METHODS OF ACQUISITION AND DATA PROCESSING CARRIED OUT WITH DJI PHANTOM 4 PRO V2.0 UAV EQUIPMENT

F. C. BÂRLIBA[1], Luminiţa Livia BÂRLIBA[1], C. BÂRLIBA[1]

[1] Banat's University of Agricultural Sciences and Veterinary Medicine
"King Michael I of Romania" from Timişoara, Romania
Corresponding author: barlibacristian@gmail.com

Abstract. The purpose of the work was to perform scanning and determination works of the roof of the Timişoara Metropolitan Cathedral, a building included in CF 447217 Timisoara by performing a drone flight to visualize the current state of its roof and create a 3D model. The architectural concept for the Orthodox Cathedral in Timişoara is in the Moldavian style, creatively processed with several different influences, of which the Gothic style is predominant. The buildings, belonging to this style, present a completely different architecture from that of other Orthodox buildings in Timişoara, built in the interwar period. The construction itself is also characterized by the ample play of roofs. The cathedral building contrasts harmoniously with the great triumphal arch of the Timişoara Opera, creating a plastic tension, which brings new scenic values to the urban space in Victoriei Square.
Several phases were completed, so the identification of areas was performed and topographic strategies were established. In the information gathering phase, a topographic survey was performed with the help of GPS-RTK GNSS technology, in order to perform the drone flight. The data processing and the elaboration of the documentation was done with specialized computer programs specific to UAV technology, respectively Agisoft, transcalculated in Stereo 70 projection. The steps used are part of the methods used in the work of all profile offices, high-performance high-performance equipment for state-of-the-art field work for the execution of data retrieval, as well as for post-processing of data in order to accurately perform the final work. This ability to perform rapid spatial analysis provides both a qualitative and quantitative advantage by being on an upward slope and expanding use in various fields of activity. The most important qualities are the possibilities of automating works in the field of spatial analysis compared to graphically oriented systems: computer graphics processing. These possibilities of automating such works allow geographic reference data to be created and used in different fields of activity..

Keywords: UAV, RTK GNSS receiver, dense cloud, Agisoft PhotoScan Professional

INTRODUCTION

The theme of the paper was chosen due to its usefulness in all branches of our field of activity. The automation of topogeodesic works is a necessary way to manage spatial information.

The methodology used is part of the methods used in the work of all profile offices, high-performance equipment for state-of-the-art fieldwork for the execution of data retrieval, as well as for post-processing of data in order to accurately perform the final work.

During the data acquisition phase, aerial photography equipment was used.

In the post-processing stage, LIDAR image and data processing software such as Agisoft PhotoScan Professional was used, using a high-performance computer graphics station.

This ability to perform rapid spatial analysis ensures both a qualitative and quantitative advantage by being on an upward slope and expanding use in various fields of activity.

The final goal was to obtain a complex digital work necessary from an architectural point of view for the restoration of the roof of the Timișoara Metropolitan Cathedral.

MATERIAL AND METHODS

To achieve the lifting of the reference points and targets, the RTK method was used using as a device an RTK GNSS receiver LEICA GS 08 which is a receiver built for precision.

The main unit of the receiver has integrated GNSS interface, radio interface, GSM / GPRS modem and Bluetooth for easier use. (ȘMULEAC, A. et al.. 2018)

A Phantom 4 drone was used for the work itself, which is an extremely intelligent instrument with flight capabilities, being able to track objects without the need for other devices, avoid obstacles and fly with just one push, all in time. which shoots videos at a 4K resolution or photos at 12 megapixels (Figure 1.) (POPESCU, G. et al.. 2019).

Figure 1. UAV DJI Phantom 4 pro V2.0
Source: https://www.f64.ro/dji-phantom-4-pro-v2-0-eu/p

Data collection methods using DJI Phantom 4 PRO V2.0 UAVs

With the TapFly function, users can tap the screen of the mobile device to guide the drone to fly in the indicated direction without using the remote control. The drone can automatically avoid obstacles or initiate braking and then glide automatically during flight, provided the light is not too dim (<300 lux) or too strong (> 10000 lux).

