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:

1. **Question:** I have a client who uses my favorite unmanned aircraft system (UAS), who came across a white paper that the UAS manufacturer published a few years ago. According to the white paper, the manufacturer claims that with their PPK (post-processed kinematic) system and their super technology, users can create orthophotos with a positional accuracy of 1.0 cm (0.4 inches) as RMSE (root mean square error) without using GCPs (ground control points). I read the article and it doesn't seem to pass the smell test. Would you be able to look through the white paper and give me a few quick thoughts on whether the manufacturer's claim is even remotely plausible? I've told my client that it's not and they need GCPs, and I also told them I'd check with you.

   Anonymous Mapping Matters Reader, Colorado, USA

Dr. Abdullah: I read through the white paper, and I can assure you that the claim made by this manufacturer is exaggerated. Although it may not be intentional, misleading claims such as this are widely happening throughout our industry because the people conducting these evaluations do not always understand the basics of error distribution, statistics, and the fundamentals of testing. The main reason I published this question is to share that users of this technology need to be educated on how to identify false claims and misleading accuracy results. I carefully read through the white paper and learned that the manufacturer used two testing sites to assess UAS accuracy. In the first site, only 5 checkpoints were used. The absolute horizontal accuracy of the checkpoints was reported to be 2 mm as RMS using the GPS/Global Navigation Satellite System (GNSS) Continuously Operating Reference Stations (CORS) and PPK technique. Here, I need to note that achieving 2 mm absolute accuracy using GNSS surveying techniques can be hard to understand and has caused some confusion in reporting. The product accuracy as RMSE is reported to be 0.7 cm (0.3 inches) horizontally and 2.6 cm (1 inch) vertically based on the 5 checkpoints as reported by the photogrammetric image processing software.

At the second site, only 9 checkpoints were used, and they were surveyed using real-time kinematic (RTK) techniques where the data for the base station was processed through the Online Positioning User Service (OPUS) site. No absolute accuracy was given to the surveyed checkpoints other than describing the sub-centimeter accuracy of OPUS processing. For Site 2, the product accuracy was reported to be 1.0 cm (0.4 inches) horizontally and 2.5 cm (1 inch) vertically based on the 9 checkpoints as reported by the photogrammetric image processing software. It is possible to achieve such high accuracy and I appreciate the manufacturer's efforts in documenting product accuracy, but there are general guidelines to substantiate the accuracy verification process. Without following these guidelines, the results as documented in this white paper cannot be verified or accepted.

> ***"In addition to making sure imagery meets a demanding accuracy standard, GCPs can be used to correct datum variability issues, model issues with less-than-perfect GNSS signals, and to conduct analytical camera self-calibration."***

My concern with the approach and the reported accuracy results are highlighted by the following:

1. According to American Society for Photogrammetry and Remote Sensing (ASPRS) Positional Accuracy Standards for Digital Geospatial Data of 2014, the absolute accuracy of the checkpoints should be three-times better than the tested products. According to this standard, to support a product accuracy of 1 cm, as the white paper claimed, the checkpoints should be surveyed to a horizontal accuracy of 0.33 cm. The white paper reports that the survey accuracy of the 5 checkpoints used for Site 1 was 2 mm. I am finding it difficult to accept this claim, especially if the survey is based on CORS and GPS technique. I am afraid that the individuals who conducted the survey took the 2 mm number

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from the GPS receiver computations report. Many of the GPS receiver manufacturers report the quality as "precision" in their reports and not the absolute accuracy to a certain datum. This precision number indicates the repeatability of the survey sessions the user made, often multiple times, over that station. All it tells you is how well the GPS-determined position values, computed from the different sessions, agree with one another. But it does not report an absolute accuracy to the datum. I assume that is what happened here, so the criteria of three-times more accurate is not satisfied in this test.

As for Site 2, the surveyor obviously utilized the RTK techniques, which are well known to provide no better than 1.5 cm accuracy. In which case the survey is only valid to test a product accuracy of no better than 4.5 cm according to ASPRS standards. This illustrates another way that the accuracy assessment failed to meet the ASPRS standards.

"misleading claims such as this are widely happening throughout our industry because the people conducting these evaluations do not always understand the basics of error distribution, statistics, and the fundamentals of testing."

2. According to ASPRS standards and the National Standard for Spatial Data Accuracy (NSSDA) accuracy testing guidelines, for the sample mean to be approximately and normally distributed, and for the normal probability model to be used to quantify uncertainty for the mean of the errors, one needs at least 20 independent checkpoints to perform an accuracy assessment of a mapping product. As a matter of fact, a well-regarded method in statistics, the Central Limit Theorem, calls for a minimum of 30 checkpoints. Here, both tests were conducted with fewer checkpoints, 5 and 9, respectively, so I will not consider these tests to be valid.

"To me, achieving 2 mm absolute accuracy using GNSS surveying techniques is hard to understand and believe and there must be some confusion around reporting such number."

3. The reported accuracy results were based on the numbers reported in the aerial triangulation processing quality report and not based on actual measurements on the final orthorectified imagery. This approach is not recommended as the orthorectification process is influenced by the quality of the digital terrain model used for the orthorectification. The fit to the checkpoints within the aerial triangulation process may not result in the same fit of these checkpoints to the orthorectified imagery. Mapping product accuracy should be evaluated on the final delivered product within the same environment that the product will be utilized by the user to derive information, whether this is in ArcGIS, MicroStation, AutoCAD, or another GIS software.

Finally, to achieve high product accuracy, I do not recommend processing imagery without GCPs. In addition to making sure imagery meets a demanding accuracy standard, GCPs can be used to correct datum variability issues, model issues with less-than-perfect GNSS signals, and to conduct analytical camera self-calibration.

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