Precise UAV Camera Positioning for 3D Mapping

Photogrammetric mapping is the new 'hot topic', although the concept has been around since Leonardo da Vinci's time and it has been in use in practice for over a century. Drone technology has now consumerised photogrammetry, introducing data acquisition and 3D model processing to thousands. From a surveying standpoint, accuracy is key. To build 3D models in a known spatial frame of reference requires some form of control, either on the ground, in the air or a combination of both, which is where ground control points (GCPs) come in.

GCPs provide a solid tie to a real coordinate system with known coordinates on targets across a project. Accuracy of the project can be assessed in the aerial triangulation (AT) process, combining a weighted combination of data from the photo matching and the GCPs.

Aerial Cameras

The photo matching process creates a point cloud of data projected into 3D space based on matching pixel positions in photos. Any lens distortions introduce errors in this process and degrade the accuracy of the model. Built-for-purpose aerial cameras, expensive as they are, minimise these errors with high-spec lens calibration and having no moving parts, so that calibration remains constant. Lesser aerial systems, such as drones carrying commercial off the shelf (COTS) cameras, inherently have significant errors due to lens quality. Camera sensor size and shutter type are also critical factors in a camera's fitness for photogrammetry. Survey control of a UAV photogrammetry project is essential to manage these errors.

Ground Control Points

GCPs have typically been the only means available to add control to a project, requiring a surveyor to place and measure targets distributed over the site. Accuracy of the project is dependent on distance from the GCPs, so as the AT process resolves the model further from the GCPs it is reliant more on the photo matching and becomes less accurate. Placing those GCPs can be a time consuming and expensive task, and sometime not even possible on inaccessible sites.

RTK and PPK Aerial Control

The other option is to put the control on the camera. RTK and PPK aerial control, such as the Klau Geomatics PPK system, provide high accuracy (3cm) positions of the point where each photo was taken. Effectively the project may then have hundreds of control points in the air, spread evenly over the project. No need to place GCPs on the site and the control blankets the entire site evenly with many times more fixed control points than a GCP survey.

No GCPs? This depends on the purpose of the project. For accurate 2D mapping and orthomosaics, aerial control points on their own will work well. No GCPs required other than to check for a mistake in the base station coordinate or similar gross error.

3D Modelling

For 3D modelling, however, errors in lens calibration will effectively 'zoom' the model up or down, often very significantly when using COTS cameras. For this reason, and also to catch an error such as a wrong base station height measurement, a couple of GCPs are required.

With UAVs, ‘everyone’s a surveyor’, but good technical error management sets the professional surveyor apart from the cool visual 3D modeller.

Robert Klau, BSurv(UNSW), SSSI ESP-AP is a registered engineering surveyor and director of Klau Geomatics Pty Ltd.