

Low-Cost Aerial Mapping using a Consumer-Grade Drone: Accuracy and Reliability Assessment under Varying Ground Control Point Scenarios

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SUMMARY

This study explored the feasibility of achieving high-accuracy aerial mapping using low-cost, consumer-grade equipment, focusing on the impact of Ground Control Point (GCP) placement strategies on planimetric (horizontal) and altimetric (vertical) accuracy. A DJI Mavic Air 2 consumer-grade drone was employed to capture high-resolution imagery, while a Trimble R10 GNSS receiver was used to collect precise GCPs. Four GCP scenarios were evaluated: (1) no GCPs, relying solely on the drone's onboard GPS; (2) 4 GCPs placed on the edges of the study area; (3) 6 GCPs evenly distributed across the area; and (4) 11 GCPs. Orthophotos and Digital Elevation Models (DEMs) were generated using the open-source software WebODM, and their accuracy was assessed using Root Mean Square Error (RMSE) metrics.

The results demonstrated that the inclusion of GCPs significantly improved mapping accuracy. Scenario 1 (no GCPs) yielded a planimetric RMSE of 3.379 m, highlighting the limitations of direct georeferencing with consumer-grade GPS. Scenario 2 (4 edge-placed GCPs) achieved a planimetric RMSE of 0.085 m and an altimetric RMSE of 0.283 m, while Scenario 3 (6 evenly distributed GCPs) further refined the accuracy to 0.083 m (planimetric) and 0.166 m (altimetric). Scenario 4 (11 GCPs) produced the highest accuracy, with 0.064 m planimetric and 0.053 m altimetric RMSE values. The orthophotos generated in all scenarios exhibited a high resolution of 3.8 cm Ground Sampling Distance (GSD), confirming the capability of consumer-grade drones to produce detailed and clear imagery.

This study also demonstrated that low-cost aerial mapping with consumer-grade drones, when combined with appropriate GCP strategies, could achieve high levels of accuracy and reliability. The findings provided practical guidance for optimizing GCP usage and offered a cost-effective alternative to professional-grade equipment, making high-resolution mapping accessible to a broader range of users and applications.

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