APPLICATIONS OF DRONE IN ENHANCEMENT OF AGRICULTURAL PRODUCTION

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Abstract

Increasing agricultural productivity is very critical to meeting the food security and economic development of most developing countries of the world in the face of rapid population growth. The present technological trends in agricultural practices are not apt for small land holdings which is the major practice in developing countries like Nigeria. For any developing country to meet future food demands, the concepts of advanced farming techniques need to be explored and integrated into agriculture. One such notion is drones, which play significant roles in occupying the gaps of data collection and in reducing the numbers of manpower in many agricultural field operations using satellite remote sensing or manned aircraft. The objective of this paper is to briefly describe some vital approaches of drone's applications in agriculture, which include soil and field analysis, crop planting, crop spraying, crop monitoring, irrigation, health assessment, wildlife monitoring, and more. The application of these approaches has great potential in enhancing agriculture in the near future and their quick implementation is desirable for the sustainability of agriculture especially in developing countries.

Keywords: Agriculture, Food sustainability, Drones, Unmanned aircraft vehicles, Remote sensing.

Introduction

Change is the only constant thing in the agricultural sector. One of the ways through which farmers have incorporated advanced technology as part of their farming practices in other to boost the yields of their crops and livestock is through the application of technology called unmanned aerial systems (UAS) or unmanned aerial vehicles (UAVs). Unmanned aerial systems (UAS) or unmanned aerial vehicles (UAVs), commonly referred to as drones, in a technological framework are unmanned aircraft that can be remotely controlled or fly autonomously (Colomina and Molina, 2014). Drones are small or medium-sized aircraft that are remotely controlled to fly autonomously through software-controlled flight plans in their systems working in conjunction with onboard sensors and GPS.

The first uses of drones were primarily for military applications. They were used as early as the 1960s during the Vietnam War, and over 3,400 UAV missions were conducted during the war. Drones have also been used extensively for surveillance and combat missions in the Middle East in recent years. It is well understood that these human pilotless military missions have saved American lives (Steve and LSU, 2017).

Today drones are rapidly moving from the battlefield to many other uses. Recently, we have heard of package delivery companies testing the use of drones for deliveries, especially in urban areas (Steve and LSU, 2017). Uses are also expanding into other avenues, such as filming and aerial photography in journalism; search and rescue missions (especially in challenging terrains); geographic mapping; border patrol; structural safety inspections of transmission towers, buildings, bridges, wind turbines, and many others just for fun (Steve and LSU, 2017).

Moreover, in recent times, drones of different sizes, shapes, and capabilities have grown rapidly and just like most technology, the cost of UAVs has reduced intensely (Shahbazi *et al.,* 2014). In 2016 it is possible to purchase a useful mapping UAV for less than $1,000. And surprisingly powerful mapping drones can now be built at home for even less (Greenwood, 2016). While processing software can be expensive, open-source, and lower cost options exist (Greenwood, 2016). Even the rate of acquiring it for civilian operations has grown tremendously (Colomina and Molina, 2014), as well as for precision agriculture, forestry, biodiversity, meteorology, emergency (Tiberiu *et al.,* 2016). The device is meant for keeping pace with technological advancements, they have, however, found application in a plethora of disciplines (Drones and Forestry, 2019).

However, with the population of the world expected to reach nine billion by the year 2050 and agricultural consumption is projected to grow by 70 percent over the same period, thus Agri-producers need to embrace

emerging technological advancements such as UAVs in order to meet up with the percentage population increase (Gerard, 2018; Ibrahim, 2019). Drones in agriculture are simply a low-cost aerial Drones camera that has a platform, equipped with an autopilot which is using GPS and sensors for collecting relevant data (Michal, 2016). The camera can provide some information about plant growth, plant coverage, and other things. It also has a multispectral sensor that expands the utility of the technique and allows farmers to see things that cannot be seen in the visible spectrum, such as moisture content in the soil, plant health, stress levels, and fruits (Gerard, 2018). Agricultural use of drones could comprise 80% of the market. Price Waterhouse Cooper projected the potential market for drone-powered solutions in agriculture at USD 32.4 billion (Adam, 2019). The application of UAVs in agriculture opens the doorway to acquire real-time information on the farm. Drones are utilized at various stages throughout the crop growing cycle (Adam, 2019).

