Brief description of building detection from airborne LiDAR data based on extraction of planar structure

Name and Affiliation of Participants:
Chen Qi, Sun Mingwei
School of Remote Sensing and Information Engineering, Wuhan University, China

Email: daoqiqi@gmail.com; mingweis@whu.edu.cn

Study Area:
Vaihingen (area 1, area 2, and area 3)

The detection target:
Buildings.

Data set used:
Only LiDAR data. The provided image data were not used.

Export of results:
The building detection results were exported as binary Geo-TIFF (tif) files along with World (tfw) files containing the georeferencing.

Procedure of the proposed method:
1. Generation of DTM

The filtering algorithm based on adaptive TIN models (Sithole, 2001) was adopted to obtain the ground points from LiDAR data. The DTM was generated by interpolating the ground points into a regular grid.

2. Extraction of small planar patches

LiDAR data are gridded first, then, in each grid, all the points in that grid are fitted into a plane. To make sure there are enough points for plane fitting in most of the grid, the grid size is set to 1.5 m by 1.5 m. When the root mean square error (RMSE) of the fitting is less than a threshold of 0.1 m and the mean elevation within the grid is at least 2 m higher than local average DTM, the grid will be labeled as a patch of a building facade or roof. Since we are only interested in building roofs, the façade patch will be removed according to the normal vector's angle of the fitted plane. The extracted patches of buildings in Area-2 are shown in Figure 1.

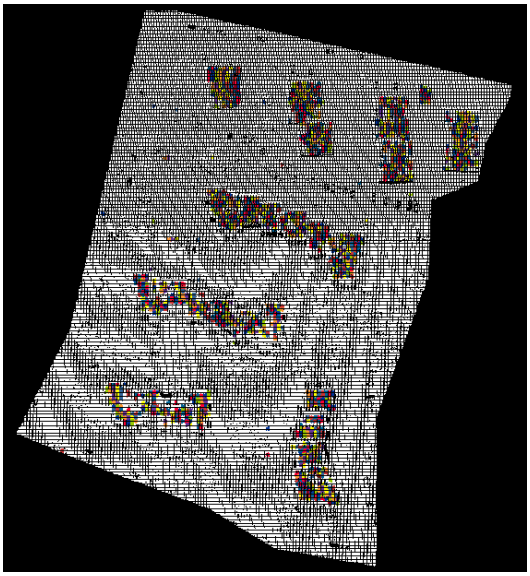

Figure 1: planar patches extracted from Area-2

3. Mergence of planar patches

For each grid labeled as building patch, search in the neighboring grids which are also labeled as building patches; merge current patch with the patches found if the plane fitting using points from the two patches has a RMSE less than 0.1 m. Repeat this merging process until no more patches merge. The merging results of Area-2 are shown in Figure 2.

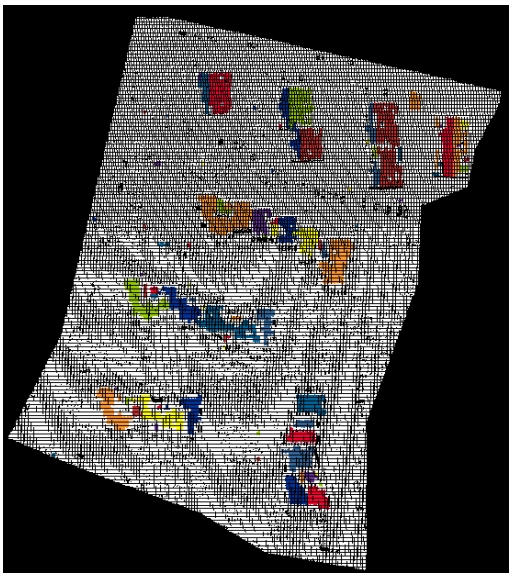

Figure 2: merging results of planar patches in Area-2

4. Region growth of building structure

The merging results are generally incomplete building structures, there are still some points belonging to the detected planes in the neighboring grids that are not detected as plane patches. For each plane, search in the surrounding grids, if the vertical distance from a point in the grids to the plane is less than 0.1 m, the point is determined as part of the plane. When the number of approved points of a grid is

more than a threshold (10 points or 40% of the total in our case), the growth continues at the gird. After every round of region growth, the parameters of the plane will be updated. The region growth results in Area-2 are shown in Figure 3.

