ACQUIRING AND PROCESSING OF FIELD INFORMATION BASED ON UAV, GNSS AND GIS TECHNOLOGIES

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***Abstract**: The present work consists in taking photogrammetric images with the help of the drones, making their mosaic and georeferencing of the orthophotoplan resulting in the national stereographic projection system 1970. The flight took place at the University of Agricultural Sciences and Veterinary Medicine of Banat, King Mihai I of Romania, in Timisoara. Also, 15 targets were measured in the 1970 stereographic projection, based on GNSS technology. To achieve these objectives, the following equipment was used: PHANTOM 4 ADVANCED drones, GPS GS08, the 15 targets as well as the ArcGIS, PIX4D, SKYCATCH (iOS) data processing software's.*

***Keywords:** drone, GNSS, GIS, photogrammetry, UAV*

1. Introduction

If classical photogrammetry deals with the determination in time and space of fixed, mobile or deformable objects and their photographic, graphic or numerical representation (by coordinates) based on special photographs called photograms [1], [2], UAV photogrammetry is an alternative method to classical photogrammetry, which deals with the airborne registration of terrestrial data from small and medium heights. With UAV technology, data can be obtained from a large surface area in short time, including hard-to-reach areas [3], [4] or inaccessible land access safely.

The purpose of this paper is to present a modern alternative [5] to the classical topography. This is much faster and more accurate in both accessible places and areas with unsafe conditions for the human factor. At the same time, this method offers the possibility of collecting a much larger number of field details at the same time, compared to an ordinary measurer. The research carried out in this paper was conducted within the BUASVM Timişoara [6].

Fig.1. Google Earth image of BUASVM Timisoara Campus

2. Materials and Methods

The drone used by us in this project was PHANTOM 4 ADVANCED (www.dji.com), incorporating GPS and GLONASS. Based on the images taken, a mosaic was made to obtain an orthophotoplan [7], [8].

The digital orthophotomap is a scale aerofotogrammetric product that represents photographic part of the terrestrial surface. The images taken with the drones are in the WGS 1984 system, which is why georeferentiation of the orthophotoplan resulted in Stereographic System 1970 [9] was needed. This georeferencing [10] is based on control points [11] (Ground Control Points - GCP), measured on the ground and found in the images taken from the drones. For this purpose, 15 targets were used, located on the ground on the whole area of interest. These targets were measured using GNSS technology, with GPS LEICA GS 08plus instrument.

Fig. 2. PHANTOM 4 Drone

Fig. 3. Target model

Fig. 4. GNSS System

Also, the following software was used to process the purchased data:

- SKYCATCH – for flight planning with drones;
- PIX4D – for image processing in drones and creation of orthophotoplan (www.pix4d.com);
- Leica GeoOffice – for processing GNSS measurements of ground targets;
- ArcGIS – for georeferencing, based on measured GPS points, of the resulting orthophotoplan.

3. Results and Discussion

Initially, land survey and recognition was carried out, and then we set the 15 ground targets, targets georeferencing (using ArcGIS software) in the 1970 stereographic national projection system of photogrammetric images, resulting images following the drones flight. Thus they were determined by the coordinates of the 15 ground reference targets based on GNSS technology using the GPS LEICA GS08plus system by connecting with the permanent ROMPOS station system. The data determined with the GPS has been downloaded and processed with the Leica Geo Office Combined software v. 8.4.

