Fusion of LiDAR pseudo-waveforms and WorldView-2 imagery for object-based land cover mapping

Yuhong Zhou[a] and Fang Qiu[b]

[a] Department of Geospatial Sciences, University of Texas at Dallas, 800 W Campbell Rd. GR31, Richardson, TX 75080-3021, USA

Email: yxz102020@utdallas.edu

[b] Department of Geospatial Sciences, University of Texas at Dallas, 800 W Campbell Rd. GR31, Richardson, TX 75080-3021, USA

Phone: +1-972-883-4134

Email: ffqiu@utdallas.edu

Abstract:

Remote sensing imagery provides information about the horizontal distributions of land covers. In contrast, LiDAR data offer information on their vertical structures. One's advantages can compensate the other's disadvantage because these two offer complementary information. Consequently, many studies have focused on fusing these two types of data for land cover mapping. It has been demonstrated the synergetic use of LiDAR and imagery can greatly improve land cover mapping accuracy, especially with LiDAR waveforms that can provide more detailed vertical information than LiDAR discrete returns. Fusion of LiDAR waveforms and spectral imagery usually takes places at the pixel level. However, the classification of high spatial resolution (HSR) imagery is normally conducted at the object level. The fusion of the LiDAR waveforms and HSR imagery at the object-level has been scarcely studied. The major obstacle is that the footprint of all LiDAR waveforms is usually of fixed size and fixed shape, but the objects

in the real world vary dramatically in size and shape and seldom match that of LiDAR waveforms.

To overcome this issue, we proposed to synthesize object-based pseudo-waveforms using LiDAR discrete returns in this study. The resulting footprints of the synthesized waveforms therefore have varied sizes and shapes, corresponding to those of different objects. The synthesized pseudo-waveforms were then fused with the object-level spectral frequency histograms from HSR WorldView-2 imagery to conduct land cover classification using a curve matching based approach.

The fused dataset has achieved an overall classification accuracy of 96.37%, a kappa coefficient of 0.95, and producer's accuracies and user's accuracies all larger than 90%. McNemar's test indicated that the classification performance based on the fusion of LiDAR and spectral imagery was significantly ($p<0.01$) better than that based on spectral imagery alone. This study demonstrated the great potential of pseudo-waveform in improving object-based image classification.

Key words: land cover mapping; fusion; LiDAR pseudo-waveform; high spatial resolution imagery