MAPPINGMATTERS

YOUR QUESTIONS ANSWERED

The layman's perspective on technical theory and practical applications of mapping and GIS

BY Qassim A. Abdullah, PH.D., PLS, CP**

QUESTION:

Question: I referenced your highlight article "Harnessing Drones the Photogrammetric Way," which you published in the May 2019 issue of PE&RS, in a conversation about how ground control points (GCPs) are necessary to create accurate maps with unmanned aircraft vehicles (UAVs). I am a licensed surveyor and strongly agree that GCPs are necessary to create accurate maps. My conversational opponent, if you will, insisted that GCPs are not needed if you use an accurate, real-time kinematic (RTK) GPS system on the UAV. Despite your years of research and experience, he is unwilling to accept your assertion. In addition, in the journal article on page 332, you mentioned that at least five GCPs are required for an accurate map. Do you have other data that supports the need for GCPs when mapping with UAVs?

Steve Moran, PLS, Moran Surveying Inc.

Dr. Abdullah: Your colleague is correct if and ONLY if certain conditions are met, and some of these conditions are difficult to meet on a regular basis. These conditions include:

SYSTEM ELECTRONICS

The system electronics and events timing on board the unmanned aircraft system (UAS) and its sensors needs to be aligned to the degree so the shutter mid-exposure pulse (MEP) is determined perfectly. There is always a time offset between the GPS event stamp and the MEP. Some companies invest a great deal in determining this offset, so they can correct for it during the post processing of the GPS tags. They do this because, unless the offset is determined perfectly, the wrong camera position will be measured by the on-board GPS. From my experience, very few UASs on the market time this offset appropriately.

HEALTH OF GPS SIGNAL

The GPS constellation or position dilution of precision (PDOP) supports accurate position determination. This requires flying at a certain time of day and changes according to the project location, date and time. Very few UAS field operations allow us to wait in the field until a better PDOP is met, as you want to spend as little time as you can in the field. A bad GPS signal can cause errors in the camera position. Without the use of GCPs in the aerial triangulation to model shifts and drifts, you will get positionally inaccurate orthos or digital surface models (DSM). Also, along these lines, the GPS data recording frequency has a noticeable impact on the accuracy of determining the UAS camera position. One hertz (Hz) versus 20 Hz recording frequency can introduce substantial positional errors during an unstable aerodynamic situation. During the 1 Hz GPS recording, the UAS may move 6 to 8 meters between the two epochs. Depending on the flying conditions and the method of interpolation used, estimating the sensor position between two epochs can be challenging and produce inaccuracies. The presence of GCPs in this case can prevent the uncertainty of estimating the image's perspective center position.

> **"Having GCPs in the aerial triangulation process provides peace of mind. With the proper software, it can be used to model GPS shift and inertial measurement unit (IMU) drift and can flag datum compatibility problems"**

GEODETIC DATUM CONVERSION

There is always the possibility of introducing an anomaly in the datum conversion between GPS-based WGS84 and the product's intended vertical datum, such as NAVD88. By not having any GCPs in the project area, you risk introducing errors due to geiod modeling and conversion. Even when flying with airborne GPS for manned aircraft operations, I never advise anyone to execute a project without GCPs and to rely only on airborne GPS. We have always used GCPs in every project; it is an industry standard. Some of the newer UAS operators neither understand nor appreciate that fact. For that reason, industry experts are working hard to help them

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learn the best practices involved in processing data from UAS.

Finally, on this topic, having GCPs in the aerial triangulation process provides peace of mind. With the proper software, it can be used to model GPS shift and inertial measurement unit (IMU) drift and can flag datum compatibility problems. Having GCPs in place also assists with quality control, ensuring you don't blindly deliver products of unknown accuracy.

> **"There is always the possibility of introducing an anomaly in the datum conversion between GPS-based WGS84 and the product's intended vertical datum, such as NAVD88"**

As for the rule I referenced in the journal that requires you to have at least five GCPs in place to create an accurate map, that number is not carved in stone. You can have more or fewer GCPs, based on the project size and shape. This is based on my research findings and the findings of separate research by Professor Riadh Munjy of California State University, Fresno. Five points safely covers a block of imagery from RTK and non-RTK drones. Four GCPs in the corners results in great horizontal accuracy especially from non-RTK drones. Adding a fifth point in the center of the block is the only way to bring accuracy into the elevation, i.e. Z, in a non-RTK imagery.

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