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## EXPLORING WEAK AND OVERLAPPED RETURNS OF A LIDAR WAVEFORM WITH A WAVELET-BASED ECHO DETECTOR

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**Abstract.** Full waveform data recording the reflected laser signal from ground objects have been provided by some commercial airborne LIDAR systems in the last few years. Waveform data enable users to explore more information and characteristics of the earth surface than conventional LIDAR point cloud. An important application is to extract extra point clouds from waveform data in addition to the point cloud generated by the online process of echo detection. Some difficult-to-detect points, which may be important to topographic mapping, can be rediscovered from waveform data. The motivation of this study is to explore weak and overlapped returns of a waveform. This paper presents a wavelet-based echo detection algorithm, which is compared with the zero-crossing detection method for evaluation. Some simulated waveforms deteriorated with different noises are made to test the limitations of the detector. The experimental results show that the wavelet-based detector outperformed the zero-crossing detector in both difficult-to-detect cases. The detector is also applied to a real waveform dataset. In addition to the total number of echoes provided by the instrument, the detector found 18% more of echoes. The proposed detector is significant in finding weak and overlapped returns from waveforms.

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