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THE PRECISION OF ORTHOPHOTO MAPS MADE AFTER THE DRONE FLIGHT

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Abstract

The present paper consists in carrying out a study on precision in cadastral works by means of the comparison between orthophoto map and terrestrial measurements for a district in a locality in Brasov county.
For this study, terrestrial measurements were made using GNSS technology and photogrammetric measurements using Dji Phantom 4 with the help of which a series of images were taken and processed with special software resulting orthophoto of the studied area. Finally a statistical analysis was carried out, calculating a series of statistical indicators whose results provide information on the accuarcy between the measured elements and those resulting from the vectorization of the orthophoto map.

Keywords: *Dji Phantom 4, GNSS, orthophoto.*

INTRODUCTION

The purpose of this essay is to verify the accuracy of the orthophoto map resulted from the drone's flight, as compared to the terrestrial measurements made in a locality in Braşov County.
In order to achieve this goal , the following objectives were considered:
-Identification of land and the mapping base;
-Measurements made by terrestrial methods;
-Flying the drone and drawing the orthophoto map;
-Comparison between the orthophoto map and the terrestrial methods;
-Presentation of the results from the comparative analysis;

Figure 1. Image with the area studied

The studied area: a neighbourhood from Bunloc which belongs to Săcele, Braşov county. The surface resulting from measurements is 43718.539 sqm , in which a number of 8105 points was included.

MATERIALS AND METHODS

For this essay the following research methods were used :
a. RTK (Real Time Kinematic) Real time positioning with GNSS equipment for the GPS measurements, this being a modern alternative of the cinematic method, ensuring high accuracy, in short time and high economic efficiency;
b. Photogrammetic methods from which the cloud point and the orthophoto map have resulted , using the Dji Phantom 4 type drone with which data was taken over an area of approximately 5 hectares;
c. Mathematical statistics methods that compared the results obtained by the 2 methods mentioned above;

RESULTS AND DISCUSSION

As for the terrestrial measurements, 8105 points were positioned using the GPS Stonex S9 III. In fact, several steps were required to position these points. Firstly, with the help of satellites, the signals were collected by the permanent GPS station. In the second stage the calculation of the deducted corrections from the station coordinates and those transmitted by the ephemerides took place, resulting in spatial coordinates (x, y, z) by applying the corrections resulting from the initial measurements.

In order to achieve photogrammetric measurements, a number of 15 targets homogeneously on the whole surface of the studied field were materialized on the ground by photogrammetric surveys. After the ground targets were materialized, their coordinates were determined using GNSS technology. The Dji Phantom 4 drone was planned and set beforehand . The flight was made at an altitude of 80 m in conditions of maximum visibility, the drone was raised from target number 2. Seeing the entire land with the drone, what we are interested in is that from this action resulted a total of 381 photographs that have been processed with the 3D Survey software in order to obtain the orthophoto map of the studied area.

Figure 2. GPS Stonex S9

Figure 3. Dji Phantom 4

For the preparation of orthophoto map the following steps were taken:

-Creating a new project and import the photos;

-Calculation of orientation parameters of the camera;

-Achieve image orientation using Ground Control Points;

-Reconstruction of the cloud of points;

-Classification of points in the field;

-Calculation of digital terrain model(DSM);

Finally, following the steps mentioned above the orthophoto map resulted and was exported from 3D Survey and imported into AutoCAD Land 2009 and vectorised points. Thus, differences were made on x,y and directly for 465 points,410 segments and 77 surfaces.

Figure 4. Orthophoto of the studied area

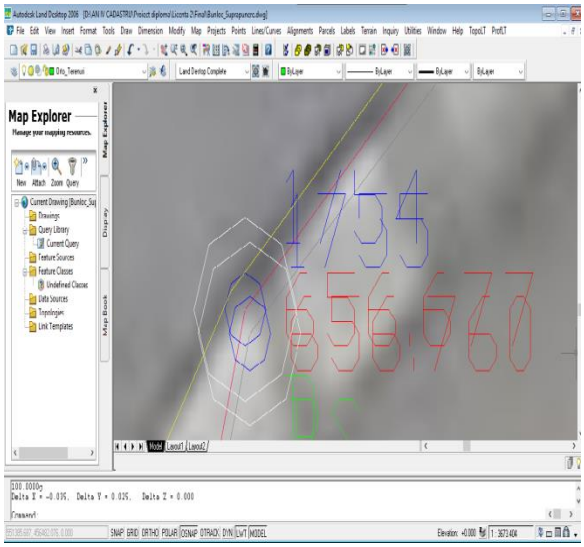

Figure 5. Calculation of the differences per x, per y and directly between the measured and vectorised point 1754

On based difference resulted between points, segments and surfaces of the measuring and orthophoto map were calculated a series of statistical indicators whose results can be seen in the tables below.

