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Scientific use of drone technology for better farming

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Abstract

At present days, precision agriculture has made several advancements that will boost agricultural output. In technologically sophisticated nations, drones are frequently used on fields to assist farmers as part of "Precision Agriculture," which is revolutionising farming. The challenge of contemporary agriculture is ensuring effective resource utilization, greater yields from agriculture, and ecologically viable practices. Drone technology has emerged as a possible solution to these concerns, with a catholic range of presentations that improve farming practices. This abstract presents a summary of drone technology's application in agriculture and it's probable to revolutionize existing farming methods. Drones, also known as unmanned aerial vehicles (UAVs), have grown reputation in agriculture due to their flexibility and capability to assemble high-resolution data across broad agricultural areas. Drones are at all piloted aircraft systems (RPAS) that have an engine system, a manager that can be programmed with or deprived of a satellite navigational system, controlled flight planning features, and the ability to carry payloads such as cameras, spraying systems, and so on. The drone may be operated wirelessly from a distance or it can be configured to follow a predetermined route by sequentially using positioning algorithms that have been built on onboard supervisors. Drone-captured real-time data enables farmers to make up-to-date choices about irrigation, fertilizer application and pesticide application. This data-driven method not only increases crop quality but also shrinkages resource waste, tumbling environmental impact. Farmers can construct comprehensive maps of their fields using drone technology and Geographic Information Systems (GIS).

Keywords: Drone, GIS, precision agriculture, RPAS, UAVs

Introduction

The nation's key occupation is the agricultural sector, but it remains far behindhand other countries in positions of instituting technologies for improved productivity on farms. Total investment in agriculture has increased by 72per cent to 80per cent in the last 5-6 years (Rajput *et al*., 2021) [15]. Unmanned aerial vehicles (UAVs), sometimes known as drones, were first used in the direction of spy on the enemy during World War I. They are tiny radio-controlled aircraft that can be used for photography (Stehr, 2015) [19]. The agrarian segment is escalating by linking numerous major evolving machineries towards a new and exciting era of agriculture-food manufacture, dubbed "Agri-Food 4.0."(Boursianis *et al*., 2022) [3].

Drone use is a fantastic revolution since it allows for modifications to routine labor-intensive agricultural tasks. Farmers all across the world are increasingly revolutionising farming by utilising drone expertise (Pathak *et al*., 2020) [12]. Drone technology is an essential tool that farmers may use to get regular information on tending to their crops and animals (Ayamga *et al*., 2021) [2]. The current requirement arises from the reconstruction of the agricultural sector. The agriculture industry's low crop production may be addressed by leveraging drone expertise to get around a number of obstacles (Hafeez *et al*., 2022) [7]. Unmanned aerial vehicles (UAVs), another name for drones, are being utilised to tackle a range of issues in the agricultural sector, from crop monitoring to precise input application (Rejeb *et al*., 2022) [16].

Agriculture drones are prepared with cutting-edge radars and high-resolution cameras, aiding accuracy mapping and surveying of agricultural landscapes. These hi-tech marvels allow farmers with complicated insights into topographical variations, soil composition, and drainage patterns across their fields (Jouav.com, 2023) [8]. Agriculture is estimated to account for around 80% of all commercial UAVs, according to the Association for Unmanned Vehicle Systems International (AUVSI). Within the next 10 years, agriculture is expected to have an economic effect of $80 billion (Zalavadiya and Vasoya, 2020) [22].

Smart agriculture employs unmanned aerial vehicles (UAVs) to investigate requirements, difficulties, and opportunities. Utilising unmanned aerial vehicles (UAVs) and associated technology has greatly improved and optimised a number of agricultural operations. The efficient monitoring and spraying tasks carried out by UAVs have a positive impact on the cultivation process by maximising the effectiveness of fertilisers and insecticides. Multi rotor UAVs are mostly employed for agricultural practices, according to their study, among the several kinds of UAVs

including fixed wing, multi rotor, single rotor, and hybrid vertical take-off and landing UAVs (Maddikunta *et al*., 2021) [11]. UAVs, with their stable size and low incidence, can contribute to the economic prosperity of agriculture in smaller countries, particularly by reducing the number of workers and health risks associated with labor-intensive pesticide application (Rahman *et al*., 2021) [13].

