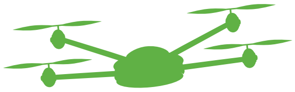

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TECHNICAL BRIEF

# Terrain Model Comparison of Data from LIDAR and UAV Imagery

One of the questions we frequently hear when talking to clients about producing digital terrain models (DTMs) from unmanned aerial vehicle (UAV) imagery is: "***How do DTMs from drones compare with LIDAR-derived datasets?***" We wanted to be able to answer this question using data from our own flights. Therefore, in November 2015, we flew a small site in the city of West Linn, Oregon, with the purpose of quantifying elevation differences between UAV and LIDAR-derived datasets.

The UAV survey was located on the western edge of a local school **(Figure 1 )**. The site has a mix of flat and gently sloping terrain and is unencumbered by vegetation. LIDAR data for the site was obtained from a 2015 flight commissioned by the Oregon Department of Geology and Mineral Industries.

For the UAV flight, we utilized a real-time kinematic (RTK) survey to establish 20 ground control points that had an average vertical root mean square error (RMSE) of 4 centimeters. The UAV flight captured 271 images at 60 meters above ground level (AGL) covering 5 acres with an average side and front overlap of 80%. The resulting terrain model from the UAV imagery is depicted in **Figure 2**.

To account for differences in the ground sampling resolution and geoid corrections applied to the LIDAR and UAV elevation data, the LIDAR data was resampled and aligned with the UAV elevation model using ArcGIS geoprocessing tools. This allowed for a common basis for comparing the systematic deviations in the UAV elevations measurements with the systematic deviations of the LIDAR data. Results showed that the UAV and LIDAR surveys are producing similar results, with variations of both systems less than 10 centimeters relative to the surveyed control points **(Figure 3)**.

Study details:
- LIDAR resolution: 1 m
- UAV resolution: 2 cm
- UAV vertical RMSE: 7 cm
- Corrected LIDAR vertical RMSE: 8 cm
- Number of verification points: 100
- Number of ground control points: 20
- Correlation between LIDAR and UAV measured elevations at verification points: 90%

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Figure One: Aerial Orthoimagery

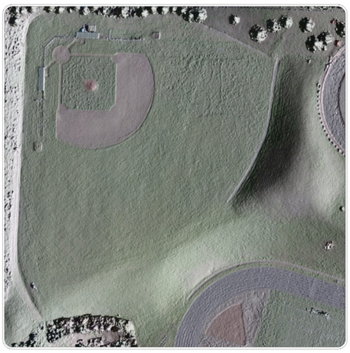

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Figure 2: Digital Terrain Model

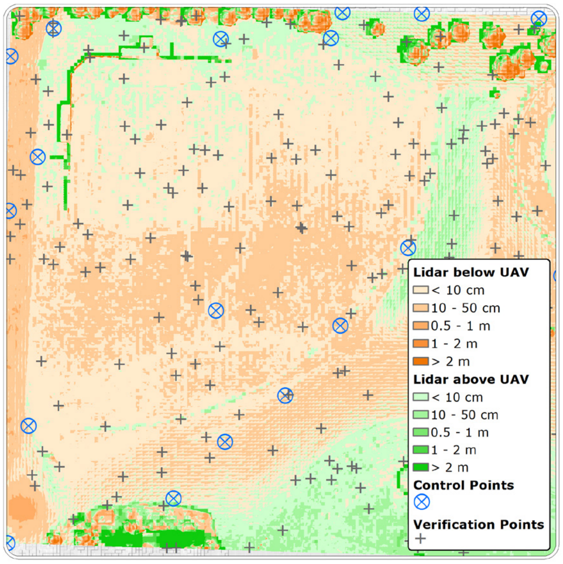

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Figure 3: Control and Verification Points

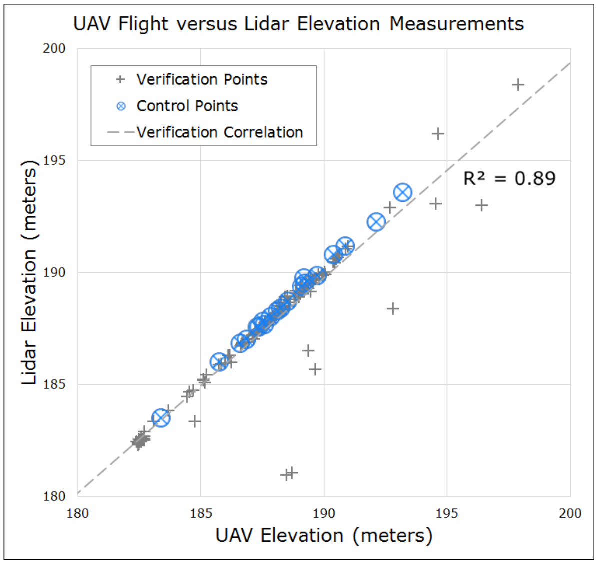

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Figure 4: LIDAR Versus UAV Correlation

In addition to comparing the results of the UAV flight to the LIDAR data at the ground control locations, the results were compared at 100 randomly generated verifications points within the survey extent. This analysis showed a 90% correlation of the relative UAV elevations to those measured by LIDAR (Figure 4). Locations where the two measurement approaches differ significantly tended to be in areas with heavy vegetative cover and near features with sharp vertical relief, such as the backstop of the baseball field.

Our analysis shows that relative elevation measurements obtained by the two systems for this site are comparable. Systematic variations within the data obtained from the two methodologies were within the documented precision level of the LIDAR flight. Although LIDAR-equipped fixed-wing aircraft have natural advantages in their ability to cover large areas, for smaller sites where high-resolution topographic data is required, UAVs and RTK can provide a cost effective alternative to LIDAR with similar accuracy.

## About Sitka FlightPath™

To complement our systems design and data management expertise, Sitka offers FlightPath for surveying terrestrial and aquatic habitats using UAVs. In a single flight, Sitka is able to collect all the data needed to provide you with detailed, high-resolution 2D orthoimagery, topographic datasets, metrics and more.

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