Building Change Detection with UAV Images

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Abstract: In this article, we try to extract DSM in urban area by photogrammetry. Firstly, image orientation are calculated by GPS-supported bundle adjustment. Then, DSM are extracted from urban by multi-view dense match method SURE. DSM difference are generated from two DSM in different time to detect change of building. This method has good effect in detecting change of village in city.

1 INTRODUCTION

Due to the unprecedented technology development of sensors, platforms and algorithms for 3D data acquisition and generation, 3D spaceborne, airborne and close-range data, in the form of image based, Light Detection and Ranging based point clouds, Digital Elevation Models and 3D city models, become more accessible than ever before. Change detection or time-series data analysis in 3D has gained great attention due to its capability of providing volumetric dynamics to facilitate more applications and provide more accurate results.

The European Spatial Data Research Organization started a benchmark on image based digital surface model (DSM) generation in February 2013. This test is based on two representative image blocks, which were processed by different groups with different software systems. There is only city in the image blocks. There is no test on the forest area. There is still some problem in the city. Because there are a lot of shade in the image.

In this article, we try to detect change in urban area by UAV photogrammetry method.

2 MATERIALS

2.1 Study area

The test site was located at Guangzhou, Guangdong Province in Southern China (38◦ 32' N, 100◦15' E). Aerial images used in this study were acquired on June 8, 2015 and 2016. Figure 1 shows the location of the test area. Figure 2 shows the flight lines in 2015 and 2016.

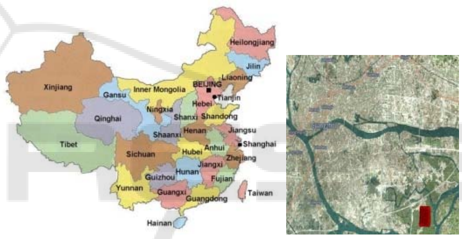

Figure 1: Location of test area

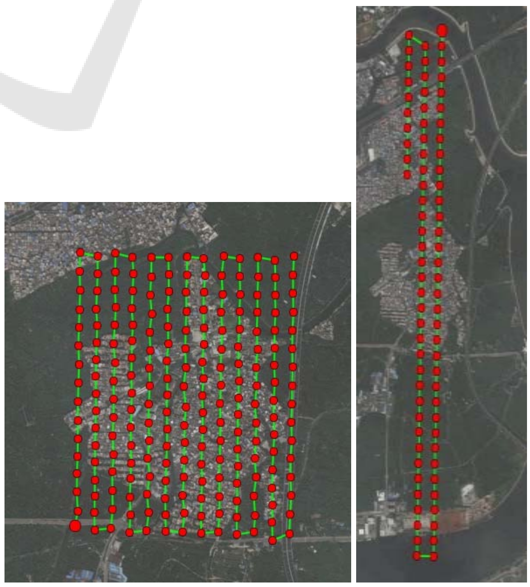

Figure 2: image of test area

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3 METHOD

This method includes accurate image orientation, DSM extraction, and change detection. After the images were captured, they were matched to generate connection points. A bundle block adjustment was then used to obtain the accurate orientation parameter. The DSM was generated using dense matching. It is difficult to set control points. Therefore, we obtained the image orientation parameters by using a GPS-supported bundle adjustment, then a multi-view dense match to generate the dense matched point cloud. Figure 3 shows the algorithm flow chart.

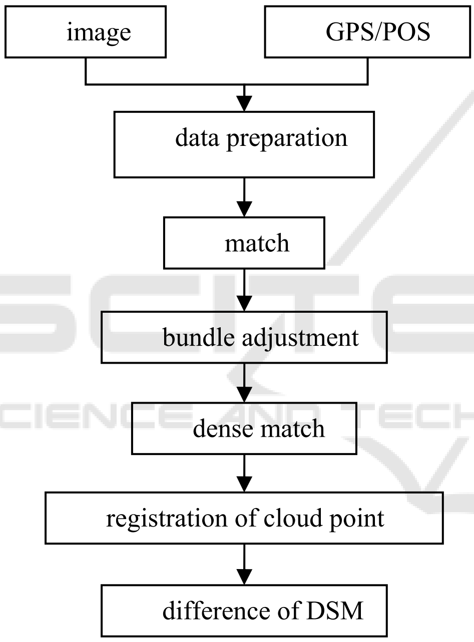

Figure 3: algorithm flow chart

Original image has initial orientation parameter, then we use the sift algorithm to extract feature points, use the kd-tree and ransac algorithms to extract match points.

We use the bundle adjustment to calculate the accurate orientation parameters.

