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RESEARCH AND EXPERIENCE OF APPLICATION OF SOFTWARE IN AUTOMATED CONSTRUCTION OF 3D TERRAIN MODEL FOR CADASTRE PURPOSES

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Abstract. Currently, the process of design automation is rapidly taking place, where constant research and use of the latest software tools is necessary. The development of information technologies in the field of cadastral activities allows us to effectively solve the tasks in the shortest possible time. In the modern world, there is a process of gradual transition from traditional design tools to more automated ones**.** Within the framework of this work, a study was carried out using software tools for the automated construction of a 3D terrain model. The article provides an overview of the software and the choice of the most automated and productive for the purposes of the cadastre. On the example of the Tashkent region, Agisoft PhotoScan software is used, a 3D terrain model and an orthophoto map are built, after which an analysis is made of the effectiveness of using this product for the purposes of conducting cadastral activities. In the process of work, the assigned tasks were solved using graphical, statistical, computational-graphical, analytical methods. In the process of work, the assigned tasks were solved using graphical, statistical, computational-graphical, analytical methods.

1. Introduction

The use of software functionality, followed by the development of stages for the gradual expansion and use in practical applications, is an important stage of the study. A competent approach to the choice of modern software allows you to fully increase labor productivity, timely completion of tasks and improve the quality of the result, which shows a practical significance in the processes of computer-aided design, this determines the relevance of the study.

It is impossible not to notice that today a large amount of work related to updating topographic maps, designing new objects and surveying existing ones is increasing, they require a lot of time, but with the rational use of modern technologies, material and labor resources can be reduced. The classical approach to solving design problems and obtaining results is gradually becoming an outdated approach to achieving the set goals, which allows a person to bring the implementation of solutions to a new level with the help of electronic computers using software. To reduce the resources expended, these operations make it possible to switch to automated processes and the creation of mathematical models, with subsequent use in land management and cadastral activities.

A person is given the choice of using a modern computer with the use of design automation software, which allows solving managerial and environmental problems, reducing the cost of production resources and technological means, for the most part saving human time and effort. Today, a gradual transition is being made from the standard display of the situation in the modern world on a topographic map to the construction of a digital terrain model, using modern software and equipment, the involvement and use of which in this area is becoming an actual topic and is of great importance. Moreover, their subsequent application helps in large quantities to solve the processes of design, land monitoring, cadastral activities, geodesy and engineering construction.

The purpose of this study is to study and apply the Agisoft Photoscan automation software for automated construction of a 3D terrain model to improve the efficiency of industrial production of a geographic information system.

The subject of this submitted work is the study and application of the Agisoft Photoscan software tool, which enhances the production and creation of a quality product, with использованием наименьшего the amount of time and labor costs, and the improvement of a stable system for storing and processing information in software.

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The work presented in the article acts as the result of research in the field of constructions and a phased transition to functional and automated technologies for creating digital maps, as well as successful research and application of software in the automated construction of a 3D terrain model for the purposes of the cadastre. The developed approaches to solving the problem make it possible to see a significant increase in labor productivity, optimize management processes, and improve the quality of the products obtained. Thus, it is possible to express the scientific novelty of this work.

To the greatest extent, labor-intensive tasks require increased productivity, the use of affordable software and hardware. The decisions made by the results of the study help to see the correspondence of the characteristic composition of the digital map to the original, and the fidelity in the process of transferring the attributive and geometric characteristics of the objects of the territory. Reliability of the conclusions and proposals made is confirmed by the study and application of the results of the proposed software tool, which is also relevant for cadastral work.

2. Materials and methods

Creating a textured 3D model of an object takes place in three stages:

1. Determining the positions of the parameters of the external and internal orientation of the cameras. That is, the process of finding all common points in the images and determining the parameters of the cameras (orientation, position, etc.) takes place. As a result, first a sparse point cloud is obtained, then a dense point cloud in 3D space.

2. Next, the object geometry is restored, that is, a three-dimensional polygonal model is created with texture restoration. It is also possible to export the model for further work in a third-party editor..

3. Building an orthophotomap. It is built on the basis of the obtained dense point cloud. Use the original photographs to obtain a higher image image - a 3D terrain model. Orthomosaic can be exported for further work in programs such as AutoCAD, Credo DAT, and other editors.