Use and description of the specialized program (software) Agisoft PhotoScan Professional

AgiSoft PhotoScan Professional (https://www.agisoft.com/) is an advanced, image-based 3D modeling program used to obtain professional and quality 3D models. Agisoft PhotoScan Professional allows the generation of georeferenced dense point clouds, textured polygonal models, digital height and orthomiosis models from a set of overlapping images with the corresponding reference information. This tutorial describes the main workflow processing steps for generating DEM / Orthomosaic for a set of images with ground control points (VÎLCEANU BEATRICE, 2013).

The fully automated workflow ensures the possibility for all operators to process a multitude of terrestrial or aerial images, with a natural clarity, without the need for advanced knowledge of working in graphics programs. The finished product obtained with this program consists of professional photogrammetric data (BÂRLIBA F. C., 2017).

RESULTS AND DISCUSSIONS

Recognition for topographic works to be performed with Dji Phantom 4 Pro V2.0 UAV equipment

The topo-cadastral methods used were established in this phase of recognition, so that strategies can be created to address the situation (eg: equipment, methods used, stages, location of stations, etc.).

In order to carry out the specialized photogrammetric works requested by the beneficiary, it was necessary to visit the field to determine the methods of topogeodesic and photogrammetric survey of the objective.

It was found that there is a grid in the area, which has not been modified, but which cannot be used in the procedure for picking up the details of the objective, as it does not technically correspond to the requirements of the type of work to be carried out.

It was established the arrangement of the ground targets for the processing of the data to be obtained from the drone so that they can be determined by ground coordinates with the help of GNSS RTK equipment, as well as the achievement of their air visibility.

The position of the drone launch point (home point) has also been established so that there are no natural and artificial obstacles leading to possible damage or accidents. It was taken into account that for the flight is required the approval of the Romanian Civil Aeronautical Authority, the drone being registered to perform these types of flights, following the date of execution of field works to be established according to weather conditions and intervals schedules for which the flight approval will be issued.

Collecting field data with Dji Phantom 4 Pro V2.0 UAV equipment

The field stage performed with the Dji Phantom 4 Pro V2.0 UAV equipment was performed on 27.02.2019, between 09.00 - 13.00, when there was a flight approval issued by the Romanian Civil Aeronautical Authority and favorable atmospheric conditions (Figure 2.).

Figure 2. UAV Dji Phantom 4 Pro V2.0

In the field, the position of the targets was established and their coordinates were raised and determined in Stereo 70 Projection with the help of Leica Viva GS 08 GNSS in RTK system.

Subsequently, a drone flight session was performed at altitudes between 55 - 130 meters above ground level in order to see all the details of the roof of the Timisoara Metropolitan Cathedral (Figure 3.). This was necessary because the objective has 11 towers whose full visibility can only be defined with a circular trajectory around them.

Figure 3. UAV Dji Phantom 4 Pro V2.0 at the starting point

At the same time, the visible elements from the vertical walls of the building were recorded as much as possible due to the cover with arboreal vegetation. The front of the Cathedral could be fully registered.

Post-processing of data obtained from Dji Phantom 4 Pro V2.0 UAV equipment using Agisoft

In the first stage, the files from the Leica Viva GS 08 GNSS equipment were downloaded and imported and processed with the Autocad 2013 computer environment. in Figure 4. (ŞMULEAC, A. et al.. 2019)
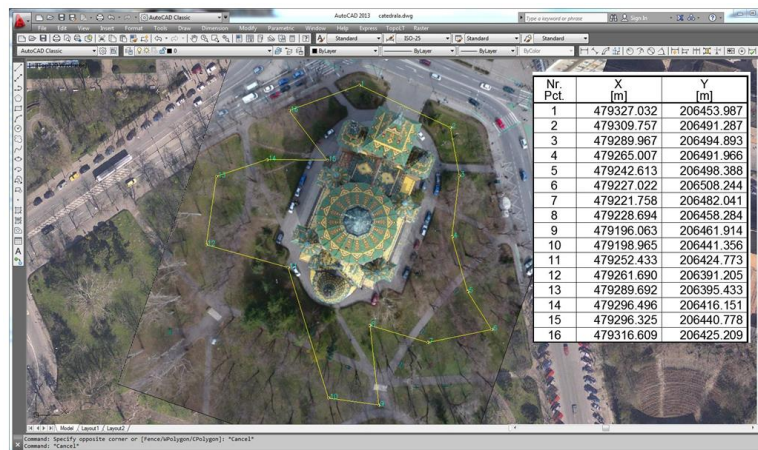

