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Investigating performance of Airborne LiDAR data filtering algorithms for DTM generation

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ABSTRACT

Digital Terrain Model (DTM) is an important topographic product and essential demand for many applications. Traditional methods for creating DTM are very costly and time consuming because of land surveying. In time, Photogrammetry has become one of the major methods to generate DTM. Recently, airborne Light Detection and Ranging (LiDAR) system has become a powerful way to produce a DTM due to advantage of collecting three-dimensional information very effectively over a large area by means of precision and time.

Airborne LiDAR system collects information not only from land surface, but also from every object between plane and terrain that can reflect the laser beam. So filtering out non ground points from raw point clouds is the major step of DTM generation. There are many filtering algorithms due to several factors that affect the filtering procedures. The performances of these filters change based on the topographic features of the area.

In this study the five different algorithm is used to filter LiDAR point cloud that is collected from two different sites. While one of these sites is a rural area, the other site is an urban area; therefore these sites have different topographic features. In addition, the reference DTMs are available for these sites. In order to test the performance of algorithms, the LiDAR point clouds are filtered and used to generate DTM for the sites. Finally, the generated DTM is compared with the reference DTM for each site.

1. Introduction

Airborne Light Detection and Ranging (LiDAR) is a remote sensing technology that is used in field for variety purpose such as hydrological modeling, coastal monitoring, forest inventory [10,20,21], urban three-dimensional visualization [5,1], land-cover and land-use classification, and object detection [7,2,12] producing accurate Digital Terrain Models (DTMs). The acceptance and prevalence of LiDAR systems are growing day by day because it is far more practical than aerial Photogrammetry for collecting data. LiDAR systems have reached high economic importance due to its high accuracy capability and have been recognized as one of the standard methods for topographic data acquisition thanks to the technological advances of laser scanners, Global Positioning System (GPS), Inertial Measurement Unit (IMU) and airplanes [14]. Nowadays, data collecting with LiDAR for generating a DTM has become an alternative to the traditional recording [6].

DTM is a structured surface that contains elevation data with some critical features of terrain such as ridge lines, peak points etc. [9]. During the DTM generating process, higher vegetation-horizons, buildings and also other, non-terrain objects are removed [6]. Removing non-terrain objects to get bare earth is called filtering. The software will be used for filtering must have a powerful algorithm to filter LiDAR data because a LiDAR file may consist of

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Fig. 1. Rural and urban study areas, F21 and G21.

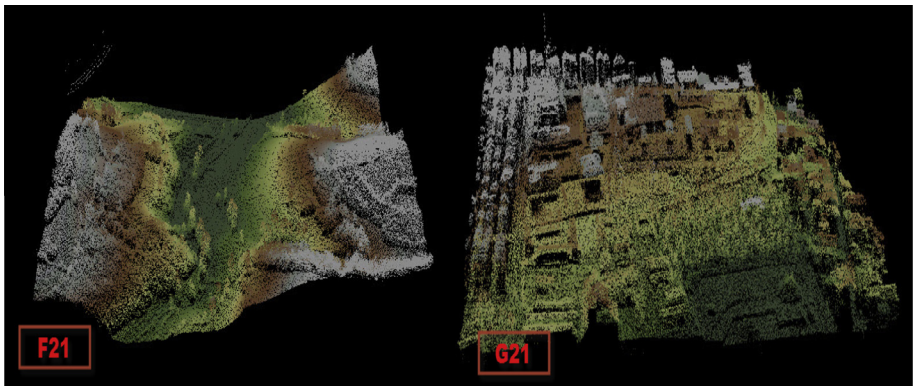

Fig. 2. Raw LiDAR point clouds for F21 and G21 study sites.

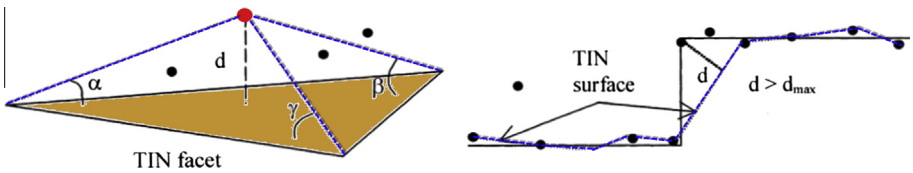

Fig. 3. Facet planes, angles to the nodes and edge cutting [3].

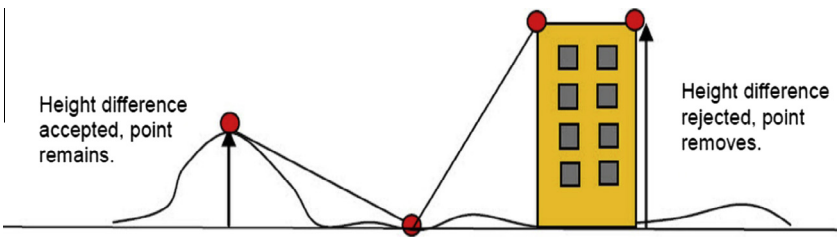

Fig. 4. Height differences between neighborhood points [13].

billions 3-dimensional (3D) points which is also known as point clouds. So today it is still a daily topic to develop a powerful, automatic and less time consuming filtering algorithm. However, the method of filtering process varies for different software and not all of the filtering algorithms will give the best DTM [13].

The ground filtering is an essential step to separate LiDAR points which are from the ground surface and which are from non-ground surface features for almost all LiDAR applications. Distinguishing ground from non-ground can be a considerable challenge in regions with high surface variability [15,3]. Besides accurate DTMs can only be