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MIN-CUT BASED SEGMENTATION OF AIRBORNE LIDAR POINT CLOUDS

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Abstract. Introducing an organization to the unstructured point cloud before extracting information from airborne lidar data is common in many applications. Aggregating the points with similar features into segments in 3-D which comply with the nature of actual objects is affected by the neighborhood, scale, features and noise among other aspects. In this study, we present a min-cut based method for segmenting the point cloud. We first assess the neighborhood of each point in 3-D by investigating the local geometric and statistical properties of the candidates. Neighborhood selection is essential since point features are calculated within their local neighborhood. Following neighborhood determination, we calculate point features and determine the clusters in the feature space. We adapt a graph representation from image processing which is especially used in pixel labeling problems and establish it for the unstructured 3-D point clouds. The edges of the graph that are connecting the points with each other and nodes representing feature clusters hold the smoothness costs in the spatial domain and data costs in the feature domain. Smoothness costs ensure spatial coherence, while data costs control the consistency with the representative feature clusters. This graph representation formalizes the segmentation task as an energy minimization problem. It allows the implementation of an approximate solution by min-cuts for a global minimum of this NP hard minimization problem in low order polynomial time. We test our method with airborne lidar point cloud acquired with maximum planned post spacing of 1.4 m and a vertical accuracy 10.5 cm as RMSE. We present the effects of neighborhood and feature determination in the segmentation results and assess the accuracy and efficiency of the implemented min-cut algorithm as well as its sensitivity to the parameters of the smoothness and data cost functions. We find that smoothness cost that only considers simple distance parameter does not strongly conform to the natural structure of the points. Including shape information within the energy function by assigning costs based on the local properties may help to achieve a better representation for segmentation.

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