Project 2.02 | Feature Extraction from Multi-source Airborne and Space-borne Imaging and Ranging Data

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Objectives To develop a toolbox to process full-waveform LiDAR data. Processing will include waveform restoration to remove instrument effects from the received waveform, and improved feature extraction through utilisation of waveform geometry

Outcomes Standalone software toolbox and callable library routines to support improved dense & accurate 3D point cloud production and enhanced feature extraction and modelling from full-waveform LiDAR data, for use in urban modelling, vegetation mapping and DSM/DEM production

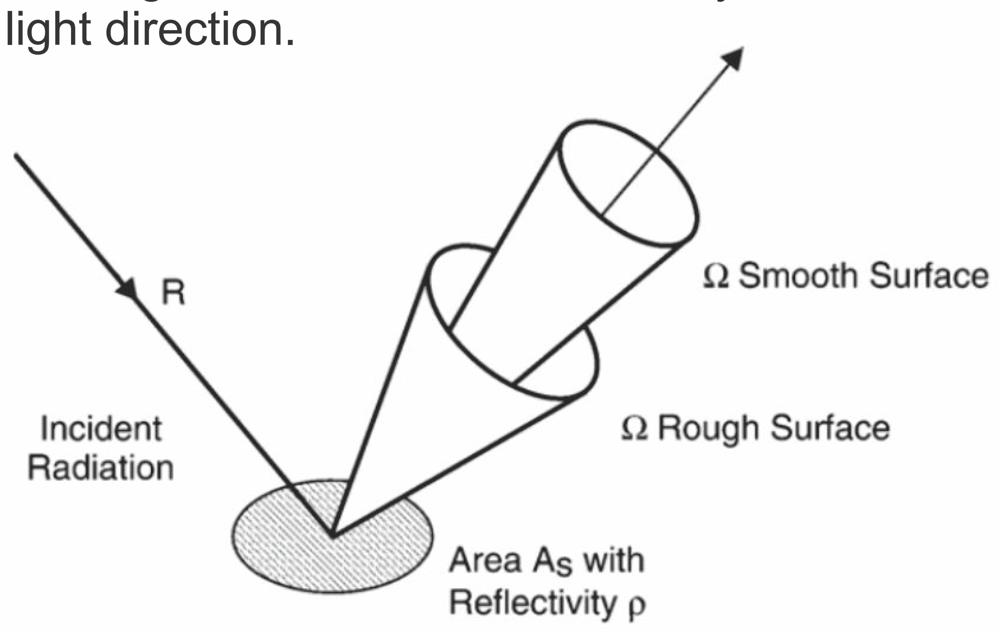
Introduction

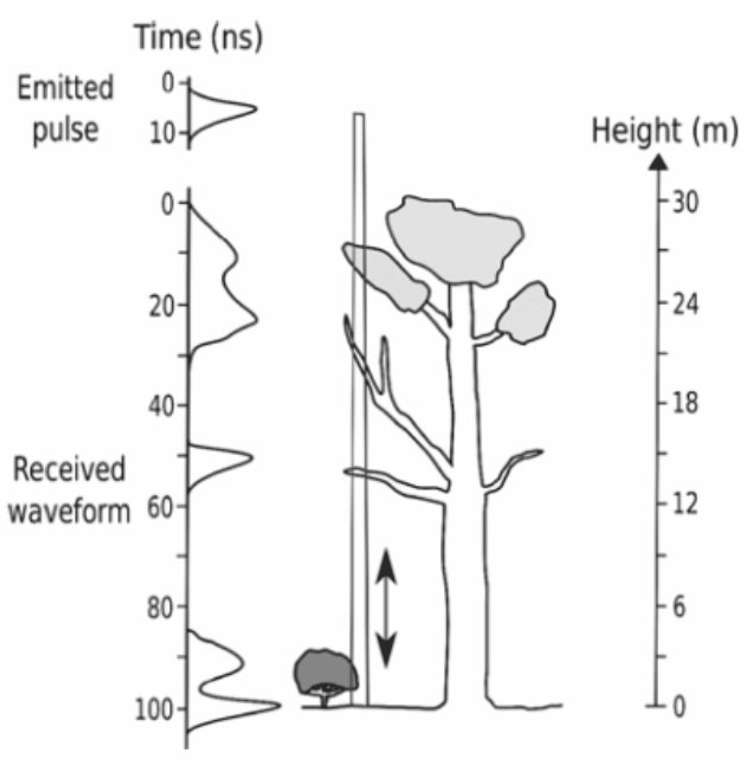
Waveform restoration facilitates the removal of dependencies on the waveform from the instrument, and forms a basis for the analysis of target backscattering. Regularisation methods are necessary in order to solve the waveform deconvolution problem. In this research, sparsity constraints have been investigated using both synthetic and real datasets. Optimal regularization parameters have been estimated by the L-curve method to high consistency over different LiDAR recording conditions. Unknown system waveforms were approximated from the recorded waveforms based on blind deconvolution. The benefits of the research are: to robustly extract meaningful descriptive features (comparable in different conditions), making no assumption of signal shape or number of targets within laser path.

