The Ohio Department of Transportation and
UNMANNED AIRCRAFT SYSTEMS

Image of a culvert using the near infrared camera.

The Ohio Department of Transportation (ODOT) has been an innovator in geospatial technologies for the past several years—provide spatial data, software and support not only to internal customers, but also externally maximizing the latest in technology to provide the very best information by encouraging the most efficient use of resources. In this tradition, the ODOT is in the process of implementing Unmanned Aircraft Systems (UASs) for more efficient and effective operations.

There have been many advances in technology that have led to the innovations in inexpensive miniaturization of sensors, battery technology, mechanical

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technologies and computer processing. These advances have promoted efficiencies gained in remotely piloted vehicles for a variety of remote sensing type operations. The Ohio Department of Transportation is looking into these technologies to further improve its business functions.

With UAS technologies ODOT is investigating several platforms for a variety of functions such as:

- A fixed wing UAS for aerial photography in support of GIS, transportation asset management, construction project documentation and incident management.
- A multi-rotor UAS for asset condition assessments.
- A lighter than air UAS for incident management and traffic monitoring.

The current UAS implementation that ODOT has implemented is the first UAS that is being used in production by a department of transportation in the United States for the capture of aerial imagery and surface models. The UAS is a senseFly swinglet CAM, an inexpensive 1.1 lb 2.5 foot plane that captures aerial photography. The imagery is orthorectified and used in ODOT’s geographic information system (GIS) to support its business functions.

As with any tool there are certain jobs that it may be more suited for its particular function. The existing platform is well suited for small projects that if compared to a traditional manned aircraft could not be justified in using due to the high cost of mobilization. ODOT is investigating the use of larger platforms to fulfill the needs of projects where its existing platform may not be the best tool, but still offers cost advantages, efficiencies and improved safety as compared to the traditional manned aircraft.

The biggest challenge hasn’t been flying the UAS, but rather clearing the UAS to fly in United States airspace. To get the UAS off of the ground, ODOT works closely with the Federal Aviation Administration in establishing a standard procedure prior to each flight. After a site is determined, ODOT files...
an application with the Federal Aviation Administration (FAA) for a Certificate of Authorization (COA). The FAA evaluates the request and determines if the UAS can safely enter the National Airspace System (NAS) and perform the intended operation. Automated processes are set up using specialized Geographic Information System (GIS) software (Safe Software FME and ESRI ARCGIS) to streamline the COA application process. Once the COA has been reviewed and approved by the FAA, ODOT begins the coordination with local air traffic control and is able to conduct the mission.

Once approved ODOT’s pre-mission planning includes planning the flight, site evaluation and setting ground control points to increase the horizontal accuracy of the imagery and insure safe operations. Obstacles are noted and plans are made to minimize any potential issues.

The small UAS deployed by ODOT is equipped with a small 12 megapixel camera (visible light or near infrared) that takes images at predefined coordinates computed with its flight planning software; a single frequency GPS; barometer for elevation and an Inertial Measurement Unit. Typical flights last around 20 minutes and can cover 100-150 acres at 300 feet above ground level (AGL). As a contrast to larger manned aircraft, the small UAS can be routed around potentially sensitive objects on the ground insuring safety and privacy while capturing its subject, in most cases ODOT transportation infrastructure, in current high-resolution photography. Current missions have only been conducted in sparsely populated, rural areas and have consisted mainly of culverts and bridges.

Once the images have been collected, the data is analyzed using the onboard sensors such as the telemetry and GPS data to get the general location and perspective of each image. The imagery is then processed by a software program called PIX4D UAV 3D where the imagery is then further corrected by using sophisticated software algorithms in combination with ground control points set prior to flight to produce highly geospatially accurate orthorectified aerial photography.

The software matches pixels in each overlapping image and computes the elevation and further refines the horizontal coordinates. Typically the imagery that is produced is less than 1” per pixel which means that details such as rebar, tire tracks, mailboxes and even overhead utility wires are clearly visible.

These results produce a highly detailed and accurate image and a 3 dimensional colorized point model of the surface for enhanced project visualization and analyses. The data is then stored and referenced in our centralized servers where they are disseminated throughout the organization supporting both CAD and GIS applications.

The current results have assisted our engineers by providing them with an inexpensive way to capture current high resolution aerial photography giving them access to unprecedented information they either did not have or could not justify the resources to acquire. Data used for geographic information systems, like asset management and condition assessments, have been proven useful for project planning.
Deficiencies such as broken pipes, sinkholes and drainage problems can easily be identified and planned for.

ODOT future UAS plans include, evaluating several different types of platform/sensor configurations to help solve some of the inefficiencies of projects that could capitalize on the new technologies. One such application is the evaluation/assessment/documentation of bridge pier conditions using small rotor aircraft equipped with a camera and GPS. This typically required expensive equipment and logistics to get around places that could not easily be accessed. This is eliminated with small UAS that have loitering capabilities, GPS, high-resolution camera and distance measuring.

Another project ODOT is researching is the use of tethered lighter than air systems that can be quickly deployed in the event of an emergency. Typically aerial assets can take several hours to get out to the site of an emergency. As with the right tool for the job, a tethered lighter than air UAS could be deployed in minutes and have a high endurance for assessing natural disasters or emergencies that could cause a failure in the transportation infrastructure. Training for this type of UAS is minimal and the systems are small enough to be placed in the back of a truck. Setup and take down can be completed in less than 20 min and being tethered adds additional levels of safety, increases endurance as well as lowers the logistical requirements with the FAA.

We are excited to be forerunners of the new technology and plan on expanding our existing portfolio and capabilities in the very near future. As always, ODOT will continually work directly with the FAA to further the UAS technology and to insure its safe operations.

Fred Judson is a certified Geographic Information Systems (GIS) Professional from the Geographic Information System Certification Institute (GISCI). Education includes Bachelors of Science from Excelsior College and a Post-baccalaureate Certification in GIS from Pennsylvania State University. Fred also has a Private Pilot Airman Knowledge Certification from the Federal Aviation Administration and a swinglet CAM Unmanned Aircraft System Certification. As well as, over 18 years’ experience at the Ohio Department of Transportation, District 2.