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Application of Drone Technology in Agriculture

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Abstract

The way farmers monitor and manage crops has been completely transformed by drones, also known as **Unmanned Aerial Vehicles** (UAVs), which are outfitted with sophisticated sensors and imaging capabilities. High-resolution imaging of vineyards and orchards made possible by aerial surveillance enables the early identification of pests, diseases, and other stressors that may have an adverse effect on crop health. Drone data collection enables targeted and precise interventions that maximise resource utilisation and raise crop productivity overall. Drones also aid in canopy management, yield estimation, and post-harvest monitoring. Even though the technology has many benefits, issues like payload restrictions, weather sensitivity, and regulatory compliance need to be resolved. It is anticipated that future research and technological developments will surmount these constraints, solidifying drones' status as essential instruments for the sustainable and effective management of crops. This article summarises the state of the art, identifies new directions, and describes potential future applications of drone technology in agriculture farming.

Introduction:

They give farmers an aerial perspective of their fields and offer high-resolution photos and information on pest infestations, crop health, and general field conditions.

With the help of this aerial viewpoint, farmers can practise precision agriculture by making data-driven decisions about pest management, fertilisation, and irrigation (Zarco-Tejada PJ *et al*., 2014).

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Drones help boost crop yields, save resource consumption, and increase efficiency. It can be used successfully in crops cultivation for many different purposes, such as managing water, managing crop disease and pest infestation, and managing soil fertility. Recent studies have demonstrated that the area that drone technology can cover is approximately 10 to 15 times larger than the area that can be covered by traditional land-based methods (Davies*et al*.,2015).

Aerial imaging and mapping

Robust sensors and high-resolution cameras on drones make it possible to record detailed aerial imagery over wide areas precisely. Aerial imaging offers a thorough overview of landscapes, infrastructure, and natural resources in domains like agriculture, urban planning, and environmental monitoring (Rejesus*et al*., 1999). This aerial imaging and mapping are likely to expand, contributing to more effective and sustainable resource management practices (Wang *et al*., 2003).

Precision agriculture

Drones with sophisticated sensors, cameras, and GPS systems give farmers a level of accuracy and productivity that was previously unthinkable. These unmanned aerial vehicles provide precise, real-time field monitoring in the agricultural domain, providing information on pest infestations, crop health, and nutrient levels (Ben-Gal A*et al*., 2009). Drones aid in the early detection and resolution of problems by providing high-resolution aerial imagery. This facilitates targeted interventions and maximises the use of resources like pesticides, fertilisers, and water. This lowers production costs, has a minimal negative impact on the environment, and increases crop yields.

Water management

Drone technology has brought about a significant transformation in agricultural water management. Drones with sophisticated sensors and imaging capabilities are now essential for evaluating and optimising field water usage. By precisely identifying areas with water stress or over-irrigation, these unmanned aerial vehicles enable precise adjustments to irrigation practices (Natu *et al*., 2016). Drone technology integration into water management plans is an example of a data-

driven, sustainable strategy that guarantees the prudent use of water resources while boosting agricultural output (Zhang *et al*., 2012).

Figure- Water distribution

Pollination assistance

Drone assistance with pollination is an innovative use of technology to solve problems in agriculture. Drones have emerged as potential allies in ensuring successful crop fertilisation due to the decline of natural pollinators and concerns about pollination efficiency (Huang *et al*., 2009). These unmanned aerial vehicles can transport and distribute pollen over crops like that of bees and other pollinators because they are equipped with specialised devices.

Fig.- Pollination assistance through drone

Drone technology can cover large areas quickly and lessen the impact of declining bee populations, which are just two benefits of using it for pollination. Drones can precisely navigate across fields, distributing pollen to particular plants and enhancing pollination (Primicerio*et al*., 2012).

Canopy management: Drones have become indispensable tools for managing fruit crops' canopy, which is a crucial component of crop optimisation. Drones with sophisticated imaging equipment give farmers an aerial perspective of vineyards and orchards, allowing them to monitor and control the density and arrangement of the plant canopy (Berni *et al*., 2009). Drones can capture high-resolution imagery, allowing for detailed analysis of the foliage and identifying areas of overgrowth, disease, or stress. This data aids in strategic pruning, thinning, and overall canopy manipulation to enhance sunlight exposure, air circulation, and fruit quality. This targeted approach not only improves fruit quality and yield but also contributes to resource efficiency by minimizing unnecessary interventions (Suryawanshi *et al*., 2022).

Fig.-Canopy management through drone

Inventory and yield estimation

Drone-based yield estimation has become a game-changing tool in horticulture, transforming the way farmers evaluate and tend to their crops. A unique aerial perspective made possible by drones fitted with high-resolution cameras and sensors makes it possible to monitor horticultural fields in great detail (Ren *et al*., 2020). Accurate yield estimation is made possible by the comprehensive data that these unmanned aerial vehicles can gather on fruit development, canopy density, and plant health. Farmers can detect differences in crop health and productivity throughout the field by using their ability to survey large areas quickly and effectively. Drone data is processed using sophisticated analytics software to create comprehensive maps and reports that support decision-making (Saha *et al*., 2018). In the end, yield estimation in horticulture using drones not only increases crop management efficiency but also supports sustainable farming practices by maximising output and minimising resource inputs (Egi *et al*., 2022).

Fig. Yield estimation through drone

Disease and pest surveillance

Drones with sophisticated sensor and imaging systems have shown to be very useful for monitoring agricultural crops for pests and diseases. Drones' ability to fly allows for the thorough and efficient monitoring of sizable vineyards or orchards, giving farmers a clear picture of the condition of their harvest (Upadhyaya *et al*., 2022). It is easier to implement timely interventions, like targeted pesticide application or disease management strategies, when the entire crop area can be surveyed quickly and precisely.

Fig.- Disease and Pest surveillance

Drones are especially useful for spotting patterns in the movement of pests or the spread of disease because they can cover big areas quickly (Surekha *et al*., 2020). With the use of specialist software, the data gathered by drones is processed to produce intricate maps that identify problem areas. Farmers can take proactive steps to lessen the impact of disease and pest threats and ultimately increase crop yields by integrating drone technology

into their disease and pest surveillance practices (Alam *et al*., 2022).

Limitation of drone technology

- The kinds of sensors or equipment that can be carried may be limited by the payload capacity due to the size, shape, and density variations in fruit crops (Alyafei *et al*., 2022).
- Another restriction is the requirement for skilled operators; people must receive training to operate drones and appropriately interpret the data they gather (Mandla *et al*., 2021).
- Furthermore, for smaller-scale farmers with fewer resources, the upfront costs of purchasing and maintaining drone technology, in addition to the costs of software and data processing, may be a barrier.
- The use of drones in agriculture may give rise to concerns about data ownership, security, and compliance with airspace regulations, which presents challenges in addition to privacy concerns and regulatory compliance.

Conclusion

India's agriculture could undergo major change as a result of drone technology. It is projected that future technological developments will drive down the cost of producing drones. The hard work and tedium of farming makes it unappealing to today's youth. Young people may become fascinated by drones and be motivated to pursue careers in agriculture. Additional uses for drones include the localization of weeds and diseases, the assessment of soil properties, the identification of vegetation, and the development of accurate elevation models. Drones will help farmers gain more knowledge about their fields. Farmers will thus be assisted in producing more food with fewer chemicals. Nearly all farmers who have employed drones have experienced some sort of gain. Drone technology in India has enormous potential in a number of industries. Drones have the potential to completely transform a range of industries, including logistics, healthcare, agriculture, and surveillance. They can also boost productivity and foster creative problem-solving.

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