Figure 4. Arrangement of targets for the execution of the flight

After the field phase executed with the Dji Phantom 4 Pro V2.0 UAV equipment, we went to the office stage to post-process the data with the Agisoft PhotoScan Professional program, a program compatible with the raw data obtained from the drone. These office operations were performed after the following steps:

1. **Importing photos**, which was done by the suggestive command "Add photos" from the Workflow menu or by the "drag & drop" method (Figure 5.).
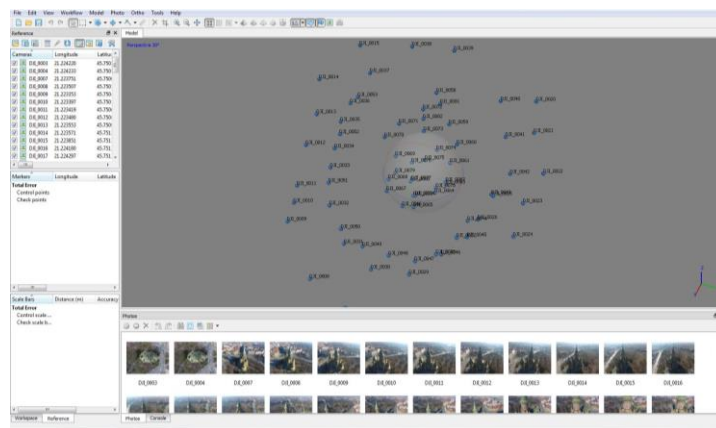

Figure 5. Import photos from the file

2. **The joining / triangulation** of the photos was done by using the "Align photos" command from the "Workflow" menu of the program. To obtain the point cloud, the "High" precision option was chosen, the PhotoScan program finding the position and orientation of each camera, shown in Figures 6-7.
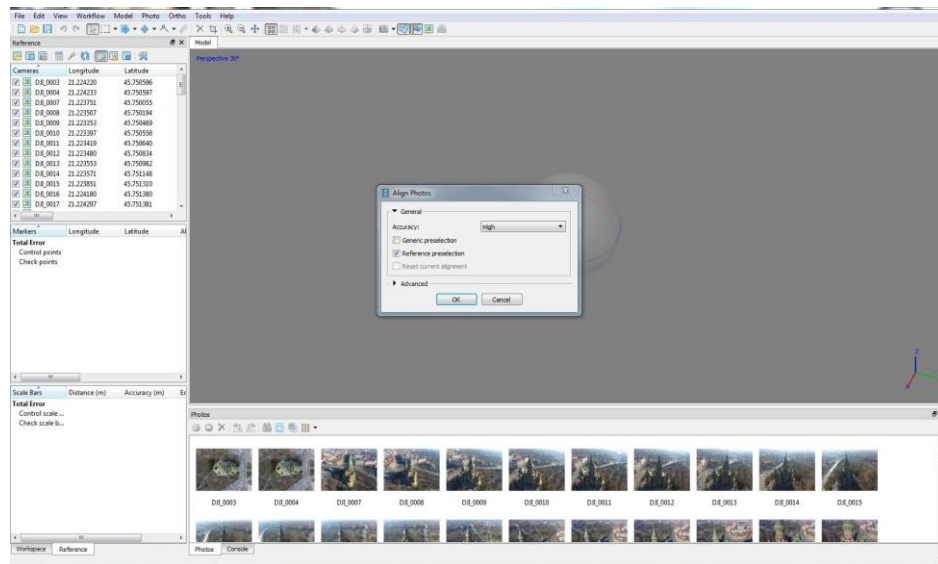
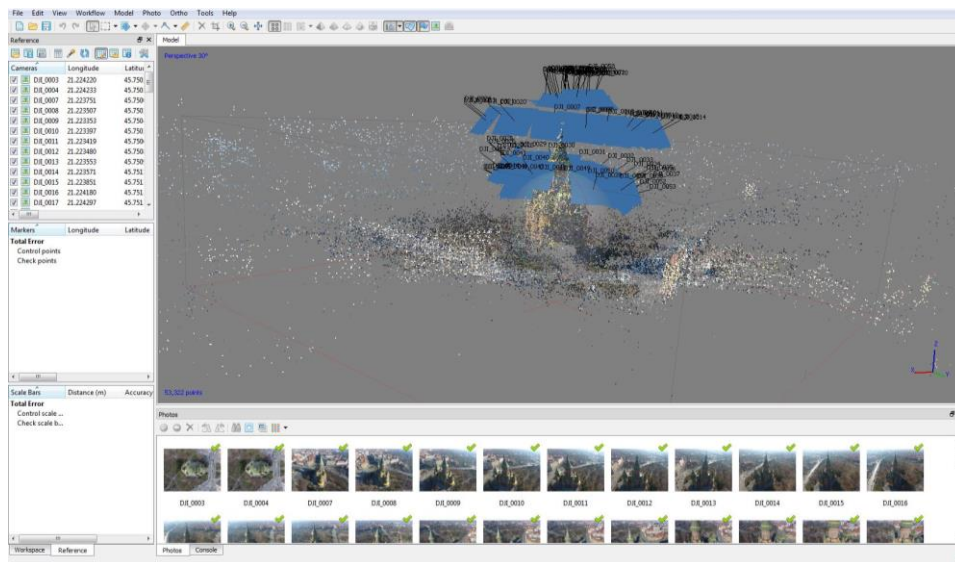

