Comparative Accuracy of GNSS, NTRIP, and Base Station UAV Surveys

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SUMMARY

Achieving accurate positioning data when UAV (Unmanned Aerial Vehicle) surveying can be challenging. While surveyors often plan carefully by controlling variables such as GSD (Ground Sampling Distance) and image overlap to achieve high quality outputs. The accuracy of the data also heavily depends on the baseline precision of the onboard GNSS (Global Navigation Satellite System) receiver. Typically, onboard GNSS can achieve in the range of 2-10m accuracy depending on survey conditions but when corrected with an RTK (Real Time Kinematic) connection, this can be reduced to centimetres. As the surveying industry increasingly adopts autonomous methods, this study aims to compare RTK corrected and standard GNSS with the sub-millimetre accuracy of traditional total stations, determining the suitability of UAVs for high-precision survey applications.

Data was collected using a DJI Mavic 3 Enterprise RTK at three UK sites with varying environmental challenges, such as limited satellite visibility and coastal weather. At each site, three flights were conducted using different positioning methods: standard onboard GNSS, a DJI D-RTK2 base station, and an NTRIP server providing RTK correction signals. The UAV was flown at an altitude to achieve a GSD of <10 mm with the camera maintained at nadir. A fourth control site was also surveyed with a total station. Nine Ground Control Points (GCPs) were placed at varying elevations and measured for comparative analysis then coordinates from the UAV surveys were extracted and analysed against the control data to assess positional accuracy for distances between points.

Three methods for analysis were applied to assess positional accuracy across each dataset. First, raw EXIF data was extracted and exported to a CSV file to identify positional deviations among the positioning methods. Photogrammetry software then generated a 3D dense point cloud, which was analysed in specialised software to measure post-processed deviations along the X, Y, and Z axes.

Finally, GCP's were extracted from the point cloud to compare inter-point distances with measurements calculated from total station data, providing an independent benchmark for accuracy assessment.

Results showed that all three positioning methods achieved point-to-point accuracies within 25mm. The on-site base station provided the most consistent accuracy, achieving <15mm, while the NTRIP connection demonstrated occasional accuracies below 10mm but with a mean error of <20mm, indicating variability in accuracy.