DRONES
AND FOREST MANAGEMENT

By
Dave Boyt

The term drone applies to a wide range of unmanned, remotely-piloted aircraft ranging from backyard toys to military strike platforms. Somewhere in the middle of that range are commercial drones, or "small Unmanned Aerial Systems" (sUAS) that can collect images and data from an overhead point of view. They combine global positioning satellite systems (GPS) with accelerometers, magnetic compasses, and other sensors linked to a microprocessor to maintain a precise flight path. Typically, the drone pilot sets preprogrammed flight waypoints for efficient image collection over the desired area. Once the flight path has been set, the electronics take over all aspects of the flight from take-off to landing. In flight, drones either transmit video back to the operator or store images for later analysis. Other components of the sUAS include the computer and software for programming the desired flight path and type of imagery desired, and, in some cases, manual operator controls. A very practical use for commercial drones has been low-cost, aerial photography by filmmakers, real estate developers, and disaster response teams.

Drones can carry an array of image sensors that detect light in the ultraviolet, visible, and infrared ranges. In agriculture, they can help determine where moisture, fertilization, and pest control can optimize a crop with minimum input. With the ability to provide an aerial view over otherwise inaccessible areas, drones are quickly becoming the go-to tool for a variety of forest management objectives, such

as fire control, forest health, crop tree release, harvesting, planting, and laying out trails. While attending the 2019 National Walnut Council meeting in Topeka, Kansas, I had the opportunity to visit with Ryan Armbrust, who, along with Jamie Gose of Gresco Unmanned Aircraft Systems, presented a workshop on the use of drones for forest management.

Ryan is the Forest Health and Conservation Forester for the Kansas Forest Service (KFS). His duties include the study of invasive plants, insects, diseases, and abiotic stress. "I've also had the opportunity to work on improving production methods and diversity contained within the Conservation Plant program here at KFS," he noted. While he still uses many traditional tools and methods, he recently began using drones to help gather information about forest health. "I started by buying a personal drone in the summer of 2018, after learning what they could do from presentations at some forestry and natural resources conferences," Ryan recalled. "It was quickly evident that a drone was a powerful tool, and we started the Kansas Forest Service's sUAS committee shortly afterwards." To legally fly drones for his work, Ryan got his FAA (Federal Aviation Agency) Part 107 certification as a commercial drone pilot. His program currently uses two DJI Mavic 2 drones, owned by the Kansas Forest Service.

Aerial Photography in Forest Management

The use of aerial photography in forest management is nothing new. For many years, aircraft and satellites have provided aerial imagery to document forest extent, forest type, land changes, and other information that can only be seen from above. "For imagery of large landscapes, aircraft and satellites equipped with high-resolution sensors are still more cost-effective than drones," Ryan noted. "As I see it, drones excel when you need to capture smaller-scale, high-resolution, rapid-response data," he continued. With the current

Ryan Armbrust (above) describes some of the applications for drones at a presentation for the National Walnut Council meeting in Topeka, Kansas.

These images (left and above) from the Walnut Council drone demonstration clearly show erosion issues. This information helps the landowner and Kansas Forestry Service develop a management plan and monitor the area over time.

Federal Aviation Agency limitations on operating drones at no more than 400 feet above ground level, within visual line-of-sight, and with roughly 30 minutes of flight time per battery, Ryan has found that a drone mission is well-suited for a landscape of a few dozen up to a couple hundred acres. The high-resolution (0.5 to 1.5 inches per pixel) images can be viewed within minutes of a flight. "With advanced processing and photogrammetry software, a 3D model of the landscape can be created with good accuracy, which is not available from any satellite or most aerial photography sources. And unlike satellites, drones can capture data at exactly the time desired."

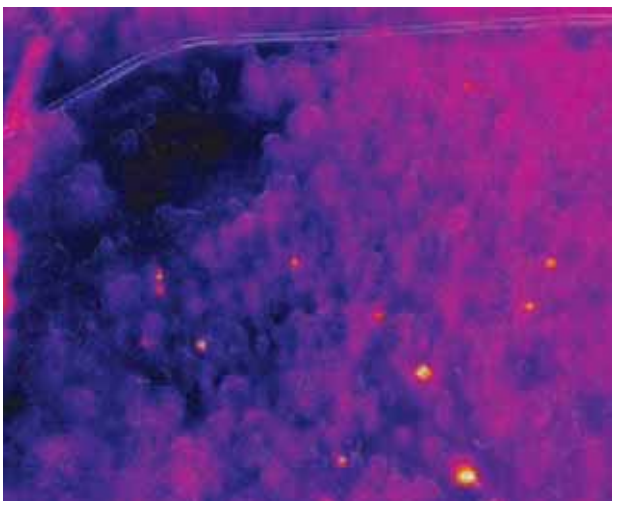
Drones come in two basic varieties—fixed-wing and multirotor (four-rotor, or quad-rotor, being the most common). Fixed-wing drones are similar to scaled-down conventional airplanes, with an uncanny resemblance to a soaring buzzard in flight. They can fly faster and cover a larger area than their multirotor counterparts. According to Ryan, they would be cost effective for a 500-acre mapping project. Multirotor drones, on the other hand, are highly maneuverable and hover—an advantage when acquiring imagery of smaller parcels and providing oversight or situational awareness of burn operations, inspecting structures such as towers and bridges, and providing aerial images of natural disasters. "The minimum practical area for drone use depends on the work to be done," says Ryan. "Some arborists, for example, use multirotor drones to assess individual trees for climbing hazards."

