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# Application of Unmanned Aerial Vehicle remote sensing image to large-scale surveying and mapping of the hilly area in Qinghai Tibet Plateau

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**Abstract:** The Unmanned Aerial Vehicle remote sensing has a predominance of large-scale mapping because of its advantages including being flexible, fast, efficient and cheap. Using the example of an application of Unmanned Aerial Vehicle to the mapping which includes 25 square kilometers by the scale of 1 to 1000 in the hilly area of a county in Qinghai, this article demonstrates the feasibility of processing data by Unmanned Aerial Vehicle.

**Key words:** Unmanned Aerial Vehicle; aerial triangulation; DEM; DOM; DLG

## 1 Introduction

Unmanned Aerial Vehicle (UAV) has its unique technological superiority of being flexible, convenient and cheap, it is widely used in various fields and it has become an important way in airborne remote sensing. Although it has become a very important way to gain spatial data, the flying pose of UAV is unsatisfied and it has smaller flying coverage compared to traditional air photogrammetry. UAV is mainly involved in fast puzzle, but it is rarely used in large-scale surveying and mapping.

The technology of UAV remote sensing is applied to the drawing of topographic maps by the scale of 1 to 1000, the direction of technical improvements, which refers to the application of UAV remote sensing platform to a wide range of topographic map surveying, is also proposed in this article.

## 2 General introduction of the survey area

The survey area is a hilly area which is 4km long from North to South and 7km wide f rom East to West. The Northeast is a little bit lower and the altitude of this area is 225 6m-2804m.

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## 3 Brief introduction of UAV system

1) UA V hardware system

UAV hardware system includes wireless remote control, autopilot flight control, airborne communication equipment, external loads and so on. This experiment used a fixed wing UAV and the parameters of the UAV platform are shown in table 1:

**Table 1.** Parameters of UAV platform

| wingspan | length | empty weight | external loads | cruising speed | ceiling | material | rate of climb |
|---|---|---|---|---|---|---|---|
| 3.1m | 2.05m | 15kg | 7kg | 110km/h | 6000m | FRP | 15m/s |
| | | | | | | | |
| operating radius | off mode | recover y mode | endurance | flying range | communicat ion distance | camera model | power system |
| 100km | slip\ca tapult | glide, parachut e | 2.5h | 250km | 20km | canon 5Ⅱ | gasoline |

2) Remote sensing image processing software system

PixelGrid UAV module of Chinese Academy of Science was used to process the data from aerial photograph. PixelGrid, which is based on all-digital photogrammetry and remote sensing technology theory, is a new generation of remote sensing image process software. Using the high-precision image map making and stitching, the network adjustment of sparse remote sensing control area and the automatic matching of the precision digital and elevation model, PixelGrid has been developed. This system can process the data from various high-resolution satellite images and UAV aerial images, measurements from aerial triangulation, large-scale DEM and DOM can be carried out by the job method of computer multi-core parallel processing and automation combined with manual editing.

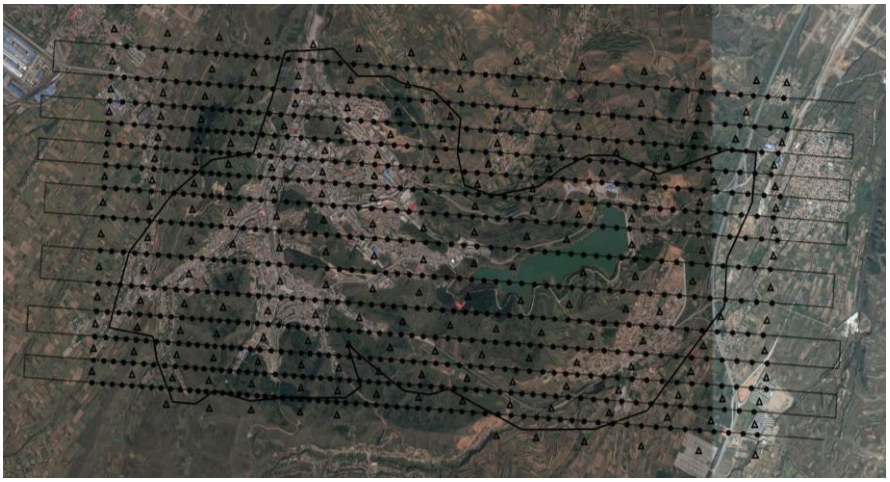
## 4 Image data acquisition

It was a sunny day when the aerial photograph began, the visibility was high and the wind speed reached force 1-2. The aerial photography provided outdoor workers with 900 high resolution photos. 14 air lines were planned, the degree of foreword overlap was 65%, the degree of lateral overlap was 40% and the resolution ratio was better tha n 0.1m. The survey area was about 25 square kilometers and the relative altitude was 300m. The designed parameters are shown in table 2.

