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Agricultural Drones: A Revolutionary Advancement in Farming

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Abstract

Agriculture is often considered as the backbone of our economy. With the growing population and subsequent shrinkage in agricultural land, there is a need for increasing the efficiency of crop cultivation practices to reach the optimum level.

Incorporating novel technologies like that of drones in agricultural operations, farmers can increase efficiency, reduce costs and improve the crop yields through a more precise and informed manner. A drone also known as an unmanned aerial vehicle (UAV), have multiple advantages in comparison with other remote-sensing technologies such as its high quality and high-resolution pictures even on cloudy days along with adequate data regarding crop health proves beneficial for early detecting of various disease and pest infestations. This article provides an overview of various aspects of drone, its origin, technical considerations, potential applications in agriculture, benefits, challenges and future prospects.

Keywords: Drone, crop health, unmanned aerial vehicles, agricultural drones

Introduction

The growing importance of agriculture lies in its ability to address critical global challenges, from feeding a growing population to ensuring environmental sustainability and global stability. A lack of manpower, a growing population and a diminishing size of farm areas is compelling farmers to look for a more precise way of farming which can ensure optimum level of production along with reduced crop losses. The expansion of smart agriculture is largely driven by agricultural robots, with unmanned aerial vehicles (UAVs) being particularly widely used. UAVs have significantly reduced working hours with increased efficiency, productivity and sustainability. Many agricultural activities are threatened by pests and diseases, water scarcity, labor shortages and many more, these threats could be addressed with the instalment of drones.

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Origin of drones and its introduction to agriculture

The concept of drones began in the early 20th century. The Kettering Bug, developed during World War I, was one of the first attempts at creating a UAV. During World War II, drones like the Queen Bee and the Radioplane OQ-2 were developed primarily for target practice.

Drones have been used in agriculture since the early 2000s but it wasn't until 2010s that the technology became widespread enough for the farmers to employ it in their fields. As technology advanced, agricultural drones started to be utilized for additional activities such as crop monitoring and crop spraying. Over the years their applications has been changing. Since the early 20th century, aerial photography has been employed in agriculture to survey and map farmland, monitor crop growth, and detect potential issues like pests or irrigation problems. By using aircraft and satellites to capture images of crops and fields, farmers can more efficiently and accurately oversee vast areas of land compared to inspecting the fields on foot. In recent years, drone technology has seen substantial growth in agriculture. Advances in technology have made drones more affordable and user-friendly, resulting in their increased adoption by farmers. Today, drones are employed for various purposes, including crop spraying, monitoring, mapping, and precision agriculture. The integration of GPS and other technologies in agricultural drones has significantly enhanced the accuracy and efficiency of tasks such as crop spraying, monitoring, and mapping.

Fig. An agricultural drone

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Initiative to promote Drone technology

The Drone Scheme, introduced on September 30, 2021, is part of the Production-Linked Incentive (PLI) Scheme designed to encourage the production of drones and drone components in India. The Drone Scheme aims to create a robust domestic drone manufacturing industry.

The Indian government has introduced policies to support drone technology for farmers, such as the NaMo Drone Didi Scheme. This initiative aims to supply 15,000 drones to women self-help groups (SHGs) between 2024 and 2026.

These schemes and policies have been playing a crucial role in encouraging the farmers as well as the producers for production of drones and drone components in India.

Technical aspects of a drone

1. **Sensors and Imaging Technologies**
   - **Cameras:** High resolution cameras are used for capturing detailed images and videos.
   - **LIDAR (Light Detection and Ranging):** Uses laser pulses to create detailed 3D maps of the terrain, useful for topographical surveys and forestry.
2. **Navigation and Control Systems:** The GPS (Global Positioning System) provides precise location data, essential for accurate flight paths and automated missions.
3. **Communication Technologies:** Facilitate communication between the drone and the operator or ground control station.
4. **Data Processing and Storage:** Drones are equipped with storage solutions (SD cards or internal memory) to hold captured data until it is transferred for analysis.
5. **Power Systems:** Most drones use rechargeable lithium-polymer (LiPo) batteries, known for their high energy density and lightweight properties. Some advanced drones use hybrid power systems for extended flight times.
6. **Flight Dynamics:** Include features like GPS hold, altitude hold, and return-to-home, enhancing ease of operation and safety.
7. **Safety and Compliance:** Provides situational awareness by broadcasting the drone's position to other aircraft and air traffic control.

Various applications of drone in agriculture

1. **Crop monitoring:** Drones equipped with cameras and sensors can monitor crop health by capturing high resolution pictures and multi spectral data.

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2. **Field mapping and surveying:** Drones can create detailed maps of fields, including topography which assists in planning irrigation systems and assessing drainage issues as well.
3. **Precise agriculture:** Drones ensure precise application of fertilizers, pesticides and herbicides, reducing waste and environmental impact. They can target specific areas rather than treating entire fields uniformly.
4. **Irrigation management:** Drones equipped with thermal cameras can identify areas of a field that are over or under-watered, helping farmers optimize irrigation schedules and conserve water.
5. **Crop spraying:** Drones can spray crops with fertilizers, herbicides and pesticides more evenly and accurately than traditional methods, reducing chemical usage and labor costs.
6. **Data collection and analysis:** Drones can collect vast amounts of data that can be analyzed to gain insights into crop performance, soil health and other critical factors enabling data-driven decision making.
7. **Sustainable agriculture:** The use of drones in agriculture offers significant benefits for advancing sustainable practices. They enhance farming efficiency and contribute to achieving Sustainable Development Goals by improving agricultural management and monitoring.

Benefits

Like any technology, drones come with their own set of advantages and disadvantages that farmers should consider before making an investment. The advancements in drone technology and their decreasing costs have led to a rise in their use.

1. **Increased Productivity:** Agricultural drones play a crucial role in addressing the challenge of feeding a growing global population. By providing precise imagery of crop development, drones enable farmers to enhance productivity. This improvement is essential for fostering prosperity in smallholder communities and bolstering local economies.
2. **Reduced pollution:** Drones help farmers minimize agricultural runoff, leading to reduced pollution and less environmental impact.

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3. **Adapting to climate change:** As extreme weather events become more frequent, climate change posses new challenges for agriculture, affecting food security and productivity through droughts, floods, and storms. Drone technology aids farmers in adapting to these conditions, promoting sustainability.

Challenges:

Barriers to the widespread adoption of drones include:

1. **Safety Concerns:** Ensuring safe drone operations is crucial, as accidents or malfunctions can pose risks to people and property.
2. **Privacy Issues:** Drones equipped with cameras can raise privacy concerns, especially regarding the capturing of images or data from private properties without consent.
3. **Insurance Coverage:** Determining appropriate insurance coverage for potential damages or liability related to drone operations can be complex and costly.
4. **Operational Complexity:** The technology behind drones can be intricate, requiring specialized knowledge for effective operation and data interpretation.
5. **Cost:** The initial investment and ongoing expenses for drones, including maintenance and training, can be significant.
6. **Extreme Conditions:** Flying drones in adverse weather conditions or challenging environments can be difficult and may affect their performance and reliability.

Conclusion

Drone technology is revolutionizing agriculture by providing farmers with tools for precision management, efficient resource use, and improved decision-making. This transformation is driving increased productivity, sustainability, and innovation in farming practices. Their ability to provide detailed, real-time data and automate various tasks is driving innovation and efficiency across the agricultural sector. Drone technology is likely to see increasing acceptance within the farming community due to its benefits in efficiency, productivity, and sustainability. However, addressing challenges related to cost, complexity, and regulations will be crucial in facilitating broader adoption.

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