Agisoft PhotoScan was chosen. The program is used on any personal computer, is automated and performs photogrammetric processing of materials obtained during aerial photography. With the help of this software, it is possible to process any digital photos and get the following output:

- Cloud of terrain points;
- Surface with detailed detailed information in the form of TIN or GRID model;
- 3D models of objects based on original images;
- Orthophotomaps that can meet the required accuracy

topographic plans up to 1:500 scale.

The process of creating this terrain model can be defined specifically in two stages:

1. Photographing an object of the area.

2. Generation and texturing of the 3D model.

The object of study is a site located in the Tashkent region. The selected area requires shooting from a height, in which case a special device is selected - a quadrocopter.

With its help, you can shoot any structure, the device has a flight range of up to several tens of kilometers. But these criteria depend on the type, quality and price of the selected unmanned aerial vehicle. To create an orthophotomap and a 3D terrain model, a collection of

information, the study of materials available to us, the location of objects in the area. The information we study includes object coordinates, characteristics, and descriptive data.

A special route is formed for the flight of an unmanned aerial vehicle, which is executed by a program that is part of the complex - this is a flight path planner

. The route provides coverage of the polygon of interest to us. On the map, which is provided for the selected area, the contour of the survey area and the approximate start of the survey are set, and the overlap and resolution are also assigned and built. The program helps us plan the flight and monitors the quality of execution.

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Reference marks are laid during the execution of the survey on the territory of the survey. This sign is geodesic and represents itself as a mark of a certain nature, in this case a cross painted with paint. The coordinates of each mark are recorded in the records and, of course, calculated using a GPS receiver.После сбора необходимой информации были произведены работы с камеральной обработкой данных для subsequent acquisition of a digital terrain model. The area of this territory is 7.81 hectares. The average flight altitude was 100 m and the area to be filmed was 0.0692 km2. As a result, 325 images were obtained.

First of all, photos are loaded, the process of specifying their location takes place in the program, and not the actual loading of digital images into the project. Where image files are required, they are used in these data processing steps.

After loading the photos into the program, we can observe the UAV flight path presented as dots (Fig. 1).

The pictures were saved in (.JPG) format and had the same width and height. The quality and processing time of the resulting model depends on what size is presented to us. Data processing: only joint processing of all images was used - batch.

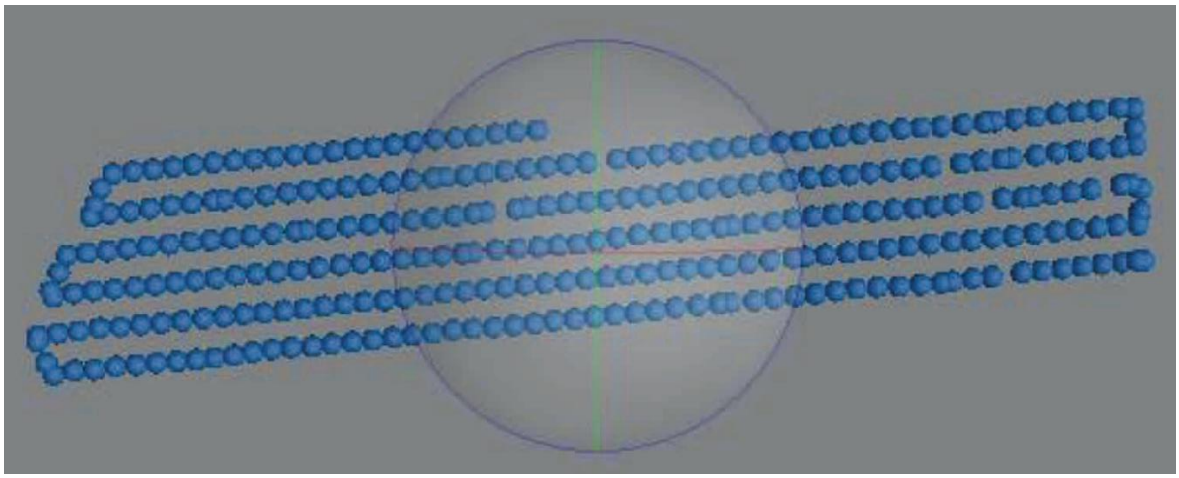

Figure 1. Image of the flight path of an unmanned aerial vehicle and the position of images in the form of points

At this stage, the following operations were performed:

1. A point model of the surveyed area is formed;
2. The program determined the points inherent in photographs;
3. A search was made for relationships between points;
4. The parameter of relative orientation of images is determined.

