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Survey Paper on Role of Drone In Modern Agriculture

Nandashree N. Koujalagi[1], Savitri Y. Sonnad[2], Mr. Vinod Kokitkar[3]

Department of MCA, K. L. S. Gogte Institute of Technology, Belagavi, Affiliated to Visvesvaraya Technological University, Belagavi, Karnataka, India[1]

Department of MCA, K. L. S. Gogte Institute of Technology, Belagavi, Affiliated to Visvesvaraya Technological University, Belagavi, Karnataka, India[2]

Department of MCA, K. L. S. Gogte Institute of Technology, Belagavi, Affiliated to Visvesvaraya Technological University, Belagavi, Karnataka, India[3]

Abstract: The use of drones in agriculture has gained attention in recent years as it has the potential to significantly improve traditional farming practices. Drones, also known as unmanned aerial vehicles (UAVs), offer several benefits that can improve crop productivity and quality while reducing labor costs and environmental impact. Modern management in sustainable agriculture requires rapid information on crop status and rapid response to undesirable events. Indian agriculture faces numerous challenges Productivity decline, climate change, global warming and loss of natural resources, labor shortages, pandemic situations. Drones contribute to agricultural sustainability from social, economic and ecological perspectives. Drones can be used for soil analysis, crop growth and establishment, accurate application of agricultural inputs, plant disease identification, irrigation monitoring, plant health assessment, livestock care and disaster monitoring, plant biomass for agriculture and damage assessment and material transportation. Studies around the world have shown that drones save time, labor, water and reduce chemical costs.

Keywords: Drone, Modern Agriculture, Environmental Impact, Farming.

I. INTRODUCTION

Agriculture is the backbone of our country. Most of the grain is supplied to cities from rural areas. Currently, it is difficult to farm using traditional methods. Therefore, it is essential to adapt to modern farming methods to reduce labor costs, time etc. and improve crop productivity. In the end, the farmers benefit. The purpose of this document is to provide an overview of agricultural drones, one of the modern forms of agriculture.[1]

Drones are reliable, high-quality flying tools that farmers can use to inspect farm conditions at the beginning of the crop year. Drones create his 3D maps for soil analysis and help farmers carefully cultivate seeds. Soil and field analysis using drones also provides data that can help control irrigation and field nitrogen levels to improve crop growth.[2]

One of the main benefits of using drones in agriculture is that they can provide real-time, high-resolution data on crop health. By using sensors and cameras onboard drones, farmers can monitor their crops more efficiently and easily. This data can be used for a variety of purposes, including identifying areas of crop stress, predicting yields, and detecting the presence of pests and diseases in specific areas. Additionally, drones can be used to precisely apply pesticides and fertilizers to crops, reducing chemical usage and minimizing environmental damage and consumer health impacts. The use of drones in agriculture reduces labor costs and increases efficiency by automating tasks that would otherwise require extensive manual labor, such as crop mapping, monitoring, spraying, and even irrigation management. You can also increase it. These benefits are numerous and impactful and have the potential to significantly improve crop production and sustainability. Drones can also collect data on factors such as soil moisture, nutrient levels and temperature, helping farmers make more informed decisions about irrigation and fertilization. Collecting this data in real time allows farmers to respond quickly to changes in their crops and make any necessary adjustments.[3]

II. TYPES OF DRONES IN MODERN AGRICULTURE

Different types of agricultural drones have been studied in detail based on their characteristics. A comparative analysis has also been conducted to draw conclusions about the types of drones used for agricultural activities.

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Furthermore, a short list of drone manufacturers is presented and a brief discussion is given on the effective integration of drones in the agricultural sector in terms of best practices. There are different types of agricultural drones, which are discussed in sections A-D. [1]

A. Multi Rotor

Multi-rotor drones are the simplest form of drones with features such as top view image framing. Multirotor drones allow you to control the shooting position, which gives you more accurate results. The disadvantages of multirotor are their low durability and speed. Multicopter drones, with multiple rotors for increased lift and stability, are widely used aircraft for a variety of applications due to their versatility and ease of control. Common configurations include four-rotor quadcopters, six-rotor hexacopters, and eight-rotor octocopters, each with different degrees of stability and payload capacity. For this reason, this kind of drone is only used for some agricultural activities. The following figure 1 shows the structure of a multi rotor[1].

