Exploring Advances in UAV Remote Sensing Technology in Agriculture

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Abstract. The application of UAV(Unmanned Aerial Vehicle) remote sensing technology in the field of agriculture has various advantages, such as high-resolution data acquisition, real-time monitoring of crop and soil conditions, relatively low operating costs, etc. However, it will also appear in the actual use of battery life, weather impact and other problems.To this end, the aim of this paper is to analyze the development history of UAV remote sensing technology and the challenges it faces, and to propose solutions accordingly.Through analyzing the related literature and personal research, this paper proposes software development, data sharing, the establishment of power exchange base station and other countermeasures for the problems that occur nowadays. Based on the above description, finally, it further looks forward to the future development of China's agricultural UAV remote sensing technology and puts forward some relevant suggestions, hoping to make the technology more effectively used in the process of China's agricultural modernization in the future.

Keywords: Agriculture; UAV remote sensing technology; agricultural modernization.

1. Introduction

China is a large agricultural country, and agriculture is our primary industry, which is related to the development of the country's economy and people's livelihoods, and is also the basis for economic and social development [1]. As the population grows and the demand for food rises, new problems and challenges are being ushered in about agricultural production. Nowadays, the accelerated progress of China's urbanization, a large amount of arable land has been occupied, the area of arable land has been reduced, and at the same time, a large number of rural laborers are flocking to the cities, resulting in a decline in the number of rural laborers in China. The emergence of these problems requires us to promote the modernization and intelligence of agricultural production. There is a certain gap between the overall degree of agricultural modernization in China and the comprehensive characterization of the late stage of agricultural modernization in developed countries, and there is still much room for improvement in the rate of agricultural mechanization and agricultural productivity [2].

Nowadays, the development of UAV remote sensing technology is more and more mature, the data is more accurate and credible, and its role in agriculture is more important, with the development of science and technology, the application of agricultural UAV remote sensing technology is also expanding. UAV remote sensing is the use of drones equipped with sensors and cameras, thus realizing comprehensive monitoring and information collection on farmland, such as soil moisture, crop growth conditions, and the distribution of pests and diseases. This information provides farmers with accurate agricultural management and decision-making support, which in turn effectively improves the efficiency of agricultural production, and the development of remote sensing technology for agricultural drones will be a major trend to promote the modernization of China's agriculture [3]. UAV remote sensing images are characterized by comprehensiveness, efficiency, macroscopicity, etc., and their natural advantages such as lower labor cost and risk, adaptability, sustainability and environmental protection [4]. If UAV remote sensing technology is better combined with agriculture, it will greatly promote China's agricultural development and agricultural modernization.

However, with the promotion of agricultural UAV remote sensing technology its problems are also emerging, mainly in the practice and promotion of the two levels, probably for the reception and processing of data, the personal quality of the use of personnel and scene limitations. UAV remote

sensing equipment has the problems of insufficiently perfect performance, complex data processing process of remote sensing information, and low data integration and fusion [5]. Therefore, to clarify the future development direction of this technology, it is necessary to synthesize the current status of the development of agricultural UAV remote sensing technology.

The purpose of this paper is to explore the development history of remote sensing technology for agricultural drones, as well as to analyze the challenges it has encountered and propose corresponding solutions. The article firstly briefly describes the technology and its development history secondly summarizes its development status, and finally further combines domestic and foreign related literature to provide directions and suggestions for agricultural UAV remote sensing technology to better serve China's agricultural development in the future.

2. Overview of UAV remote sensing applications in agriculture

2.1. Overview of unmanned aerial remote sensing technology

Remote sensing technology utilizes sensors to collect information from the Earth's surface, while UAV remote sensing involves sensor-carrying drones that collect data at low altitudes, offering the advantages of high resolution and flexibility. UAV remote sensing system is mainly composed of flight platform, remote sensing sensor, positioning navigation system and data transmission system, which uses the sensor to receive the electromagnetic wave information of the ground, and then obtains the relevant characteristics of the ground after data processing and analysis. Drones can quickly acquire extensive and accurate data and support accurate management [6]. The sensor captures image data in different wavelength bands, which is subsequently processed and analyzed to extract useful information. The technology is widely used in agriculture, environmental monitoring, urban management and disaster response. The steps of UAV remote sensing to acquire information are shown in Fig. 1.

