The Realities of Drone Surveying

Charlton Bland shares his experiences in operating drones and sets out guidelines for successful piloting of the platform and processing of the data collected.

The introduction of drones into mainstream surveying is as significant as the previous introductions of Electronic Distance Measurement (EDM), GPS and terrestrial laser scanning. Drones permit aerial photogrammetry or lidar to take place on sites in which it would not be economical or practical to implement manned aircraft flights. They can enable accurate mapping with accuracy equivalent to terrestrial lidar. However, like any piece of surveying hardware, be it a total station or Global Navigation Satellite System (GNSS) receiver, their accuracy, utility and effectiveness is limited by the skill of the surveyor.

The purpose of this article is to suggest guidelines for the effective application of drones for the photogrammetric processing of Small Format Aerial Photography (SFAP).

Controlling a Drone Survey

The benefits of drones are now well known, including improved mitigation of health and safety hazards, reduced survey times, reduced site disruption and high survey fidelity. Most of these benefits result from the simple fact the drone operates overhead. For many surveys, this usually means 100m above ground level which facilitates a suitably low ground sample distance (GSD) that, combined with a robust ground control network, permits 1:200 3D CAD deliverables.

It is important to remember that the drone itself does not produce accurate maps; it is in essence a platform for a sensor. There are four key factors that are intricately connected and together contribute to an accurate drone survey. They are:

1. **The drone**: The purpose of the drone is to safely, reliably and accurately position the camera. Therefore, the stability of the drone platform to follow the designated flight plan and maintain the orientation of the camera in the nadir regardless of external factors such as wind is critical. Since the drone operates overhead and above client assets and personnel, a key consideration is the amount of safety features and redundancy built into the drone's onboard systems i.e. redundancy in propulsion, onboard navigation systems, batteries and communication systems to name but a few. Many drones now feature dual and sometimes triple redundancy in these systems.
2. **The camera**: The quality and internal geometry of the camera, its sensor and its lens are critical to the production of high accuracy maps. Very wide angle lenses can cause severe lens distortions which degrade the accuracy. Telephoto lenses with large focal lengths overly restrict the image footprint and increase the time required to map a given area. For high accuracy work, high quality lenses are preferred as their optimised internal geometry minimises optical distortions and results in sharper images with fewer artefacts, improving the accuracy of the final mapping. Some cameras and lens combinations are best suited to land survey, whilst others are more suited to inspection work and video.
3. **The surveyor**: The skill and knowledge of the surveyor and or photogrammetrist to plan the image acquisition mission, that is the drone flight plan (which covers: image overlap, relative orientation and GSD) and their ability to design the ground control network is critical to ensure the integrity and accuracy of the survey. The ground control is crucial for high accuracy aerial survey as the photogrammetry is orientated and scaled to it; getting this wrong will degrade the survey accuracy. Quality ground control will significantly increase the accuracy of the project, while poor ground control will distort the project and reduce accuracy. A well-designed network includes inbuilt checks that serve to independently verify the photogrammetric processing. Checkpoints should be positioned as far from control points as possible yet remain within the project boundary. This helps minimise any statistical skew which may arise if checkpoints are positioned too close to control points. Once the imagery returns to the office, the surveyor is responsible for meeting the client's specifications and the production of the required project deliverables be it 3D CAD drawings, point clouds, DEM/DTM/DSM terrain models, orthophotos, GIS analysis or even virtual reality outputs.
4. **The pilot**: The pilot may or may not be the same person as the surveyor. The pilot is critical as they must be aware of all relevant Civil Aviation Authority (CAA) legislation as well as the wider rules governing the use of the drone; keeping the survey safe and legal. They are also essential in ensuring the image acquisition (flight plan) is flown in accordance with the surveyors' design. Finally, they are there to take control should an emergency arise be it, component failure, airspace incursion (bird or other aircraft) or signal interference resulting in unplanned behaviour of the drone. The pilot should be selected to ensure that he or she is suited to the job in hand. For instance, if working in a busy city centre a pilot who has special permission from the CAA to operate in closer proximity to the public than the standard CAA permission allows should be used. Ultimately, it is paramount that the project manager has confidence in the pilot's ability to legally and safely operate the UAV.

Noise in the Market

The affordability of drones, combined with ever capable automatic survey processing software, has resulted in the emergence of a large number of drone service providers with a significant number of them offering survey and mapping services. Many of them have a limited amount of survey knowledge with no formal survey training and instead rely on automatic flight planning and processing to create survey deliverables. This is important because the automatic processing, while very easy and intuitive to use, is limited in the quality of its output by the standard of the inputs. Without a strong knowledge of photogrammetry and control network establishment using GNSS and total station/lidar equipment, it is easy to create stunning 3D models and orthophotos that are inherently inaccurate.

Conversely, drone surveys undertaken by professionally qualified and experienced surveyors implementing a robust survey methodology and utilising drones with multiple safety features and highly experienced pilots are inherently more expensive than surveys offered by inexperienced ‘surveyors’ utilising consumer grade drones and near fully automatic workflows for product creation. Ensuring that the survey is conducted as safely as possible, and that the deliverables meet the client’s expectations, is well worth the small added cost for a professional aerial survey service and peace of mind.

Closing Remarks

To conclude, drones have arrived as a significant and beneficial tool for surveyors to utilise. They are not a panacea, but in the right hands and for the right job they offer a safe, rapid and high-fidelity alternative to traditional ground-based surveys.

When considering the use of this technology for a land survey it is worth ensuring that you have confidence in the skill of the surveyor undertaking the task to meet the projects’ specifications; relationships with the RICS, ICES and TSA is a good indicator. The project manager should have good knowledge of photogrammetry, awareness of the safety features and experience to assess the characteristics of the site; the skills required to operate a drone over open land are different to those required to operate over live infrastructure or in busy built up areas.

It is hoped that this article helps those who may be less well informed about the intricacies of drone survey services to consider some of the wider aspects beyond the innovative use of the platform itself.

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