, farmland was displaced by industry, and the advent of the steam engine accelerated the industrialization process. The invention of the telegraph and the telephone symbolizes the second industrial revolution, which was also a technological revolution. During this era, chemical synthesis became the dominant mode of development and fostered the growth of the industrial industry [1]. The rise of computers and telecommunications systems is the archetypal representation of the third industrial revolution. The invention of programmable logic controllers and robots led to the development of advanced automation [2]. With the development of new information technology brought about by the increasing demands of people, such as cloud computing, the Internet of Things, big

data analysis, and artificial intelligence, the contemporary industry has undergone significant transformations, leading to the emergence of the Industry 4.0 concept [3]. The so-called Industry 4.0 is the era of the use of information technology to promote industrial reform, that is, the era of intelligence. In Germany, it is referred to as i4.0, in China as Made in China 2025, and in the United States as the Internet of Things [4]. This is a new phase based primarily on automation, interconnection and real-time data.

The Internet is a revolutionary invention and the Internet of Things brings a huge future for the Internet, everyone and everything will be connected to the Internet. The Internet of Things started in 1982 when a modified coke machine connected to the Internet was able to report the drinks contained and whether they were cold. In 1999, Kevin Ashton proposed the term "Internet of Things" [5]. With the continuous development of the Internet of Things technology, it has affected all aspects of our life, among which consumer electronics is the most closely related to the public life. With the advent of the Internet of Things information era, the consumption of electronic products occupies an increasingly important position in the current consumption pattern of China. As the product of the intelligent era, the development of contemporary consumer electronics in many fields such as household electronics, personal electronics, wearable electronics, commercial electronics, entertainment electronics, and transportation electronics not only improves the quality of people's life experience, but also creates a more convenient and comfortable living environment for people [6-7].

Agriculture is an important foundation for national survival and development. Although our country is a big agricultural country, agricultural production has not yet been professionalized and scaled. China's population has been in negative growth for a long time, and the number of population has decreased year by year. Meanwhile, the number and age structure of rural population have changed with the migration of young labor to cities and towns. The decrease of rural labor force further aggravates the phenomenon of rural aging. Therefore, promoting the scale of agricultural production, accelerating the transformation of agricultural farming mode from labor-intensive to modernization and mechanization, and developing smart agriculture have become the inevitable trend of the development of agricultural production in today's society. The concept of "smart agriculture" and "unmanned farms" has gradually been put forward, and the demand for machines to replace labor is increasing. In addition, with the deepening and promotion of land transfer policies, it has promoted the improvement and upgrading of agronomy, agricultural machinery, and farmland infrastructure construction. The new generation of information technology, including the Internet of Things, big data, artificial intelligence, robots, etc., has become a key factor in promoting agricultural transformation and upgrading, greatly improving the scientific and technological content of agricultural production, thus greatly improving labor production efficiency.

Multi-machine cluster operation mode refers to an operation mode in which multiple agricultural machines are formed into a cluster to complete farmland operation tasks through cooperative operation. This operation mode includes different types of agricultural machine operation modes of cooperative operation of master and slave agricultural machines and cooperative operation mode of multiple agricultural machines of the same type. The cooperative working mode of master and slave farm machines refers to the mode in which one or more slave machines work with the host according to the command requirements of the host. Multi-machine cooperative operation refers to the use of multiple agricultural machines to operate in the same area of farmland and realize the cooperative operation among fields in different areas. These agricultural machines start from different starting points, respectively perform their own farmland tasks, and plan multiple optimal paths for multiple agricultural machines on the premise of ensuring operation efficiency. At the same time, ensure that these paths make the operation tasks do not miss, do not repeat, do not conflict, reduce the operation

cost, improve the utilization rate of agricultural machinery and agricultural machinery operation efficiency.

