Automatic Building Extraction from Airborne Laser Scanning Data using TIN

Jae-Wook Jeong, Hwi-Jeong Chang
Department of Geoinformatic Engineering, Inha University
253 Yonghyun-dong Nam-gu, Incheon 401-751, Korea
g2031303@inhavision.inha.ac.kr, g2001330@inhavision.inha.ac.kr

Woosug Cho
Department of Civil Engineering, Inha University
253 Yonghyun-dong Nam-gu, Inchon 401-751, Korea
wcho@inha.ac.kr

Kyoung-ok Kim
Spatial Information Research Team, ETRI
161 Gajeong-dong, Yuseong-Gu, Daejeon, 305-350, Korea
kokim@etri.re.kr

Abstract: Building information plays a key role in diverse applications such as urban planning, telecommunication and environment monitoring. Automatic building extraction has been a prime interest in the field of GIS and photogrammetry. In this paper, we presented an automatic approach for building extraction from lidar data. The proposed approach is divided into four processes: pre-processing, filtering, segmentation and building extraction. Experimental results showed that the proposed method detected most of buildings with less commission and omission errors.

Keywords: LIDAR, Building Detection, Extraction, Airborne Laser Scanning, TIN.

1. Introduction

In recent years, accurate 3D data in urban areas is in great demand for many applications such as urban planning, telecommunication, environment monitoring, 3D city modeling and virtual reality. Usually urban areas are dynamically changing due to construction and extension of urban features, especially buildings. Detection and reconstruction of buildings are one of the highest interest in the geospatial community. Since manual digitizing is time consuming and very costly, a fast and automated method for detecting and extracting buildings is required by many users of geographic information system (Palmer,2001).

Airborne laser scanning is a relatively new and promising technology for obtaining Digital Surface Models (DSMs) with high density and high position accuracy of the earth surface. The development of airborne laser scanning system comprised of laser scanner, GPS receiver and IMU computes the range to the target point by emitting a laser pulse and measuring the round-trip time. Contrary to the passive sensor such as optical sensor, the laser scanner is an active sensor so that it works day and night, and is less affected by the shadow and weather (Baltsavias,1999).

A number of research works have been performed on building detection and reconstruction from airborne laser scanning data in automated fashion (Mass and Vosselman, 1999; Morgan and Tempfli, 2000; Lee and Schenk, 2001; Elaksher and Bethel, 2002, Rottensteiner and Vriese, 2003, Cho and Jwa, 2004). Figure 1 illustrates the schematic diagram of the proposed approach for building detection and extraction using airborne laser scanning data

2. Building Detection and Extraction

The proposed approach is divided into four processes: pre-processing, filtering, segmentation and building extraction. Pre-processing consists of pseudo-grid generation for predefined area and noise removal. Points clouds

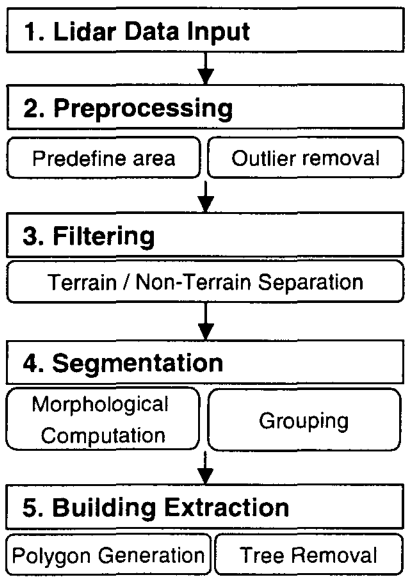

Fig. 1. The schematic diagram of the proposed approach for building detection and extraction.

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3. Dilation

Points which are removed to process lidar data in erosion stage are restored using Dilation. At this time, lidar points are assigned to each group using representation value of neighbor grid.

In figure 4, a) and b) show terrain points and non-terrain points and c), d) and e) are results after erosion, grouping and dilation, respectively.