**Table 2.** Designed parameters

| absolute flying height | focal length | pixel | ground resolution | foreword overlap% | lateral overlap% |
|---|---|---|---|---|---|
| 2900m | 24mm | 5616*3744 | better than 0.1m | 65% | 40% |

Aerial photograph is shown in figure 1. The black irregular area is DLG mapping area, DOM is made within the range of area covered by the air lines. This article focuses on mapping accuracy in DLG mapping area.



△photo control point ●aerial photograph point

**Fig. 1.** Schematic diagram of the designed air lines

## 5 Cryptographic calculation and analysis of aerial triangulation

Before the calculation, original images distortion should be corrected by UAV module of PixelGrid according to the calibration parameters of the camera. The aerial triangul ation of PixelGrid matches the corrected images with feature points of the same name according to the topological sort order of POS point. The flow diagram of the aerial tr iangulation technology is shown in figure 2.

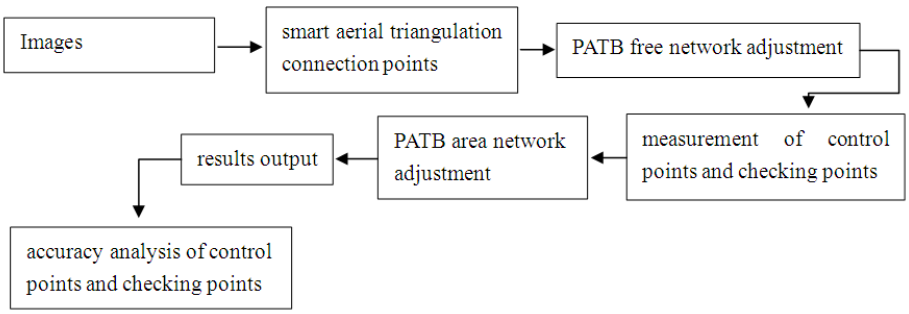



**Fig. 2.** Flow diagram of the aerial triangulation technology

The residual calculation results are shown in table 3. Table 3 shows that the accuracy of the results copes with the demand of 1 to 1000 aerial triangulation.

**Table 3.** Statistic of mean square error of height of control points and checking points

| Control point error/x | Control point error/y | Control point error/h | Checking point error/x | Checking point error/x | Checking point error/h |
|---|---|---|---|---|---|
| 0.195 | 0.183 | 0.234 | 0.243 | 0.231 | 0.223 |

## 6 Topographic mapping and accuracy test

Using the system of space vision digital photogrammetry, the collection of the vector data is completed by the scale of 1 to 1000 which copes with 79 of national standard subdivision. 10 pictures are collected randomly and evenly by network RTK in the range of the survey area to do the plane and elevation accuracy test. The results are shown in table 4. The results show that the outcome data plane and the elevation test meet regulatory requirements.

**Table 4.** Statistic of the plane and elevation accuracy test

| number | mean square error of a point | mean square error of height | number | mean square error of a point | mean square error of height |
|---|---|---|---|---|---|
| 1 | 0.47 | 0.38 | 6 | 0.43 | 0.45 |

| | | | | | |
|---|---|---|---|---|---|
| 2 | 0.52 | 0.39 | 7 | 0.44 | 0.43 |
| 3 | 0.42 | 0.42 | 8 | 0.52 | 0.39 |
| 4 | 0.49 | 0.37 | 9 | 0.39 | 0.42 |
| 5 | 0.51 | 0.46 | 10 | 0.47 | 0.44 |

## 7 Conclusion

UAV remote sensing image is applied to the topographic mapping by the scale of 1 to 1000, the practice of the mapping in the hilly area of Qinghai Tibet Plateau leads to the formation of this production process. UAV remote sensing image can be settled for mapping of a large hilly area, it has become a kind of efficient mapping technique because of the trial of the mapping by the scale of 1 to 1000. With the development of the technologies includes sensor, UAV, communication and data processing software, there will be a wide range of application of UAV aerial photograph technology to large-scale surveying and mapping.

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