Research on 3D modelling based on UAV tilt photogrammetry with KQCAM5 swing tilt camera

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Abstract. With the continuous development of UAV and tilt camera, tilt photogrammetry technology has been well applied in various fields. However, there are some problems in the practical application of tilt photogrammetry technology, such as the position of tilt camera is always in a relatively fixed position, which is easy to miss out photos, etc. In this paper, a method of establishing a three-dimensional real scene model by using a swing five lens camera is proposed. It is proved that the 3D model established based on the KQCAM5 swing tilt camera contains abundant texture information, which reduces the hollowness and stretching deformation of the model. At the same time, the UAV tilt photogrammetry with swing tilt camera can reduce the extended range of the measuring area, thus reducing the number of photos taken and improving the overall efficiency.

Keywords: KQCAM5, UAV, tilt photogrammetry technology.

1. Introduction

The emergence of UAV tilt photogrammetry technology breaks through the limitation that traditional aerial survey remote sensing images can only be taken from the angle of vertical ground of aviation, realizes the image acquisition from five different angles: vertical, front, rear, left, and right, and obtains the three-dimensional ground information. However, there are some problems in the practical application of tilt photogrammetry technology, such as the general tilt camera position is always in a relatively fixed position, which easily leads to missed shooting. In this paper, a five-lens swing tilt camera is proposed to study the method of quickly establishing a three-dimensional real scene model, and an example is given to prove that the three-dimensional model based on the tilting camera of KQCAM5 swing lens contains rich texture information, which can reduce the hollowness and stretching deformation of the model. At the same time, the UAV tilt photogrammetry with swing tilt camera can reduce the extended range of the measuring area, thus reducing the number of photos taken and improving the overall efficiency.

2. Principle of UAV tilt Photogrammetry

The tilted image refers to the image data obtained by using an aerial camera with a certain tilt angle. Oblique photography is to use a vertical plane and four inclined plane aerial cameras to shoot images of
surface objects at a total of 5 angles of view, so as to obtain texture information of surface objects. Moreover, the three-dimensional position and aircraft attitude acquired at the time of shooting can be used to assist the modeling technology to obtain a real three-dimensional model and express the surface feature information more intuitively.

The traditional tilt camera generally uses a five-lens or three-lens camera fixed on UAV. During the shooting process, the position of camera and UAV is always in a relatively fixed position, that is, in the process of flight, the lens of each camera is always shooting along one direction, which is bound to cause the problem of missing shooting in areas where the buildings are dense or where the obstacles are severely blocked. In addition, there will be hollowness and stretching deformation in 3D modeling. The swing tilt camera is added to the function of sweeping and swinging based on the traditional tilt camera. In other words, the camera rotates a fixed angle every time the camera takes a picture in flight, so that the tilt camera can take photos alternately in two directions. Due to the increase of the orientation of the camera, more details can be captured. In this paper, based on KQCAM5 swing tilt camera, the tilt photogrammetry of Shiyang village in Xi'an was carried out, and the 3D real scene model was established by using context capture 3D modeling software.

3. Technical process of UAV tilt Photogrammetry

UAV tilt photogrammetry mainly includes field data acquisition (route planning, layout of image control points and aerial photography), data preprocessing, aerial triangulation solution, 3D modeling, etc. The specific technical flow chart is shown in Figure 1.

![Figure 1. Technical process of tilt photogrammetry.](image)

3.1. Field data acquisition

(1) Route planning

Before flight, the route should be planned first, and the specific requirements are as follows: 1) the whole survey area should be planned as a rectangular area, and the longer side of the rectangle should be the UAV heading direction. 2) The survey area should be extended to a certain extent. For traditional tilt camera, the extended range is at least flight height; for the swing tilt camera, the extended range is generally three-quarters of the altitude. 3) In the survey area, the route should be arranged vertically or parallel to the building orientation as far as possible. 4) The heading overlap is required to be 80% and the lateral overlap is 50%.
(2) Layout of image control points
In order to ensure the accuracy of mapping, the layout of image control points should be completed in the survey area before flight. The layout requirements are as follows: 1) the image control points should be evenly distributed in the whole survey area. 2) The position of image control point should be prominent and easy to identify.

(3) Data acquisition
After completing the layout of image control points, select the appropriate position to take off. The take-off position requires that the ground is open and free of obstacles. After completing all the setup and preparation work, Dajiang M600 Pro can complete one key takeoff operation, automatically fly according to the route planning, and conduct image acquisition according to the preset photo overlap.

3.2. Data processing
In this paper, Context Capture software is used for 3D modeling. After the flight, the image data is preprocessed and the preprocessed image data is imported into the software. Then, aerial triangulation calculation is performed on the imported image, and a large number of feature points are extracted, and the corresponding points of multi view image are matched for the feature points, so as to calculate the attitude and spatial position information of each original photo, and finally determine the position relationship between each image. In order to express the details of terrain and features more accurately, dense image matching and 3D grid model generation are implemented. Finally, the point cloud can be calculated to form triangulated irregular network (TIN), and then the TIN is used to form the white model. The software extracts the corresponding texture from the image, and automatically maps the texture to the corresponding white model to form the real 3D model.

4. Experimental procedures
This paper takes Shiyang village in Xi’an as an example to study the method of establishing 3D real scene model based on UAV tilt photogrammetry with swing tilt camera. The survey area was about 0.1 square kilometers. In this flight, Dajiang M600 Pro was selected as the flight platform, and KQCAM5 swing lens camera was used to obtain data, and the data of the whole survey area were collected in one flight. Six image control points were set up in this experiment. The weather was clear and met the flight conditions. The flight altitude was 90 meters and the flight extension range was 70 meters. The ground resolution is better than 2cm. After the flight, the modeling results were obtained by data preprocessing and 3D modeling according to the method described in this paper. The 3D models was shown in Fig. 2 and Fig. 3.

![Figure 2. The overall 3D modeling result of survey area.](image)
Fig. 2. shows the overall effect of the 3D modeling of Shiyang village, and Fig. 3. Shows the local details of the modeling. From the perspective of modeling effect, due to the high degree of image overlap, there are no errors or holes in the entire measurement area, and all the feature information of the measurement area is retained. From the local effect picture, the building contains more abundant texture features, which greatly reduces the local deformation and hollow problems. However, the UAV tilt camera cannot observe the position where the occlusion is more serious, and there is still the phenomenon of stretching deformation. At this time, it is generally necessary to take photos manually on site to obtain the texture information of the building, and then use Context Capture software to fine modify the model again to get a more realistic 3D model. In this experiment the mapping accuracy is within 5cm.

5. Conclusions
In this paper, the method of quickly establishing 3D real scene model is studied based on UAV tilt photogrammetry with the five-lens swing camera. The example shows that the image data obtained by the KQCAM5 swing lens tilt camera provides more abundant texture information. In the follow-up fine model repair, the office workload is greatly reduced, and the work efficiency of 3D modeling is improved. At the same time, the use of the swing camera can reduce the extension range of the survey area, and the number of images will be reduced under the same survey area, which saves a lot of time for aerial triangulation calculation and improves the efficiency of office work.

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