Agricultural drone remote sensing is a technology that utilizes a drone platform with sensors and camera equipment, such as optical, infrared, lidar, multispectral and hyperspectral sensors, to collect and analyze data in the agricultural field. It can be used for drought detection, pest and disease monitoring, weed monitoring, growth vigor and biomass monitoring, nutrient status assessment, and yield prediction. Agricultural drone remote sensing technology can obtain accurate farmland data, and remote sensing technology can also monitor soil moisture, crop health, etc. in real time, thus helping farmers to carry out more accurate agricultural management [7].

Remote sensing technology for agricultural drones can not only improve the productivity and sustainability of agriculture, but also provide some new solutions to the problem of global food security. The technology has contributed significantly to agricultural development by reducing labor costs in agriculture and giving farmers more accurate decisions. China's vigorous development of agricultural drone remote sensing technology is one of the important means to promote China's agricultural modernization, and the technology has a high development prospect.

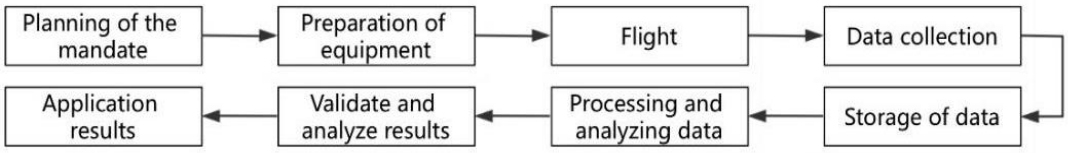

Fig. 1 Steps of UAV remote sensing to obtain information

2.2. Current status of application of UAV remote sensing in agriculture in China

The development of remote sensing technology for agricultural drones in China is a gradual evolutionary process. Drone technology was first utilized in the military in the late 20th century. After entering the 21st century the agricultural field began to utilize UAV technology for soil and plant

monitoring, but it is in the preliminary exploration stage, and the technology and equipment are not mature enough. With the development and advancement of drone technology and remote sensing technology, UAV remote sensing technology began to be formally applied to agriculture roughly after 2010. The range of applications continues to expand along with technological advances to cover a wider range of areas, while the cost and difficulty of operation have been further reduced. Nowadays, the country is also providing policy support to encourage the use of drone technology in agriculture. High-resolution image sensors, artificial intelligence and data analysis technologies have entered into UAV remote sensing, and the application of agricultural UAV remote sensing will be more intelligent and be able to meet the needs of more complex agricultural management. However, while the technology has flourished, a number of issues and challenges have arisen. Issues such as data privacy, technical standards, and legal regulation still need to be addressed to facilitate its wider application and promote the modernization of agriculture [8-11]. Overall agricultural drone remote sensing technology has a broad development prospect in China.

3. Problems and solutions to the development of UAV remote sensing in agriculture in China

3.1. Problems facing the development of UAV remote sensing in agriculture in China

Although China's agricultural UAV remote sensing technology has made great progress in recent years, there are still problems such as insufficient endurance and data processing and analyzing ability of the UAV platform, greater influence by weather factors, imperfect UAV regulatory system, higher popularization cost, and data security.

First, in terms of data processing, the UAV platform range and data processing and analyzing capabilities are insufficient. While drones are capable of collecting large amounts of data, the processing of that data consumes a lot of power. Agricultural drones are generally small and have poor range to support their complex data analysis. At the same time, if the farmland that requires the use of UAV remote sensing technology is in complex terrain such as mountains or hills, the terrain will affect the accuracy of the extracted information, and the ability of this technology to accurately extract the information of the farmland in complex terrain still needs to be improved [12-14].

Secondly, in terms of the impact of weather, UAV platforms are highly influenced by weather factors. When encountering bad weather such as high wind, rain and snow, it will cause the UAV's fuselage to sway or even fall, affecting its safety, and in serious cases, the UAV will not be able to take off, affecting the efficiency of the work [15].

