FIG Standards for Surveying by Drones

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SUMMARY

Over the past decade, surveying by drones has evolved for a variety of civilian applications including aerial surveying and mapping. As a result, the entire surveying industry has been evolving by implementing drones carrying different payloads in their daily surveying activities. Currently, drone surveys are done using a variety of payloads, including but not limited to cameras, LiDAR's, multispectral scanners, hyperspectral scanners, etc. Additionally, some drone payloads include a GNSS receiver and an inertial measuring unit (IMU) for payload positioning and orientation purposes, especially LiDAR's since GNSS/IMU is an enabling technology for LiDAR's. Some drone payloads use the Real Time Kinematic (RTK) approach for positioning the imaging sensor in real time, while others use a Post-Processed Kinematic (PPK) approach for higher precision positioning. As for the data processing workflows, there are multiple approaches as well, e.g., Structure from Motion (SfM), Aerotriangulation (AT), Direct Georeferencing (DG), Integrated Sensor Orientation (ISO), Simultaneous localization and Mapping (SLAM), etc.

On the other hand, payload sensor calibration influences the overall accuracy of any mapping product produced by any drone survey. Additionally, if the payload comprises more than one sensor, spatial and orientation offsets between these sensors must be calibrated. As a result, calibration is an important task when surveying by drones. Examples of calibration are: Camera interior orientation, camera to GNSS antenna lever arms, and LiDAR or camera to IMU boresight angles.

To conduct a successful drone surveying mission, proper project planning, flight planning, data acquisition, data processing, quality assurance and quality control are all needed to end up with a successful, accurate, and consistent mapping product. Therefore, this paper will address the scientific background for surveying by drones, including comparing PPK to RTK, SfM to AT, DG,

and ISO. Moreover, best practices for the entire recipe of high precision aerial surveying by drones will be addressed in detail. While presenting the best practice for system integration and calibration, the results of multiple geometric accuracy assessment projects using different drones, cameras, and LiDARs that took place in the USA and Canada, from 2016 to 2023, are used.

This paper is the first paper of a serious of publications addressing the planned activities for the newly established FIG Standards Committee for Surveying by Drones.