Waveform Calibration

Target cross-section:

Independent of the instrument and more related to the target effective area, reflectivity and incoming light direction.

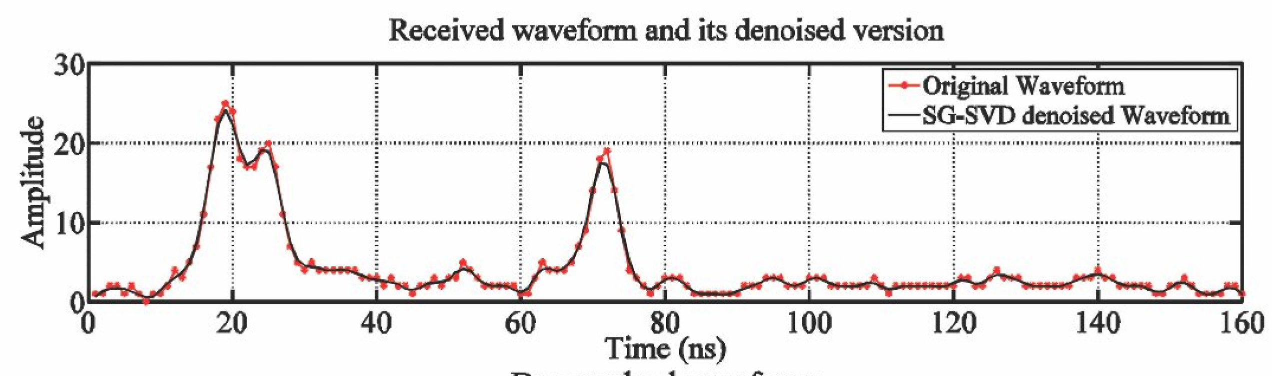




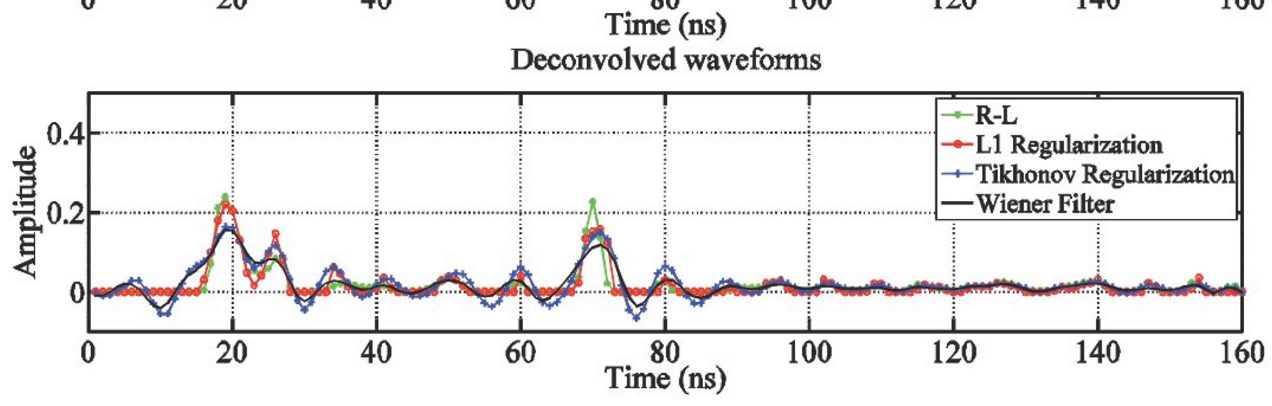
Transmitted & received waveforms in small footprint LiDAR

