A Rapid UAV Image Georeference Algorithm Developed for Emergency Response

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I . Introduction

- The high-resolution image collection system based on the Unmanned Aerial Vehicle(UAV) has the advantages of lightweight, low cost and flexibility. It has to be a vital tool for **rapid collecting and viewing the disaster information** in post-earthquake response and reaction, and attracts more attentions.
- At present, the main processing methods of UAV images are image stitching and 3D point cloud model reconstruction usually **consumes one or several hours**.
- We propose and validate the algorithm in this paper, which could achieve rapid georeference **within three minutes** for up to hundreds UAV images.

II . Method

❑ The rapid georeference of UAV images

The disaster information collecting system based on the UAV is usually equipped with high resolution digital camera and autopilot system, which could record the time, position and attitude of the camera exposure. The UAV images could be achieved the georeference by synchronizing the images and POS(Positioning and Orientation System) data. We can acquire the position and attitude data of camera theoretically, which output from the autopilot system.

❑ The data organization form of georeferenced UAV images

Considering the processing efficiency of the UAV images rapid georeference, we do not implement the pixels resampling in the process of the rapid georeference, but adopt the **World File** to organize the georeference parameters. It comprises of **six parameters**, which are organized in a file with the specified suffix name and text encoding. All of these parameters consist of the affine transformation matrix as flows.

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} A & B & C \\ D & E & F \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Each pixel will acquire the geographic coordinates, when the GIS software loads the georeferenced image data as Fig. 1. The key problem of UAV images rapid georeference is how to quickly calculate parameters C and F. Since the autopilot system collects the angle data, which indicates the image rotates around its symmetry center, but the World File adopts the upper-left as its rotation center, we have to change the center rotation to upper-left rotation and reduce the error caused by rotation.

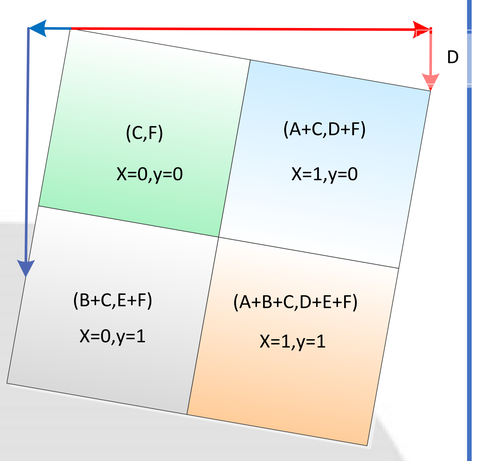

Fig. 1 The imaged georeferenced based on the World File.

❑ The parameters of rapid georeference determination

- The position parameters calculation

A direct and simple way to obtain the coordinate parameters is calculating the numbers of pixels between the center and the upper-left corner, then multiply the image resolution, finally plus the center coordinates.

- The transformation between different rotation systems.

The remote sensing images collected based on the Unmanned Aerial Vehicle rotate around their symmetry center theoretically, but the images georeferenced based on the World File rotate around their upper-leftcorner. Therefore, they have the different positions after the rotation。

In the Fig. 2, the left Figure shows the image rotates around the upper-left corner in different angles from position 1 to position 8, and the right Figure indicates the image rotates around the symmetry center according to the same angle form position 1 to position 8.

❑ The rapid georeference accuracy improvement based on the reference image

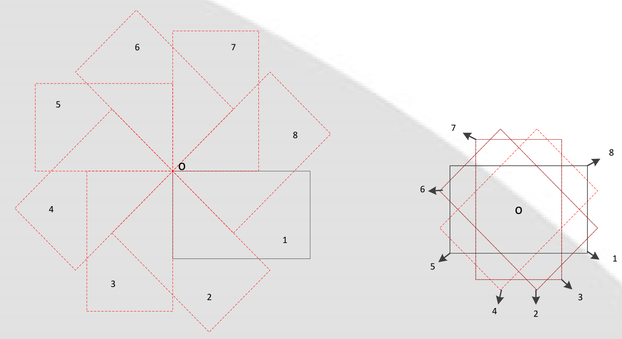

Fig. 2 The image rotates around the upper-left corner and the image rotates around the symmetry center.

In order to improve the georeference accuracy and time efficiency further, the whole georeference accuracy improvement method based on the SURF (Speeded Up Robust Features) features extraction and matching is proposed in this paper.

Fig. 3 The SURF features extraction and matching.

Since the reference image always covers a big area, the SURF features extracted from the UAV images to match the features extracted from the reference images will exhaust much time. To solve this problem, the features are extracted from reference image in the given area which is initialized according to the boundary area of the georeferenced UAV images, and match with the features extracted in the UAV image.

III. Experiments and Analysis

Experiments adopt C# language combined with GDAL (Geospatial Data Abstraction Library) function to compile the rapid geographic reference software, and achieve the UAV images rapid georeference.

Taking the UAV remote sensing image data obtained from the Danling County in Sichuan Province as an example, the average flying height is 250m.

The UAV images are achieved the georeference without considering the image rotation and the error correction. The UAV images rapid georeference meets the time requirement, but we could not get ground objects distribution situation of the entire flight area.

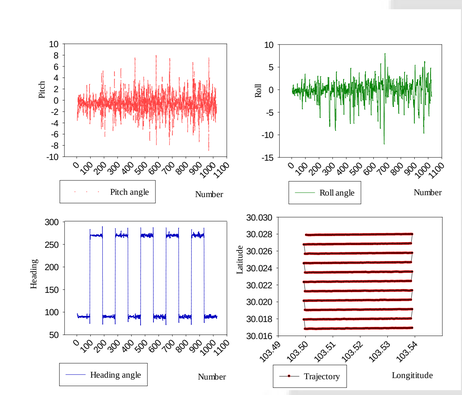

Fig. 4 The attitude and trajectory of fixed wing UAV.

In the Fig. 6, it indicates the result of UAV images rapid georeference based on the algorithm proposed in this paper. All the images get the spatial reference.In the emergency response period, saving time is very important. In this situation, dozens of meters accuracy totally satisfies the emergency response requirements.

Fig. 5 result without considering the angle information.

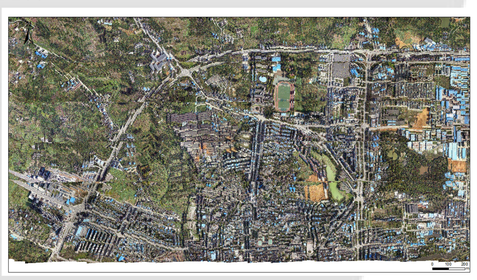

Fig. 6Application

IV. Conclusions

- In this paper, the method and model of UAV images rapid georeference are discussed in detail and the algorithm is implemented through C# language combined with GDAL library.
- It has an important application value in the post-earthquake response period. In the future work, the images rapid georeference for UAV with differential GPS module will be studied to improve the localization accuracy and reduce the relative error between adjacent images.