Current Perspective on Different Structure Design of Unmanned Aircraft in Intelligent Agriculture

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Abstract. With the progress and development of modern science and technology, people's productivity and work efficiency in agriculture has been constantly improving. One reason for this is the use of drones. Over the years, people have been optimizing the various structures of drones to ensure that they can better play a role in smart agriculture. For example, different agencies of unmanned aerial vehicle (UAV) are responsible for pesticide spraying, field measurement and biomass estimation, which are all dependent on the precise design of UAV structure. Some of the components involved are different for different purposes, but they are fundamentally the same: the need for a platform -- a drone. In this paper, the structure of UAV is reformed so that it can meet the different requirements of today's intelligent agriculture to a greater extent. At the same time, from the advantages and disadvantages of each structure, to improve the structure and discuss the future development and trend of agricultural UAV. At the same time, this paper also introduces some specific parts of UAV in detail, so that readers can further understand the role of these structures for UAV in different scenarios, so as to better help people to choose the right and correct UAV for different occasions. This part is also mainly focused on agriculture.

Keywords: UAV, Intelligent Agriculture, Structure

1 Introduction

Agriculture is a vulnerable industry affected by natural conditions and social and economic factors. It requires comprehensive information support at all stages of production and farm operation. In this context, the application of UAV in the agricultural field has attracted much attention because of its ability to provide multi-category and all-round information support. However, the construction of agricultural drones involves not only the drone itself, but also several basic components, resulting in a wide range of functions and capabilities.

A key component of every drone is its flight controller, which is central to its operation. Flight controllers vary for different types of agricultural drones because they are designed to control specific parts of the aircraft, not just takeoffs and landings. For example, industrial drones used for tasks such as ranging, and measurement require specialized sensors and controllers to ensure accurate data collection. Instead, drones

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used for observation or filming prioritize high-quality cameras to maximize their efficiency in the desired area. As UAV technology continues to advance, many structural improvements have been made to improve its performance. This paper aims to explore the different structural designs of unmanned aerial vehicles customized for various agricultural applications. In addition, it also tries to put forward a new concept of UAV structure upgrading and optimization and analyzes its development direction and future prospects in the agricultural field. By examining these aspects, this paper aims to clarify the advantages offered by UAVs and identify potential obstacles that may affect their future agricultural development [1, 2].

The discussion of different structural designs will cover various types of UAVs, including fixed-wing, multi-rotor and hybrid designs. Each structure has unique characteristics and advantages suited to specific agricultural tasks. Inspired by traditional aircraft, fixed-wing UAVs excel at large-scale monitoring and mapping operations, covering a wide area and capturing high-resolution images. Multi-rotor UAVs with vertical takeoff and landing capabilities offer excellent maneuverability and accuracy, making them ideal for close inspection and targeted intervention [3]. The hybrid design combines the advantages of fixed-wing and multi-rotor configurations, extending flight time and flexibility for different agricultural scenarios.

In addition to discussing existing structural designs, this paper will also propose innovative ideas for upgrading and optimizing UAV structures. The goal is to leverage emerging technologies and trends to improve the performance, efficiency and versatility of agricultural UAVs. In addition, the analysis will consider the future prospects for drones in agriculture and explore how they can help address key challenges facing the industry. While drones offer many advantages for future agricultural development, it is important to recognize the potential obstacles that could arise. Obstacles include regulatory issues, privacy concerns, and the need for specialized training and knowledge to operate drones effectively. By identifying and addressing these challenges, stakeholders can ensure the responsible and widespread adoption of UAVs in smart agriculture.

Therefore, in intelligent agriculture, the structural design of UAV plays a crucial role in its performance and function. By studying different designs and considering innovative concepts, researchers and engineers can unlock the full potential of UAVs in optimizing agricultural practices. With continued advances in technology and a focus on overcoming obstacles, drones have the potential to revolutionize agriculture, promote sustainable agricultural practices and contribute to global food security. Figure 1 showed A mind map to classify different types of drones and different parts of drones.