Fig.1. Multi-Rotor

B. Fixed Wing

Fixed wing rotor drones use a wing-like structure for operation. Fixed wing rotor drones use airplane-like wings and have a different launch method than other drones. First, they need inertia generated by an external force to take off. This characteristic again limits these drones to only some agricultural activities.[1]

Fig.2. Fixed-Wing

C. Single rotor helicopter

Single rotor helicopters have many advantages compared to other types of drones. They are equipped with a gas control system to ensure a longer service life. The laws of aerodynamics dictate that a system with larger rotor blades will rotate

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less and the system will be more efficient. This is why single rotor helicopters are more efficient compared to other types of drones. Single rotor helicopters have an advantage in agriculture because of their long rotor blades. The structure of a single rotor helicopter is shown in Figure 3.[1]

Fig.3. Single rotor helicopter

D. Fixed Wing Hybrid VTOL

Fixed-wing hybrid VTOL (vertical take-off and landing) drones combine the functionality of a UAV (unmanned aerial vehicle) with the ability to hover in one place while maintaining hybrid functionality. This feature allows these types of drones to take off from one location and stay vertically over a particular area as shown in Figure.4.[1]

Fig.4. Fixed wing hybrid VTOL

III. LITERATURE REVIEW

Drones, also known as unmanned aerial vehicles (UAVs), have attracted significant attention in recent years due to their potential to revolutionize agricultural practices. Their ability to capture high-resolution images and collect data across vast fields has made them an essential tool for farmers, agronomists, and researchers.

MR Dileep (2020) highlight the diverse uses of drones in agriculture, including crop monitoring, pest detection, and yield estimation. Equipping drones with multispectral and thermal imaging cameras allows researchers to assess crop health indicators such as chlorophyll levels, water stress, and pest infestation with unprecedented accuracy and efficiency.[1]

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Anand Nayyar (2017) address technological advances that facilitate the use of drone technology in agriculture. They discuss how improvements in drone flight stability, battery life, and payload capacity have expanded capabilities to enable farmers to collect timely data and make informed decisions throughout the growing season. [2]

In their review, MC Ahire (2020) highlight the integration of drones with other technologies for precision agriculture, such as Combining aerial imagery with spatial data and predictive analytics allows farmers to optimize inputs, minimize environmental impacts, and maximize crop yields.[4]

Furthermore, the cost-effectiveness and efficiency of drones compared to traditional methods of crop monitoring and management. For example, R Ramraj(2018) conducted a comparative analysis of drone-based and ground-based methods for estimating crop yields and concluded that drones offer a more accurate and time-efficient solution.[7]

Additionally, researchers have explored the regulatory and logistical challenges associated with the widespread adoption of drones in agriculture.The drone uses a consistent memory that stores the latest statistics on previously visited areas. Each time the drone transmits a map, the data on where it is currently located is updated. The drone itself deletes useless records, so that the intelligent drone can finally choose the next step. The intelligent drone records the inspected environment and selects a route that is not inspected. The smart drone selects the unmarked area that is closest to the drone. The parasite's migration technique basically works by allowing the presence of plants to monitor the parasite independently of the movements of other animals. He has a limited field of vision of his surroundings. Once the parasite has infested a plant, it will remain active until the plant dies. If it is in an area of a field without plants, it will wait until it finds a plant.[5]

IV. APPLICATIONS OF DRONES IN MODERN AGRICULTURE

A. Soil and Field Analysis

Drones can be used to obtain useful data at every stage of the crop cycle. By creating a 3D map of the existing soil, potential soil quality, nutrient management and dead zones in the soil can be monitored. This information helps farmers determine the most effective patterns of planting, crop management, soils, etc. Continuous monitoring can help make better use of water resources and manage nutrient levels for crops more effectively.[6]

