Analysis of Benefits and Drawbacks of Unmanned Aerial Vehicles in Precision Agriculture

A growing world population coinciding with increasing levels of world hunger demands an increase in agricultural output, and technological application to the field is believed to be the best way of achieving it. There are many potential applications of biotechnology, ranging from genetic modification to biofuel manufacturing. A concept that has received a large amount of attention recently is the usage of unmanned aerial vehicles (UAVs), or drones, in various applications. They would be able to assist in planting and irrigation, produce precise maps for soil analyses and health assessments, and assist in crop monitoring and chemical spraying. 45,000 drones have been already purchased by farmers in the United States; however, this is only a small fraction of the 600,000 UAVs registered for flight in the country (Patel, 2016). In the U.S., despite a strong scientific consensus for the multiple benefits of drones in agricultural applications, other scientific studies and political organizations have pointed out potential flaws in implementation and have delayed a more complete rollout of any unmanned aircraft.

A majority of the scientific community has argued for technological applications to the agricultural industry due to a research which indicates that innovation will lead to increased crop yields with less human labor and much higher efficiency. UAVs have a number of attractive qualities. Unlike the wide scope of a satellite, their focus on a small area can capture images with much higher resolution. They can process data in-flight, such being able to identify crop and soil quality and determine risk mitigation plans based on the data with aid of the Geographical Information System (GIS) servers and Normalized Differential Vegetation Index (NDVI) libraries (Abdullahi, Mahieddine & Sheriff, 2015). The post-processing of its data by hand upon the drone's return can lead to observations of crop type, land mapping, and biomass totals. Research has been done to manufacture custom drones and sensors for use in farming, leading to new usability for old sensors, such as enabling a depth sensor for use in plowing (Tripicchio et al., 2015); the versatility of drones illustrates just how useful these machines can be.

However, other figures in the professional community have pointed out that while these drones may be able collect more data, they are also proportionally more expensive. A UAV may have to carry up to 1kg due to the assorted sensors, cameras, actuators, and gimbals needed to collect data. Research has also indicated that UAVs with between 45 and 60 minutes of flight time require a battery pack taking up to 40% of the payload capacity. On average, the price of a UAV increases by $2,360 for every additional kilogram of weight, so a drone capable of 45 minutes of flight time and weighing between 2 and 5kg can cost over $10,000 (Marinello et al., 2017). The purchase of multiple drones at this price can lead to a rapidly escalating accumulation of costs.

To partially address the issue of expense, research has been focused on customizing drones specifically for farms. By building UAVs to fall under legal thresholds on flight altitude, range, and payload weight, the vehicle can be made less expensive. For example, in Japan, the Yamaha RMax (Scherer et al., 2008) enjoys massive popularity. The RMax was developed in response to the demand in the Japanese market for precise unmanned crop dusting and aerial spraying. It has a flight time of 1 hour, a payload of 31 kg, and is remote-controlled by its operator. Instead of being a helicopter suffering from these federal limitations, it benefitted by maximizing everything else available to it, such as computing power and its sensor suite. It became so popular, its use "rapidly spread to other crops besides rice, including wheat, oats and soybean in 1992, lotus root in 1993, daikon radish in 1994, and chestnut groves in 1995" (Freeman & Freeland, 2014). 20 years after that, 90% of aerial crop dusting in Japan is now done with the use of unmanned aircraft, covering 2.4 million acres of farmland. This model has been adopted internationally in over 20 countries. However, despite the foreign popularity of UAVs, their usage in the US have failed to similarly take-off due to both import restrictions on potential weapons as well as restrictions set by the Federal Aviation Administration (FAA). In recent years especially, the FAA stands as the most vocal opponent to the wide rollout of UAVs in the United States.

The FAA strongly opposes the widespread usage of aerial vehicles in the US. Chief among their reasons for opposition are safety concerns, a fear of increase privacy invasions, and public perception of drones as weapons of war. The Government Accountability Office (GAO) pointed out that drones use a non-encrypted GPS signal to navigate. This enables jamming and hacking by corrupt agents (Smith, 2015). Additionally, it should be noted that "one of the world's largest drone manufacturers advertises a 1.6-pound drone capable of capturing high definition video and still images, which retails for around $1,000" (Cody, 2018), which indicates just how easily anyone can acquire high-resolution images of nearly anything. On the issue of safety, crashes can often lead to fatalities - 81 aerial applicators were killed between 2000 and 2009 in the US (Freeman & Freeland, 2014). Thus, some of the FAA's legislation is well-reasoned, and they have succeeded in limiting the expansion of UAVs by approving legislation on a case-by-case basis instead of implementing rules for a wider rollout.

Concurrently, the FAA recognizes the strong scientific argument behind the use of drones specifically for agricultural purposes. Brian Wynne, the CEO of the Association for Unmanned Vehicle Systems International, states that "half of the 5,500 exemptions that the U.S. Federal Aviation Administration (FAA) has approved up to now were for agricultural purposes," (Patel, 2016) which indicates promise if the FAA and UAV-manufacturing companies can come to some agreement specifically when it comes to the agricultural sector. For example, in 2015, the FAA granted Yamaha approval to market and sell the RMax model for agricultural purposes in

California’s Napa Valley, and in 2018 they allowed a second Yamaha-branded UAV with a larger payload and longer flight time to also be sold in the same location (n.a., 2016). The FAA can loosen legislation around specific geographic areas in this way, and they also may favor UAVs that have already proven their capabilities internationally.

Across the world, many countries have widely embraced UAVs in their agricultural sectors, using them as a means to increase agricultural productivity and decrease labor costs. In the US, as research becomes even more intensive over the next decade and a compromise becomes closer to being found, it seems likely that customized drones will soon succeed in reaching the agricultural market.

Citations

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