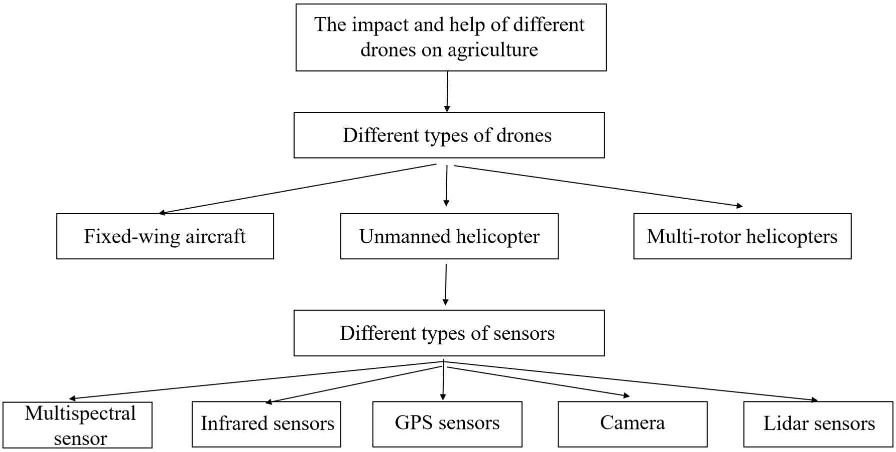

Fig. 1. A mind map to classify different types of drones and different parts of drones

2 Related Works

First, we need to understand how drones could be used in the future of agriculture and what different jobs they could do in different configurations. The first step is the choice of flight platform. First of all, UAVs are mainly divided into three categories: fixed-wing aircraft, unmanned helicopter and multi-rotor UAV. Different types of drones are used in different areas. The fixed-wing aircraft is characterized by its high speed and long flight time, but its maneuverability is relatively poor. Therefore, fixed-wing UAVs are often used for surveying, searching and patrolling large areas. Compared with fixed-wing UAVs, multi-rotor UAVs use multiple propellers to generate lift to drive the aircraft to move. Therefore, it also has extremely high maneuverability, and can hover in the air, vertical takeoff and landing characteristics. But its smaller fuselage also contributed to its poor endurance. Therefore, it is more suitable for plant identification, more accurate land survey, and better photography. Unmanned helicopters are bigger and more stable than the former. Therefore, it is suitable for the field of pesticide dispersal, pollen transfer and so on [4]. In a word, different structures of UAVs have their own advantages and disadvantages. Only when they are respectively used in their corresponding fields, can they play their maximum role and ultimately lead to efficient and high-quality agricultural work. Figure 2 represented a fixed-wing aircraft, unmanned helicopter, and multi-rotor UAV.

Fig. 2. Different types of aircraft (https://pilotinstitute.com/wp-content/uploads/2021/08/Fixed-wing-aircraft.jpg)

The Selection and Use of Different Airborne Sensors for UAVs. There are many different types of sensors in UAVs, and their corresponding functions and effects are also different. There are five main types of sensors that we see today [5].

a. Multispectral sensors: These sensors measure the reflectance of different wavelengths of light to provide information about the health and growth of crops. For example, multispectral sensors can detect the chlorophyll content and vegetation cover of crop leaves to help farmers determine the extent to which crops are dehydrated or fertilized.

b. Infrared sensor: This sensor measures the infrared radiation of the crop to provide information about the moisture content and temperature of the crop. For example, infrared sensors can measure the leaf temperature of crops, helping farmers detect how hot their crops are and take timely measures.

c. GPS sensors: These sensors determine the location and altitude of drones, allowing farmers to more accurately map the land and assess crop growth. For example, GPS sensors can help farmers map their land across different plots and calculate crop yields for each plot.

d. Camera: This sensor can take high-definition photos or video to provide visual information about how the crop is growing. For example, cameras can take images of crops and help farmers monitor their crops for pests and diseases.

e. Lidar sensors: These sensors measure terrain and altitude to provide three-dimensional information about the land and crops. For example, lidar sensors can help farmers determine the slope and elevation of their land to better plan crop planting and irrigation schemes.

2.1 Flight Control of UAV

The control of UAVs is usually achieved by remote control or autonomous flight control system [6].

Remote control: Remote control is one of the most common control methods. Usually, the transmitter mounted on the remote control sends wireless signals to the UAV, and the UAV realizes control by receiving signals. The remote control usually has two joysticks, one to control the altitude and direction of the aircraft, and the other to control the steering and tilt Angle of the aircraft. Remote controls need to be manned and are suitable for smaller UAVs, because larger UAVs require more complex operations and more precise controls, so more advanced control systems are needed.