2. The Development of Smart Devices in the 5G Era

2.1. The Development of Smart Phones

With the increase in the number of electronic product terminals, the application scenarios of interconnection, data transmission and sharing between multiple devices are increasingly rich, and the progress of technology has promoted the continuous development of consumer electronics to intelligence and integration. The wireless network in the 5G era has a very low packet loss rate, low latency and high reliability. From the forecast of global mobile data traffic, the greatly increased traffic generated by 5G will change the communication mode of consumer electronic devices [8].

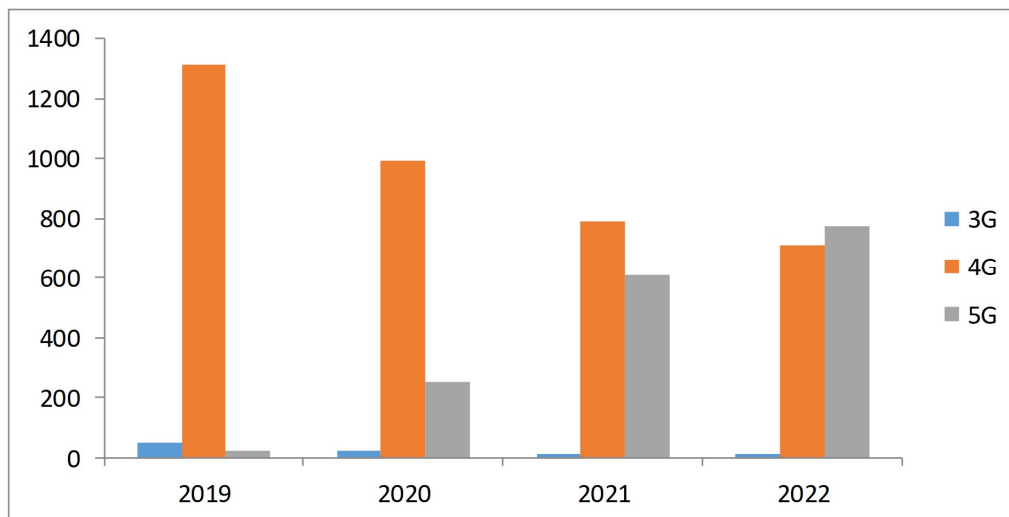


Figure 1. Global smartphone statistics and forecasts

With the development of mobile networks year by year, the telephone, as one of the typical examples of electronic devices, has developed from car phones including shoulder-mounted phones to mobile phones and then to smart phones. The form of mobile communication has also changed from simple voice communication to voice calls on smartphones. The communication system has also developed from 1G to 2G represented by the global System for Mobile communications, and after the global 3G system based on code division multiple access technology, it has developed to 4G using orthogonal frequency division multiple access technology and multiple input multiple output technology. The innovation of these technologies has achieved high speed and large capacity, and the communication speed has been improved a lot. The 5G era is different from previous generations in that it not only speeds up communication to meet people's access to big data loads such as high-definition photos and videos, but also ensures high reliability, ultra-low latency and multiple, concurrent connections. These features have brought about a continuous improvement in user experience, major smartphone manufacturers have continued to launch 5G mobile phones, and the 5G replacement cycle has been opened.

2.2. Application Scenarios and Classification of Wearable Devices

Connecting all things to the network is the concept of the Internet of Things. Wearable devices, as a typical paradigm of the Internet of Things, bring great convenience to people. Wearable

devices of the Internet of Things can be worn as external accessories, embedded in clothes, implanted in the body and even adhered to or tattooed on the skin, while mobile phones and sending data on the move, and receiving Internet information. Smartwatches, wristbands, eye masks, headphones, earplugs, and hand-worn devices have been developed to suit different applications [9].

Fitness activity tracker: Smart bracelet as a healthy weight loss monitoring design and application is more people compete to buy. It uses the traditional waist acceleration motion sensor to monitor physical activity and obtain effective data for analysis and processing. With the increase of data information, machine learning is introduced to deal with big data, which can not only process the original data but also improve the operation efficiency of the learning model. The method uses pedometers, GPS positioning, and heart rate sensors to obtain people's step count, position, and life-form characteristics information, and enables health monitoring by collaborating with other sensors to achieve accurate motion analysis. Because smart bracelets are inexpensive, easy to wear, and in line with consumer psychology, using them to monitor the human body's sports health is becoming more and more popular [10].