Figure 6. Selection of the pictures quality

Figure 7. The result of aligning the pictures

3. At this phase, **the coordinates of all drone pictures were converted** from geographical coordinates WGS 84 (Latitude, Longitude, Altitude) into absolute rectangular coordinates (x, y, h) Stereographic 1970, system related to our country (Figure 8.).
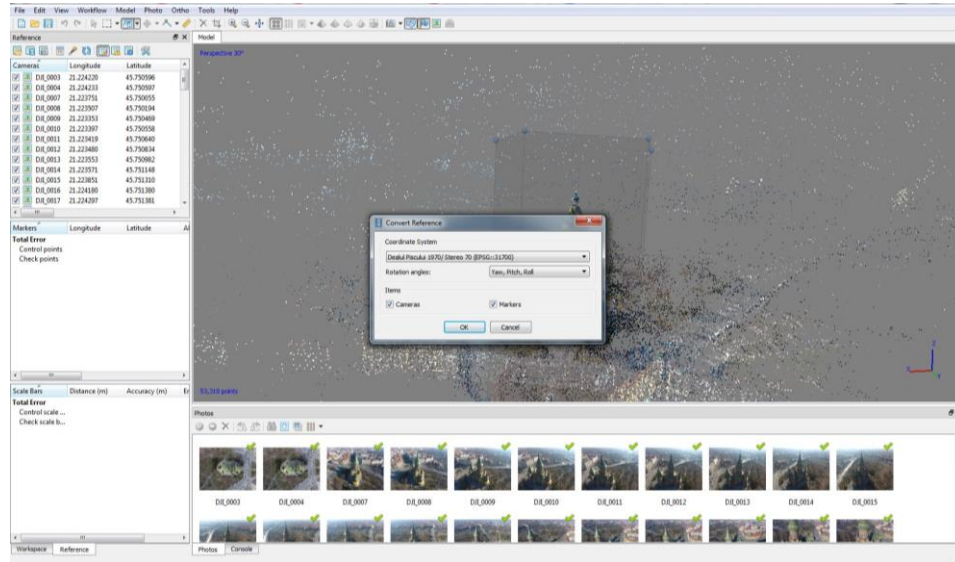
Figure 8. Coordinate conversion