We used a SURE(Photogrammetric Surface Reconstruction from Imagery) algorithm to generate the dense matched point cloud. It applied the SGM algorithm to match between image pairs, and then fused the results to obtain the resulting point clouds. The SGM algorithm aims to estimate disparities across stereo pairs such that the global cost function shown in equation (1) is minimized.

$$E(\mathrm{D}) = \sum_{x_b} (C(\mathrm{x}_b, \mathrm{D}(\mathrm{x}_b))) + \sum_{x_N} P_1 T\left[\left\|\mathrm{D}(\mathrm{x}_b) - \mathrm{D}(\mathrm{x}_N)\right\| = 1\right] + \sum_{x_N} P_2 T\left[\left\|\mathrm{D}(\mathrm{x}_b) - \mathrm{D}(\mathrm{x}_N)\right\| > 1\right]$$

(1)

In this equation D represents the disparity image holding estimates of all base image pixels x_b. T is an operator that evaluates whether the subsequent condition is true and is set to zero if false. x_N denotes the base image pixels in the neighborhood of x_b. The global cost function, E, is composed of a data term and two terms representing smooth surfaces. The data term is computed using pixel-wise similarity measures $C(\mathrm{x}_b, \mathrm{x}_m)$. The penalty parameters, P_1 and P_2, control the gain of surface smoothing (Rothermel et al., 2011; Rothermel et al., 2012; Wenzel et al., 2013).

Figure 4: 2015 Dense matched cloud point

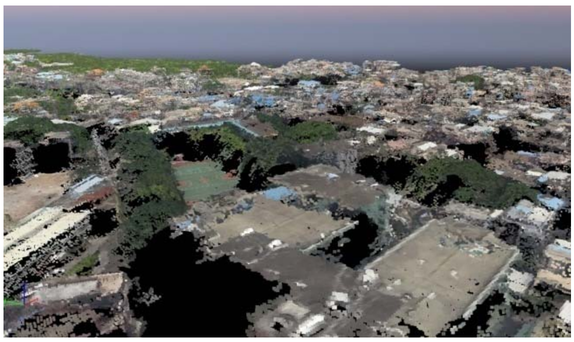

Figure 5: 2016 Dense matched cloud point

After the DSM was calculated, then we match the two DSM by using the ICP algorithm. after that, we calculate the difference of the two DSM.

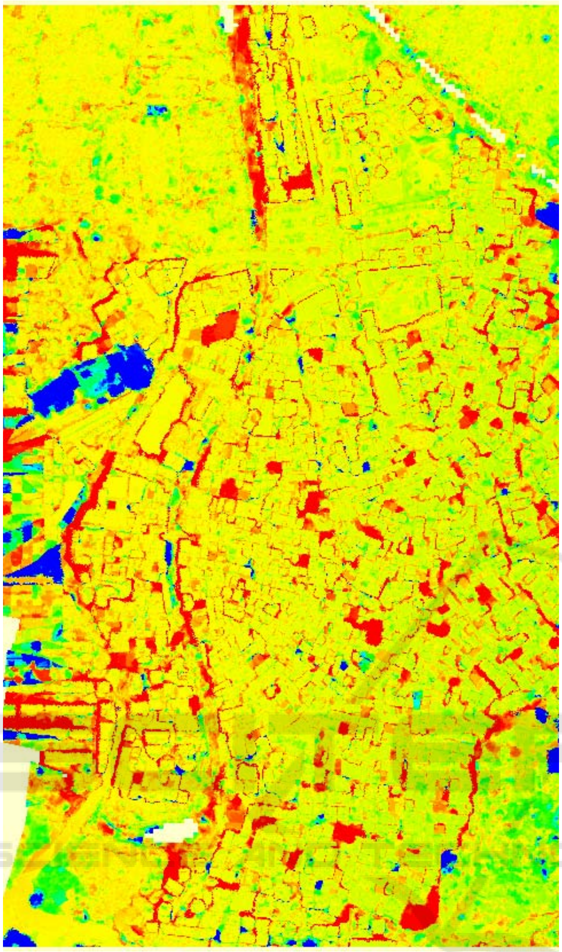

Figure 6: change of two DSM

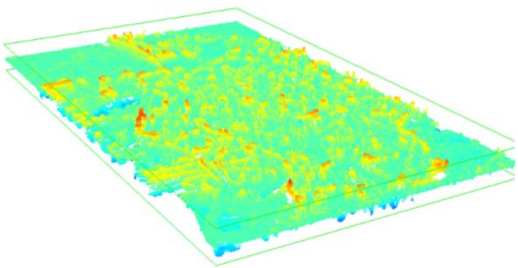

Figure 7: change of DSM in 3D

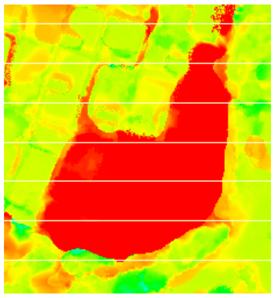

Figure 8: difference of DSM in local area

Figure 9: two uav images in the change area

Figure 6 shows the result of difference of two DSM. Figure 7 shows the 3D display of the difference. By analysing the difference, we can find where is the change area. In the figure 6, difference is zero in most yellow area. the difference is big in the red area and blue area, the difference is negative value in blue area, difference is positive value in the red area. Here, we should detect the unauthorized construction, so we analyse the red area.

4 CONCLUSIONS

We use photogrammetry method, get the cloud point of the research area. We detect change in the urban area by the difference of DSM from different time. We can detect change area in the difference image successfully.

There are a lot of dense match error in the river, forest. That is what we should do in the future.

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