EXTRACTION OF BUILDING'S GEOMETRIC AXIS LINE FROM LIDAR DATA FOR DISASTER MANAGEMENT

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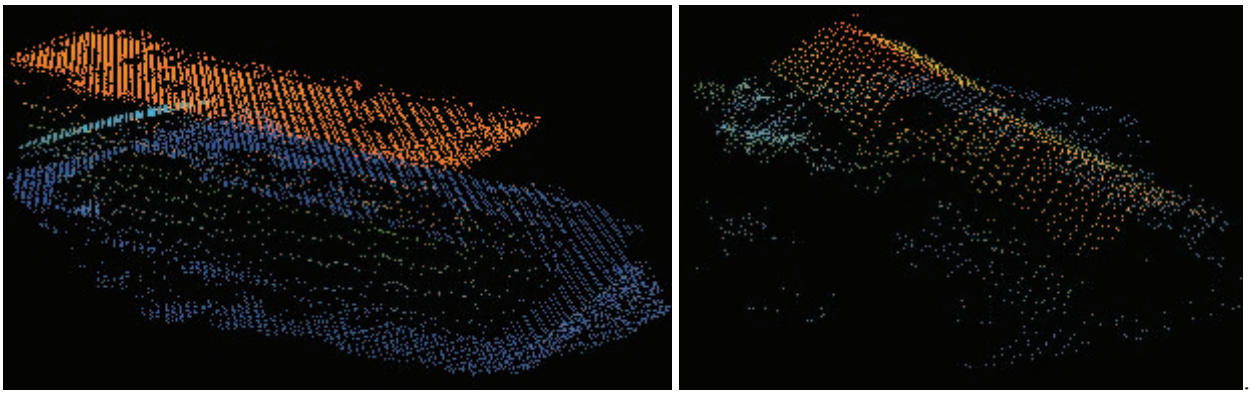
1. INTRODUCTION

Fast and reliable identification of inclined buildings is crucial for survivors rescue in case of earthquake disasters in urban areas. Figure 1 shows collapsed and inclined buildings after 5.12 Wenchuan Earthquake (Ms 8.1). Due to the possibility of acquiring precise data of large areas rapidly, airborne laser scanning offers the possibility to obtain information about the building damage [1] situation immediately in large scale after an earthquake. This paper presented an approach for extracting the geometric axis line of general buildings from airborne LiDAR data and determining whether the buildings are inclined. Two primary operations were carried out in the approach: 1) the first operation is extracting the geometric axis line of buildings; 2) secondly, by comparing the angle between the geometric axis line and the normal vector of foundation plane, inclined buildings were identified.

Figure 1. Collapsed buildings in 5.12 Wenchuan Earthquake (Ms 8.1)

2. EXTRACTION OF BUILDING' GEOMETRIC AXIS LINE

According to current research, three main methods were commonly used for detecting the building roof planes [2]: region growing, Hough-transform and Random Sample Consensus (RANSAC [3] [4]) paradigm. The RANSAC algorithm introduced by Fischler and Bolles is a general robust approach to estimate model parameters. In this paper, not only the roof plane, but also the foundation planes (ground plane) of building are automatically extracted from LiDAR data. In this research, two primary types of building roof (flattened roof and gable roof as shown in Figure 2.) in urban areas were taken into account.



(a) flattened roof (b) gable roof

Figure 2. Two primary types of building roof in LiDAR data

To extract the geometric axis line of building, several steps were involved:

(a) The potential points of an independent building and correlative foundation points were selected. If there is any groundplan available, this work will be more efficient.

(b) Confirm which roof type the building belongs to. In this research, we only consider flattened roof and gable roof were considered.

(c) An improved RANSAC method was used to extract the primary planes. The geometric shapes of seismic damaged buildings are much more complex which may contain noise points and small details. Whereas, an adaptive RANSAC algorithm could eliminate those noise and give a good results. If the building roof type is flattened roof, only two plane will be extracted (foundation plane and roof plane), and planes normal vector will be calculated. As shown in Figure 3 and Figure 4. If the building roof type is gable roof, three planes will be extracted (foundation plane and two roof planes) and normal vector will be calculated according to these three planes.