Building a point cloud

At this stage of processing, we perform the photo alignment procedure. It is necessary to determine the orientation and position of the cameras for each frame we have and subsequently build a sparse point cloud.

The alignment stage includes the following characteristic parameters:

1. Accuracy;
2. Pair preselection;
3. The maximum number of points.

Upon completion, the following results are obtained:

- Sparse cloud of common points (Fig. 2);
- Parameters for determining the position and orientation of images;
- Camera calibration options.

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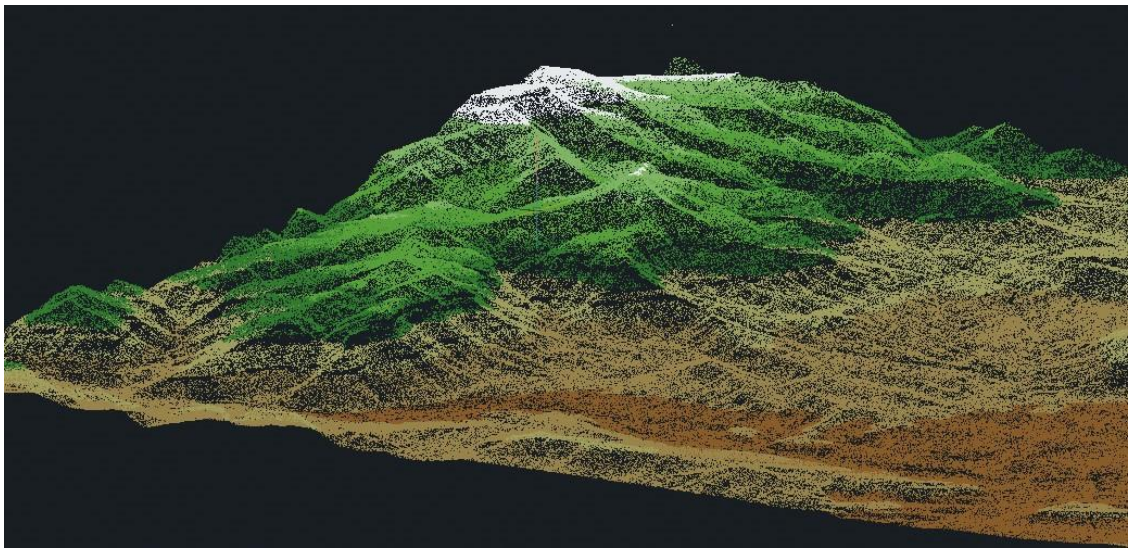

Figure 2. Sparse point terrain model, consisting of a cloud of common points

Building a dense point cloud

At the next stage, we loaded the reference signs - markers, and searched for these markers in the photographs, followed by their placement on the survey justification points.

Reference marks are necessary to increase the efficiency of the results of calculating the positions of cameras and parameters of their interior orientation. We load the catalog of coordinates, previously prepared. This process was done by hand.

The brighter the image was, that is, the weather conditions were favorable for shooting, the better the reference marks themselves were visible. If the marker position was set on three or four images, then Agisoft PhotoScan automatically sets their location on other images where they could be present (Fig. 3).

The Agisoft PhotoScan program has built-in functions - a contour selection tool, for this we zoom in on the image and select the object of interest to us along the contour and add a selection. This procedure is repeated for each image, where there are secondary superfluous elements to exclude them from further processing.

