

COMBINING TOPOGRAPHIC MEASUREMENTS AND PHOTOGRAMMETRIC WORKS IN ORDER TO ACHIEVE DIGITAL 3D MODEL OF THE APOR PALACE

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Abstract: In recent years, there has been a strong emphasis on developing tools to streamline the realization of three-dimensional virtual models of cities. Therefore, the algorithms used to create 3D models are based on the combination of classical or GPS measurements with images taken using digital terrestrial or aerial camera systems. The visualization of the three-dimensional virtual models of the buildings is most often made on the basis of online platforms, created for this purpose. Such a well-built platform will quickly load the 3D model of the building and will allow its exploitation to the maximum level. The obtained result is very important in fields such as architecture and urbanism, offering the possibility to make simulations and visualizations on the project, to draw up projects for the reconstruction or restoration of monuments and buildings.

Keywords: building 3D model, digital modeling, topographic measurements, photogrammetry

1. Introduction

Carrying out field measurements, measurements adjustment, data processing and correct representation on plans and maps of planimetric elements and landforms, is based on the use of topographic and geodetic tools, means of calculation and graphical processing and representation, which require knowledge of theoretical notions and practices in various fields of science and technology [4], [6].

3D modeling is the process of creating a 3D representation of any surface or object, by manipulating polygons, edges and vertices in simulated 3D space. 3D modeling can be done manually with specialized 3D production software that allows an artist to create and deform polygonal surfaces or scan real-world objects into a point data set that can be used to represent the digital object [4], [9], [10].

For this paperwork, the Apor Palace, located in Alba Iulia, was chosen as a case study.

Apor Palace is a historical monument, located on Gabriel Bethlen Street inside the Alba Carolina fortress, near the Bathyanem Library. The palace was built in the second half of the seventeenth century, between 1670-1690, by order of Count Stefan Apor. During the communist period, the palace was abandoned, reaching an advanced state of degradation. In

2007 the renovation works started, when the palace is restored to its former beauty. Now the palace is the headquarters of the Rectorate of the "1 Decembrie 1918" University of Alba Iulia [7], [12].

2. Materials and Methods

The main goal of the paperwork is to combine the topographic measurements of the Apor Palace building and surroundings with photogrammetric sampling and their common processing, in order to achieve the three-dimensional model of the building, using specialized graphic modeling programs.

For the topographic plan, several steps are completed: the design of the works, field measurements and office operations, implying the calculation and processing of the measured data [1], [11].

The first step to be followed in order to achieve the topographic survey is to inspect the objective (buildings and surroundings) in order to create an overview in order to design the stages of the work. This step is also essential for the photogrammetric works, the operator being able to establish, based on the inspection, all the parameters that are involved in the photogrammetric shooting [1], [2], [13].

The equipment that was used to determine the position of the detail characteristic points necessary to generate the 3D model is the total station, and a GPS system was used to determine the reference points (Fig. 1) [1], [2], [14].

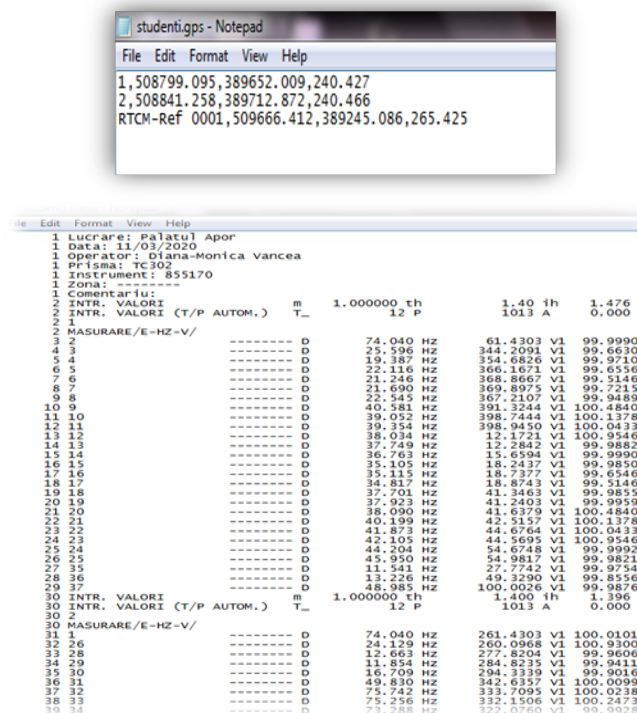


Fig. 1 Field measurements – GPS and total station

The topographic measurements were computed, adjusted and processed with specialized software TopoSys (Fig. 2).