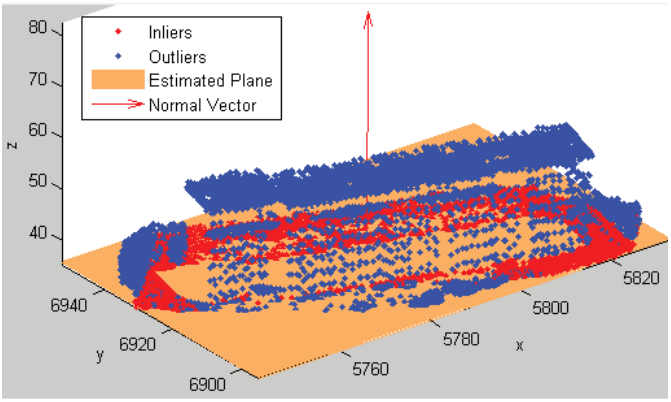


Figure 3.Extraction of foundation points

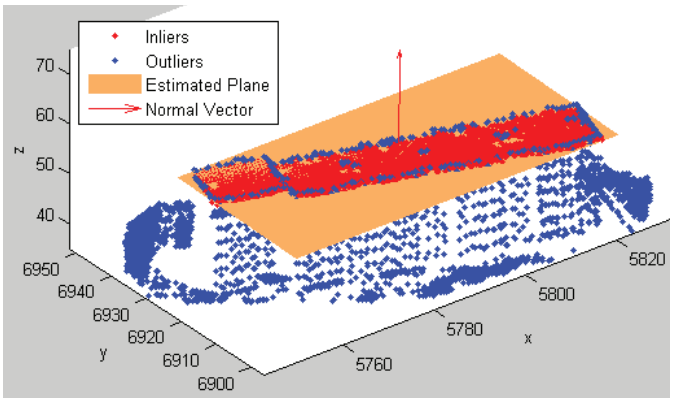


Figure 4. Extraction of roof points

Red points in the Figure 3 were identified as the foundation plane and extracted by using RANSAC algorithm. Then the optimal plane and normal vector of foundation plane were calculated. After the iterative calculation, points on foundation planes were removed from the data set (as shown in Figure 4). In Figure 4, Red points were considered as the roof plane and the optimal plane, normal vector were calculated using above method

3. INCLINATION JUDGMENT OF BUILDINGS

Normally, the geometric axis line of building is parallel to the normal vector of foundation plane or only in a small angle φ. In our method, an angle threshold φ was employed to determine whether a building is inclined. The geometric axis line of a flattened roof building was considered to be the normal vector of roof plane; while to the gable roof, the geometric axis line was calculated by the sum of two roof planes' normal vectors.

4. CONCLUSION AND OUTLOOK

The main purpose of this article focus on identification of the inclined buildings from airborne LiDAR data in the natural disaster and this work was approved to be significant in the survivors rescue. In the future, we plan to take different roof types into account and more reliable solutions will be proposed.

5. REFERENCES

[1] C. Schweier, M. Markus, "Classification of collapsed buildings for fast damage and loss assessment". Bulletin of Earthquake Engineering, Vol. 4, No. 2, pp. 177-192. 2006.

[2] F. Tarsha-Kurdi, T. Landes,, P. Grussenmeyer, "Hough-transform and extended RANSAC algorithms for automatic detection of 3D building roof planes from lidar data". ISPRS Workshop on Laser Scanning 2007 and SilviLaser 2007, Espoo, Finland, Sept. 12-14th. ISPRS International archives of Photogrammetry. Remote Sensing and Spatial Information Systems. Vol. XXXVI, Part 3/ W52, 2007, pp.407-412.

[3] M.A. Fischler, R.C. Bolles, “Random Sample Consensus: a paradigm for model fitting with application to image analysis and automated cartography”. Communications of the ACM, 24(6):381-395. 1981.
[4] M. Rehor, H.P. Bähr, F. Tarsha-Kurdi, et al., “Contribution of two plane detection algorithms to recognition of intact and damaged buildings in lidar data”. The Photogrammetric Record, Vol. 23, No. 124, pp. 441-456.2008.