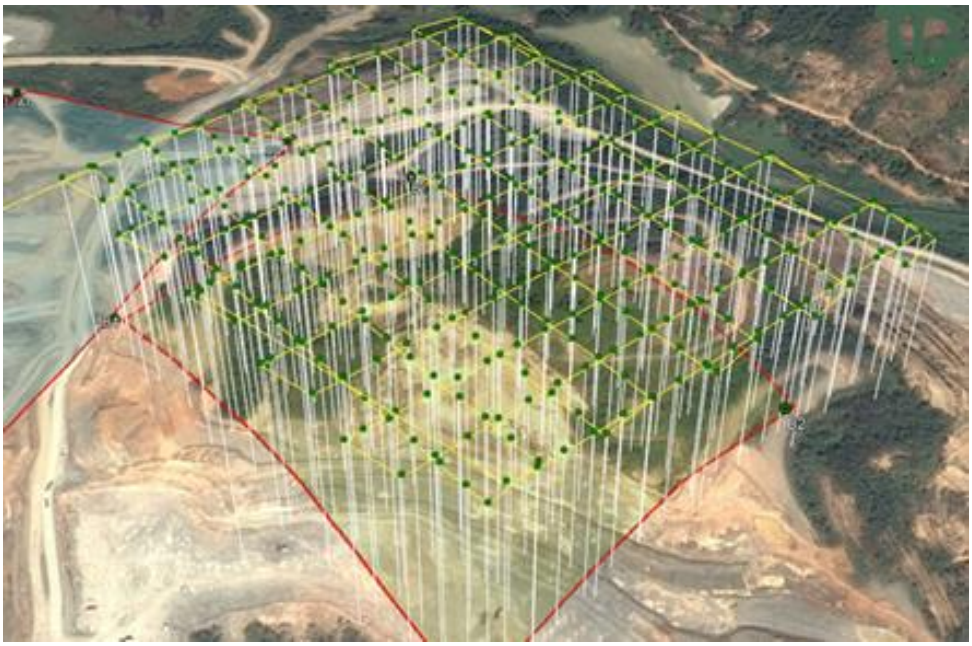

Figure 3. Setting anchor point labels

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Building a polygonal model and creating a height map.

After creating a dense point cloud (Fig. 4), it is possible to construct a three-dimensional polygonal modelFig. 5).

Figure 4. Constructed dense point cloud of photographs obtained during shooting from a quadrocopter in the Agisoft PhotoScan program

To build a more realistic model, the next step was to build a texture and create a height map in an automated mode (Fig. 6). For thematic mapping, it is favorable to present a height map in the form of a gradient fill, for a visual representation of the altitudinal position of points in a given area.

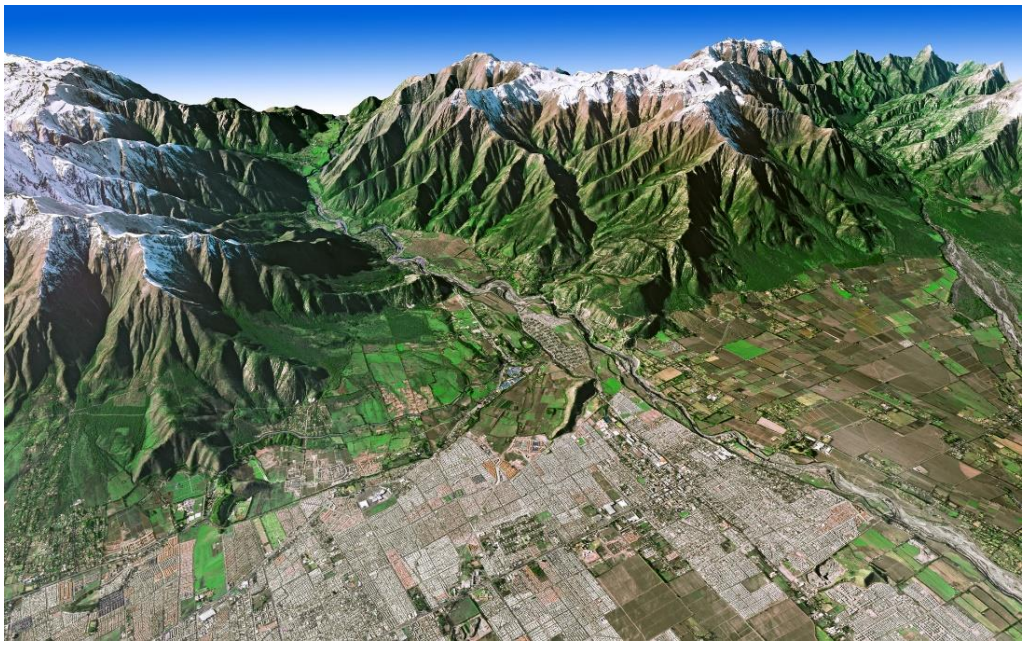

Figure 5. Three-dimensional polygonal model.

The process of orthomosaic creation in Agisoft Photoscan is automated. For export use the most convenient TIFF format. This format contains both the image itself and its georeference. Next, we set a name, and in the GeoTIFF format, all the necessary information about the binding is noted in

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the file itself. Resolution 19530x34295 pixels. On fig. 7 shows the final result of the work - an orthophotomap of the territory of the Kibray district of the Tashkent region, in the Agisoft Photoscan program.

