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GEOG 270- Intro to Small Uncrewed Aircraft Systems

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The Use of sUAS in Agriculture

The interest in drone technology in agriculture has typically been in replacement helicopters and aircraft in aerial applications. Small Uncrewed Aircraft Systems, also called sUAS's, have been given other equally important tasks in the agriculture industry. Considering that on average farmers spent $911 per acre raising corn in 2022, farmers have a lot of money to be made using sUAS technology to optimize their crop production (2023).

Crop and soil health monitoring is one valued tool in the realm of smart agriculture where sUAS's play an ever-increasing role. Today, farmers use a variety of methods to monitor their fields for pests, water stress, and weeds that are left untreated can decrease crop yields and therefore require a fast and accurate response. A fast and accurate response to Weeds, Pests, nutrient deficiencies, and water stress can save thousands of dollars per acre of crop. It's estimated that weeds that 27 billion dollars worth of corn and 16 billion dollars' worth of beans fail to grow due to weed infestations and a weed infestation can lead to around a 50% loss in yields (*Crop Loss*). For pest, they cause the loss of 20-40% of global crop production annually (Gula). Water stress can reduce yields by 2.5-5.8% per day during kernel development (Lauer, 2018). The treatments for these also cost money, however. Pesticides alone averaged 128 dollars per acre in 2022 (Paulson et al.). In other words, there is a lot of money to be made by maximizing yields while simultaneously decreasing input costs in crop production.

The traditional method of crop and soil health monitoring is to drive to the field walk a few rows in and get a close-up look at the soil, the plants, and some fields allow you to quickly scan for more severe drought, but you won't be able to get a top-down view of your fields without an airplane or a satellite and if you can see the problem with just your eyes then it might be too late. Earth Observation satellites are a good option, but because space technology is cost-prohibitive, and services are too infrequent and too low resolution, they are often not the right tool for the job. The Landsat 8 and 9 satellites, which a service such as Google Earth uses, pass over the same location every 8 days between the two of them (*What are*). Another option is to use the onboard sensors and GPS unit of a harvester to create a map of yield, moisture, and other metrics to inform decisions about which seed variety to use the following planting season, but that doesn't help the farmer actively grow his crops.

This is where drones come into play with high-resolution sensors at the fingertips of the farmer and a cheap price. An entry-level, camera-equipped drone can be purchased for as low as $300 (Karanja, 2022). Depending on what the farmer would like to use the drone for there are a variety of drones available for a variety of price points. A typical drone camera can spot lodged crops, a pest, or a severe drought. Its main benefit is height, and it can't do much more than the human eye would be able to do 400 feet above the ground. A multispectral camera is designed to detect specific wavelengths of light. One example, sold with the DJI Mavic 3 (M3M), can detect Green (G), Red (r), Red Edge (RE), and Near Infrared (NIR) (*DJI Mavic 3 multispectral*). The DJI Mavic 3 can be purchased for a little over 5000 dollars as of today. One other detail to note is that a multispectral camera will have a lower resolution than the visible camera typically. A Multispectral can be used to detect issues that a human can't detect in the visible light

spectrum. Nutrient deficiencies can be caught earlier with a multispectral lens. A hyperspectral lens does something similar, but it measures a large number of narrow bandwidths of light instead of a few specific bandwidths like the multispectral sensors. Hyperspectral cameras are often used in the mining industry to detect certain minerals. As such, hyperspectral cameras can detect soil health and composition along with detecting plant health. A thermal, or infrared, camera is best at detecting water stress by detecting the heat being given off by the plants or detecting livestock and counting livestock. DJI also sells the Mavic 3 with a Thermal camera which is currently priced at about $5700. It can detect area or spot temperatures within 3.6 degrees Fahrenheit (*DJI Mavic 3 Thermal*). Keep in mind, that there are most likely thermal and multispectral drones available for purchase and that prices are likely to change with time. A lidar sensor used with an RTK, or real-time kinematic positioning, module on the ground can create a more accurate 3d mapping of the field terrain and estimate biomass volumes (AviationOutlook, 2023). I believe that thermal and multispectral camera drones are more appropriate for agricultural uses as they are widely available and for a reasonable price.

An Infrared camera mounted to a drone would simplify “checking the pasture” quite a bit. Currently, a farmer on an ATV drives through a pasture on a predictable route to scan crevices for calves that are no longer being cared for by their mama in an attempt to save them. The problem with this is that the human eyes are severely limited at this task and a calf can make its way through dense forest and shrubs where an ATV can’t check for them. With a drone equipped with a thermal camera, the advantage goes back to the humans, because the drone can maneuver over the terrain and spot the calf's heat signature.

With time, drones will likely become one of a farmer's greatest tools like the plow or the combine. While they are currently a niche product, they have almost limitless potential and R&D pushing them forward.

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