For the graphic processing, the AutoCAD Map 2000i software was used, accompanied by the TopoLT application.

Finally, the topographic plan of the Apor Palace objective was drawn up (Fig.3).

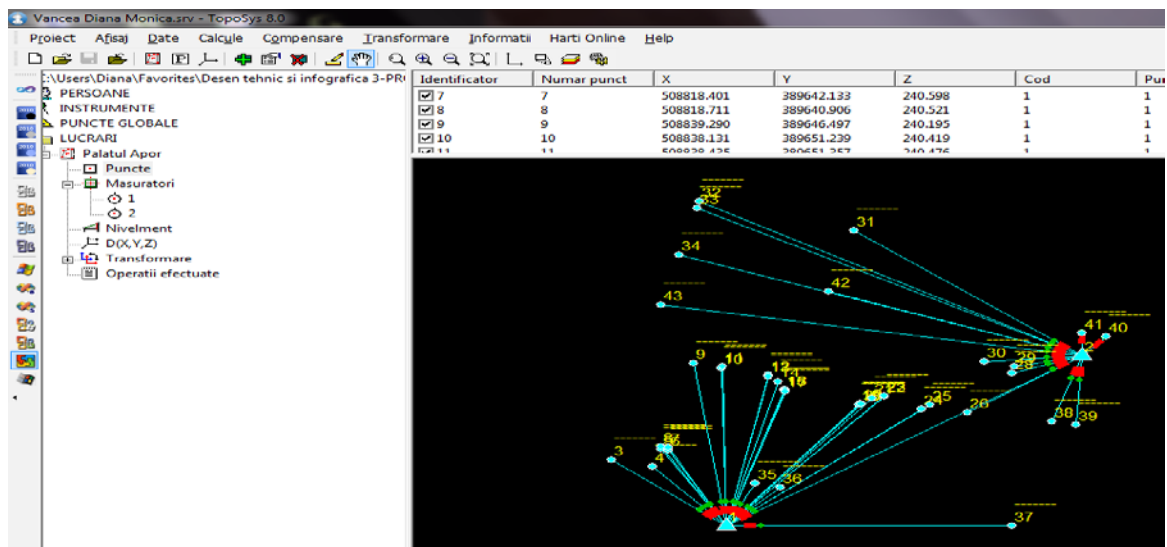


Fig. 2 Computed reference and detail points – TopoSys 8.0

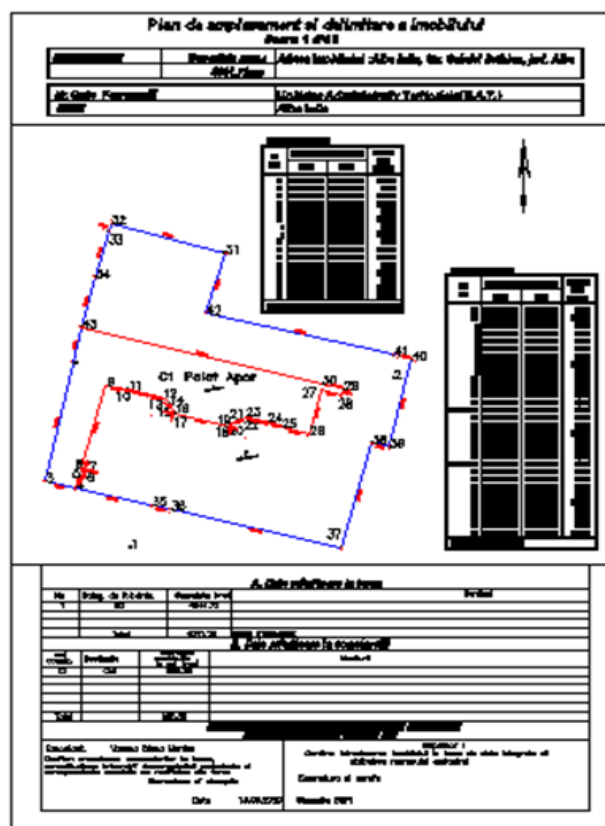


Fig. 3 The topographic plan

In order to create a 3D model of a construction site by combining topographic measurements with the photogrammetric images taken on the construction and the surroundings, certain steps must be completed [4], [8]:

