

DJI Matrice 300RTK Topography Mapping for Khojикent PSPP, Uzbekistan

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Abstract. The purpose of the work is to create topographic plans on a scale of 1:1000 for the construction of the Khojикent pumped storage power station, which will be located on both sides of the Chirchik River next to the Khojикent Hydroelectric Power Station in the Tashkent region of the Republic of Uzbekistan. In order to display the territory as accurately as possible and obtain digital cartographic materials for it, at this object, the marking of plan-elevation markers and their binding are first carried out. The identification of identification marks (IPO) was carried out from the surviving points of the geodetic network using the GPS measurement method (fast statics - RTK - mode). Unmanned aerial photography was carried out with longitudinal and transverse overlap of 70% on a scale of 1:500, at an altitude of 200 meters with a digital camera with four sensors - H20T, installed on a DJI MATRICE 300 RTK unmanned aerial vehicle. Processing of unmanned aerial photography materials was carried out in the Agisoft Metashape photogrammetric complex based on materials which digital topographic plans were created in AutoCAD software for the territory designed for the construction of the Khojикent pumped storage power station.

1 Introduction

Today, the creation of any digital cartographic products using unmanned aerial photography has become a pressing issue for all topographic and geodetic production both throughout the world and in Uzbekistan as a whole [1-4].

Unmanned aerial vehicles allow you to create maps, plans, orthophotos, elevation matrices, 3D models in the shortest possible time, with high quality [5, 6], using specially created photogrammetric software products for processing unmanned aerial photography [7-10]. Currently, having digital technologies, the need for analog methods for creating maps, plans and any other cartographic products has completely and irrevocably disappeared [11]. The era of digital technologies and digital revolutions has arrived not only in topography, cartography, GIS technologies, but also in many sectors of the national economy.

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2 Materials and research methods

This paper discusses the technology for creating topographic plans on a scale of 1:1000 to solve the problems of constructing the country's first pumped storage power plant near the Khojikent hydroelectric station using a DJI Matrice 300 RTK quadcopter.

The work area is located 80 km from Tashkent along the R12 highway, next to the Khojikent hydroelectric power station, on the Chirchik River in the Bostanlyk district of the Tashkent region of the Republic of Uzbekistan. Figure 1 shows the location of the future object.

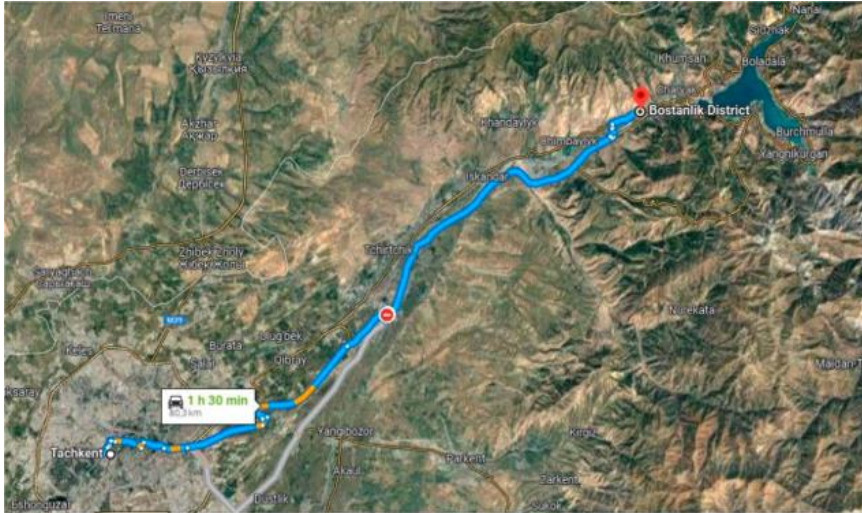


Fig. 1. Location of the future object.

Below, Figures 2 and 3 show the locations of the future pumped storage power plant on both sides of the Chirchik River.



Fig. 2. Site on the right bank of the Chirchik River.



Fig. 3. Site on the left bank of the Chirchik River.