The application of drone technology in agriculture offers significant advantages to those who embrace it (Adam, 2019; Drone Major, 2019). This exciting and rapidly evolving technology from drones possesses the capability to capture high-resolution images as part of an even larger collation of data that can enable organizations and researchers alike to better understand and track the health of forests and their inhabitant (Hassaan *et al.,* 2016). Drones can monitor tree health, track animal locations, and migration patterns, even locate or communicate with lost or malicious persons. The technologies are far more efficient and cost-effective compared to the traditional methods of data collection (Drone Major, 2019; Hassaan *et al.,* 2016). Additionally, agile drones can reach places that are dangerous or impossible for humans to safely navigate. To note a few applications, we will discuss drones in tree disease detection and prevention, wildlife monitoring, and human interaction comprising security, as well as search and rescue (Drone Major, 2019).

Finally, the main aim of this paper was to highlight some areas of applications where drone technology will give the agriculture industry a high-technology transformation. Drones have many applications ranging from soil and crop field analysis to planting and pesticide spraying and many more.

Major areas of drones' operations in agriculture

Remote sensing using drones has a series of benefits such as less costs, flexibility in time and space, high precision data, and the benefit of no human risks. The following will briefly present current examples of applications of drones in Agriculture.

Soil and field analysis: Drones are instrumental at the start of the crop cycle (Michal, 2016). The drones produce precise 3-D maps for early soil analysis that are very useful in planning seed planting patterns. After planting, drone-driven soil analysis also provides data for irrigation and nitrogen-level management.

Seed planting: Drones have the capacity to shoot seeds with nutrients into the soil with an average uptake of 75 percent, therefore reducing the costs of planting. Drones are being utilized in sowing seeds for Aging Farmers in China (Ibrahim, 2020). For instance, Happy Farms in China has just introduced XAG's autonomous drones to replace manual labour for seeding, fertilization, and crop spraying. The drone was introduced to solve the challenge of age-long workforce associated farming. Many farms today are haunted by the problem of labour dependence, which has increased their vulnerability to the aging farming population. But with the advent of XAG agricultural drone, it can seed 50,000 square meters of land per hour, which would otherwise take 50 to 60 field workers to complete (Ibrahim, 2020). According to Jeremy, (2019), drones is capable of delivering up to 57 pounds of payload in the form of tree seeds, herbicides, fertilizer and water per aircraft per flight to assist reforestation and replanting projects. This technology according to the researcher can help to minimize the need for on-the-ground planting, which can be costly, time-intensive, and strenuous work.

Figure 1: XAG Drone JetSeed Module Conducts Direct Seeding on Rice Paddy

Source: www.prnewswire.com/news-releases, 2019

In April 2020 XAG Drone JetSeed conducted direct seeding on Rice Paddy (Figure 1). The world's first-ever rice direct seeding demonstration was organized to make a comparison between manual broadcasting and drone seeding (Ibrahim, 2020). The operation was carried out in China's *'Happy Farms'*, one of the largest modern agricultural parks with a smart agriculture demonstration site. Two workers were invited to spread 5kg of rice seeds, walking slowly through the waterlogged paddy field with their feet swamped in the mud. It was a laborious and lengthy process that took them 25 minutes to cover 1,200 square meters of land. However, XAG's drone performed the same operation by following a pre-programmed route and dispensed rice seeds from the air (Ibrahim, 2020).

According to Ibrahim, (2020), China's rural population has substantially reduced by 23% in the past two decades, while those aged over 55 constitute one-third of the agricultural workforce. When the older generation of farmers retire and young people pour into the cities for better employment, the future of food supply seems unsecure if counting on manpower.

Crop spraying: The UAVs could scan the ground and spray the correct quantity or dosage of liquid, modifying distance from the ground and spraying in real time for moderate coverage as shown in Figure 2. Distance measuring equipment, ultrasonic echoing and lasers such as those used in the light detection and ranging, or LiDAR method enables a drone to adjust altitude as the topography and geography vary, and thus avoid collisions (Michal, 2019).

Subsequently, drones can scan the ground and spray the right amount of liquid, modulating distance from the ground and spraying in real time for uniform coverage. The result: improved efficiency with a decrease in the number of chemicals infiltrating into groundwater. Professionals estimate that aerial spraying can be done up to five times faster with drones than with old-style machinery (Michal, 2019). UAV technology is now very useful for fighting agricultural pests. The FAO has begun to investigate how drones may be used for detecting and eliminating locusts before they begin their destructive journeys (Greenwood, 2016).

Figure 2: Drone under operation for spraying and irrigating a farm
Source: Jeremy, (2019).