B. Seeds Planting

Although drone planting is a new technology and not yet widely adopted, some companies are experimenting with drone planting. Essentially, manufacturers are experimenting with custom systems that can launch seed pods into prepared soil. Drone startups have helped develop unique drone technology that can help solve a variety of environmental and agricultural problems. Example: Drone Seed. The same drone technology can be adapted and applied to a variety of farms, reducing overall planting times and overall labor costs.[6]

C. Plant Protection and Spot Spraying

This is the most important process in a crop's life cycle. For plants to achieve high yields, they need regular fertilization and spraying. Traditionally, this is done manually, using vehicles or even planes.These methods can be inefficient and laborious as well as very costly. Drones can be equipped with large tanks that can be filled with fertilizers, herbicides and pesticides. Using drones to spray fields is much safer and more cost-effective. Drones can also be operated fully autonomously and programmed to fly according to specific schedules and routes.[6]

D. Crop Mapping and Measurement

One of the great benefits of drone technology is its effectiveness in large-scale monitoring of crops and growing areas. Until now, satellite or aerial imagery has been used to provide a large-scale overview of farms while identifying potential problems. However, these images were not only expensive but lacked the accuracy that drones can provide. Now, not only can real-time footage be captured, but also time-based animations that show the progress of crops in real time. Drone mapping and surveying now allows technology decisions to be made based on real-time data rather than stale imagery or proven guesses. Near infrared (NIR) drone sensors can be used to determine plant health based on light absorption and provide an overview of the overall health of the farm. Agricultural drones can be used to collect information such as general crop and plant health, area distribution based on crop type, crop life cycle, and detailed GPS maps of current crop areas.[6]

E. Real-time Livestock Monitoring

Some drones are equipped with thermal imaging cameras, allowing a single pilot to manage and monitor livestock. This allows farmers to monitor their livestock more frequently with less time and manpower. The drone pilot can quickly

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check the herd to see if any animals are injured or missing, or to check on animals that are giving birth. Additionally, thermal cameras also help to watch for predators, which can be a major advantage for some farm owners.[6]

F. Irrigation Monitoring and Management

Irrigation has always been an issue for farmers. When irrigation systems stretch for miles, problems are bound to arise. With this information, plants can be better designed to maximize drainage, accommodate natural runoff, and avoid pooling of water that can damage delicate plants. Water and irrigation problems are not only costly, they can also erode crop yields. Drone surveys can help detect these issues before they become a problem.[6]

V. BENEFITS OF DRONES IN MODERN AGRICULTURE

1. Useful and adaptable technology: The use of drones gives farmers regular, up-to-date information about their crops, helping them develop improved agricultural techniques. They can adapt to weather conditions and allocate resources more efficiently.[3]

2. Increased Safety for Farmers: It is safer and more convenient for farmers to use drones to spray pesticides on hard-to-reach areas, infected areas, tall crops and power lines. Also, farmers can avoid spraying crops, which reduces contamination and chemicals in the soil.[3]

3. Increased Production: Farmers can improve their production capacity through comprehensive irrigation planning, proper monitoring of plant health, improved knowledge of soil health and adapting to environmental changes.[3]
Reduce resource wastage: Agriculture drones allow optimal use of all resources such as fertilizer, water, seeds, pesticides, etc. [3]

4. 99% Accuracy: Drone surveying helps farmers calculate the exact size of the plot, segment different crops and perform soil mapping.[3]

5. Insurance Company Verification: The agricultural insurance sector uses Agrid drones for efficient and reliable data. It records the damage caused to enable a correct assessment of financial compensation to farmers.[3]

6. Helps in Insurance Claims: Farmers use the data collected by drones to purchase crop insurance in case of any damage. They also calculate the risk/loss associated with the land while it is insured.[3]

