Eyes in the sky

21 July 2016

Data processing and developing technology will make drones even more practical and widely used for land surveys, says Philip Buchan

---

In the last few years, unmanned aerial vehicles (UAVs) have become an increasingly viable tool for land surveyors. Autopilots, batteries, cameras and airframes have become smaller, lighter and cheaper, putting UAVs within the reach of survey professionals. Aerial imagery of commercial quality can be acquired for a number of purposes, including aerial surveying, industrial inspection, construction progress monitoring and search and rescue.

In the land survey sector, UAVs are now being deployed to capture high-resolution aerial imagery that can be processed using advanced photogrammetry software to generate accurate topographic survey information, including digital elevation models, 3D point clouds and orthophotos.

UAV-acquired information is highly beneficial for assessing potential site locations, designing layouts, generating 3D visualisations, assessing site visibility, calculating earthworks volumes, monitoring construction progress and producing as-built records.

The main benefits of a UAV survey compared with a traditional land survey are that:

- site work is carried out far quicker
- surveyors reduce their exposure to risk
- limited site access is required
- inaccessible or hazardous areas can be surveyed remotely
- improved data is available with high-resolution aerial imagery
- it is more cost-effective.

Case Study 1: Network Rail Dover

Figure 1: Drone's-eye view of Dover sea wall

In late December 2015, a severe storm damaged a sea wall protecting the Dover to Folkestone railway line, undermining the rails and forcing the temporary closure of the route. Cyberhawk used a multi-rotor UAV platform to survey an area extending to 900m along the coast within 1 day. Geo-referenced orthophoto imagery at 2cm ground resolution, 3D point cloud and vector survey data with a verified level accuracy of 20mm root mean square was collected for the client, along with oblique inspection imagery of the sea wall, aerial spherical imagery and aerial video footage showing the wave action. Cyberhawk also flew at low tide to collect topographic information on the beach, which had changed profile due to the storm.

LiDAR comparison

Over the last few years, light detection and ranging (LiDAR) surveys have become popular for large-scale survey projects, being carried out by a manned aircraft flying at 1,500ft or above. A UAV survey offers significant advantages over a LiDAR survey, however, in that:

- it is more responsive and has a quicker turnaround
- UAVs fly lower, so atmospheric issues are reduced
- digital imagery from UAVs is of a higher resolution
- UAVs can get very close to particular areas of interest
- it is more cost-effective.

UAV operation and safety

UAVs come in 2 main types: fixed-wing and multi-rotor. Fixed-wing UAVs, which are normally less than 2m in wingspan and 4kg in weight, are ideal for mapping areas up to 2,000 hectares. Typically, they have a flight duration of up to an hour, which could allow an area of 50?100 hectares to be photographed per flight, and a whole project to be completed within 2 days. Multi-rotor UAVs, usually being less than 1m in length and 2kg in weight, have a shorter flight duration, but have the advantages of being able to perform a vertical take-off and landing and hover to acquire oblique or panoramic imagery. Cyberhawk, which uses both types, is a national qualified entity recognised by the Civil Aviation Authority (CAA), which means that the team is able to certify its own pilots internally to CAA standards.

Figure 2: Pilots need to have care and experience

Flight planning

The process of carrying out a topographical survey is not simply a matter of flying a UAV around a strip of land. It requires care, experience and pre-planning, as is outlined in the following steps.

- Ground control points are established across the area of interest and precisely positioned using GPS equipment.
- A flight plan is prepared taking into account the area to be surveyed, wind direction, take-off and landing areas, the image resolution required and maximum flying height.
- The flight plan is then uploaded to the UAV wirelessly.
- The UAV is launched and will follow the flight plan using the on-board autopilot system. A series of overlapping vertical images are taken at locations defined in the plan. Once the planned flight is completed, the pilot will bring the UAV in to land at a suitable location. Most survey UAVs have an automatic landing function, but it is important that the pilot has the skills to land the craft safely under any site conditions.
- The images and GPS photo logs are downloaded from the UAV. When processing the data, the ground control points are identified and coordinated in the photos. The software uses photogrammetric principles to calculate the topography from the numerous overlapping images.
- The resulting output is a digital elevation model that can be produced on a grid with a resolution of less than 1m, as well as in geo-referenced orthophotos ? aerial photographs with a uniform scale similar to a map that can be provided at resolutions down to 2cm.
- UAV survey data is issued to the client in formats that will be compatible with standard software packages such as AutoCAD, Civil 3D and ArcGIS.
  Geo-referenced imagery is supplied in standard image formats, such as jpeg, png or tiff.

This method of data acquisition and processing is rapidly evolving. Cyberhawk has recently commissioned its latest fixed-wing UAV platform, which features on-board precision GPS, eliminating the need for ground control points to be established on site. The system has a flight endurance of up to 2.5 hours and a parachute recovery system. With the CAA?s extension of line-of-sight permission up to 1.5km from the ground-based pilot, this system will allow much larger areas to be surveyed in a single flight.

Data analysis is also developing rapidly, with cloud-based processing becoming a viable alternative to office-based systems. In the near future, survey-grade data will be available almost immediately, sent directly from the UAV to the cloud via 4G networks and delivered to the client in a browser-based viewer.

Case Study 2: Gryphon FPSO Internal Tank Inspection, North Sea

Floating production, storage and offoading (FPSO) vessels are used for the production and storage of hydrocarbons.

Cyberhawk?s client,Maersk Oil , requires visual inspections of its cargo tanks for integrity, damage assessment and class certification. This type of inspection is usually conducted by rope access technicians.

Cyberhawk mobilised an experienced 2-man UAV team, consisting of a UAV pilot and inspection engineer. The inspection of the critical components of the tank was completed within a day, whereas with rope access it would usually take between 3 and 4 days for the same scope of work.

Inspecting the tank with a UAV allowed Maersk Oil to undertake a quick, safe audit and identify and plan for any possible contact-based inspections in both this and other tanks.

UAV inspection

Multi-rotor UAVs are also being used for close visual and thermal inspection of tall and inaccessible industrial assets. UAVs have the ability to hover close to structures to acquire high-quality images that can inform asset maintenance decisions. This technique has been rapidly adopted by the onshore and offshore oil and gas industry on a global basis, and Cyberhawk also provides aerial inspections of chimneys, cooling towers, transmission towers, overhead line equipment for railways and onshore and offshore wind turbines. This enables planning of plant shutdown and repairs, removes the need for working at height and offers major cost savings compared with traditional inspection techniques such as rope access, cherry-pickers and scaffolding inspections.

Future developments

In future, UAVs will benefit from improved battery and digital camera technology. New sensors are being trialled with UAVs, including LiDAR, near-infrared cameras and gas detectors. It is also expected that payload limits and flight durations will rise as new UAVs come to market.

Philip Buchan is Commercial Director at Cyberhawk

Further information

- Images ? Cyberhawk
- Related competencies include Remote sensing and photogrammetry , Legal/regulatory compliance
- This feature is taken from the RICS *Land journal* (June/July 2016)