STUDY OF THE ACCURACY OF UAV SURVEY TECHNOLOGY FOR TOPOLOGY MAPPING ON DISCREPANCY TERRAIN CONDITIONS

Quang Khanh Nguyen[1], Anh The Hoang [2,3*], Thi Phuong Thao Ngo [1]

[1] HaNoi University of Mining and Geology, HaNoi, VietNam.

[2] School of Agriculture and Natural Resource, Vinh University, Vinh City- 460000, Vietnam

[3] Department of Geophysics, School of Geodesy and Geomatics, Wuhan University, Wuhan 430079, China

Abstract: *The create topographic map of hilly and mountainous area has long been a difficult problem for manufacturers in terms of both measurement methods and accuracy requirements. Traditional technologies have their own advantages and disadvantages. Currently, Unmanned Aerial Vehicles - UAV technology is being applied a lot in the field of mapping and is increasingly improving to have better results in production. But how much accuracy it has with comparing traditional survey methods in the discrepancy of terrain conditions? So, we have checked its in the 500ha hilly areas in Vietnam. Those areas have much different elevation (200m), hiking trails, build-up area, slope and flat area. The topographic map was conducted using UAV technology had done the comparison with the checking points generated by RTK-GPS in term of accuracy. The result shows that the map produced by UAV technology matched with the topographic map do by RTK-GPS.*

UAV technology:

The general structure of the UAV system includes four main parts: The aircraft; The digital camera; The ground control station; The image processing station (Fig. 1)

Phantom 4 RTK type of rotary-wing aircraft with the positioning system GNSS and RTK receiver to achieve position accuracy of up to cm level. Phantom 4 RTK uses a camera with CMOS sensor of 1", resolution of 20 Mps, focal length f2.8 - f11, lens field 840, can recognize objects 2.74 cm at flight height 100m

Fig 1. Phantom 4 RTK UAV system

In this study, the research methodology is done as showing in Figure 2.

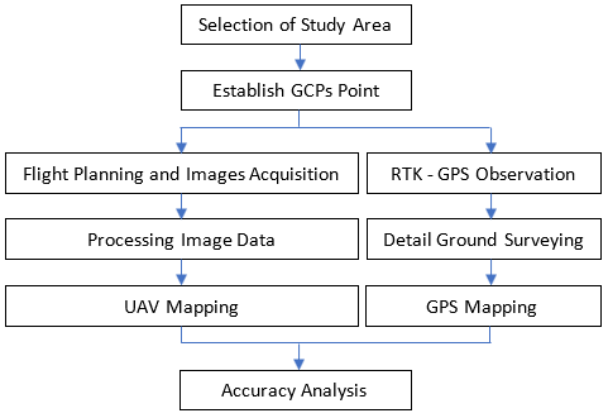

Fig 2. Research methodolody framework.

Study Area:

The study area is a tea growing area in Thanhson district, Phutho province, Vietnam (Figure 3a). The total study area is about 500 hectares. This is an area with high hill-mountain terrain, with alternating population (Figure 3b). The highest point in the study area has an altitude of 250 meters, the lowest point has an altitude of 70 meters.

Fig 3. The study area

UAV mapping:

- *Ground Control Point (GCP):* The number of GCPs is 03 point (namely GCP1, GCP2 and GCP3), evenly distributed over the study area. We use artificial marker, marked with highly reflective material, the geometry and the center is perfectly defined, and it can be correctly measured with high accuracy.
- *Image acquisition:* The height for data acquisition of RGB images using UAV was 180 meter to get the image with size 5472x3648 pixels. Each flight, the Base Station was put at the GCP, the coordinate of GCP was input to the Base Station to transmit to the Aircraft. The result of the flight process, we had 641 images with means error of position center image coordinate was 0.018 meter.
- *Data processing and Map editorial:* All the data obtained from UAV observation were processed using Agisoft Metashape Professional 1.5.2. The result of the mosaicking process is presented as in Figure 4.

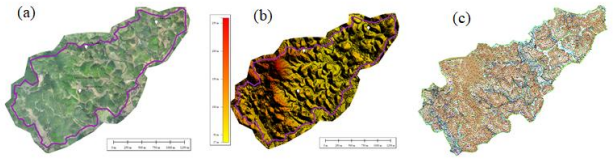

Fig 4. Data processing results
a. Orthophoto, b. Digital elevation model, c. Topographic map

Analysis and results:

The distance difference and The elevation difference between UAV and RTK-GPS are calculated as follows:

$$d = \sqrt{\left(X_{RTK\_GPS} - X_{UAV}\right)^2 + \left(Y_{RTK\_GPS} - Y_{UAV}\right)^2} \quad (1)$$

$$RMSE_{Coordinate} = \sqrt{\frac{\sum\left(d_i - \bar{d}\right)^2}{n}} \quad (2)$$

$$h = Z_{RTK\_GPS} - Z_{UAV} \quad (3)$$

$$RMSE_{Elevation} = \sqrt{\frac{\sum\left(h_i - \bar{h}\right)^2}{n}} \quad (4)$$

Table 1: Comparison of coordinates (X-Y-Z) obtained from UAV and RTK-GPS

Comparison obtained from UAV and RTK-GPS	Discrepancy of Coordination	Discrepancy of Elevation		
	Build – up	*Slope area*	*Hiking trails*	*Flat area*
Average	0.076	0.089	-0.096	0.014
Max of Discrepancy	0.124	0.428	0.126	0.156
Min of Discrepancy	0.009	-0.153	-0.259	-0.165
Root Mean Square Error	0.030	0.020	0.169	0.064

Conclusions:

- ✓ The accuracy of topographic map generated by Unmanned Aerial Vehicle (UAV) Imager compares to ground survey using Real Time Kinematic (RTK) which indicates the accuracy for X-Y coordinate is 0.076m ± 0.030m and Z coordinate is 0.096 m ± 0.169m.
- ✓ Using UAV technology to build topographic maps in difficult terrain such as mountain area in this study is very easy, without spending too much time and has a lower cost than classical technologies.

References:

1. https://www.dji.com/phantom-4-rtk
2. Nex, F., Remondino, F., 2014. UAV for 3D mapping applications: a review, *Appl. Geomatics*, 6, 1–15
3. Saari, H., Antila, T., Holmlund, C., Makynen, J., Ojala, K., Toivanen, H., Pellikka, I.,Tuominen, S., Pesonen, L., Heikkila, J., 2011. Unmanned aerial vehicle (UAV) operated spectral camera system for forest and agriculture applications. *In: Proceedings of SPIE*, 8174.