Experiences with Sensor Level Full Waveform Compression

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Full-waveform LiDAR data (FWD) provide a wealth of information about the shape and materials of the surveyed areas. FWD keeps the whole signal, at all times, regardless of the signal intensity. Hence, FWD will have a prominent role in mapping and classification in the raw data format. Full waveform systems currently record the waveform data at the acquisition stage, and return extraction is usually deferred to post-processing. Aside from the advantage of preserving all the details of the data, the full waveform induces a significant challenge due datasets sizes that are larger than those of classical discrete return systems.

Atop the need for more storage space, the acquisition speed of the FWD may also limit the pulse rate on systems that cannot store data fast enough, and thus, the acquisition system appears of reduced performance. This work introduces a true 3D compression model for a decreased storage yet with the preservation of the maximum pulse rate of FWD systems. In our experiments, the waveform cube is compressed using classical methods for multi-component imagery. The spatial distribution of airborne waveform data is irregular; however, the manner of the FWD acquisition allows the organization of the waveforms in a regular 3D structure similar to familiar multi-component imagery, as those of hyper-spectral cubes or 3D volumetric tomography scans. This study presents the performance analysis of several lossy compression methods applied to the LiDAR waveform cube. The compression of tests real airborne FWD datasets shows the benefits of the JPEG-2000 Standard where high compression rates incur fairly small data degradation. In addition, the JPEG-2000 Standard-compliant compression can be used in real-time systems, as compressed data sequences can be formed progressively during the waveform data collection. We conclude from our experiments that classical image compression strategies are feasible and efficient approaches, applicable to FWD sensors at the acquisition stage.