How Drone Imagery Is Used

Drone image sensors can pick up parts of the light spectrum beyond the human eye. Ryan explained that the choice of image sensor depends on the information desired. "For instance, a TIR [thermal infrared, or heat] sensor is very useful for keeping an eye on prescribed burn operations. A high-resolution visual spectrum sensor [which senses what the human eye sees] can locate vegetation and landscape features for promoting ecotourism and other possible opportunities. A near-infrared sensor produces an NDVI [Normalized Difference Vegetation Index] image that indicates tree stress and/or vigor, which can help determine forest management practices." "Understanding the landowner's objectives is key in determining which type of drone imagery will be the most beneficial," he concluded.

Ryan is enthusiastic about the roles that drones have taken with the Kansas Forest Service. "First off, in almost any work we do, there is value in documenting images from the air. For example, they assist in public relations, showing the diverse kinds of forests in Kansas and the ways in which people engage and manage tree resources in rural areas and urban communities," he explained. The Kansas Forest Service also uses drones in its Fire Program. "On the large fire mitigation project we did this spring in Chautauqua County, we were able to provide real-time situational awareness to show exactly how the fire line looked from the air and how the burn was progressing. With the TIR sensor, we could quickly and efficiently monitor large areas outside the burn area for any spot fires that could have popped up, and also to identify hot spots that needed to be extinguished during mop-up operations," he said, adding, "We also understand the [public relations] value of a pretty picture of a Kansas woodland or prescribed fire!"

This visual spectrum image of a recent prescribed burn at the Geary Wildlife area helps the fire crew monitor the progress of the burn.



A thermal image of the same controlled burn area pinpoints remaining hot spots, giving fire crews a quick heads-up on any pop-up fires across the fire line.

Drones Assist, They Don't Replace

Back in the office, he uploads the images to a

computer for further analysis. "Beyond visual inspection, there are a variety of software tools available to analyze and process these data. We use photo-stitching software to create large high-resolution maps from hundreds of individual photos. We have also used photogrammetry software to create 3D models of landscapes." He is especially interested in enhancing images of riparian areas. "We have some great 3D photogrammetry software to create models of streambanks on riparian forestry stabilization projects. The ability to create low-cost, accurate models in a short time not only helps with accurate estimation of project costs but is valuable for detecting and monitoring changes in those stream systems." Ryan says that drone images also assist with forest health assessment by detecting stress in trees for early detection of problems such as emerald ash borer, thousand cankers disease, pine wilt, oak wilt, and other rural and urban forest health concerns.

As a forester, Ryan was quick to point out that as useful and versatile as they are, drones are no substitute for ground-based observations. For example, he noted that verification of land boundaries is still best done by a ground-based surveyor. Assessments of forest health and stand type are also best accomplished by a trained forester on the ground. "I see drone imagery as being a useful complement to these efforts, but not a replacement for them."

Opportunities

At this time, it may take a bit of research to locate a drone service. Searching online can usually bring up some prospects, but outside of metropolitan areas the choices may be slim. Often, finding someone local who is both technically qualified and legal can be a challenge. Some of the biggest current clients of commercial drone operators include real estate agents and utility companies, so asking them for referrals may help point you in the right direction. Potential drone contractors should be able to provide proof of holding a current FAA Part 107 certificate, which is a legal requirement to operate commercially.

As a technology still in its early stages, there are opportunities for those interested in starting their own drone services. In addition to an FAA Part 107 certificate that shows you are aware of all the regulations and restrictions imposed on drones, Ryan says it is also wise to carry liability insurance. Entry-level professional drones capable of high-resolution images and videos cost as little as $1,000, but systems with more sophisticated image capabilities and longer flight times will set you back considerably more. As far as experience required to fly them, Ryan says that drones are pretty much self-flying, "... but I would highly recommend taking some formal training such as the excellent classes offered at KSU Polytechnic [Salina, Kansas]." With a fleet of over 40 drones, they offer training ranging from a fully accredited program to short courses that vary from half a day to a week.

Ryan also noted, "With the rapid advance of technological developments in this field, there are many applications that have yet to be fully fleshed out. As we continue to look at opportunities to expand our capabilities, we are focusing on areas that bring efficiencies in how we gather data to better inform management on the ground." Some of the advancements, Ryan believes, will involve technology that results in longer flight times, ability to fly safely in adverse weather/wind conditions, and the advancement of sensors. He suggests that perhaps the biggest advancement will be technological innovations that will increase safety to a point where the FAA can safely relax regulations to allow drone operation at more than 400 feet above ground and beyond the visual line of sight. "We're still in the early stages of applying commercial drones to natural resource uses," he concluded. ■

Dave Boyt has a BS degree in Forest Management and an MS in Wood Technology. He manages a tree farm (2006 Missouri Tree Farm of the Year), and operates a band saw sawmill.