HIGH PERFORMANCE AIRBORNE LIDAR FOR TERRAIN AND BATHYMETRIC MAPPING TECHNOLOGIES

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ABSTRACT:

Current discussions in lidar technology often focus on the ability to report multiple returns from each laser pulse. For example, three or more data parameters can be reported from a single pulse (e.g., ranges and intensity). Lidar systems capable of reporting five or more returns are now commercially available. This presentation however, takes the position that merely increasing the number of pulse returns is of limited, and even questionable utility. Instead, an entirely different approach is presented: Waveform Digitization, a technology with far greater potential to add value to the information in the lidar data set. Full waveform analysis has clear advantages over a multiple return approach. The laser pulse's waveform reveals useful information for classifying the surface target. A pulse reflecting off a vertical wall, for example, shows an extended waveform caused by the elliptical "footprint" of the laser spot. From this waveform "signature," the angle of the reflecting surface with respect to the laser beam can be inferred. Waveform characteristics such as "stretching" and "flattening" reveal surface qualities of roughness and smoothness. Multi-peaks and bottoms indicate target characteristics such as density and shape complexity, aiding in point classification. As far back as 1984 Optech Incorporated introduced a bathymetric lidar system with waveform digitization that extracted bottom surface classification information based on the amplitude of bottom returns. Waveform digitization in the Scanning Hydrographic Operational Airborne Lidar Survey (SHOALS) enables it to identify fish, plankton, algae, turbid materials, etc. Flying at altitudes of 200 - 400 m, SHOALS can locate a bottom elevation to within 25 cm (1σ) accuracy. This degree of accuracy is all the more striking when the phenomenon of backscatter in the water column is considered. What SHOALS demonstrates in water is directly applicable to terrain mapping because it proves that the elevation of the target of interest can be accurately measured even in the presence of ground fog. Waveform digitization however, produces voluminous data. To avoid exceeding storage capacity an Intelligent Waveform Digitizer (IWD) is proposed. Based on intelligent algorithms for lossless data compression the IWD stores data only from "trigger event" to "event end." Unlike a general purpose digitizer which operates indiscriminately, the IWD stores data only from the area of interest. In a forest survey, for example, the IWD stores forest data only, discarding redundant zeroes from non-forest targets. Technical limitations also make it difficult for indiscriminate waveform digitizers to operate at the frequencies common among today's laser systems ($\approx$ 50 kHz). Building upon the success of waveform digitization used in its bathymetric lidar systems, Optech Incorporated proposes to offer IWD in all its lidar systems.