Results

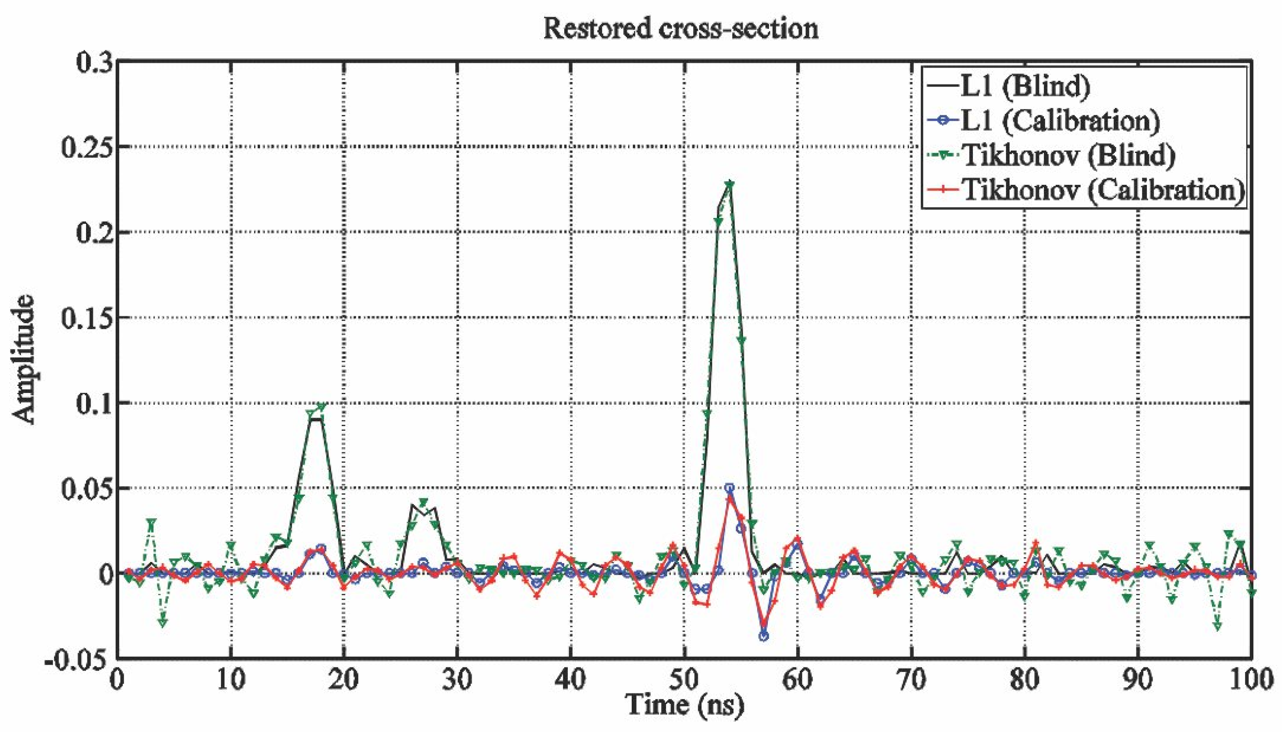
Noise reduction:



Signal restoration:



System waveform approximation:



Challenges

- Bias in attributes extracted from pulse fitting methods (e.g. Gaussian decomposition)
- Complex waveforms (return numbers)
- How to efficiently control the solution (in deconvolution)
- Unavailable system waveform (in some cases)
- Standard features without making strong assumptions

Conclusions & Future work

- Least oscillation + high accuracy in retrieved cross-section (without making any assumptions on waveforms)
- Blind deconvolution as a meaningful tool in estimation of the unknown system waveform
- Retrieval of weak/overlapped pulses: Dense point clouds, DTM enhancement, detailed vertical profile of targets
- Signal denoising without any distortion
- Improved segmentation and feature extraction though modelling of new feature classes
- Additional attributes related to forest metrics by processing the whole signal

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