Third, in terms of laws and regulations, China's drone regulatory system is not perfect. Different regulations in different regions may hinder the widespread diffusion of this technology. The laws and regulations governing the use of drones in agriculture are also limited and the coverage is not comprehensive enough. UAV remote sensing needs to collect a large amount of geospatial data, which may cause data security leakage problems and even threaten national security [16,17].

Finally, the promotion of remote sensing technology by agricultural drones is relatively lagging behind in terms of large-scale diffusion of the technology. Many farmers do not have enough knowledge about it, and the promotion requires professional operator guidance and placement of related equipment, which is relatively costly and may affect farmers' willingness to choose to use the technology [18].

3.2. Solutions to related problems

First, for the problem of insufficient data processing and analyzing capabilities of UAV platforms. We can encourage research institutions and enterprises to jointly develop specialized software for agricultural data processing, and at the same time establish an open data processing platform for data sharing, and we can also try to use artificial intelligence technology to improve the efficiency and accuracy of data processing [19,20]. Addressing the weak range of UAV platforms. Mobile base

stations for power exchange for drones can be constructed so that drones can quickly change their batteries during operations, reducing stoppages due to insufficient power and improving their work efficiency. High-performance batteries, such as new long-endurance lithium batteries, can also be introduced to improve the range of the drone and reduce the frequency of power changes.

Second, to address weather and environmental issues. Relevant equipment can be developed to acquire meteorological data in real time and mounted on the drone platform to improve the ability to cope with sudden weather changes, and to cooperate with meteorological departments to keep abreast of weather information and reasonably plan drone operation time based on the prediction of weather conditions [21].

Third, to address the problem of the imperfect regulatory system for drones in China. China needs to improve the laws and regulations on the regulation of drones, implement effective regulatory measures to ensure the safety of drone operation and avoid illegal and non-compliant operation behavior. Meanwhile, to prevent the leakage of important information, relevant laws can be introduced to strengthen the regulation and encrypt the data to ensure the security of flight data and farmland information [22-24].

Finally, it addresses the high cost of technology diffusion. The government should build a drone training and education system for farmers, and offer different stages of courses for different levels of farmers, as well as set up an incentive mechanism to improve the learning motivation of farmers and promote the large-scale promotion of remote sensing technology for agricultural drones [25].

4. Prospect

Agricultural drone remote sensing technology has a broad development prospect in China, China as a largely agricultural country needs to promote the modernization of agriculture and improve labor efficiency, the technology can provide strong support. For the future development of China's agricultural drone remote sensing technology, the problems and challenges that arise today should be addressed, making full use of the convenient and flexible characteristics of the drone platform to maximize its role [26]. Regarding the prospects for the development of remote sensing technology for agricultural drones, one is the popularization of precision agriculture, which, through real-time monitoring and data analysis, can help farmers make timely production management decisions, reduce resource wastage and improve crop yields. The second is to improve the ability of data integration and intelligent analysis and to utilize artificial intelligence and other technologies for data processing and diversified analysis, to improve the efficiency and accuracy of decision-making. In general, agricultural drone remote sensing technology has brought new opportunities for the modernization of China's agriculture, and the technology should be fully allowed to serve China's agricultural development, thus accelerating the construction of China's agricultural power.

5. Conclusion

This paper mainly summarizes and puts forward the problems arising from the application of UAV remote sensing technology in China's agriculture nowadays, and puts forward some solutions and suggestions for the problems that have arisen. This paper finds that nowadays, the application of UAV remote sensing technology in China's agriculture has the problems of insufficient endurance and data processing and analyzing ability of the UAV platform, being affected by weather factors, imperfect UAV regulatory system, high popularization cost, and data security. Solutions such as developing software, sharing data, the need to improve laws and regulations on drone regulation, and building a drone training and education system were proposed. This paper mainly reviews a large number of domestic papers, but the development of this technology abroad is not sufficiently elaborated. Hopefully, it can provide some reference for the future development of China's agricultural UAV remote sensing technology, so that UAV remote sensing technology can be better integrated into the process of China's agricultural modernization in the future.

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