Fig. 5. Processing of GPS observations with Leica Geo Office software

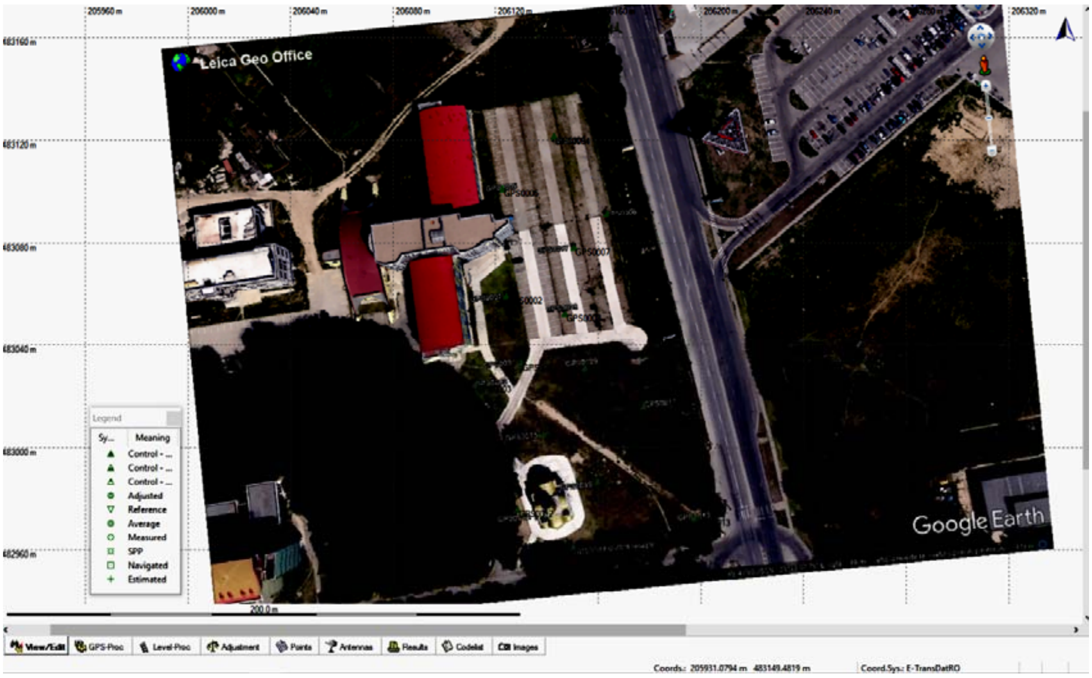

Fig. 6. Representation of GNSS observations

The drone used was PHANTOM 4 ADVANCED, having a camera (with a 4K video capture capability and 12 megapixel images, the image quality being influenced by the camcorder's sensor, the optical parameters of the lens used, and the aerofoil platform's stability), GNSS, GPS and GLONASS positioning (enabling image acquisition in the WGS 1984 system), propeller, intelligent battery, obstruction detection system.

The maximum flight altitude of the drones is up to 3 km, our flight being at an altitude of 80 m. The flight was made at this altitude because the lower the flight height, the better the clarity of the images. At this altitude, a total of 51 photos were taken, all passing the quality test. Aerophotography was made when the sun's elevation angle was greater than 25 degrees, about 12 PM. The flight took place in conditions of maximum visibility that did not affect the rendering of natural colours existing on the field. These relevant details have not been omitted because the map obtained does not show clouds or shadows. The drone was picked up from target number 1. Absolute orientation of the images needed photogrammetry. The drone is maneuverer with the remote. The drone is attached to the mobile phone or tablet, making a connection between them via a USB cable. Once the mobile phone has been attached and connected, the SKYCATCH (iOS) application was used to make the flight plan and accurately track the drone flight in real time. Thus, the operator can guide the drone to the left or right side respectively, or change the inclination of the camera to obtain the desired results.

Fig. 7. The mission plan of flight

The route that the drone follows was planned and settled in advance, not following the route set by the operator. The drone went straight lines to acquire photogrammetric images that overlap 60% +/- 5% longitudinally and 30% +/- 5% transversally to ensure increased accuracy and 3D model creation. In the overrun, the drone captured all 15 landmarks that were then usable for georeferencing aerofotogrammetric images. We calculated the flight height according to the scale the orthophoplan had to be done. The height must be constant, once set, it must be kept until the end of the flight, otherwise there will be errors in data and the orthophotoplan processing.

After the entire surface was reached, and the flight was completed, the drone returned to the point where it left to start the flight. The resulted images and mosaic were processed with the PIX4D software, specifically processing the data acquired from the drones, resulting in an orthophotoplan of the area of interest.

In order to be able to use such products in practical cadastral works or to perform various spatial analyses, correlating the data obtained from the workings carried out, it is necessary to georeference the orthophotoplan resulted in the Stereographic Projection System 1970. This was done using the package of ESRI ArcGIS programs, using as the ground control points (GCP) and the satellite observations made during the first stage of the research.