Since the planned pumped storage power plant will be built for the first time in Uzbekistan, its purpose will be determined by the production of electricity to cover morning and evening energy needs and the use of nighttime excess energy. At night, the station receives cheap electricity and uses it to pump water using pumping mode into the upper reservoir. And during the evening and morning peak electricity consumption, the station discharges water from the upper reservoir into the lower one, generating expensive peak electricity, which it sends to the power grid. The construction of pumped storage power plants shows that they are not only a generating source, but also a source of providing system services that contribute to both optimizing the daily load schedule and increasing the reliability and quality of power supply [12].

To carry out the planned work in the study area, a DJI MATRICE 300RTK quadcopter was used (Figure 4).



Fig. 4. Appearance of the DJI Matrice 300 RTK quadcopter.

DJI Matrice 300 RTK is a commercial flight platform, industrial drone with a flight time of up to 55 minutes, 6-way positioning, obstacle detection/avoidance and a modular design with 3 configuration options. The drone is capable of rising to a height of up to 7 km with a

take-off speed of up to 23 m/sec. It sets a completely new standard, combining intelligence with high performance and unrivaled reliability [11]. If flights are carried out near objects with a high level of interference, the system automatically switches between 2.4 GHz and 5.8 GHz frequency channels. At the same time, a high level of security during data transmission is maintained thanks to the AES-256 encryption system. The quadcopter is equipped not only with dual vision sensors, but also with time-of-flight sensors, which guarantees a maximum level of obstacle detection in a range of up to 40 m. In addition, you can adjust the sensitivity of the quadcopter sensors using the DJI Pilot application [1, 2, 11, 13]. This model also implements a redundancy system, where key modules responsible for flight stability and safety are duplicated, so that in difficult situations the operator can continue the flight mission or safely complete the flight and land the drone without incident.

3 Research results and discussion

To carry out aerial photography using UAVs, preparatory work was carried out on marking plan-altitude markers, their placement in a given territory and their plan-altitude reference [9]. Plan-altitude reference of reference points was carried out from the surviving points of the geodetic network using GPS measurements (fast statics - RTK - mode) [7, 14]. A total of 24 plan-height points were identified at the site (Figure 5).

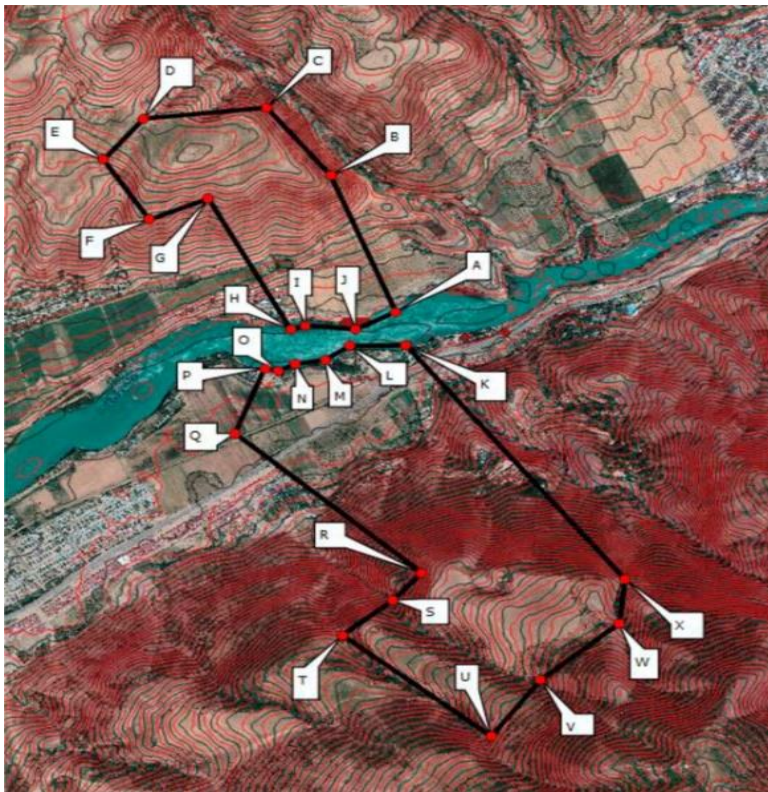


Fig. 5. Reference points in two areas with elevation contours (red color is an isoline of 5 m; black is an isoline every 10 m).

