BUILDING EXTRACTION FROM LIDAR DATA USING DEVIRED NORMALIZE DIGITAL SURFACE MODEL

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ABSTRACT In recent years, LiDAR technology has been becoming more popular and important. Its applications are completely replacing the traditional remote sensing technique. One of these applications is creating Digital City Models in urban areas, which is essential for many others such as disaster management, cartographic mapping, simulation of new buildings, updating and keeping cadastral data. In most of these cases the building outlines is the primary feature of interest. In this paper, a method of extracting building outlines from LiDAR data will be performed.

KEY WORDS: LiDAR, building extraction, NDSM

1. INTRODUCTION

LiDAR technologies have been developed in the 1970s and 1980s originally in United State and Canada (Ackermann, 1999). At the present, LiDAR technology is becoming more popular and important in remote sensing and photogrammetric applications. In the last few years, a number of researches have been performed for building extraction from LiDAR data. Some successes have been achieved, but the successes are limited. Automatically extraction building outlines is still an unsolved problem. There are several methods for extracting building outlines. Using the height difference between the DSM and DEM distinguished building and tree groups (Rottensteiner and Briese, 2002). Classification method based on the minimum description length criteria to separate buildings and trees (Axelsson, 1999). An idea based on the difference between first pulse and last pulse laser scanner data to extract building outline have been proposed (Elberink and Mass, 2000)

This paper propose a method based on general knowledge about building's geometric characteristics such as height, size and shape information are used to separate buildings from other objects.

2. METHODOLOGY

Data used

The LiDAR data used in this paper was collected for a part of the small urban area.

The area covered by the data has residence, and commercial building. There were total 104 buildings, including buildings which touching the area boundary.

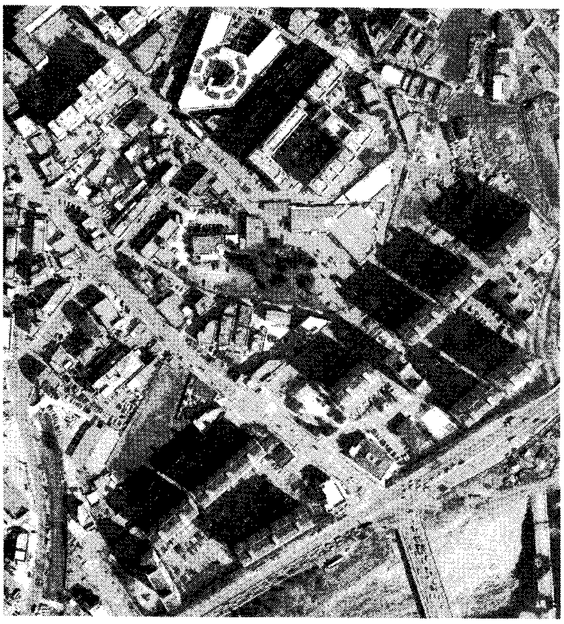

Figure1. The aerial photograph of the study area

The laser scanner was acquired simultaneously in first pulse and last pulse modes with the OPTECH ALTM 3070 system. The flying altitude was 1500 m above ground level, which resulted in a point density of about 3.329 point/ m^2.

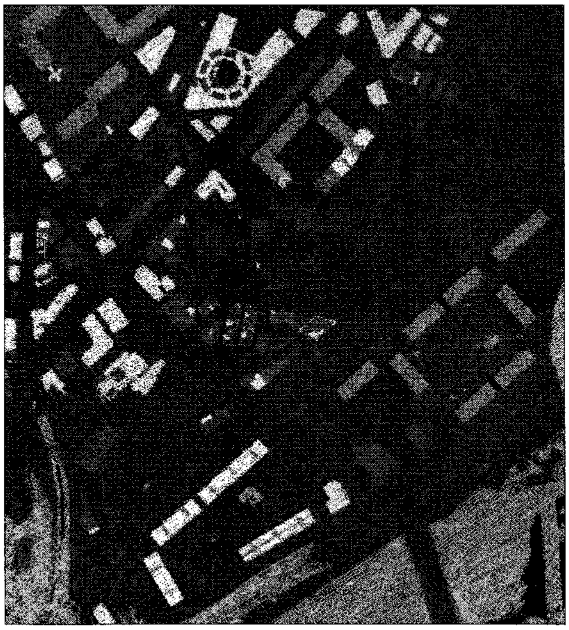

Figure2. The elevation of point cloud

Preprocessing

LiDAR data consist of random point cloud, which needs effectively post-processing. The process have been removed random noise in LiDAR data such as high-points, low-points and below-surface points based on using elevation threshold that fallout the surface elevation range defined by the maximum elevation and the minimum elevation of an area.