Health monitoring and care: With the emergence of the novel coronavirus, health care has attracted attention. With the increase of wearable devices and smartphone applications, telemedicine monitoring is also developing at a high speed. This paper proposes a health detection system based on intelligent Internet of Things devices, which uses sensors to monitor body temperature, pulse rate, indoor temperature and humidity, and uses wireless communication to send data to the medical server, which can prevent the spread of diseases and diagnose health conditions [11].

2.3. The Development of Smart Home

With the rise of smart phones, the popularization of 4G and 5G, the control of mobile home devices has become increasingly popular, and diversified intelligent control methods such as voice control, gesture control and induction control derived from this basis have also become popular.

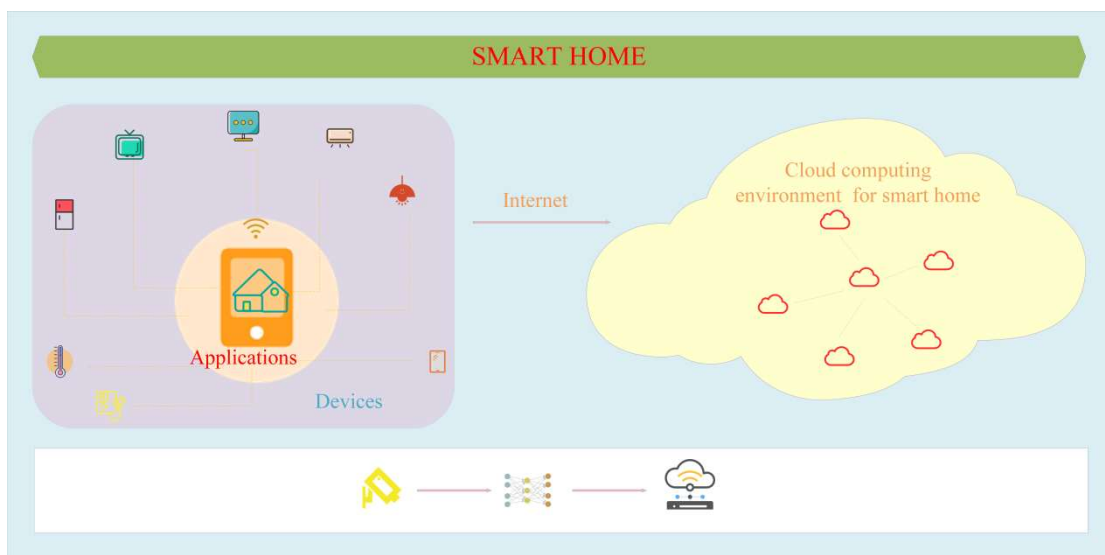


Figure 2. Smart home based on cloud computing

Smart homes not only enable disaster monitoring and maintain a pleasant living environment, but also enable access to devices in the home or office through an integrated network. For example, TV sets, refrigerators, lighting, water, air conditioning, doors and Windows, cameras, weather sensors, etc., can be accessed, but these electronic devices cannot be pulled out of the

current, which is very large for energy consumption. The proposal of artificial intelligence just solves the problem of energy optimization. Smart homes provide data to monitor the pattern of daily activities through sensors, use automatic learning or supervised learning to enable control devices to self-program, and use deep learning on control devices at home to optimize energy consumption of smart homes [12].