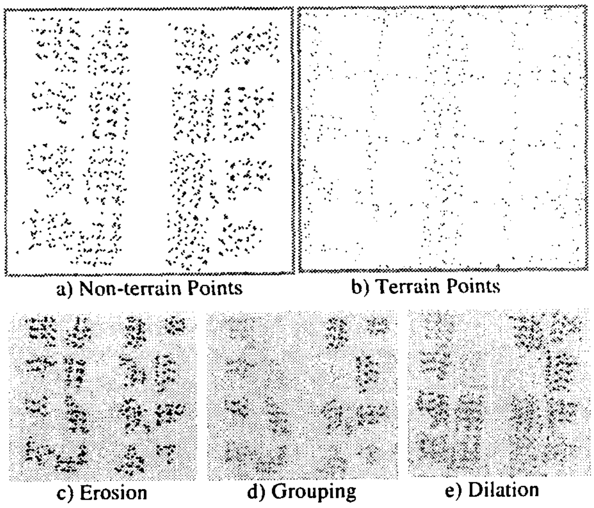

Fig. 4. Segmentation.

4) Building Extraction

1. Polygon generation

Polygon generation searches building boundary candidate and link them for expressing the building boundary. To reconstruct the building, we use method of encasing polygon. This method can extract various building shapes which can not be detected using convex hull.

2. Tree removal

After polygon generation, tree still exist as building polygon candidate. Those polygons could be removed by two simple measures: minimum building area and circularity. However, some of polygons belonging to trees can't be eliminated if their size and shape are similar to buildings. Figure 5 shows example of convex hull and encasing polygon.

Fig. 5. Example of convex hull and encasing polygon.

3. Experiment results

The target area is located at Chungjoo city in Korea and its size is about 1000m(width)×500m(length). The equipment was Optech's ALTM 1020. The flight height, flying speed, laser repetition rate, swath width, width overlapping and average point density per pass are 1000m, 180 km/h, 5000Hz, 450m, 87% and $0.2/m^2$, respectivly.

The raw laser scanning data of the target area is shown in Figure 6. Figure 7 and 8 show the results after filtering segmentation. Figure 9 shows the final result for buildings extracted in 3D vector format. When Buildings extracted by aerial image and our method are compared, omission error, commission error are 2.36% and 19.27%. Table 1 shows the result for building extraction.

Fig. 6. Raw laser scanning data of target area.

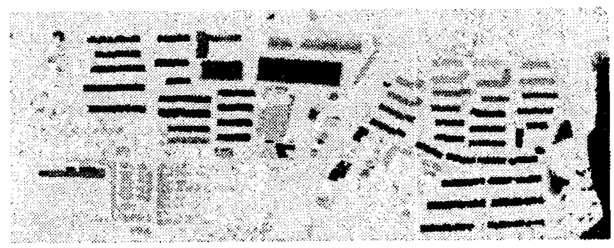

Fig. 7. Non-terrain points after filtering.

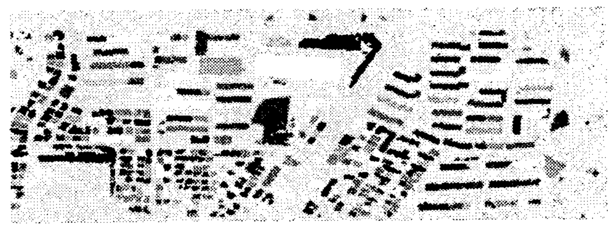

Fig. 8. Result after segmentation.

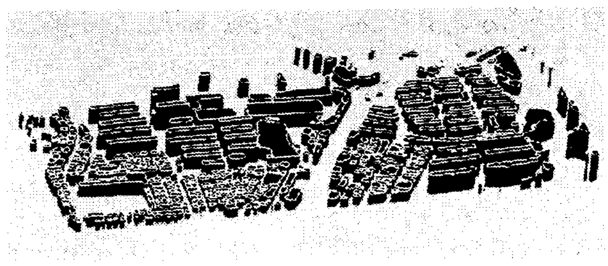

Fig. 9. Final result for buildings in 3D vector format.

Table 1. Commission and omission errors.

Lidar Data / Aerial image	Building	Non-Building	Total
Building	289	7	296
Non-Building	69	N/A	-
Total	358	-	-
Producer's Accuracy : 2.36% omission error User's Accuracy : 19.27% commission error			

4. Conclusions

In this paper, we used concepts of tin and pseudo-grid and introduced segmentation method using a center of weight. The results show 2.36% omission error and 19.27% commission error. However, the proposed approach suffered from separating trees and buildings. It should be mentioned here that a simple measure such as circularity and minimum building size is not enough to differentiate them. In order to overcome the drawbacks, we need to incorporate new approach such as data fusion into the proposed approach. Nevertheless, we could conclude that the proposed approach is promising for building detection and extraction in automatic fashion

Acknowledgement

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