

Introducing Drone Technology to Agriculture Students in a University Laboratory Course

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Introduction/need for innovation or idea

One of the challenges facing production agriculture is the ability to produce more food and fiber from less available acreage. Increasing costs of inputs (seed, fertilizer, chemicals) and decreasing availability of water require growers to adopt site-specific management practices, also known as precision agriculture (Davis, Casady, & Massey, 1998). The use of global positioning systems (GPS) and geographic information system (GIS) technologies are valuable tools of precision agriculture (Bates, Erlien, & Nielsen, 2002). One of the latest technologies employing GPS and GIS technologies available to agriculture is Small Unmanned Aerial Systems (sUAS), better known as “drones” (Jones, 2019).

With increasing extreme weather conditions and a growing world population, the necessity to increase yields is helping drive the adoption and use of drones in agriculture (Kipkemoi, 2020). Drones are used in collecting digital imagery used to help identify and troubleshoot issues in the field (De Koff, 2017). Since receiving FAA approval, drones equipped with tanks and sprayers are now applying fertilizers and pesticides and capable of spraying with more precision than traditional methods (Meola, 2021). Current uses of drones in agriculture include soil and field analysis for determining evapotranspiration and soil moisture, crop nutrient monitoring, yield and biomass analysis, spray applications, and irrigation. This abstract presents a method of introducing drones to students.

How it works/methodology/program phases/steps

Drone technology was first introduced as a five-week instructional unit in our Operations in Agriculture laboratory course. This course addresses small engines, and agriculture and turf machinery operations. Inexpensive, non-GPS drones were used to introduce students to the process of connecting drones to their smartphones using a free flight application. These drones are designed to be used indoors. A drone flight simulator (RealFlight9.5®) provides hands-on operation of a virtual drone. The program was loaded on a laptop and connected to a large mobile monitor. A local high school agriculture instructor with Part 107 Certification (FAA, date) was invited to speak on field mapping of high school athletic fields and land laboratories. The guest presenter brought a Mavic 2 drone and conducted hands-on flight mission mapping using DroneDeploy®. Students used a DJI Phantom 4 Pro drone to practice launching and flying a GPS-guided drone in square-patterns. The goal is to fly a drone using pitch & roll movements with the right-thumb controller. The second operation is using the left thumb controller to introduce yaw movement (rotating the head) to fly the square-pattern using the head of the drone to lead. All students were successful in launching, flying, and landing a drone. A “dronie” (selfie pic with drone) culminated the flight operations.

In the second offering of this course, the FAA TRUST Certification Exam for Recreation pilots (FAA, 2022) was introduced. Tello drones (DJI.com) were acquired to replace the interior-flight drones. Additionally, basic flight programming instruction was introduced using a free program (Drone Blocks®). An indoor obstacle course was assembled from PVC pipe and components. After successful operation of the Tello drone through the obstacle course, students working in groups, took measurements of course obstacles, and learned to program the Tello drones to fly the course autonomously using the Drone Blocks ® application on their smartphones.

Pilots from a local agriculture drone foundation brought drones from their fleet to present and demonstrate to the class. Eight different mapping and spray-application drones were displayed

and flown for the students. The presentation included drone operation safety, drone mapping application for agriculture, and hands-on instruction of larger drones used in spray applications, and “drone-in-a-box” remote mission operations. Students engaged in hands-on flight of all the drones.

Results to date/implications

Our drone technology unit has been taught twice (Spring 2022, & Spring 2024) to two laboratory classes of 24 undergraduates. Students were introduced to drone careers in agriculture and other fields. A regional agriculture equipment sales dealership is including drone operations in their Precision Agriculture service. This reinforces a need to include this technology in our agriculture technology curriculum. In June 2021, the FAA launched The Recreational UAS Safety Test (TRUST) online exam for operating drones for recreation-purposes. Students complete the exam (free) and obtain a certificate of completion for passing the exam. Students completing the TRUST certification are compliant with FAA to operate drones for recreation purposes. To date, 48 students have completed the TRUST exam and carry certificates. Students learn of the requirements for completing the Part 107 requirements for a commercial license. Students fly an indoor drone through an obstacle course, and program their drone to fly the course autonomously. All students gain hands-on experience preparing, launching, and flying a drone on two missions and landing successfully.

Future plans/advice to others

Start off with less expensive models of drones if the goal is to get a controller into the hands of students and practice with flight controls. Look for resilient models which when crashed will be able to be used again. A flight simulator such as RealFlight 9.5® includes a controller and DVD loads to a desktop. Students using the hand controller can quickly develop their fine psycho motor skills and observe the reaction of the drone developing confidence before taking control of an actual drone and controller in the field.

Each year, newer (GPS-guided) drones are added to the classroom fleet providing more students the opportunity to gain hands-on flight experience. A goal is to acquire a thermal-imaging drone with capabilities to locate livestock or inspect ground-mount solar arrays will expand instructional capabilities and applications. Inviting spray drone operators to demonstrate preparation and operation of the larger Piloting drones for spray application activities requires completion of an aerial pesticide applicator’s license, and Part 137 certification.

Costs/resources needed

The cost of drones will vary depending on their intended use. Agriculture drones used for spray applications are typically larger in size, include multiple rotors to support the added payload of a larger battery, spray nozzles, distribution lines, and a holding tank. These types of drones will range in price from \$5,000 to \$16,000. Thermal imaging drones begin at \$5,000.00

Associated expenses related to operating drones include the following items. Note: these are approximating and vary by type and model.

- Drone system: \$1,200-16,000
- Rechargeable batteries: \$189-2,500
- Storage cases: \$120-250
- Tablets or Monitors: \$300-700
- Chargers: \$50-150
- Replacement propellers: \$15-20
- Micro SD Cards: \$26.00
- Mapping Application Subscription: \$1,200/yr
- Flight Simulator: \$175.00
- FAA Certification: \$100.00

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