4. For better accuracy, ground reference points were imported, measured with GNSS technology, whose coordinates correspond to the targets set in the field. For this aspect, the **Import** command was used from the toolbar of the reference panel and the .txt or .csv file containing the rectangular coordinates of the points was selected (Figure 9.).
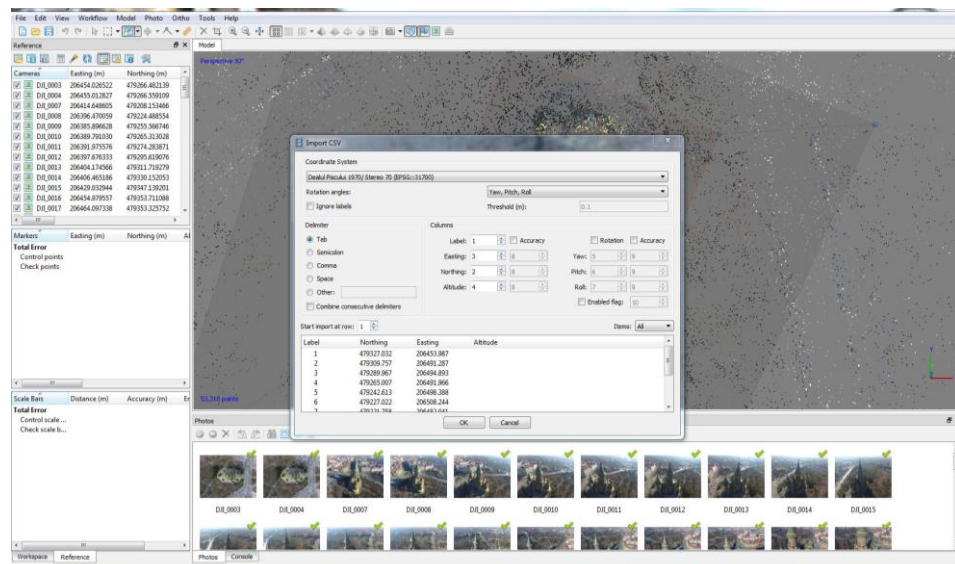

Figure 9. Import coordinates from file

5. In this phase, an **overlap and correlation** was performed between absolute coordinates of the points measured on the ground and the targets visible on the orthogonal projection image obtained with the drone (Figure 10.).
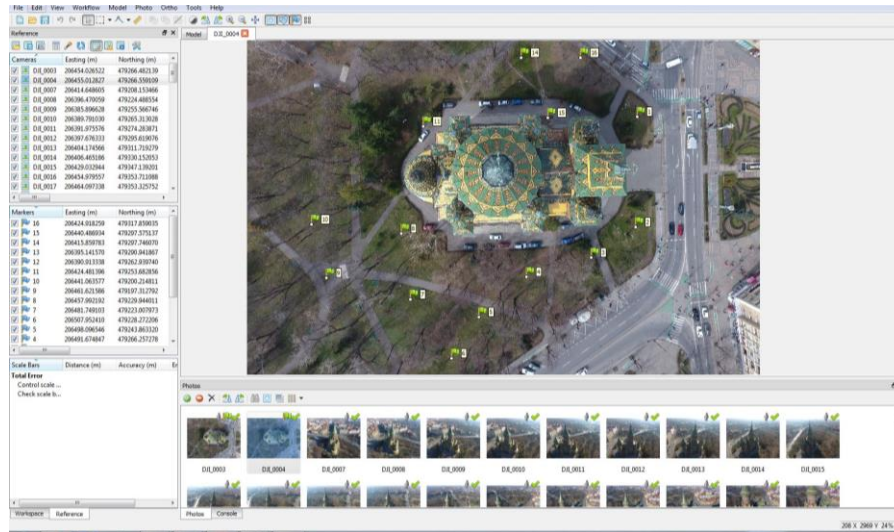