Table 1.The calculate statistical indicators for differences on the points

Differences	Mean (m)	Median (m)	Minim (m)	Maxim (m)
Δx	0.004	0.004	-0.160	0.123
Δy	-0.0003	0.001	-0.127	0.117
Δ direct	0.047	0.040	0.010	0.200

Table 2. The calculate statistical indicators for differences on the segments

Difference	Mean (m)	Median (m)	Minim (m)	Maxim (m)
Δx	0.014	0.001	-0.255	1.467
Δy	-0.019	-0.001	-1.906	0.457
Δ direct	-0.007	-0.010	-2.200	0.190

Table 3. The calculate statistical indicators for differences on the surfaces

Difference	Mean (m)	Median (m)	Minim (m)	Maxim (m)
Difference on surfaces	0.011	-0.220	-6.663	4.601

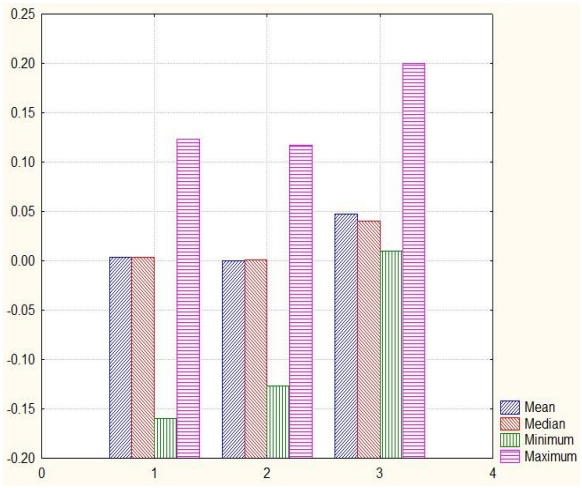

Figure 6. Distribution of arithmetic mean, median, minimum and maximum based on the points

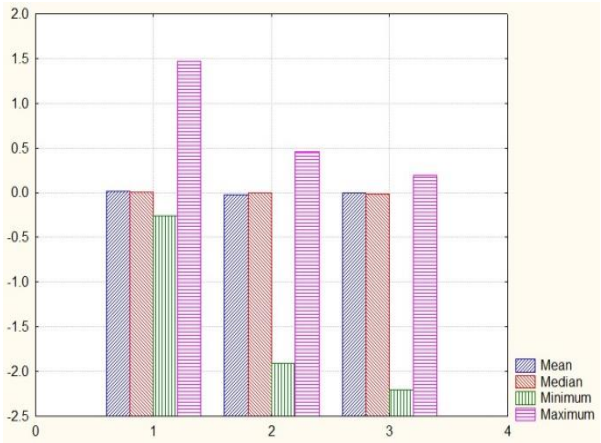

Figure 7. Distribution of arithmetic mean, median, minimum and maximum based on the segments

Figure 8. Distribution of arithmetic mean, median, minimum, maximum based on the surfaces

By interpreting the values in the figures presented above, it can be noticed that the positioning accuracy of the points is relatively good. Each of the above statistical indicators provides some information regarding the positioning accuracy of the points. For example, if we take into account the arithmetic mean value the best accuracy (-0.0003) occurs in the case of y differences and the worst accuracy (-0.047) occurs in the case of the resulting direct differences. In the case of segment differences in terms of median value, the best accuracy (-0.010) occurs at the measured difference directly and the worst accuracy (0,001) occurs in the case of x differences.

CONCLUSIONS

In conclusion, within this essay was presented the applicability of UAV (Unmanned Aerial Vehicle) technology in cadastral work making a comparative analysis between orthophoto map and terrestrial measurements. It can be noticed that the differences between the two measuring technologies: Dji Phantom 4 drone and the Stonex S9 III GPS are small registering on average a difference of:0.04 m per x , -0.0003 per y and 0.04 m on the direct distance within the points difference. For segments an average of 0.014 m per x , -0.019 per y and -0.007 on the direct distance was obtained.

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