IS NEW BETTER?

SLOWLY BUT SURELY, UAVS ARE STARTING TO DOMINATE THE MAPPING MARKET IN THE CZECH REPUBLIC. AS A RESULT, IT HAS BECOME NECESSARY TO INDEPENDENTLY TEST THE RESULTS OF UAV SURVEYS, ESPECIALLY IN TERMS OF ACCURACY. JAKUB KARAS AND VÁCLAV SAFAR REPORT ON THE RESULTS OF A PROJECT TO COMPARE TRADITIONAL METHODS WITH DATA OBTAINED USING UAVS

Classic orthophotomaps have been used in the Czech Republic for a long time, in both the public and private sectors. The Czech Republic is split into two areas for mapping (West, East) and every two years, the Czech State Administration of Land Surveying and Cadastre produces new, classic orthophotomaps of the country at 25cm/px resolution, using mapping by airplanes and classic photogrammetry.

But for local orthophotomaps or mapping in high resolution and the creation of digital surface models for construction projects, such as roads and railways, unmanned aerial vehicles (UAVs) are better: at a resolution of 1cm/px, you can see almost everything. Orthophotomaps from UAVs can be used for making technical maps or updating them at the same or better accuracy, more quickly and more effectively than classic land survey. But it is important to know the accuracy of this data.

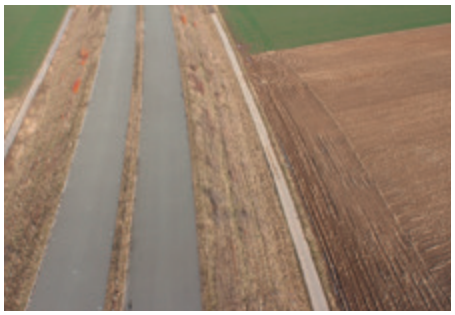
In combination, the Czech Research Institute of Geodesy, Topography and Cartography (VUGTK) and the UAV surveying company Upvision decided to test the positional accuracy of orthophotos and height accuracy of point clouds obtained from UAV surveys. Also important for precision mapping by UAV was to determine the number of ground control points needed and their location on the mapping area.

In 2013, VUGTK had created a test base on a stretch of the D11 highway in eastern Bohemia near Hradec Kralove. This part of the D11 had been closed for several years, as there was a problem continuing its construction – the state had not reached an agreement with the owner of one parcel of land along the route. However, construction resumed last year and the highway is expected to open in 2016.

The length of the test section was 1.5km and the highway was slightly curved. To the test base, VUGTK added 101 ground control points/checkpoints. These points were painted white and their positions and heights were measured by precise geodetic methods in the Czech coordinate system.

The tests

In May last year, the test base was used to test UAV accuracy. Upvision conducted test flights to determine the positional accuracy of ortho-



The test base with 101 checkpoints on highway in Czech Republic

Hexacopter with pilot and operator

A ground control point in situ and at 1cm/px resolution

Location of the ground control points

photos and the elevation accuracy of digital surface models. It used a calibrated Canon 700D camera with a 28mm lens installed on a hexacopter G6 built on a MikroKopter system. Base mapping was conducted in three flights, 40 minutes long in total. There was a light wind and the temperature was about 10°C.

The test location was imaged with a nominal 1cm/px image resolution. The location was imaged in three blocks in five series, with overlapping blocks. 1,235 images were acquired in a longitudinal image overlay of 80% and transverse overlap of 60%. UAV imaging was controlled online at the base station using a monitor and an orthophotomap was quickly generated in the lowest quality after landing.

After the flights, the data were analysed. One GCP was displayed by an average of 18 images. In photogrammetric calculations, 4, 6, 10 and 34 GCPs were successively manually measured. The GCPs were compiled and four orthophotos and four digital surface models (DSMs) were generated. All the points in which the variants were not GCPs were used as checkpoints (CPs).

The coordinates of the checkpoints of relevant variant orthophotos and DSMs were calculated by an independent expert. These were compared with their values from land surveying. The height accuracy of the point cloud from the DSM was also tested.

All calculations, orthophotomaps and DSM generation were done in Agisoft Photoscan Pro. Coordinates control were checked in Microstation V8i software. The results are in Table 1.

The results

The end result is that the positional accuracy orthophotomap is approximately twice the resolution of the scanned image resolution and 3-4 times the height accuracy of the scanned image resolution.

Accuracy is also affected by the quality, number and position of focus GCPs. For this test, the optimum number of control points relative to the articulation and the length of the area in the layout proved to be 10.

These results mean that the outputs can be used in applications that require high accuracy, such as classical land surveying, and to enhance technical maps, orthophotomaps, point clouds and 3D models.

This test is also the core of the project 'Precision mapping line constructions by UAV', which was awarded third place by the Czech Ministry of Transport in the Czech round of the European Satellite Navigation Competition 2014 (Galileo Masters). It has also initiated discussions in the Czech Republic about the use of UAVs by the public sector.

Another larger base is currently being constructed for the practical verification of practices and mapping accuracy in various sectors in the Czech Republic.

Tests of positional and height accuracy comparing photogrammetric methods that use classic cameras and UAVs are an important part of modern photogrammetry in the Czech Republic. These show that UAVs are a great alternative for mapping areas and line structures with high accuracy.

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Description variants (values are the mean error in Czech coordinate system in metres)			Root mean square error		Maximum			Minimum			Mean squared error (z)
			Y	X	Y	X	Z	Y	X	Z	
1	4 GCPs	96 CPs	1.014	0.080	1.664	0.107	3.753	-0.361	-0.173	-0.906	2.148
2	6 GCPs	94 CPs	0.041	0.041	0.113	-0.020	0.120	-0.020	-0.107	-0.113	0.038
3	10 GCPs	90 CPs	0.015	0.015	0.040	0.036	0.143	-0.035	-0.042	-0.094	0.039
4	33 GCPs	67 CPs	0.012	0.011	0.032	0.025	0.115	-0.014	-0.026	-0.093	0.035

Table 1. Results – height and positional accuracy (VUGTK)