2.4. The Development of Intelligent Agricultural Machinery

At present, the development of intelligent agricultural machinery combined with navigation technology and machine vision technology has improved the degree of agricultural modernization. The farmland environment is complex and diverse, including fields, orchards, greenhouses and other scenes, and the demand for agricultural autonomous navigation technology and equipment is increasingly urgent. Rapid and accurate extraction of the center line of farmland crops is helpful to find the operation path of agricultural machinery. The precise navigation of agricultural robots still faces challenges. The integration of machine vision technology and agricultural machine navigation makes real-time and accurate navigation of agricultural robots become the future development direction. Navigation route detection algorithms based on computer vision have become the core technology of automatic navigation system, and these algorithms play a key role in the process of realizing autonomous navigation of agricultural machines. At the same time, target detection and recognition make an important contribution to avoid the collision between agricultural machinery and obstacles. The cluster operation of multiple agricultural machines can realize the operation scale, and the operation can cover a larger farmland area, improve the operation efficiency and production capacity, reduce the operation cost and optimize the operation quality.

3. The Application of Semantic Mining Technology

The emergence and spread of the Internet of Things has promoted the application of artificial intelligence in human life. Autonomous devices are becoming more and more intelligent in interacting with people and themselves. A related trend of artificial intelligence is the technology of recognizing human natural language, in this way of human-computer interaction, machines will learn how to understand human language and adjust and interact.

As a typical example of artificial intelligence, voice assistant has been embedded in various products, such as smart phones and smart speakers, and has become an important part of consumers' lives. AI is a welcome move towards machines learning to communicate with people and explore actions, habits and behaviors. Activated by the pronunciation of key phrases, the voice assistant translates the user's text into N optimal options for understanding the user's phrases, and then the conversation engine interprets and classifies these phrases to determine what needs to be done based on the information received [13]. Apple's Siri, Amazon's Alexa and Apple's Home are voice assistants that let users navigate, listen to music, control smart home devices, make phone calls, order food and more. In order to further promote consumers' willingness to use, it is found through sampling experiments that people are more satisfied and willing to continue using personalized voice assistants with functional intelligence, sincerity and creativity.

User-centered neurofuzzy energy management based on semantic optimization, using sensors and interoperability, intelligent integration to collect current state data about buildings and smart homes, and using heterogeneous data sources required for semantic mid-tier integration as knowledge bases and GUI interfaces for energy management systems and integration components, Analyze these data to achieve performance monitoring and optimization recommendations to cope with unforeseen situations and requirements [14]. In order to analyze consumers' behaviors and preferences, data mining technology is applied to the data of e-commerce online we-media platform. Since consumer behavior is affected by many factors

and behavior tendency is prone to great changes, a customer identification model is established to mine consumption preferences, and text feature extraction and semantic analysis methods are used to classify consumption preferences. This research will be extended to the recommendation system of e-commerce. Provide users with good user experience [15].

4. Data Storage and Processing

To perform manufacturing operations, an increasing number of devices in the manufacturing environment must be linked to the Internet, prompting a significant number of machines and sensors to generate wide-ranging data. Due to the vast volume of data produced, it is extremely challenging to process the data. Edge computing and fog computing [16] are proposed as a result of network unreliability, bandwidth saturation, latency, and security and privacy issues in the cloud smart manufacturing paradigm. Edge computing is the use of constrained hardware resources for CNC machine tools, smart robotics, and sensors. Edge layers, such as terminals, execute data gathering, filtering, uploading, storage, and analysis, which not only enables real-time data processing but also offers offline localized application services. The edge layer collects data, which the fog layer then processes and sends to the cloud layer. The fog layer might minimize transmission and service delays. By assessing the complexity and delay sensitivity of the data received from the edge layer and the fog layer, the cloud layer establishes a data processing model. It can facilitate smart manufacturing implementation more effectively [17].

