

CREATING THE 3D MODEL OF THE " DECEBALUS PER SCORIOLO" STATUE USING DIGITAL PHOTOGRAMMETRIC APPLICATIONS

Ionuț Cosmin GHEORGHESCU, Florin Cristian BÂRLIBA

Scientific Coordinator: Assist. PhD Eng. Anca Maria MOSCOVICI

Polytechnic University Timisoara, Faculty of Civil Engineering, Email: anca.moscovici@upt.ro

Corresponding author email: gheorghescu_ionut@yahoo.com

Abstract

The paper presents the current state of development of digital photogrammetry, the processing of photogrammetric images that are done manually or automatically in the digital environment, in order to elaborate the 3D model of a lens. Digital photogrammetric processing is based on object characteristics, which are visible in images. The main purpose in automatic digital photogrammetry is to extract the geometric characteristics of the identified objects. Agisoft PhotoScan is an autonomous photogrammetric and advanced 3D image modeling software used to create professional and quality 3D models. Agisoft is a state-of-the-art program used to reconstruct 3D objects from multiple images. The totally automated workflow allows all users to process thousands of aerial or terrestrial images without the need for advanced modeling knowledge using a computer. This way you can get final products, which consist of professional photogrammetric data.

Keywords: Agisoft PhotoScan, Digital photogrammetry, 3D model.

INTRODUCTION

Evolutionally, planimetric photogrammetry began with the discovery of the photograph and the first terrestrial photogrammetric elevations. The analog collection method was followed, then the analytical method still performing and the digital method respectively.

Photogrammetric technologies, as well as remote sensing technologies, are modern and very useful methods for studying large areas of land and are increasingly used in terrestrial measurements.

The digital method revolutionized photogrammetry. Digital photogrammetric stations completely solve the problem of collecting and processing the digital data needed in any of the above mentioned areas. Contrary to the first two methods, these types of devices do not analyze analogue (positive or negative) pictures, but digital images (Barliba et al., 2013).

As a ground-based field science, photogrammetry serves to draw up maps and topographic plans, but is widely used in other spheres of activity such as architecture.

The principle of data acquisition using the photogrammetric method aims to obtain physical and environmental information

without physical contact with physical objects and the environment by recording, measuring and interpreting metric photographic images called photograms. Reproduction of photograms is done using photogrammetric cameras, grounded (ground photogrammetry) or located on airborne platforms.

Photogram is a special photo that is a central projection from a mathematical point of view. On it can be made accurate measurements, mathematical relations can be established between the points on the photographed terrestrial surface and their correspondences on the photographic image (Stoian et al., 2009). Photogrammetry is the technique of measuring objects (2D or 3D) on photograms: photo = light; grammar = description; metron = measure.

With photogrammetry, plans and topographic maps are obtained from photograms. Photograph is a photographic (or digital) image of the terrain.

MATERIALS AND METHODS

Agisoft PhotoScan is an autonomous photogrammetric and advanced 3D image modeling software used to create professional and quality 3D models. Agisoft is a state-of-

the-art program used to reconstruct 3D objects from multiple images. This program uses arbitrary images and is effective both under user-controlled conditions and under unruly conditions. Photos can be taken from any position, provided that the object to be rebuilt is visible in at least two of them. Image alignment and reconstruction 3D models are fully automated. The program allows alignment of imported images without the need for special shooting conditions or the use of targets. Enables automatic dense cloud generation, textured polygonal patterns, true georeferenced ortho-geosynthetics, and Digital Surface Model (DSM) / Digital Terrain Model (DTM) from static images (Agisoft PhotoScan User Manual, 2006).

Based on Agisoft's state-of-the-art technology, it enables very fast processing, while delivering very precise results (up to 3 cm precision for aerial photographs and up to 1 mm for short-range photos).

Agisoft PhotoScan is capable of processing thousands of photos, but all operations are done locally, making Agisoft an ideal solution for processing sensitive data. The software package has a project-based linear workflow that is intuitive and can be easily controlled even by a non-specialist.

The recently developed software has been focused on the use of automatic feature extraction features for image orientation and photointerpretation of various forms (constructions, architectural models). The implementation of these objectives should allow the 3D model of objects in photos to be extracted using photogrammetric processing methods (Herbei et al., 2015).

