22B-Robbins- Mari Maja-2019

I Have a Drone, Now What Can I Do With It? ©

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SUMMARY

There will be increasing opportunities in using drones, small unmanned aircraft systems (sUAS), in green industry production systems. The potential usage of drone activity include: crop monitoring, (application of chemicals and nutrients, asset tracking and management), plant inventory, and marketing and sales. Information is included on types of aircraft, flight preparation, and image processing – stitching.

Keywords: aerial images, drone, green industry, nursery, sUAS - unmanned aircraft system, UAV- unmanned aircraft vehicle

INTRODUCTION

Small Unmanned Aircraft Systems (sUAS) or 'drones' are an emerging technology that can be used to automate or augment certain operations in outdoor plant production systems. They may be used for a variety of activities including 1) crop monitoring (i.e. nutrients, water, pest, general health, indoor plant propagation), 2) application of chemicals and nutrients, 3) asset tracking and management (e.g., estimate volume of bark piles), 4) plant inventory, and 5) marketing and sales.

Until recently, the greatest challenge to wide-scale adoption of this technology has been regulatory issues. From a regulatory standpoint, horticulture applications of sUAS should be viewed as a low risk (minimally intrusive) flight environment. sUAS offer several advantages over other methods (i.e. satellite, manned aircraft) including: higher image resolution; autonomous flight path which can be repeated; 'as needed' use; lower flight altitude so image collection is less likely to be influenced by clouds; safe solution for dull/dangerous/dirty applications; reduction in time needed to prepare and initiate flights; and lower cost. The increased image resolution is cited most often as the primary reason for using sUAS.

AIRCRAFT

A challenge to sUAS users is the large number of aircraft options, each having their strengths and weaknesses, which need to be considered to achieve the best option for the user (Table 1). This discussion will focus on 'small unmanned aircraft systems' (sUAS), which are defined by the U.S. Federal Aviation Administration (FAA) as having a take-off weight of less than 55 lb. (~25 kg). It might be worth noting that frequently the terms UAS and UAV are used interchangeably; however, UAS (unmanned aircraft SYSTEM) more often refers to the 'aircraft plus sensor(s)' whereas a UAV (unmanned aircraft VEHICLE) is simply the aircraft (platform). There are two broad groups of UAV including rotary and fixed-wing. However, there are a small number of 'hybrid' aircraft that lift off vertically like a rotary and then reorient propellers to fly as a fixed-wing. This discussion will focus on rotary aircraft since that is the primary platform used in specialty crop plant production.

Beginning sUAS users are encouraged to purchase a 'practice' sUAS as a cost-effective (<$50) means to learn the basics of flying an aircraft using a remote control (RC). There are many criteria that must be considered when purchasing a sUAS including: 1) intended use (e.g., recreation, image collection), price, payload capacity, ability to interchange sensors, flight time, and object avoidance capability. Although advances in aircraft (e.g. lightweight, strong frames; improved battery life) has been made - the most significant change has been in the flight navigation software which enables for repeated and complex flight plans.

Remember that not all sUAS can carry additional payload and that modifications to the payload requires weight and balance considerations. The object avoidance sensors on sUAS must be considered when adding user-installed payload. Retractable landing gear reduces the potential for shadows and obstruction when capturing imagery. sUAS users need to evaluate whether purchasing an aircraft system is the best option for their needs or whether it is more cost-effective to hire an outside firm to collect and process imagery. Remember that regardless of the size (weight) of the sUAS, if it is used for commercial purposes, the operator must be Remote Pilot Certified by the FAA.

FLIGHT PREPARATION

Before flying a sUAS, it is essential that the pilot evaluate the airspace they will be flying in. Under 'Part 107' guidelines sUAS can fly up to 400 ft above ground level (AGL) in uncontrolled airspace (Classes G, E3, E4). To fly in controlled airspace (Classes A, B, C, D, and E-surface) sUAS pilots must get permission from the FAA. The first step in planning your flight is to obtain the latitude and longitude for the location where you will fly. While coordinates may not be necessary, they are a good piece of information to have. There are many ways to get coordinates, but one method is to use Google Earth or Google Maps. The next step is to access the FAA UAS Data Map or alternatively called the 'facility map' or 'grid map'. By entering the address of your flight location, you will immediately learn whether air traffic control (ATC) authorization is required, what altitudes are likely to be allowed, and how (e.g. LAANC or DroneZone) you can apply for flight authorization if required. Flight areas that are covered by the Low Altitude Authorization and Notification Capability (LAANC) will likely receive authorization faster than non-LAANC areas. Consulting the FAA Sectional Chart for your specific flight area before flying is recommended to give the pilot a full understanding of the airspace around the flight area. Current regulations require that a pilot must keep their aircraft within visual line of sight (VLOS).

IMAGE PROCESSING – STITCHING

Besides using your sUAS to capture a single photograph or short video, it is likely many users will need to 'stitch' images together to capture a larger area of interest. The first step is to understand the overall workflow in capturing imagery using a sUAS. The process begins by understanding the airspace and receiving proper authorization where required. The next step is to plan specific parameters (e.g. altitude, orientation of sensor, flightpath, when and where to capture images) of the flight using waypoint navigation software. Once proper planning is complete you can fly the aircraft to capture images. In most cases, the images will be downloaded to a computer once the aircraft has landed. Be prepared for very large datasets. It is recommended that you view your Images shortly after flying to make sure the sensor was working and to edit images that are not needed or of poor quality.

