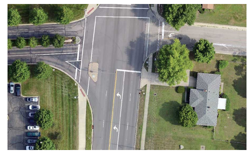
POINT OF BEGINNING

# Drones Important Tool for Surveyors

This is a colorized 3D rendition of a point cloud generated from 2-cm imagery from the Woolpert Renaissance system fo
Bypass project in Ohio. The imagery was processed using Pix4D.

*Image courtesy of Woolpert*

*September 3, 2018*

*Qassim Abdullah, David Kuxhausen PLS, and Tom Mochty PS*

The mass marketing of unmanned aircraft systems (UAS), or drones, through the retail market has generated tremendous excitement amongst gadget enthusiasts and working professionals alike. Such excitement is justified, as it is a defining moment in our history. For the first time, anyone can remotely fly and control an aircraft and capture aerial imagery without obtaining a pilot's license or making a costly investment in a manned aircraft.

It is commendable to see model aircraft and rocketry enthusiasts excited about flying UAS as a hobby. However, seeing that same level of excitement for these emerging technologies applied professionally raises some serious concerns because it introduces the potential for deviation from sound surveying practices.

We at Woolpert are strong advocates for the use of UAS technologies, and envision a future where these systems will be just another tool in the surveyor's tool box.

Recently, we have reviewed several articles and presentations from both licensed and non-licensed proponents, who have received their Part 107 UAS remote pilot certification, along with product literature from drone equipment and software companies; all claiming to achieve very high map accuracies (such as 0.05 feet) without the aid or reference of proper ground control surveying techniques, sensor quality or acknowledgement of appropriate national map standards. In one recent article, the authors suggested that to keep the initial investment cost as low as possible, those interested in using UAS technology should avoid purchasing the upgrade for RTK/PPK (real-time kinematic/post processed kinematic) capabilities. We believe these claims hurt the professions that employ this technology.

First, a low-cost UAS is thin on the advanced avionic systems necessary for adequate control and communication. Advanced communication systems and UAS identification technology have encouraged the Federal Aviation Administration (FAA) to ease its regulations and allow professionals to conduct commercial operations over populated areas. Cheaper systems often are less reliable and potentially present more risks to the operating crew and, more importantly, to non-project participants.

Second, calling on surveyors to overlook the importance of the RTK/PPK global navigation satellite system (GNSS) option when selecting a UAS for commercial work is misleading. Having ground controls within the project area can offset some of the need for such technologies, but this can result in the survey being less reliable. Accurate, centimeter-level camera positions operating in combination with surveyed ground controls is a well-known and professional best practice method to reach a design-grade aerial survey through photogrammetric methods. Without it, the user would need a tremendous amount of surveyed ground control. Moreover, accurate GPS positions for every single image in the project provide dense aerial controls for aerial triangulation, and this cannot be substituted by a few ground control points. The latter is especially true if you are seeking to achieve survey grade products with centimeter-level accuracy from UAS.

Third, the modern photogrammetric process, whether approached through structure-from-motion or traditional photogrammetric concept, is much more complicated than many UAS operators-turned-mappers may think. Modern map accuracy is influenced by many factors, such as:

- The quality of camera calibration parameters;
- The quality and size of a charge-coupled device (CCD) used in the digital camera CCD array;
- The amount of imagery overlaps;
- The quality of parallax determination or photo measurements;
- The quality of the GPS signal;
- The quality, density and configuration of ground controls;
- The quality of the aerial triangulation solution;
- The capability of the processing software to handle GPS drift and shift;
- The capability of the processing software to handle camera self-calibration; and
- The quality of the digital terrain model used for the production of orthoimagery.

Therefore, such tight vertical accuracy claims may extend beyond the capability of consumer-grade payload (i.e. camera and auxiliary geo-referencing system) on board many of the low-cost retail UAS. Such inexpensive cameras are not metric and have various inherent instabilities in their internal camera parameters. More robust photogrammetric processing software can model and correct many of the deficiencies in these low-cost, non-metric cameras, but cannot eliminate the imperfections in the data — especially with the absence of RTK/PPK GNSS options and the negative influence of some of the factors affecting map accuracy.

It’s important to foster a clear understanding of the new American Society for Photogrammetry and Remote Sensing (ASPRS) Positional Accuracy Standards for Digital Geospatial Data.

When verifying the accuracy of a mapping product, the standards recommend a set of independent ground control checkpoints surveyed to an accuracy that is three times more accurate than the tested product specifications.

The number of ground control checkpoints used to verify product accuracy should constitute a valid statistical sample. The National Standard for Spatial Data Accuracy (NSSDA) testing guidelines suggest a minimum of 20 checkpoints required, while the new ASPRS standards recommend a minimum of 25 checkpoints to verify horizontal and vertical accuracy of the product.

For the photogrammetric processing of UAS imagery, aerial triangulation should be twice as accurate as the expected accuracy of derived maps.

(For more details, please consult the new ASPRS standards.)

Therefore, to produce an elevation data with a vertical accuracy of RMSE = 0.05 feet from UAS imagery, assuming a minimum of 20 independent checkpoints are used to verify such a claim, the ground control points according to ASPRS standards would need to be surveyed to a vertical accuracy of 0.0125 feet or 0.38 centimeters. Such high-level vertical accuracy requirements for the ground control network eliminates the possibility of using RTK surveying techniques, and makes the UAS survey operation very expensive, effectively defeating the claim of being able to conduct "cheap surveying work using UAS."

So, our question is why would any licensed professional want to go that far out on a limb technically and professionally and claim map accuracies of 0.05 feet? The costs and the professional liability incurred far outweigh the reward by severely compromising the ability to deliver. In our view, the UAS practitioner who offers mapping and surveying services through UAS technology should understand the accuracy requirements necessary to each step in the process and have the experience, education, and training to help clients balance quality and cost.

UAS has proved very useful and economically feasible for many projects that require a wide range of accuracy requirements. However, it's very important to remember that UAS accuracies are only as good as the weakest link in their hardware, software and implementation procedures, especially at the sub-centimeter level.

Caution and a full understanding of what can and cannot be achieved from UAS survey techniques is crucial to the success of any project, and is necessary to safeguard the accuracy standards of the surveying and mapping profession.


Recent Articles By Qassim Abdullah

**Mapping the Earth at the Speed of Light**



Qassim A. Abdullah, PhD, CP, PRM, RPP, is a geospatial scientist at Woolpert Inc. (www.woolpert.com ) and an adjunct professor at the University of Maryland Baltimore County. An innovator in digital aerial imagery and LiDAR acquisition, Abdullah has more than 30 years of combined industrial, research and development, and academic experience in analytical photogrammetry, digital remote sensing, and civil and surveying engineering. Throughout his career, Abdullah has developed proprietary software applications and integrated airborne GPS as well as LiDAR data acquisition technologies, including precise positioning algorithms and processes. He has published more than 50 technical papers and reports. He is also the 2010 recipient of the prestigious Fairchild photogrammetric award.

David Kuxhausen, PLS, is the Survey Discipline Leader for Woolpert.

Tom Mochty, PS, is Woolpert's Senior Vice President and Transportation Market Director.