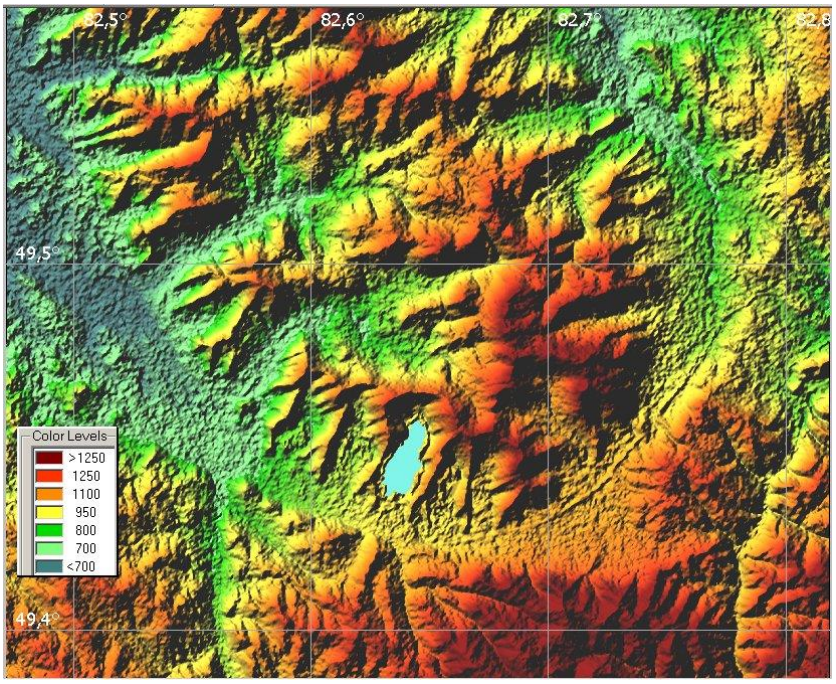

Figure 6. Map of terrain heights.

3. Results and discussion

Orthophotomap plays the role of a visual aspect for visual characterization of the territory. It is the basis of various cadastral maps, terrain maps, topographic maps and others.

Actively take part in geological work, topographic, land reclamation work, cadastral activities. They also serve to assess the condition of the soil.


Figure 7. Orthophoto plan of the territory of Kibray district, Tashkent region

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Each photo in this work contains information about the height of a set of points and coordinates, the creation of an orthophotomap, a 3D terrain model during office processing allows you to fully automate the process without unnecessary complications. Thanks to the initial information and the fulfillment of all conditions, it is possible to obtain a detailed situation of the area for further work, not only related to the cadastral engineer, but also to specialists in related fields of activity.

4. Conclusions

In the course of the study, existing software was analyzed and the most accessible Agisoft Photoscan product for solving the tasks was chosen, which, in turn, clearly demonstrated in practice the ability to automate traditionally time-consuming photogrammetric processes.

It should be emphasized that during the last 3-5 years the development of information and technical abilities for the implementation of tasks has increased markedly, as well as the use of new materials in reconstruction of unmanned aerial vehicles, testing of modern algorithms for processing photographic images using software tools, which made it possible to form an affordable alternative to obtaining high-quality three-dimensional terrain models and orthophotomaps.

Summarizing the results of the study, it can be concluded that that automation processes can improve the accuracy of the results obtained, increase labor productivity and improve the quality of the products obtained, as well as optimize management processes. It is worth noting that orthophotomaps on modern stage serve as the basis for topographic plans, maps of the area, cadastral maps and plans, as well as various bases for engineering surveys. Orthophotomaps, as well as 3D terrain models, can serve as a means of visual role for substantiating and characterizing any area and territory under study.

In conclusion, it should be noted that on the basis of practical work, conducted in the Tashkent region, a computer-aided design system was studied and developed using a software tool, which, of course, can be used in further for the work of cadastral engineers. The conducted automated technology when working on design shows that labor productivity increases by 3 or 4 times, and the quality of the project increases to a large extent, and the cost and time of design are reduced.

Examples taken from published papers:

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[5] Sechin, A. Yu. *Some aspects of the use of modern digital photogrammetric cameras* [Electronic resource] / A. Yu. Sechin // JSC "Rakurs". — Access mode: http://www.racurs.ru/

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