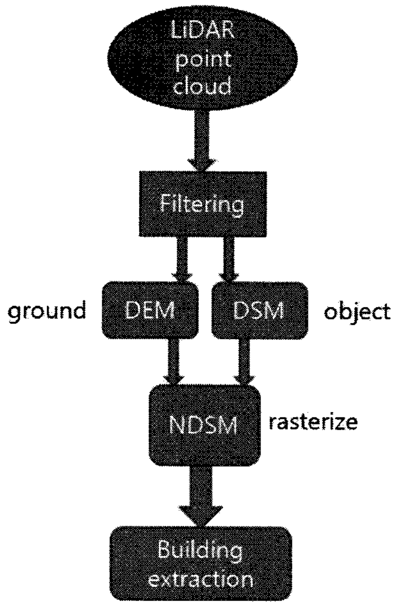

Figure3. Flowchart of the process

Digital Elevation Model (DEM) generation

After the pre-processing, the process of LiDAR data have been segmented into ground points and non-ground points. Following the segmentation, DEM can be extracted from ground points. To distinguish ground points from LiDAR cloud, segmentation operator can be applied based on the height of object with ground surface.

Normalized Digital Surface Model (NDSM) generation

After DEM was generated, objects on the non-ground class were distinguished by analyzing the object heights with a DEM. The NDSM which can describe objects on the surface (buildings, trees, bridges, etc) was generated by subtracting DSM (Digital Surface Model) the original LiDAR points cloud with DEM

NDSM = DSM – DEM

In the NDSM, object such as buildings could be viewed as sitting on a level planar surface; thus, these objects could be detected by simply checking their height values in NDSM. Using height difference threshold, the lower objects have been removed such as cars, shrubs. Remain points with heights larger than lower object were extracted as building and tree points

Gridding

A LiDAR point cloud by nature is an irregularly space data set. It could not perform many mathematical operations and image processing operations (Fernandez *et al.* 2007). The process of converting the point cloud into a regular grid data by means of interpolation has been performed for extracting building outlines in this study. There are several different surface interpolation methods such as weighted average interpolation, kriging, triangulation with linear interpolation and nearest neighbor (Zheng Wang, 1998). The target of this research is extracting buildings rather than constructing a smooth surface, therefore, a nearest neighbor interpolation method was chosen because it will perverse the sharp difference between buildings and their surrounding ground.

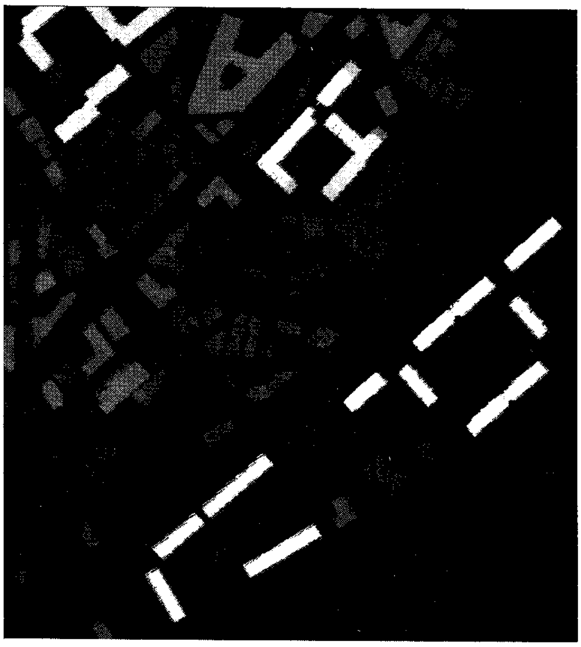

Figure4. The NDSM of the study area

Building extraction

Buildings are man-made objects so that it has height, shape and size characteristics.