For the purpose of creating topographic plans on a scale of 1:1000 for the territory of the Khojikent pumped storage power plant, aerial photography was carried out by an unmanned aerial vehicle on a scale of 1:500 at an altitude of 200 meters using a Matrice 300 RTK unmanned aerial vehicle [4,7] with longitudinal and transverse overlap of 70%, respectively. The location of the aerial routes is shown in Figures 6 and 7. 16 aerial routes were made on the right bank of the reservoir, and 25 on the left bank (Figure 6). The area of the right plot was 1,015,133 sq.m., and the area of the left plot was 2,321,773 sq.m.

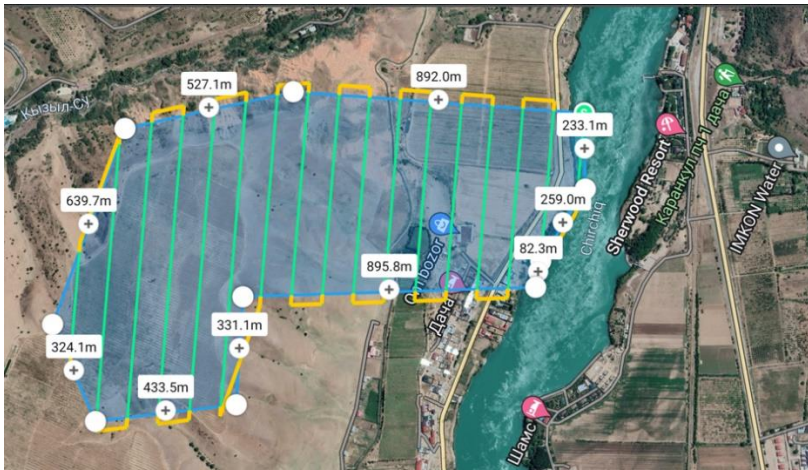


Fig. 6. Image of air routes on the right section.

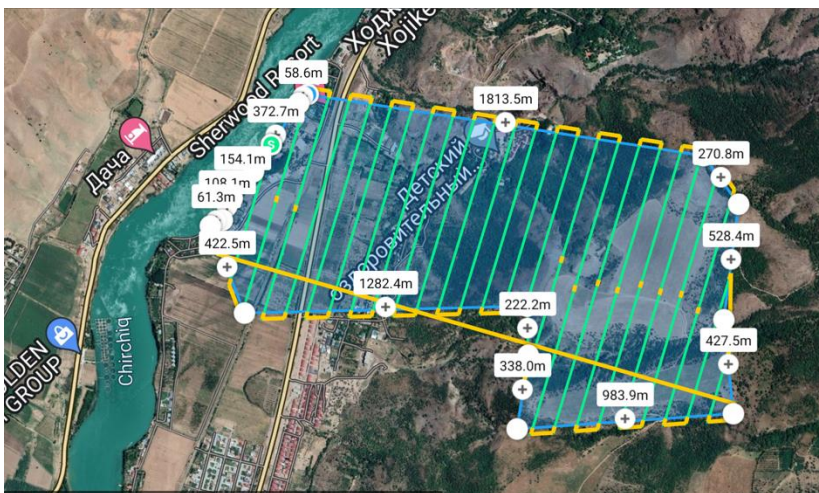


Fig. 7. Image of air routes on the left section.

Photogrammetric linking of aerial photography materials was carried out in the photogrammetric software package Agisoft Metashapex [10], from which topographic plans were created at a scale of 1:1000 using AutoCAD software. In total, 35 topographic plans were created at a scale of 1:1000 for this site, of which were created for the right section, and 21 for the left section. Below in Figure 8 is one of the fragments of the created topographic plan for the territory of the Khojikent PSPP, and Figure 9 shows compiled and stitched

topoplans for the entire territory designed for the construction of the Khojikent pumped storage power plant.