The advantages of the described application are: the practical utility of the specialized program, which results in the 3D model of the lens, using the photogrammetry and the specific equipment, obtaining very precise and detailed results, the software offers an automated process with intuitive workflow, a large network processing and easy PDF sharing.

Motion Structures (SfM) refers to the process of determining the three-dimensional structure of the scenes, based on the changes in time. As a reference model, he studies how the human vision can perceive the concept of "space," and by analogy tries to find the appropriate

numerical methods for a computing system. The current method of building monitoring involves geo-topographic measurements. These consist of making determinations, at regular intervals, of the representative points that make up the objective studied. These points, in addition to being heterogeneous samples, do not take into account the interaction of the construction with the adjacent land. This is where SfM stands out, because based on the concept of geo-photogrammetry, it offers not only high precision and efficiency but also a larger volume of data, starting from digital images methods (Herbei et al., 2016).

The principles on which this discipline is based are: the land connection is based on previously measured control points; the mathematical relationship that supports this link is known as the principle of collinearity and is part of the perspective laws; the assumption that camera recording is a central projection; the focal plane of the camera is a rigid one; the rays of light passing through the lens are not deviated.

RESULTS AND DISCUSSIONS

The process of image processing with the Agisoft PhotoScan software includes the following main steps: uploading photos to PhotoScan, diminishing uninterested parts, aligning photos, cloud generation, 3D mesh generation, texture generation, 3D model generation, export of results methods (Herbei et al., 2015). As far as the field stage is concerned, a total of 65 photos from different locations were executed in one session. The data processing and modeling step, using the specialized program described above, consisted of following working steps:

1. Import photos with the "Add photos" command (Figure 1).

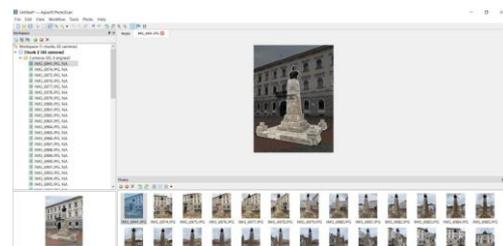


Figure 1. Importing photos and highlighting the historic monument

2. The marking of the historical monument's area consisted of establishing representative photos for processing. In this sense, the program allowed full-screen processing, with the disadvantage that the cloud of points obtained will be very dense, and will contain elements around the artifact that are not important for processing. Also, the processing time will be very high, so it is preferable for the images to be cropped using the "Intelligent scissors" tool. Selected points were selected on the contour of the object and the Invert selection and Add selection commands were used to remove the parts of the image that were not useful to us (Figure 2).

3. The photos were merged using the "Align photos" command in the program's "Workflow" menu to get the cloud of points, choosing the 10,000,000-point high precision option to find the position and orientation of each camera (Figure 3).

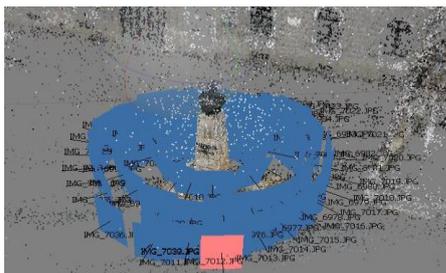


Figure 2. Triangulation of photos

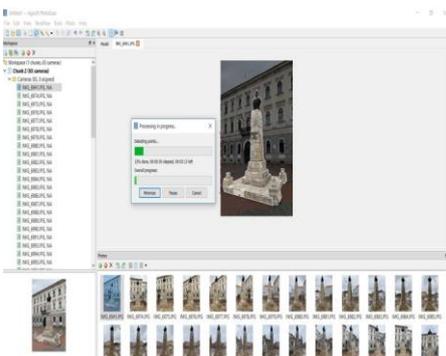


Figure 3. Orientation of cameras

4. The dense point cloud was built using the Building dense point cloud command, based on the camera's estimated positions, the program computing in-depth information for each room, information that was combined into a single cloud of points (Figure 4). PhotoScan tends to produce additional dots that are nearly the same density or even more dense (Figure 5).

