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USE OF UNMANNED AERIAL VEHICLES WHEN PERFORMING TOPOGRAPHIC SURVEYS

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The article discusses the possibility of using unmanned aerial vehicle when performing topographic survey, data processing and accuracy. Current work is based on a practically obtained data.

Introduction. One of the most popular tasks conducted in geodesy is topographic survey and drawing up a detailed plan of the area. Such methods as tacheometry, satellite positioning in RTK mode, airplane-based surveying as well as airborne laser scanning are widely used for topographic surveying nowadays. On the other hand aerial survey using an unmanned aerial vehicle (UAV) has become a worthy alternative to the traditional aerial survey from airplanes and helicopters, and in a number of cases even ground survey.

The aim of the work is to study the UAV data treatment process using Trimble INPHO UASMaster software and to analyze the possibility of using UAVs in engineering and geodetic surveys based on practically obtained data.

Among the main advantages of UAV-based surveying compared to airplane-based one are: reduction of surveying time, less expensive cameras and other equipment, convenience of transportation of aircraft, easiness of operation and route laying, objectivity and accuracy of the results, high level of details, easiness of analysis and data perception, efficiency (the whole cycle from surveying until the final results takes several hours), environmental safety, etc. An important advantage of survey using UAV compared to satellite positioning systems in RTK mode or tachometry is efficiency for surveying of poorly built and sparsely populated areas [1, 2]. UAV-based surveying has also such limitations as weather and season dependence. But these factors significantly affect other methods of surveying as well.

As for the scale range the author [3] says that UAV-based survey is limited to the scale range 1: 5000 - 1: 1000. Since the surveying at the scale smaller than 1: 5000 is more efficient when conducted using satellite images and the surveying at the scale larger than 1: 1000 is to be combined with ground-based methods.

Methods and results. In order to go through the UAV data treatment and analysis process for the purposes of the current work 60 JPEG images obtained by a quadrocopter DJI Mavic Pro over the territory of "new building" of the Polotsk State University in Novopolotsk were used. UAV carried out a remote-controlled flight by an operator. Data set consists of 4 routes.

UAV data processing for the purpose of topography is quite a new field. But the manufacturers aimed at the development of its UAV complex are interested in creating software that is capable of solving the tasks. One of the world leaders in the UAV market is the company Trimble which is a worldwide known manufacturer of geodetic equipment as well. It also develops software Trimble INPHO UASMaster for photogrammetric processing of UAV data. The software offers a streamlined batch processing and various editing tools. UASMaster is bridging the gap between simple black-box workflows for non-photogrammetrists and photogrammetric expert workflows [4]. Among other software in the field of UAV data processing are ENVI OneButton, PHOTOMOD UAS, Agisoft PhotoScan, etc.

The general data processing sequence in the Trimble UAS Master is represented by the following main steps:

- data preparation and project setup;
- phototriangulation including extracting tie points, camera calibration, report creation;
- extraction of Digital Elevation Model (DEM): creating point cloud, editing the point cloud,
- creation of orthophoto.

As a result, 2523 tie points were automatically acquied for 60 images in UASMaster.

In total, 5 ground control points and 22 check points were used in the work. Their coordinates were obtained in field within some other student's work and accuracy of coordinates is not matter of current research. Ground control points are determined on one of the images and software automatically locate it on all the images where point appears. Then it remains to clarify its position. It is enough to measure point on 3 images.

At the next step point cloud is generated. Automatically generated point cloud has gaps which appeared in places of weak overlaps of images, areas covered with tree-shrub vegetation. Gaps in the point cloud are shown in Figure. Such gaps may be edited manually if needed. The final result of data processing is an orthophoto.

As a result of processing in Trimble INPHO UASMaster phototriangulation including the tie points extraction, camera calibration, point cloud and orthophoto generation are performed. Assessment of orthophoto is performed by ground control and check points.

Discussion and conclusion. Visual analysis of the orthophoto shows a high-quality imaging result. The boundaries of the building, lawns, asphalt roads and a training car site located in the area are clearly visible.

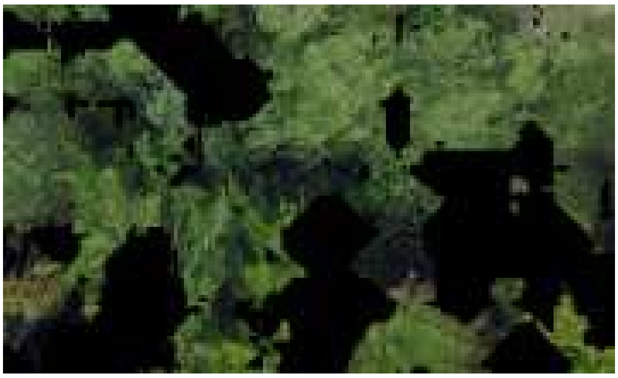

Figure. – Gaps in point cloud

Trimble INPHO UASMaster is photogrammetric software capable of processing data from various cameras. But software is quite sensitive to data features. For example, there was a problem of single camera definition for all 4 routes. The program has produced an error without mentioning the reason for the refusal for data processing, what caused some difficulties to find out the source of the error. On the other hand it helped to discover the errors within the data acquisition process. In general, it can be noted that UASMaster is a powerful software in the field of photogrammetric processing of data from UAVs.

Root mean square (RMS) errors in planned positions of check points used for orthophoto accuracy assessment have shown that it fits in general to the requirements of 1:1 000 according to surveying requirements. RMS error of vertical position was not tested. On the other hand coordinates of ground control as well as check points which were obtained within another work and their reliability must be checked as well before making final conclusion.

Nowadays, the development of the civilian UAV market, including its development for the needs of aerial photography, suffers from the lack of legal framework for the integration of UAVs into a single airspace. Unfortunately the problem of legal regulation of wider civil use of UAV nowadays is not solved completely in almost any country of the world.

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