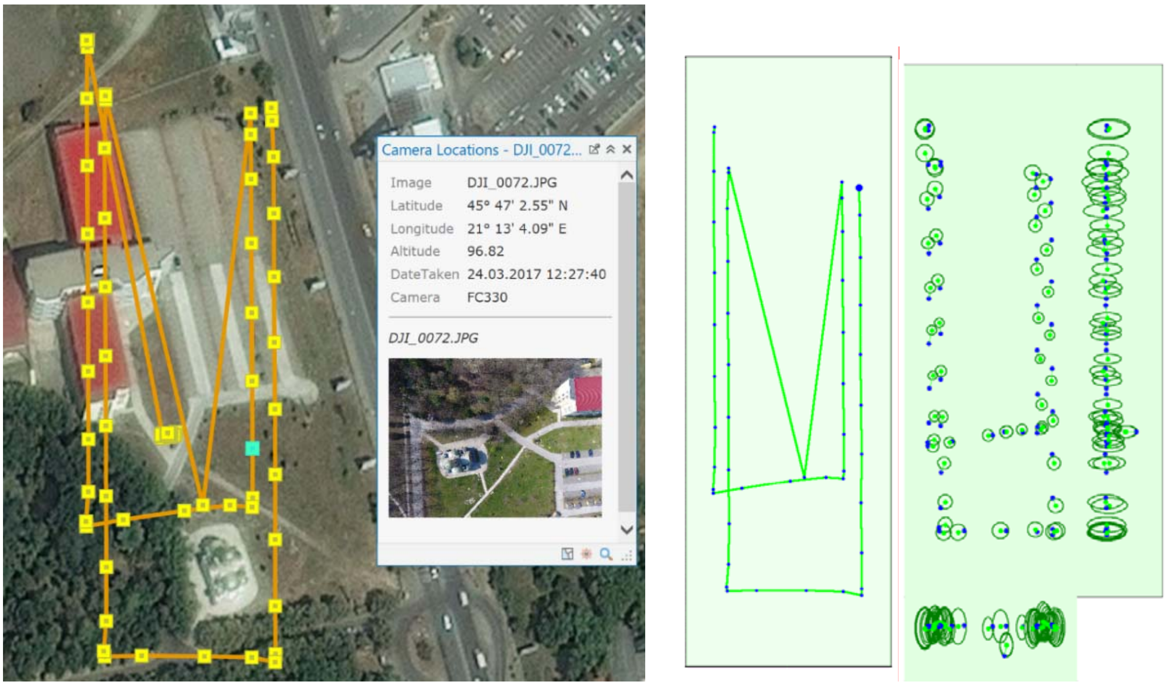

Fig. 8. The GPS position of the images

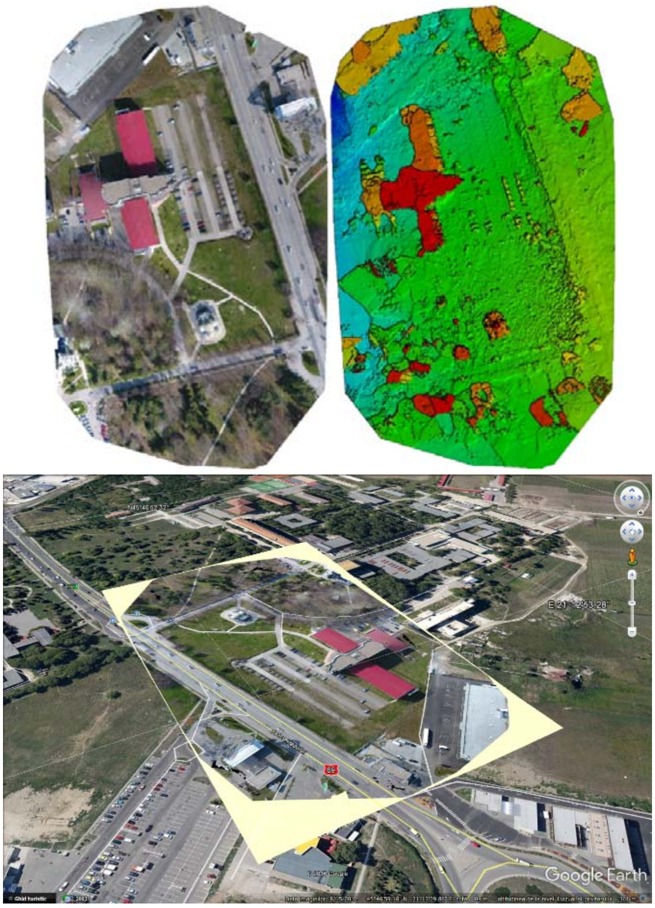

Fig. 9. The resulted Orthophotoplan (WGS 84), digital terrain model and the Google Earth view

Fig. 10. The georeferenced orthophotoplan (Stereographic 1970 projection)

4. Conclusions

The UAV (Unmanned Aerial Vehicle) technology consists of a small, pilot-sized (drone) aircraft equipped with special sensors that can collect data from a flight that can be applied in various areas of interest. In conclusion, the paper presented wants to demonstrate the benefits of using UAV technology in topography, cadastre, GIS, etc. This technology comes in support of specialists in various fields of activity such as public administration, environmental protection, inspections, agriculture, cadastre, transport, energy, public security and national security.

5. References

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