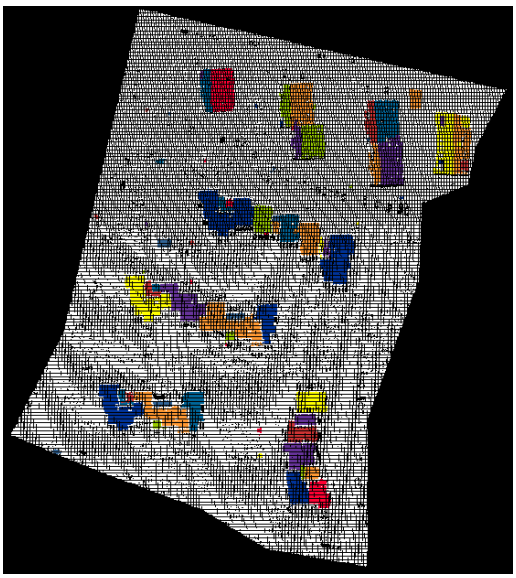

Figure 3: region growth results in Area-2

5. Point cloud clustering

Neighboring planes are clustered to a single building. But some of the planes are high tree crowns near the buildings, those planes are generally small, so planes consist of less than 3 grids or planes with less than 10 points are not included in the clustering process. The clustering results of buildings in Area-2 are shown in Figure 4.

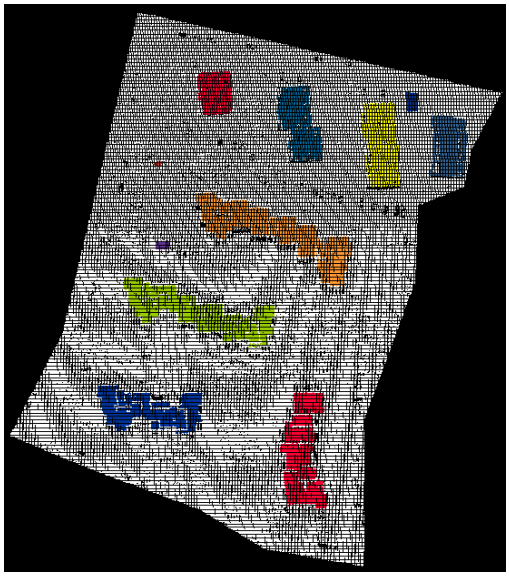

Figure 4: clustering results of buildings in Area-2

6. Contour extraction

Alpha shapes algorithm (Bernardini et. al. 2013) is used to extract the boundaries of the buildings. Alpha value is set to a large value (in our case 2.4 m) to get smooth boundaries of the buildings. Inner boundaries of a building with an area of less than

50 m^2 will be eliminated, as those boundaries have a high probability to be windows or chemise; while boundaries with areas larger than 50 m^2 can be reserved because they could be empty holes of a building structure. The contour extraction results in Area-2 are shown in Figure 5.

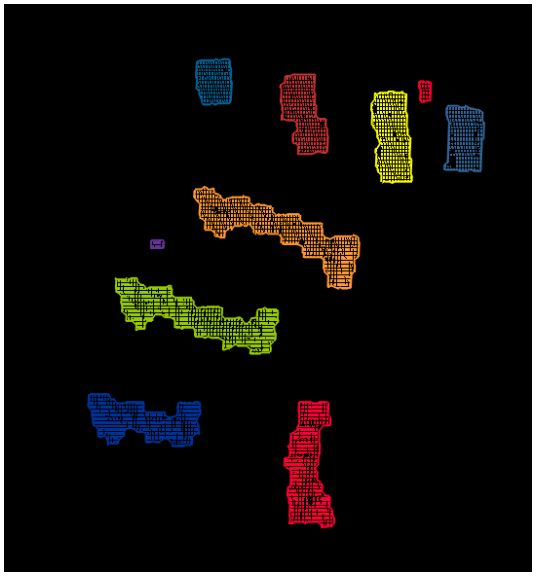

Figure 5: contour extraction results of buildings in Area-2

Reference

Sithole, G., 2001. Filtering of laser altimetry data using a slope adaptive filter. International Archives of Photogrammetry Remote Sensing and Spatial Information Sciences, 34(3/W4): 203-210.

Bernardini F., Bajaj C., 1997. Sampling and reconstructing manifolds using alpha-shapes. Technical Report CSD-TR-97-013, Dept. Comput. Sci., Purdue Univ., West Lafayette, IN.