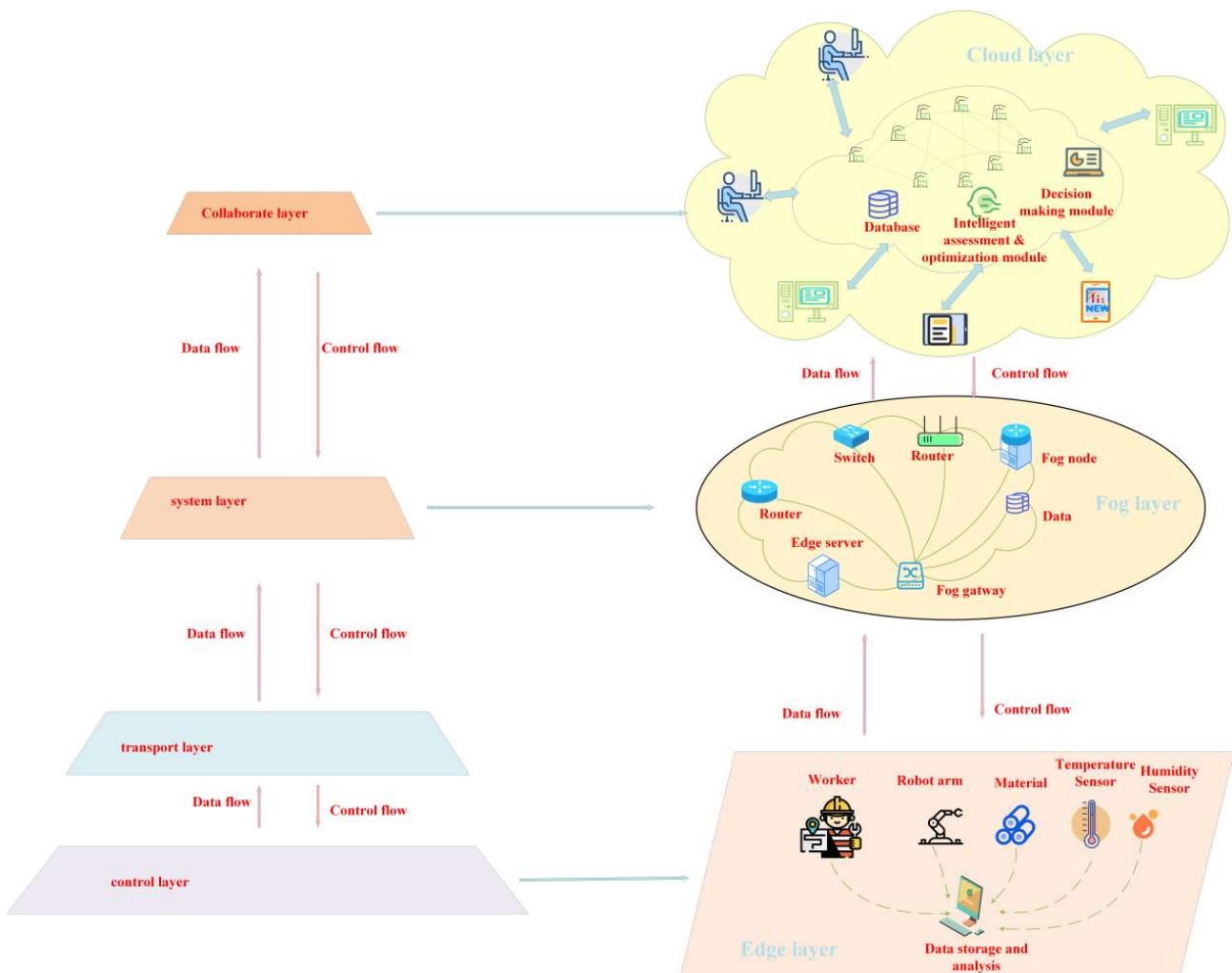


Figure 3. Hierarchical architecture of intelligent manufacturing based on cloud computing

5. Conclusion

In this paper, we analyze and summarize the application of emerging technologies in the era of the Internet of Things, and analyze that intelligent agricultural machinery has shown great advantages with the large-scale development of farmland and the reduction of rural labor force. The development of intelligent agricultural machinery combined with navigation technology and machine vision technology has improved the degree of agricultural modernization. At the same time, we also analyze the intelligent devices of the Internet of Things, including smart phones, smart homes, smart homes and other technologies. The development status of typical electronic products such as wearable devices is studied, and several breakthrough technologies and concepts are discussed. With the continuous advancement of the industrial revolution, intelligent manufacturing will make the industry earth-shaking changes.

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