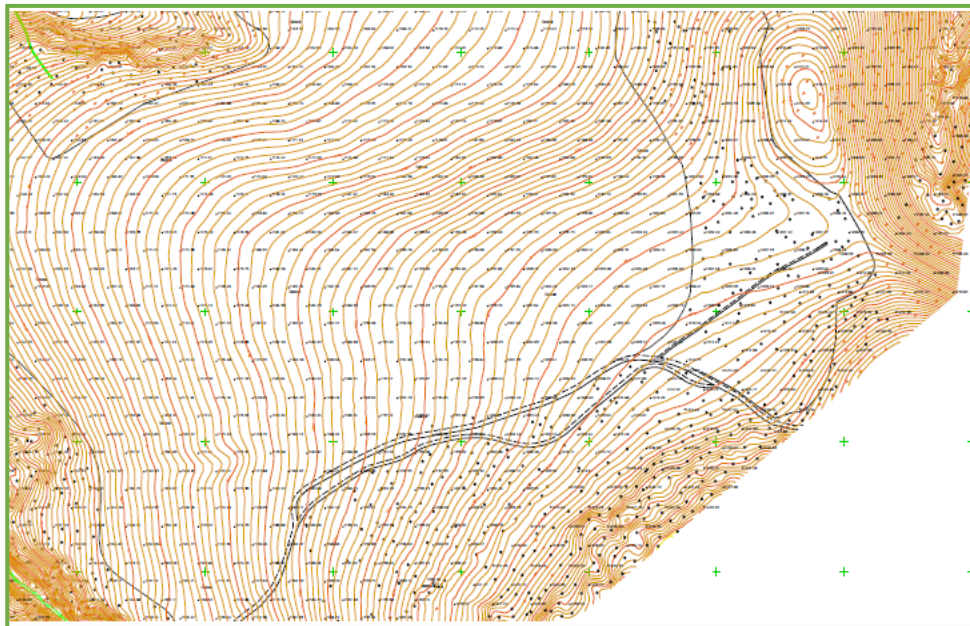


Fig. 8. Fragment of a topoplan created on a scale of 1:1000 for the territory of the Khojikent pumped storage power plant.

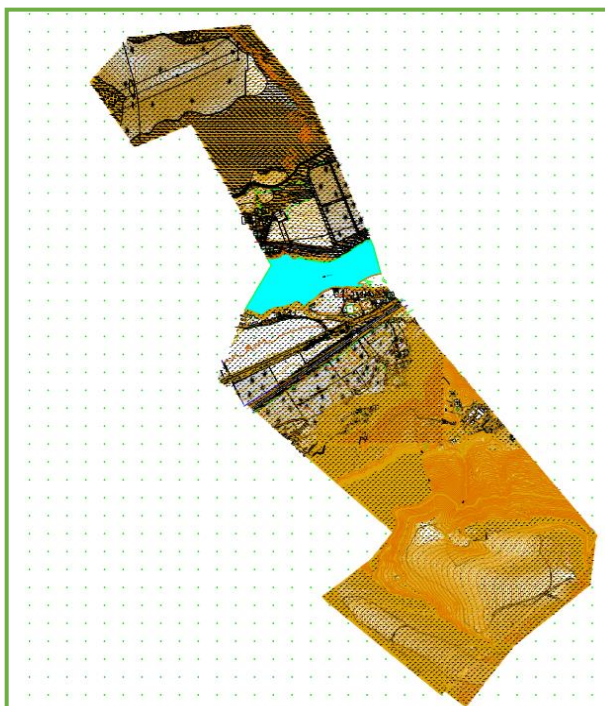


Fig. 9. Image of the right and left sections of the territory of the Khojikent PSPP, covered with topoplans at a scale of 1:1000.

4 Conclusions

This work examined the technology for creating topographic plans on a scale of 1:1000 to solve the problems of constructing the country's first pumped storage power plant near the Khojикent hydroelectric power station using a DJI Matrice 300 RTK quadcopter and related software products for processing aerial photography materials. Based on the results of the work performed for the construction of the Khojикent PSPP, we can conclude that the use of unmanned aerial vehicles, as in our case, the Matrice 300 RTK quadcopter, which is DJI's best industrial professional drone today, provides high performance and efficiency of work performed. The Matrice 300 RTK drone is a full-fledged aircraft. It can spend up to 55 minutes in the air and accelerate to 83 km/h, and can withstand temperatures from –20 to 50 °C and wind gusts of up to 15 m/s. The creation of topographic plans for the territory for the construction of the Khojикent pumped storage power plant using such equipment and digital photogrammetric products allows us to accurately assess the nature of work at this site based on the location of existing situational objects and the complexity of the terrain in a fairly short time.

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