Multi-Scale Voxel Segmentation for Terrestrial Lidar Data within Marshes

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The resilience of marshes to a rising sea is dependent on their elevation response. Terrestrial laser scanning (TLS) is a detailed topographic approach for accurate, dense surface measurement with high potential for monitoring of marsh surface elevation response. The dense point cloud provides a 3D representation of the surface, which includes both terrain and non-terrain objects. Extraction of topographic information requires filtering of the data into like-groups or classes, therefore, methods must be incorporated to identify structure in the data prior to creation of an end product. A voxel representation of three-dimensional space provides quantitative visualization and analysis for pattern recognition. The objectives of this study are threefold: 1) apply a multi-scale voxel approach to effectively extract geometric features from the TLS point cloud data, 2) investigate the utility of K-means and Self Organizing Map (SOM) clustering algorithms for segmentation, and 3) utilize a variety of validity indices to measure the quality of the result.

TLS data were collected at a marsh site along the central Texas Gulf Coast using a Riegl VZ 400 TLS. The site consists of both exposed and vegetated surface regions. To characterize structure of the point cloud, octree segmentation is applied to create a tree data structure of voxels containing the points. The flexibility of voxels in size and point density makes this algorithm a promising candidate to locally extract statistical and geometric features of the terrain including surface normal and curvature. The characteristics of the voxel itself such as the volume and point density are also computed and assigned to each point as are laser pulse characteristics. The features extracted from the voxelization are then used as input for clustering of the points using the K-means and SOM clustering algorithms. Optimal number of clusters are then determined based on evaluation of cluster separability criterions. Results for different combinations of the feature space vector and differences between K-means and SOM clustering will be presented. The developed method provides a novel approach for compressing TLS scene complexity in marshes, such as for vegetation biomass studies or erosion monitoring.