Figure 10. Overlap and correlation of known coordinate points

6. The construction of the dense point cloud was done by the command **"Building dense point cloud"**, based on the estimated positions of the cameras. The program processed the in-depth information for each camera, information that was combined into a single dense cloud of points. We also opted for a high quality by selecting the "High" option and moderate filtering, which required a large volume of hardware resources and time (Figure 11.).
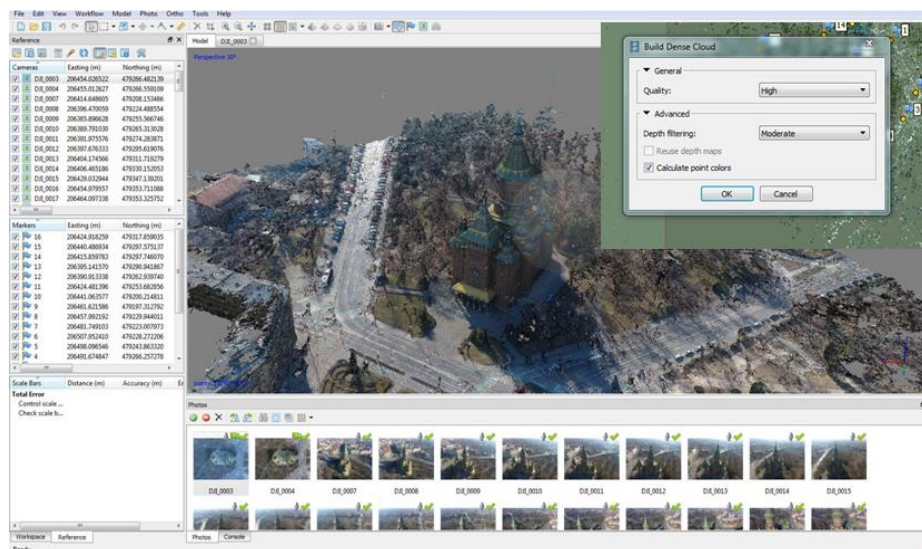

Figure 11. Dense cloud of resulting points

20

7. From the dense cloud of points obtained, **the area of interest** was selected and the unimportant areas were eliminated, using the Select and Crop command from the main menu (Figure 12.).
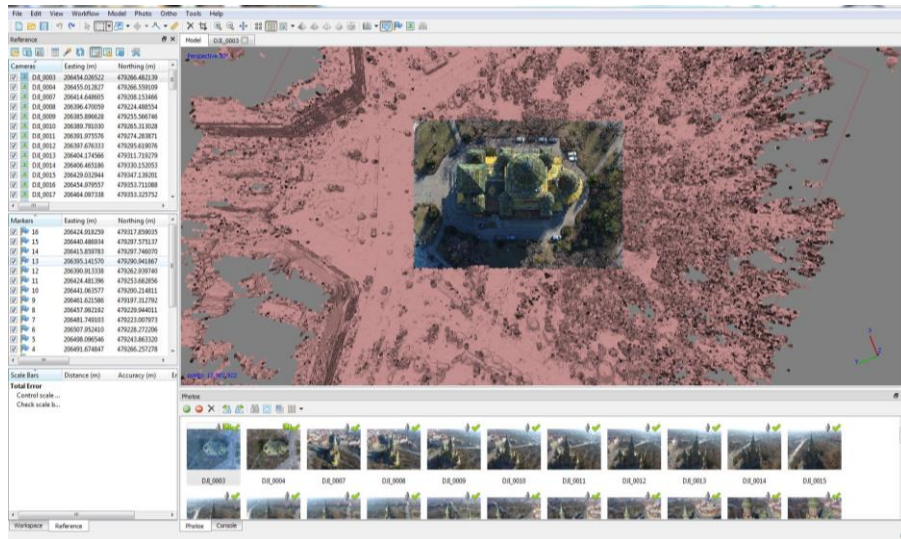