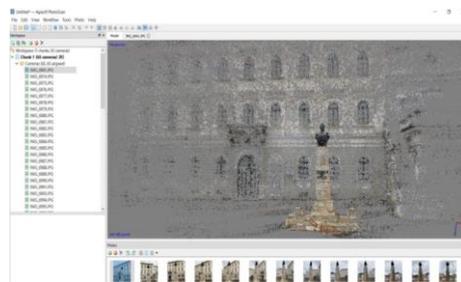


Figure 4. Dotted cloud



Figure 5. Dense cloud of dots

5. Building the cloud geometry was done by the "Build Mesh" command (Figure 6).

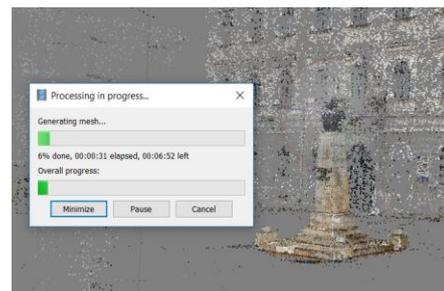


Figure 6. Building the cloud geometry of points

For the reconstruction of the dot cloud geometry, the "arbitrary" surface setting method was used (Figure 7).



Figure 7. Resulting modelling

6. The final model consisted of exporting the 3D model obtained in dxf files in 3ds format

(3D Studio) and wrl format Cortona 3D (Figure 8).

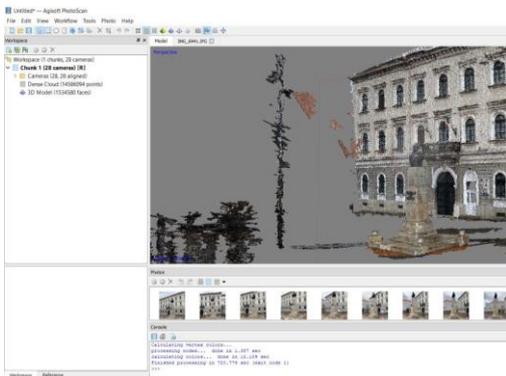


Figure 8. Final Model

Model Comparisons – Reality

In the figures below (Figures 9 - 10), the details obtained from the processing process using Agisoft PhotoScan software.



Figure 9. Before the photo processing process



Figure 10. The result obtained from processing the photo using the Agisoft PhotoScan software

CONCLUSIONS

The 3D model of the statue was obtained from the processing of photographs taken with a 24 megapixel Nikon D 610 digital camera and a

Tamron 24-70 lens. Agisoft PhotoScan, which was used to create 3D imagery, is an advanced image-based 3D modeling solution used to create professional and quality 3D content. Agisoft PhotoScan is a standalone software that performs photogrammetric digital imaging and generates 3D spatial data for use in GIS applications, documenting cultural heritage, and producing visual effects. Based on state-of-the-art 3D reconstruction technology from multiple images, this product uses arbitrary images and is effective both under user-controlled conditions and under unruly conditions. The development of modern programs for "patter recognition" or "image understanding", in other words, of modern digital photogrammetry, has enabled the automation of functions for extracting object characteristics from images. In conclusion, the totally automated workflow allows all users to process thousands of aerial or terrestrial images without the need for advanced modeling knowledge using a computer. This way you can get final products, which consist of professional photogrammetric data.

REFERENCES

- Barliba L. L., Barliba C., Eles G., Ciolac V., 2013. Photogrammetric flight preparation by premarking the field points for the information system of water management, International Multidisciplinary 13th Scientific GeoConference SGEM 2013, 16-22 June, Albena- Bulgaria, Conference Proceedings, Vol. II, 663-668, ISSN 1314-2704, ISBN 978-619-7105-01-8.
- Herbei M., Sala F., 2015. Use Landsat Image to evaluate vegetation stage in sunflower crops, USAMV Bucuresti, AgroLife Scientific Journal - Volume 4, Number 1, pp. 79-86.
- Herbei M., Sala F., 2016. Biomass prediction model in maize based on satellite images, AIP Conference Proceedings 1738: 350009-1 – 350009-4.
- Herbei M. V., Herbei R. C., Popescu C. A., Bertici R., 2015. Domogled – Valea Cernei National Park monitoring using satellite technology, Ecoterra 12(3):73-78.
- Stoian I., Barliba L. L., 2009., Elements of Photogrammetry, Eurobit Publishing House, Timisoara.
- ***. Agisoft PhotoScan User Manual, 2006.
- <https://www.ct.upt.ro/studenti/cursuri/vilceanu/Fotogrametrie.pdf>.