VI. CHALLENGES OF DRONES IN MODERN AGRICULTURE

There are several challenges that hinder the use of drone technology in agriculture. These challenges need to be addressed for effective adoption:

1. Internet accessibility: Poor internet connectivity makes it difficult to use digital technologies such as drones.[6]

2. Weather Irregularity: Under normal weather conditions, drones work better and more efficiently than human operators. However, it is not advisable to fly drones in extreme weather conditions due to the increased risk of crashes and reduced accuracy of operation.[8]

3. Knowledge and Skills Required: Although the use of new technology is encouraged, drones require necessary skills and expertise to be require necessary skills and expertise to be used regularly.[6]

4. d.Regulatory Uncertainty: Regulations regarding the use of drones are still being developed. As standards for approved pesticides are set, drones for spraying pesticides on agricultural land will be deployed more quickly.[6]

5. High capital costs for drones: Training and use in agriculture is more expensive. Manufacturing is done on a small scale with large fixed costs. It is not economically viable for village entrepreneurs to buy/rent drones to use for surveying/agricultural applications. [6]

6. Limited flight time and battery range: Due to their large payloads, drone flights often last 20-60 minutes. This limits the field range per charge and increases the drone's operating costs.[8]

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7. Pilot shortage: Besides technical know-how and price, shortage of trained pilots is also a major obstacle to the expansion of the UAV market in India. Farmers can afford Agrid drones, but battery technology makes maintenance expensive.[8]

8. Technical and economic feasibility: With farmers largely marginalized and land ownership fragmented in India, technical and economic feasibility may hinder widespread adoption of drone applications. [6]

9. Safety and ease of use: For safety reasons, drones cannot be operated in public places without prior government approval. Significant concerns regarding national security, crime, security and privacy.[8]

10. Import Dependency: Inadequate start-up capital and insurance, as well as a lack of investment in drone research and development, result in a high reliance on imported drone parts.[6]

11.Long-term Profitability and Operational Costs: From a business perspective, it is difficult to justify the profitability of drones in the agriculture sector. Replacing destroyed UAVs, sourcing high-resolution imaging lenses, and the associated technical solutions and other maintenance costs are all ways of compensating. This makes it difficult to connect with farmers and agri-entrepreneurs. [8]

12. Privacy Issues: Many are concerned that the use of unmanned aerial vehicles (UAVs) for tracking and surveillance will infringe on privacy. One of the main problems is the lack of defined operational and technical standards for the safe operation of UAVs. There is a risk that they could be misused to violate people's privacy or transmit information illegally.[6]

VII. CONCLUSION

In this article, we will discuss the broad categories of drones for agriculture. We will discuss the different categories of drones for agriculture based on their features, type of work, cost, and requirements. Many types of drones are found to be suitable for carrying out various activities in agricultural areas.

Apart from agriculture, there are many other related activities such as poultry farming, sericulture, fishing, etc. In these sectors too, drones play a vital role to carry out important and crucial activities. Drones are mainly used in agriculture for information gathering, reporting, certain physical activities, animal monitoring, crop information, pesticide spraying, etc. Overall, the use of drones in agriculture and related industries opens the door to smart agriculture. Percentage of drone use in agriculture sector in different regions of the world.

In conclusion, the use of drones in agriculture offers significant potential benefits, including increased efficiency, reduced labor costs, and improved sustainability. Although there are challenges and limitations associated with their use, including technical limitations, regulatory issues, and privacy concerns, ongoing technological advances and the integration of artificial intelligence offer even greater potential benefits, including improved decision-making and increased automation. Thus, the use of drones in agriculture represents a promising opportunity for farmers and farms to optimize their operations and contribute to a more sustainable future.

It is important to note that the use of drones in agriculture is still a relatively new and developing field, and there is still much to be studied and understood. Continued research and development in this field is essential and necessary to realize the full potential of drones in agriculture and address the challenges and limitations associated with their use. With continued investment in research and development, the use of drones in agriculture is expected to continue to develop and expand, bringing even greater benefits to farmers, businesses and the environment.

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