In the NDSM image, buildings and other objects have relative elevation. So that, following vertical section, there is a space between two distinct buildings which has lower height than those buildings such as cars, barriers, shrubs and lower-trees. Using a height threshold can remove objects with lower height such as cars, shrubs. But building outlines extraction still has many noises: polygon (tree crown boundary, small roof boundary), polyline (barriers) and some single points. Therefore, size threshold operator used to remove almost all smaller objects such as trees, single points, barriers. All process in this paper was operated on TerraScan software and ENVI 4.4 software.

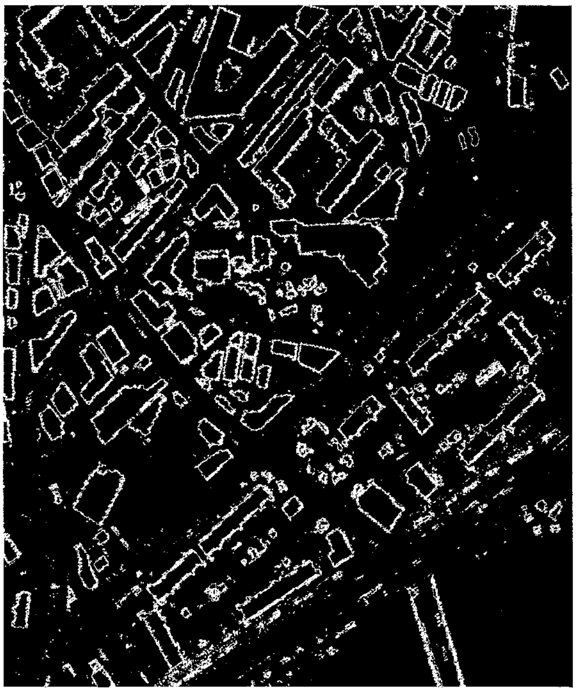

Figure5. Almost all cars, shrubs and trees which have the height smaller than 3 meters have been removed.

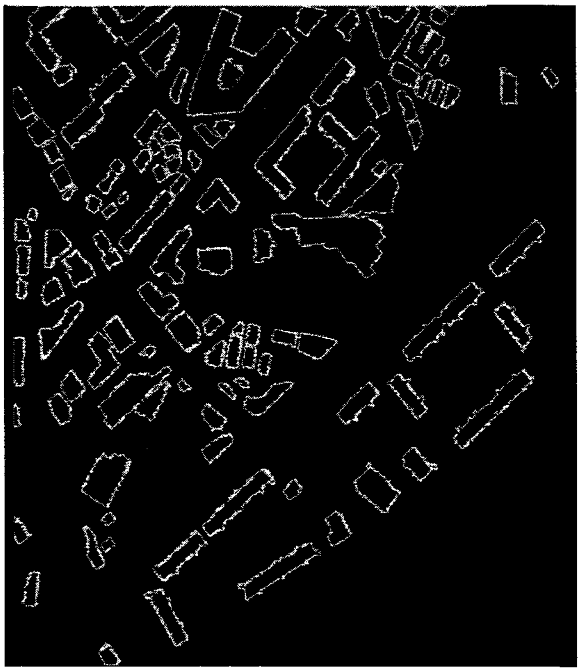

Figure6. Result of building extraction

3. RESULTS

The extracted results showed in Figure 6. Almost all buildings are successfully extracted. The area test data set is the small urban scene with high commercial buildings and residence (Figure 1). Tree is not major problem for this study area. However, some special processes are needed. The bridge across the river has a similar low-rise building's elevation and shape information. Since, masking was used to segment building objects with others in this study. With using this proposed method, the result of buildings information such as size is automatically integrated building outlines extraction which can be used for GIS analyst.

4. CONCLUSIONS

This paper represented an approach for building extraction from LiDAR data based on derived NDSM, general knowledge about building's geometric characteristics such as size, height and shape information are used to discriminate buildings from other objects.

Although this approach is a fully automatic, user still need to input few parameters such as min building size. The selection of parameters may have influence on the final results. Usually user chooses the parameters based on experience, general knowledge and also depend on the location of the study area. This approach needs to be tested on more data sets and improved to deal with more complex LiDAR data.

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