Autonomous flight control system: An autonomous flight control system is a computer system, usually attached to a drone, that runs a preset program to control its flight [7]. The system contains sensors such as gyroscopes, accelerometers and GPS, which are used to collect information about the current state of the aircraft, and then control the behavior of the aircraft according to preset algorithms and procedures. The autonomous flight control system does not require human intervention, so it is suitable for drones that need to fly for a long time, long distance and with high precision.

3 Discussion

3.1 The Advantages and Disadvantages of Using Drones

The use of drones in smart agriculture has further improved productivity. Drones can carry out quantitative and qualitative analysis of crops by carrying equipment such as high-resolution cameras and sensors, helping farmers better monitor crop growth and soil nutrition, so as to better manage farmland and improve production efficiency. At the same time, it can also save a large part of the labor cost and can complete many tasks that need to be completed manually. Most importantly, the use of drones can protect the environment to some extent [8]. That's because when drones spray pesticides or fertilizers, they can deliver precise chemicals to crops, reducing environmental pollution from over spraying and reducing pesticide residues. However, the drawbacks of drones are also obvious. The first is its high cost. The price of drones is usually higher than that of traditional agricultural management equipment, and they also require professional training and maintenance, increasing the economic burden on farmers. At the same time, UAV has certain requirements for control technology, which requires professional technology and operation. So not everyone can grasp it. In general, the application of UAV in agriculture has brought a lot of benefits to agricultural production, but at the same time, some technical and economic limitations need to be overcome in order to achieve wider application.

3.2 UAVs in Future Smart Agriculture

With the continuous progress of human science and technology, the development prospect of UAV technology in the future of intelligent agriculture mainly has several aspects.

Autonomous and intelligent: In the future, drones will be more autonomous and intelligent, able to automatically identify crop types and growth conditions in the field and carry out agricultural operations according to the actual situation, such as automatic fertilization, spraying, and weeding [9].

Big data analysis: With the continuous improvement of data acquisition and processing technology, drones can collect a large amount of agricultural data in the future and improve the efficiency and quality of agricultural production through data analysis and algorithm optimization [10].

Versatility: In the future, drones can have multiple functions at the same time, such as farmland survey, crop monitoring, fertilization and spraying, water resources management, grass monitoring, which can realize intelligent management of the whole process of agricultural production.

Intelligent agricultural system integration: In the future, unmanned aerial vehicles can be integrated with other intelligent agricultural systems, such as intelligent irrigation, intelligent greenhouse, intelligent feed feeding, to jointly form an intelligent and efficient agricultural production system.

3.3 Improved Perspective on UAV

Battery life problem. Battery life is a problem that people are trying to solve. The working time of UAV directly determines the working efficiency of UAV. So this is very important.

There are enhancement and enhancement of graph signal. The enhancement of image transmission signal can greatly improve the flight distance, so as to further realize the efficient completion of UAV tasks.

The development and discovery of new technologies. Unlike cars, drones have their own systems, which can be constantly upgraded and perfected. Therefore, only continuous optimization of the system can reduce the error more likely. For example, to fix some bugs or to become more sensitive to certain recognition functions.

4 Conclusion

In summary, this paper summarizes the status quo and development trend of intelligent agricultural UAV design. Research has shown that a variety of structural designs have been used in the field, each with its own advantages and limitations. Through the study of various approaches, it is clear that there is no one-size-fits-all solution, and that the choice of structural design depends on the specific agricultural needs and operational requirements.

On this basis, the future direction of its development is to establish a comprehensive framework to evaluate the performance and efficiency of different structural designs. This may involve conducting field experiments and collecting empirical data to assess factors such as flight stability, payload capacity, energy consumption and maneuverability. By doing so, guidance or advice can be provided for selecting the most appropriate structural design for different agricultural applications.

The significance of this review lies in its contribution to advancing smart agriculture. The integration of unmanned aircraft systems has the potential to revolutionize agricultural practices by enabling effective monitoring, data collection, and targeted interventions. By examining current perspectives on structural design, this review provides valuable insights for researchers, engineers, and practitioners engaged in the development and implementation of unmanned aircraft in agricultural environments. It promotes a better understanding of the strengths and weaknesses of different designs, promotes informed decision-making, and facilitates the development of more effective and sustainable solutions for smart agriculture.

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