- Carrying out topographic measurements, by classical methods and/or GPS, in order to determine the shape, dimensions and spatial coordinates of the construction site;
- Taking over the overall and detailed photogrammetric images on the construction site, according to the modeling software requirements;
- Preparation of the model construction: the import of the digital terrain model from Google Earth, which will be the basis of the digital modeling of the construction site, as well as of the topographic measurements carried out previously, for the spatial positioning and the correct dimensioning of the modeled objective;
- Simple modeling, with as few elements as possible, to reduce the file size and improve system performance;
- Placing the 3D model of the objective on the digital terrain model surface, in case there are inconsistencies between the topographic measurements and the digital terrain model imported from Google Earth;
- Adding textures to the building facades, which involves applying photos on the model facades and georeferencing them;
- Integration of vegetation and other urban elements, as well as framing the obtained 3D model in the environment.



Fig. 4 Modeling in Google SketchUp, based on the digital terrain model imported from Google Earth and topographic plan imported from AutoCAD

3. Results and Discussion

After the processing of topographic data, obtained from the measurements carried out in the field, using specialized programs a digital plan of the objective was obtained, which, through the details it contains, allows the formation of a suggestive image on the planimetry and terrain relief [1], [2], [3].

The modeling software allows the user to import CAD files to create excellent, useful, and lightweight SketchUp models. The modeling method assumes that a 3D model isn't created directly from the CAD geometry, but instead, the CAD geometry is used as a

reference for creating a SketchUp model. CAD geometry is often complicated to create a useful SketchUp model and is likely full of gaps that need to be closed to create faces. Before a proper modeling based on the topographic measurements imported, there are some workflow recommendations [4], [8]:

- The size of the imported CAD geometry
- CAD geometry is a single group
- Floor plan line up with SketchUp's drawing axes
- Extra layers removal and CAD group placed on a new layer
- Group lock
- Edge styles adjustment
- Scenes creation to toggle layer visibility

The SketchUp software was used to create the 3D model of the Apor Palace. The creation of the 3D model consisted of a series of stages of virtual representation of each constructive element (walls, roof, artesian well, fence, etc.) as well as the creation and application of materials on the 3D gross model. The final phase of the project consists in preparing the 3D model for presentation and visualization by positioning the lights and setting the environment [5], [8].



Fig. 5 Obtaining the 3D model of the Apor Palace – Google SketchUp

Based on the model created using both the topographic measurements and photogrammetric images taken over the Apor Palace, information about the shape and dimensions of the construction, as well as its certain features can be extracted. The applicability of the resulting product refers to the inventory and study of the construction as a whole and of the constructive elements separately, the restoration, consolidation and conservation of the construction [5].

4. Conclusions

In order to obtain the final product, which in this paperwork is represented by the 3D digital model of the Apor Palace, a wide range of specialized softwares was used in order to obtain the most rigorous and concise data.

As part of the international campaign organized by UNESCO to save architectural monuments and more, their surveys must be carried out. Through specific modeling methods, three-dimensional photogrammetric models must expressively reproduce the geometry of the characteristic structural, detailed and ornamental elements of the building.

For the historical buildings that present degradations and that must be restored, consolidated and conserved, preserving the original architectural style, three-dimensional

models of the building are made to render as realistic as possible the facades of the building (through images), with the details of the ornaments from buttresses, railings, galleries, cornices, etc. Based on them, one can also investigate the state of degradation of the construction material used and determine its replacement.

For the architectural monument that presents cracks, special measurements are made to locate them, to monitor their evolution, as well as to determine the deformations of the building.

5. References

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