OBJECT-BASED CLASSIFICATION OF URBAN AIRBORNE LIDAR POINT CLOUDS WITH MULTIPLE ECHOES USING SVM

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ABSTRACT:

Airborne LiDAR point clouds classification is meaningful for various applications. In this paper, an object-based analysis method is proposed to classify the point clouds in urban areas. In the process of classification, outliers in the point clouds are first removed. Second, surface growing algorithm is employed to segment the point clouds into different clusters. The above point cloud segmentation is helpful to derive useful features such as average height, size/area, proportion of multiple echoes, slope/orientation, elevation difference, rectangularity, ratio of length to width, and compactness. At last, SVM-based classification is performed on the segmented point clouds with radial basis function as kernel. Two datasets with high point densities are employed to test the proposed method, and three classes are predefined. The results suggest that our method will produce the overall classification accuracy larger than 97% and the Kappa coefficient larger than 0.95.

1. INTRODUCTION

Over the passed two decade, airborne Light Detection and Ranging (LiDAR) is probably the leading technology for the extraction of information about topographic surfaces. The main advantage of LiDAR technique is that it provides dense, discrete, detailed and accurate point coverage over both the objects and surfaces, which has led to an increasing interest in utilizing the data for a range of applications such as mapping, forestry, urban planning, telecommunication etc. Although most the technical hardware difficulties and system integration problems have been solved, the development of algorithms and methods for interpretation and modelling of LiDAR data is urgently needed (Axelsson, 1999). Considering the unique characteristics of LiDAR, the full exploitation of its potentials and capabilities needs new data processing methods that are fundamentally different from the ones used in the traditional community of photogrammetry and remote sensing. One of the data processing methods urgently needed is to label the point clouds with different classes such as ground, building, bridge, tree etc. The above labelling process is also known as point cloud classification.

Two ways are often utilized to classify the point clouds into different subsets. One is to separate the ground from non-ground LiDAR measurements first, and then to split non-ground measurements into low vegetation points, high vegetation points, building points etc. Particularly, the process of classifying a LiDAR dataset into ground (bare-earth) measurements and non-ground measurements is termed as filtering. Numerous algorithms have been developed for filtering, and the existing approaches can be categorized into morphological (Vosselman, 2000; Zhang et al. 2003), surface-based (Kraus and Pfeifer,1998; Axelsson, 2000) and segment-based (Sithole, 2005) filters. In 2004, Sithole and Vosselman (2004) made experimental comparisons of filter algorithms for bare-Earth extraction from airborne laser scanning point clouds. The results show that all filters perform well in smooth rural landscapes, but all produce errors in complex urban areas and rough terrain with vegetation. After filtering is performed, low vegetation measurements, higher vegetation measurements and building measurements can be identified by the features such as height differences on the normalized digital surface model and local height variance, as done in the commercial TerraSolid software (Terrasolid Ltd, 2011).

The other way is to separate grounds, buildings, trees, and other kinds of measurements from LiDAR data simultaneously. For example, Elberink and Mass (2000) segments raw laser scanner data in an unsupervised classification using anisotropic height texture measures, which suggests that anisotropic operations have the potential to discriminate between orientated and non-orientated objects. Petzold and Axelsson (2000) find that the reflectance of the laser echo is a good feature to discriminate the neighbouring objects. Secord and Zakhor (2007) proposed an approach to detecting trees in registered and fused aerial image and LiDAR data, and a support vector machine (SVM) is utilized to classify the segmented images. Although the outcomes of data fusion are promising, data fusion is not included in this paper due to its complexity in registration. Golovinskiy et al. (2009) designs a system for recognizing objects in 3D point clouds obtained by mobile laser scanning in urban environments, and the system is decomposed into four steps: locating, segmenting, characterizing, and classifying clusters of 3D points. Lalonde et al. (2006) seperated the points in natural environment into discrete ones, linear ones and the points on smooth surfaces.

The above classification approaches have made great progress. However, most of them only make use of the features about local neighbourhood without topological and geometric

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