Crop monitoring: With the time-series animations, accurate development of a crop can be shown and production inefficiencies can be revealed to give opportunity for enabling better crop management. Drones allow farmers to constantly monitor crop and livestock conditions by air, it helps to quickly find problems that would not become apparent in ground-level spot checks. For example, a farmer might find through time-lapse drone photography that part of his or her crop is not being properly irrigated (Chika and Olasupo**,** 2019). As a result, the efficiency of many aspects of the farming process is increased through high-tech drones that allow the farmers, and the drone pilots to operate them. More also, apart from monitoring the crop health, the drones can create detailed GPS maps of the crop eld area. Through this, the farmers can have a better plan of where crops can be planted to maximize land, water, and fertilizer usage (Chika and Olasupo**,** 2019).

Irrigation: Drones in conjunction with different imaging technologies like such as hyperspectral, multispectral, or thermal sensors can identify particular portions of a field that are dry or need improvements. Drones can also identify drier regions in a field and measures can then be taken to irrigate such regions with better techniques. Precision agriculture provides farmers with such concrete information that enables them to make informed decisions and utilize their resources more efficiently.

Health assessment*:* The drone carried devices that can identify plants with different amounts of green light and NIR light. This is done by scanning through a crop using both visible and near-infrared light. The information can produce multispectral images to track changes in plants and indicate their health status. A quick retort to any observations on plant's diseases can save a whole orchard. Therefore, immediately a sickness is noticed, farmers can apply and monitor remedies more accurately.

Tree disease detection and prevention: Precisely, the most probable way to monitor the health of tree crops or forests involved large scale aviation or massive time commitments from manual labour (Drone Major, 2019). This could involve spending hours in forests, counting and measuring trees to record varying heights and girths, or on the other hand spending tens of thousands of pounds on piloted aircraft to examine the area and collect mediocre data (Hassaan *et al.*, 2016; Drone Major, 2019). It worth knowing that manned craft comes with its limits in terms of mobility and getting close enough to the ground to gather sufficiently accurate data (Michal, 2016).

Throughout the past decade, drone technology has advanced to the point that UAS (unmanned aircraft systems) or UGVs (unmanned ground vehicles) equipped with remote sensors, such as infrared and LiDAR, and AI software can not only count but also analyze and compile data profiles on large forested areas (Drone Major, 2019). The integration of drone technology saves both time and money for the efficient and early detection of forest disease, consequently leading to more profitable yields for relevant stakeholders (Drone Major, 2019).

Wildlife monitoring: Drone imaging capabilities is being used to monitor and track wildlife habits, locations, or migration patterns. Infrared imaging can deliver clear pictures even in darkness or inclement weather (Michal, 2016). Movement recognition software has ability to track animals, creating detailed data banks of movement, migration, habitat preferences, and aggression. This data is invaluable to park rangers, wildlife enthusiasts, licensed hunters, and police alike (Drone Major, 2019).

Moreover, the drone's technology has the power to dramatically reduce the amount of illicit poaching in delicate areas. The data obtained can provide researchers, conservationists, and law enforcement agent with a

comprehensive and continuously updated set of imaging and tracking to further enhance animal protection and enable an immediate reaction to danger that is not available with typical stationary cameras or traditional on-foot patrols. Drones equipped with motion tracking and thermal imagery have already been successful in identifying and countering potential threats to endangered wildlife (Michal, 2016).

Farm security patrol and surveillance: Cattle ranchers with a lot of lands to cover can use drones to determine where their livestock is. Thus, taken the advantage of UAVs' ability to cut down on the time and expense of conducting patrols and reconnaissance work. Some of the rancher's managers have found UAVs useful for conducting regular surveys of fencing (Greenwood, 2016). Long-range surveillance drones are available to deter and apprehend illegal fishing vessels in protected waters. The technology has the potential to empower indigenous communities to document illegal occupants of their territories and natural resources. With UAV-gathered imagery of illegal logging and land occupancy, government agencies can prioritize and speed up their inspection efforts, ensuring that a week-long field inspection will collect enough evidence to justify government intervention (Greenwood, 2016).

Conclusion

In conclusion, drone is one of the latest technology developments that is currently being utilized in various fields ranging from the military, humanitarian relief, disaster management to agriculture. Drones have a huge potential in enhancing agricultural development and its sustainability in the developing countries of the world. Many areas of the applications of drones in agriculture has been mentioned. Despite some inherent limitations, adaptation to the use of drone will help nations of the world to meet up with food security challenges associated with the impending rising population.

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