Figure 12. Selection and cutting of the area of interest

8. Using the Build Mesh command from the Workflow menu, **the triangular grid** model was generated based on the previously processed point dense cloud data (Figure 13.).
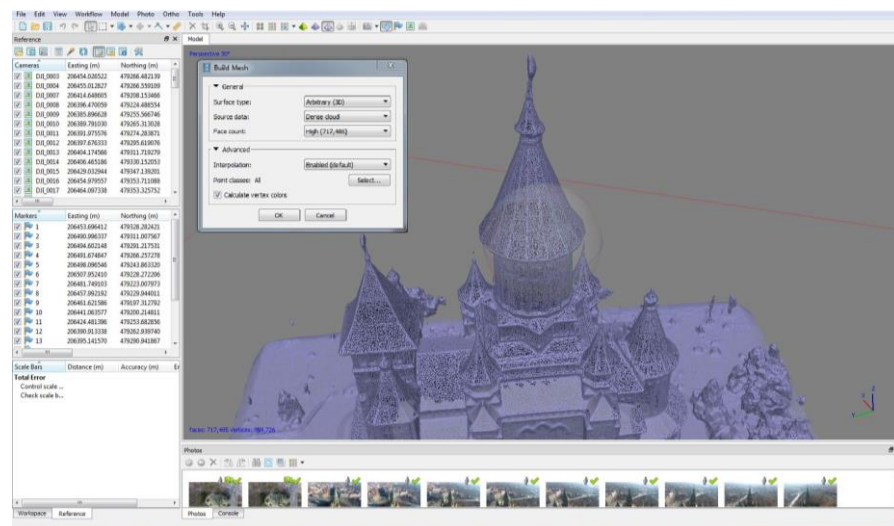

Figure 13. The triangular grid model created by the Build Mesh command

9. In the final post-processing stage of the data obtained with the Dji Phantom 4 Pro V2.0 UAV equipment, the data processing was exported in a file - multi-compatible data

format of type **"* .las"** containing the dense cloud of points in the 1970 Stereographic System (Figure 14).
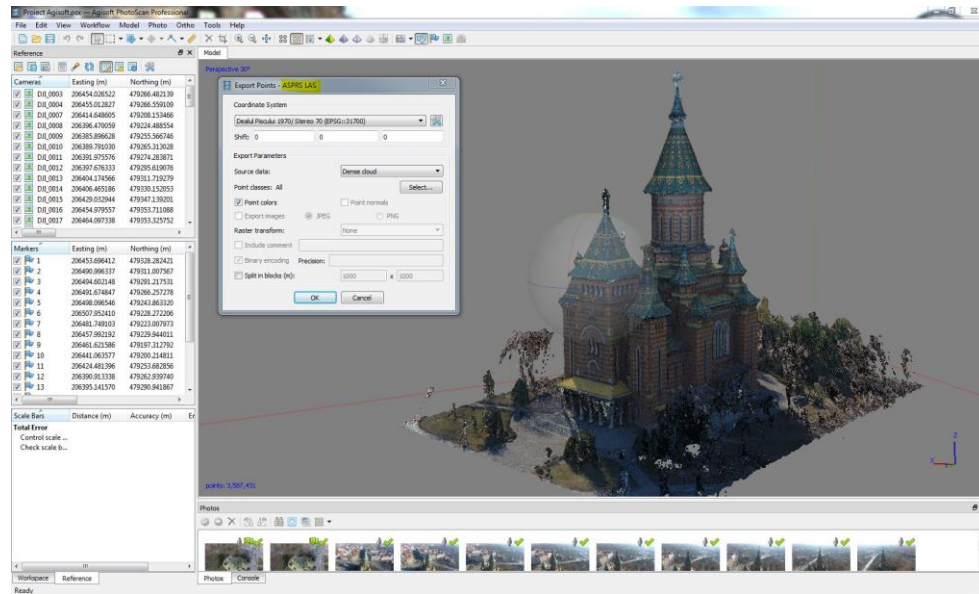

Figure 14. Export processed data to "* .las" file

CONCLUSIONS

The paper is a model for acquiring and processing data obtained with UAV equipment. Thus, the side walls of the Timișoara Metropolitan Cathedral and the roof with the roof were scanned in a flight session with UAV Dji Phantom 4 Pro V2.0.

In the post-processing stage, the data were processed with a specific program, namely Agisoft PhotoScan Professional. Subsequently, the data was exported to files compatible with common post-processing programs, thus performing a complex overall work with a detailed image.

The advantages and applicability of using the proposed model are the speed with which measurements are made for data acquisition and processing.

The final result consists in the 3D model of the Timișoara Metropolitan Cathedral building which can be highlighted both in RGB mode with natural colors and in the form of a triangular network, all of which are useful for future architectural determinations made by specialists in building restoration.

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