For this discussion we will focus solely on stitching images together. There are many software options (e.g. Microsoft Image Composite Editor (ICE); Agisoft Photoscan; Pix4D) but for this discussion will focus on Image Composite Editor from Microsoft. ICE is easy to use and is free. It should be noted that ICE will not create a GeoTIFF file if you require your stitched image to be georeferenced. The time to stitch images will vary depending the number of images and software used and can vary from minutes to hours.

CONCLUSION

There is no doubt sUAS will be a useful technology in outdoor plant production but users need to carefully evaluate their specific situation to determine what the best approach is. Some users may conclude that purchasing the sUAS and software is the best option while others may find that hiring an outside company to acquire and process the images is their best option.

Acknowledgement

The authors, who have been using sUAS for 10 years, wish to acknowledge the collaborative help from many people and organizations including the J. Frank Schmidt Family Charitable Foundation, Horticultural Research Institute (HRI), J. Frank Schmidt & Son Co., McCorkle Nurseries, Greenleaf Nursery Company, Bailey Nurseries, Cherrylake, Parks Brothers Farm, Yule Tree Farm, Woodburn Nursery & Azalea, Willoway Nurseries, Hale and Hines Nursery and R.A. Dudley Nurseries to name a few.

Both authors are certified Remote Pilots. Robbins: #3952601; Maja: #3952164

Table 1. Information of rotary aircraft, fixed wing, sensors, imaging processing software and flight planning.

Rotary Aircraft

For rotary, in general, organized from lower to higher cost (as of June 2019):

Group 1: Practice drones, some examples: Blade Nano QX RTF ($60)

Holy Stone HS170 ($36)
Cheerson CX-10 Mini ($18)
Cheerwing Syma X20 ($27)

Group 2a:

Yuneec Breeze (fixed arms; 4K) $168 (eBay)

DroneX Pro: $99
Ryze Robotics Tello: $99 (DJI is using in the U.S. at their 8 training centers)

Group 2b:

DJI Spark: (fixed arms; $500 bundle Amazon)

DJI Mavic Pro: (collapsible blade arms) Basic: $788 (Amazon)

DJI Mavic Pro 2: $1,099 w/out RC & charger (B&H)

DJI Mavic Air: $854 (Amazon)

Parrot ANAFI: $599 basic (Amazon) $899 bundle (Amazon)

Yuneec Mantis Q (collapsible blade arms) $499 (Crutchfield)

Group 3:

DJI Phantom 3: (really was a workhorse mid-level drone; was replaced by Phantom 4; no longer sold by DJI in US) Basic: $549 (Amazon)

DJI Phantom 4 (models: Advanced; Pro)

Basic: $1,049 (no RC or charger) (B&H) ; DJI P4 Multispectral ($6,500 DJI)

Autel Robotics X-Star: $450 (eBay; used)

Autel Robotics EVO: $999 (Autel Robotics)

Yuneec Typhoon H: (retractable legs) $1,199 bundle (B&H)

Group 4:

DJI Inspire 2 (retractable landing gear; difficult to attach non-DJI camera/sensor) Basic: $2,599 (DJI) Bundle: $5,199 (SSEPhotoVideo). *Example of 2lld party plugNplay* *multispectral sensor (Sentera 5 band, $3,500):* https://sentera.com/product/inspire-double-4k-upgrade-crop-health-sensor/

Group Sa:

Mikrokopter (Germany): http://www.mikrokopter.de/en/home (while you can purchase pre-built these are mostly self-built kits)

DJI Matrice 100 (quad): Basic bundle (frame, 1 battery, battery charger, 4 blades, RC)

$3,299 (NewEgg); same price at B&H. Battery: $139; Zenmuse X5S: $1,835; hard case:

$429;

Bundle (frame, 4 batteries, hard case; RGB, multispectral): $8,300 (DroneNerds)

OJI Matrice 200 series (quad copter)

DJI Matrice 210 V2 Combo, $9,600
(Advexure) DJI Matrice RTK 210 v2, $14,500
(Vertigo Drones)

Group Sb:

OJI Matrice 600 Pro (Hexa copter) (this is clearly a professional unit; retractable landing gear):

Basic (frame, 6 batteries, RC): $5,699 (B&H)

Fixed Wing

- **AgEagle** (Neodesha, KS) (models: RX-60; RX-47)
- **senseFly eBee X** (SenseFly was acquired by Parrot) ($13,000)

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Sensors

Llewellyn Data Processing, LLC (maxmax.com)

Multispectral:

- MAPIR, Survey3 RGNIR (replaces Survey 2; modified GoPro): $400 (MAPIR)
- MicaSense RedEdge ($4,900)

Thermal:

FUR Duo: $999 (Wellbots)

Image Processing Software

- Microsoft Image Composite Editor (ICE): https://www.microsoft.com/en-us/research!product/computational-photography-applications/image-composite-editor/
- Agisoft Photoscan/Metashape: https://www.agisoft.com/

Flight Planning

- FAA 'Visualize It' UAS Data Maps (or grid maps) (consult before flying): https://faa.maps.arcgis.com/apps/webappviewer/index.html?id=9c2e4406710048e19806eb£6a 06754ad
- UAS Data Exchange (LAANC) (includes list of approved 3rd party partners): https://www.faa.gov/uas/programs partnerships/data exchange/
- UAS flight planning (maps and NOTAM application): https://www.1800wxbrief.com/Website/#!/
- Pilot Certification and Aircraft Registration for Non-hobby Users of Small Unmanned Aircraft Systems (sUAS) (Jan. 2019): https://www.uaex.edu/publications/pdf/FSA-6150;pdf

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