Aligning Orthophotographs Taken with Low Altitude UAV above Traffic Intersections

Jionghua Wang[1], Xiang Li[2]

[1] Key Laboratory of Geographical Information Science Ministry of Education,
Room 325, College of Resources and Environmental Science
NO. 500, Dongchuan Road, Minhang District, Shanghai, PR China 200241.
Telephone: 0086-15002190201
Email: gubb673@163.com

[2] Key Laboratory of Geographical Information Science Ministry of Education,
Room 325, College of Resources and Environmental Science
NO. 500, Dongchuan Road, Minhang District, Shanghai, PR China 200241.
Telephone: 0086-13761431398
Email: xli@geo.ecnu.edu.cn

1. Objective

Obtaining high-resolution image, often named orthophtographs, timely and conveniently above traffic intersections is important for traffic optimization, evaluation, etc. The paper aims at illustrating a method of aligning orthophotographs (i.e. image frames of a video) taken with Unmanned Aerial Vehicle (UAV) for monitoring traffic flow above a given intersection. In this method, a unified spatial reference is obtained from semantic information of image frames, and based on it, each frame is aligned.

2. Background

Compared with traditional traffic data acquisition methods, UAV takes great advantages on data quality and convenience, especially when study area is relatively small. However, inadequate stability is a shortage of UAV-based data collection methods due to surrounding environments, such as wind, images taken when hovering are inevitably deformed, and the deformed image will definitely hinder information extraction later.

In traditional airborne remote sensing, the method that use to align images is usually based on Position and Orientation System (POS), which might not be applicable to UAV-based images with respect to the following two reasons:

1. The POS of UAV is often not sensitive enough to catch the subtle changes in attitude and position. Therefore, its accuracy of POS data cannot meet the demands of image aligning.

2. Instead of small spatial coverage and hovering images taken with low altitude UAV, existing aligning methods generally target large spatial coverage and roaming images.

In view of the above reasons, we propose a novel method, which is never a universal approach to the aligning of images covering any kind of land surfaces. Instead, the method is especially for images above traffic intersections, and semantic information inherent in each image is extracted to figure out aligning parameters.

3. Data

Video for an intersection lasts four minutes 30 seconds (25 frames per second) taken with a UAV hovering at an altitude of about 300 meters.

4. Methodology

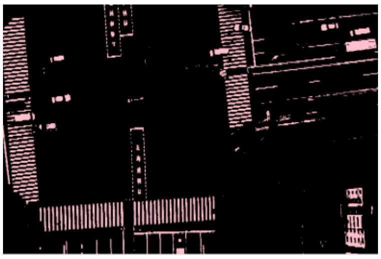

Figure 1. Create patches

First, create patches. Traverse images with recursive algorithm to create patches and take color information as selection conditions. Then, each patch returned is distinguished by a standard of patch size and patch shape to remove falsely extracted patches. As shown in Fig. 1, the standard patch actually stands for the zebra lines which can be always observed in the intersection.

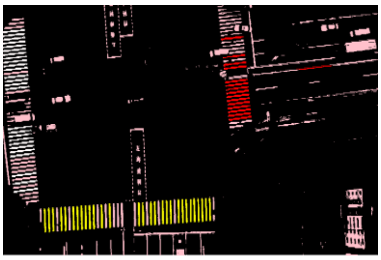

Figure 2. Classify patches

Second, classify patches. Resulting patches are divided into different categories according to their positions and slopes. Similar process is carried out twice to remove the mistake caused by violent jitter. Each patch is denoted as *P=<Size, Slope, Midpoint, Type>*. As shown in Fig. 2, different types of patches are marked in white, red, and yellow, respectively. Then, some error patches, which are shown in the top right corner of Fig. 2, are removed with a spatial analysis method.

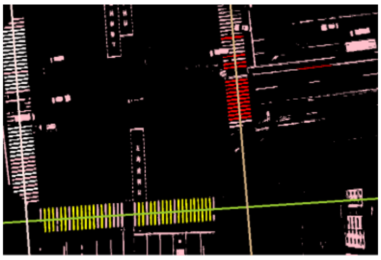

Figure 3. Curvilinear regression

Third, curvilinear regression. Each zebra-crossing line in this frame is described as a straight line, which can be approximate to the midline of itself, as shown in Fig. 3. Midpoints grouped by its type are used to produce these lines with ordinary least square method. Then, the intersection point of two adjacent zebra-crossing lines is calculated and used in the next step.

At last, the resulting lines and points are used to remove jitters with affine transformation. Let i denote the number of resulting lines. There are three cases:

Case 1: if $i = 0$, then this image cannot be aligned. Case 2: if $i \geqslant 1$ and $i \leqslant 3$, then rotation and translation are employed to align images.

Case 3: if $i = 4$, then align images with polynomial method.

5. Discussion

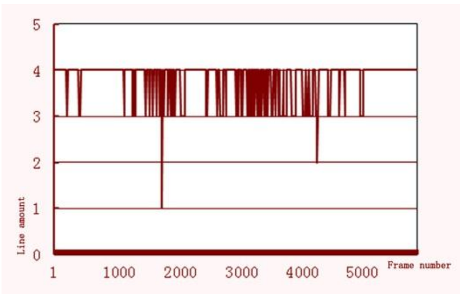

Figure 4. Regression lines (10%sampleing)

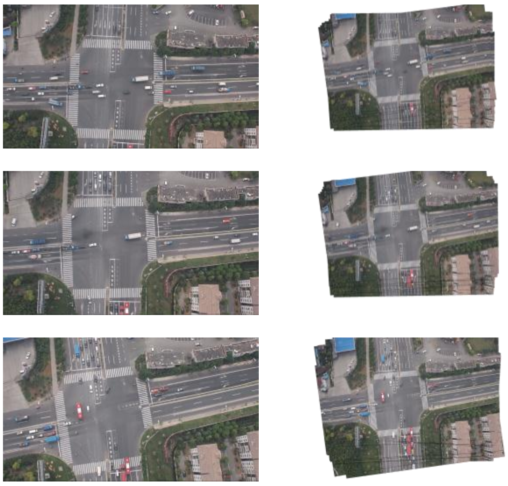

Figure 5. Corrective effect

According to the algorithm, with more regression lines in a single frame, comes the better aligning result. As shown in Fig. 4 and Fig. 5, most of the frames can be aligned with the above method.

6. Future Work

Improve the aligning accuracy using the method of corner match and interpolation. Improve self-adaption of the algorithm using Particle Swarm. Aim to make it automatic in parameter setting of patches extracting.

7. References

J.Wei, G.Hongli, D.Huaqiang, X.Xiaojun, A Review on Unmanned Aerial Vehicle Remote Sensing and Its Application. *REMOTE SENSING INFORMATION*, vol. 1, 2009.

C.Fang, Z.Minhui and W.Yirong, Adjusted polynomial method for image registration. *Journal of electronics and information technology*, vol. 23(11), 2001.

Q.Xinghui, and P.Yong, Research on image mosaic method based on corner match. *Science Technology and Engineering*, vol 11(4), 2011

L.Zhensu, H.Zhirong, Particle Swarm Optimization with Adaptive Mutation. *Acta Electronica Sinica*, vol 32(3), 2004.