Types of drones used in agriculture

Drones used in agriculture are classified into several varieties, each designed to do unique duties and satisfy specific demands during the farming process. These are a few of the most prevalent types of agricultural drones:

1. **Multi-Rotor:** Multi-rotor drones, often known as quad copters or hexacopters, are tremendously versatile and commonly employed in agriculture. They have abundant rotors that allow for vertical takeoff and landing, hovering, and satisfactory maneuverability (Jouav.com, 2023) [8]. Because of their stability and ability to fly at low altitudes, these drones are well-suited for jobs such as crop monitoring, disease detection, and field mapping. Multi rotor drones can regulate the sites from which they take photographs, ensuing in more accurate results. The drawback of the multi-rotor is that it has less durability and rapidity. As a result, these sorts of drones are limited to agricultural purposes (Dileep *et al*., 2021) [6].
2. **Fixed-Wing:** This drone type only needs the drive to move frontward and not to hold itself in the air. This makes them energy-efficient (Rennie, 2016) [17]. Because of this trait, these drones are limited to only a few agricultural routines (Dileep *et al*., 2021) [6].
3. **Single-Rotor:** When related to other types of drones, solitary rotor helicopter drones have greater welfares. It is equipped with a gas-controlled device to increase strength. Single-rotor drone types are solid and hard-wearing. They look alike to actual helicopters in assembly and design. A single-rotor has just one rotor, which is like one big spinning wing, plus a tail rotor to controller route and constancy (Rennie, 2016) [17].

Application of drones in agriculture

Farmers and agriculturists are always looking for low-cost, effective ways to check their crops on a regular basis (Ahirwar *et al*., 2019) [1]. Drone technology has grown in recognition over the previous decade, particularly in agriculture (Ayamga *et al*., 2021) [2]. Drones can be used to examine any crop in any place. Integrating drone technology may enhance crop yields, save time, and make land organization more efficient performance over time that is sustainable (Debangshi, 2021) [5].

1. **Soil analysis and mapping of field:** Drones fitted with remote recognizing cameras collect data from the ground to analyze the soil and field using the electromagnetic spectrum. Distinct elements reflect different wavelength ranges, which can be used to segregate them. Drones gather raw statistics and apply algorithms to transform it into usable information (Kantwa and Choudhary, 2022) [9]. As a result; they can be utilized in a wide range of farming applications, including monitoring. When the agricultural cycle is only getting started, drones can be helpful. According to Ahirwar *et al*. (2019) [1], they provide precise 3-D maps for early soil analysis, which is helpful for organising seed sowing.
2. **Spraying operation by drones:** Nowadays, chemical spraying is essential for crop health in order to get rid of pests and unwanted plants like weeds (Sharma and Nagaraja, 2022) [18]. Drones have the capacity to transport suitably sized reservoirs that may be loaded with chemicals for expedited spraying, such as plant growth regulators (PGRs), pesticides, herbicides, and fertilisers (Debangshi, 2021) [5]. Due of crop height, hand spraying can be particularly challenging at times. As a result, smart farms use drones to spray, minimising human interaction with pesticides, fertilisers, and other hazardous substances. With a spraying capacity of up to five times that of conventional technology, a one-hectare field can be sprayed in less than forty minutes. 30% less insecticide is used (Kantwa and Choudhary, 2022) [9]. It is expected that the usage of drones can spray substantially faster than the manual method, resulting in reduced efforts, time, and expenses (Sharma and Nagaraja, 2022) [18].
3. **Monitoring of crops:** Because of the frequent changes in environmental circumstances, it is necessary to monitor the crops at regular intervals, which is a time-consuming manual task (Sharma and Nagaraja, 2022) [18]. Drones can be used to monitor crop height, density, and stressors on a regular basis, with the flexibility to cover large fields in a short period of time. Furthermore, it eliminates much of the human error associated with traditional inventory work; however a physical assessment of a problem region after seeing the imagery is still recommended (Veroustraete, 2015) [21].
4. **Irrigation:** Drones with updraft cameras and remote distinguishing abilities can assist in the determination of irrigation-related issues and can divide areas based on different moisture regimes (Kantwa and Choudhary, 2022) [9]. Drones using thermal, multispectral, or hyperspectral sensors may determine whether parts of a field want improvement or are dry (Ahirwar *et al*., 2019) [1].
5. **Health Assessment:** This was a chore that was historically carried out by hesitant college interns walking into the fields with notepad (Veroustraete, 2015) [21]. Drone-borne apparatus may distinguish which plants reflect numerous quantities of green light and near-infrared light by scanning a crop with both visible and near-infrared light (article). Drones equipped with sensors that can detect visible and near-infrared light in crops can be used to monitor crop health over time and the reaction of the crop to remedial measures. This may be set up to identify particular characteristics in crops, including NDVI, water stress, or a lack of a particular nutrient (Kumar *et al*., 2022) [10].

Rules and Regulations for drone usage in India

The Indian government developed an unmanned aircraft policy in December of 2018 that allows the use of drones, in addition to, for example, their deployment in infrastructure projects. Except for spraying pesticides until specifically

authorized, the DGCA, GOI laws tacitly authorize the use of RPAS, or drones and unmanned aerial vehicles, for agricultural purposes (Pathak *et al*., 2020) [12]. The Unmanned Aircraft System (UAS) Rules18-Part VI govern drone operations in India and other related activities (Debangshi, 2021) [5]. The following is a list of common drone usage tactics (Pathak *et al*., 2020) [12].

Avoiding densely populated regions with a lot of people is crucial.

- Should only take off in excellent weather and during the day.
- Drone user must be qualified drone pilot and should have reached the age of 18.
- The use of drones, including camera drones, is prohibited in areas designated for government or military use, five kilometres away from airports, and in locations where aircraft are in flight.
- The drone must be fortified with a license plate comprising the tag and contact details of the operator.
- Keep your visual line of sight open when utilizing RPAS.
- No one individual can operate numerous UAVs simultaneously.

Benefits of using drones in Agriculture

Unmanned aerial vehicles provide a less stressful atmosphere, help with decision-making, create a safer environment, and allow pilots to fly for longer periods of time if the vehicle permits it (Ahirwar *et al*., 2019) [1]. In the past, a wide view of the farm and any problems were identified using satellite or aircraft imagery. However, these photographs weren't only pricey; they also needed the precision that only drones can deliver. It provides time-based animatronics that can show crop progress in real-time in addition to real-time video. This is an outsourced option that requires less labor. There is consequently less reliance on departmental staff. The results can be acquired quickly (in around 3–4 weeks), permitting for efficient treating. A drone can soar in any meteorological conditions condition. Even though drones are waterproof, captivating pictures in the rain can reduce the excellence of the images. Farmers can maximise their contributions—seed, fertiliser, and water—make better use of drones, respond faster to pressures—weeds, pests, and fungi—reduce crop hunting time—validate treatments and actions—improve variable-rate treatments in real time, and assess field yield (Debangshi, 2021 and Kantwa and Choudhary, 2022) [5, 9]. Drones' capacity to quickly and efficiently cover large areas of land has made it possible for farmers to gather data and monitor crops more successfully. Timely and effective solutions can be achieved by early problem detection (The Times of India, 2023).

Constraints faced during usage of drones in agriculture

Drones are sensitive to meteorological conditions such as strong breezes, fall, and extreme temperatures (Rajawat and Gautam, 2021). Adverse weather can limit their ability to safely operate and gather data. While drone sensors are improving, there are still limitations in terms of the quality and accuracy of data they can collect (Dadu *et al*., 2020) The effectiveness of sensors for detecting specific crop conditions, pests, or diseases can vary. Interference from other devices or structures can disrupt drone communications and control. Remote rural areas might also lack reliable internet connectivity, making real-time data transmission challenging. Traditional farmers are unable to analyze drone photographs in the required detail. The farmer must have the skills and knowledge related to imaging software (Debangshi, 2021) [5]. Most of the arable farms don't have internet connectivity. In order to use drones in this situation, farmers must either engage in connection or purchase a drone that can store local data in a format that can be transferred and processed at a later time (Pathak *et al*., 2020) [12].

Conclusion

Drone technology integration has the potential to completely transform the agriculture sector and open the door for more productive, sustainable, and efficient farming methods. Despite the difficulties and limitations that come with using drones, they have many advantages and can considerably progress modern agriculture. Drones give farmers a bird's-eye perspective of agricultural fields, permitting them to collect precise information on crop health, moisture content, pest infestations, and other topics. Farmers are able to make well-informed choices and take preventative action to maximize yield output and quality thanks to this real-time information. A game-changer is the capacity to swiftly and correctly monitor wide areas, which enables early interventions that can lessen losses and cut down on the need for excessive resource application.

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