

ARCHITECTURAL PHOTOGRAMMETRY AN EXTENSION OF CONVENTIONAL SURVEYING

Georgeta MANEA, Alexandru CALIN

Technical University of Civil Engineering Bucharest, Romania
Department of Geodesy and Photogrammetry
georgeta_manea@yahoo.com

KEY WORDS: Architectural, Church, Digital, Conservation, Photogrammetry

ABSTRACT:

Traditional surveying methods have been a source for documentation in architecture for a long time. It has always been a necessity to acquire all the technical and legal documents of constructions and lands in order to preserve them. We can guarantee the future of cultural heritage by using advanced technologies from other disciplines than architecture and by cooperation among different sciences.

The aim of this study is to point out the use of geodetic measuring techniques together with close-range digital photogrammetry and how these technologies intertwine for the photogrammetric documentation in the cultural heritage field.

In the exemplified project, the recording and documentation of the "Popa Nan" church has been realized by a combination of latest modern technology: total station surveying as well as imagery acquisition using a digital non-metric camera. Several methods of visualization have been applied to the data set using non-expensive CAD based applications, which provided flexibility for getting information and easy editing. Even if the basic condition of a full modelling and visualization was a complete 3D acquisition of the documented church, the chosen methods offered reliability, speed and precision. The results will thus be available as a primary source of information and reference in case if a reconstruction will be needed.

1. INTRODUCTION:

The development of architectural and archaeological photogrammetry has been very much a part of the whole development of close range photogrammetry since the 1960s. From the many areas of application of close range photogrammetry, this field has become one of the best established and most well known. At the same time, it has perhaps not been so glamorous or as original as some other areas of application.

Nevertheless, the field is much changed from the early years of development. In the close range applications as in the whole photogrammetric methodology, the introduction of computers has very much changed the ways in which the technique works and is applied.

While there are variations worldwide, due to different circumstances and the availability of different equipment, the underlying principles of the work are not significantly different from country to country. However, the student of the field will find it quite difficult to obtain a coherent worldwide view. Reference may be made to specialist books (Fondelli, 1992) and the publications of the International Committee for Architectural Photogrammetry (CIPA, 1993). While many valuable papers have been published, for example through the efforts of CIPA, there is relatively little straightforward description of techniques.

The most widespread use of the photogrammetric technique has been for the representation of the facades or elevations of historic buildings and structures. The most common product is the line drawing which delineates architectural form. Such surveys are needed by the various disciplines involved in building repair and conservation. The products may be used very much at the commercial end of building refurbishment, where there is no great historical interest at all, through to the recording of facades and interiors of the most important historic buildings and structures.

The continuing requirement of most specialists in the built environment for line drawings should not be underestimated. This is in part necessity, in part conservatism. Indeed, the widespread application of computer aided drafting (CAD) has

reinforced this requirement and not reduced it. Therefore, while the photogrammetric community has made great strides in automating data extraction and creating output such as orthophotography, those working in the built environment have shown little inclination to adopt these advanced products.

Photogrammetry has numerous positive attributes in architectural recording. It provides a homogeneous level of recording across a whole facade, being largely independent of the level of detail on the facade. Simplistically, more complex detail just means more plotting time. Indeed, the absolute accuracy can be very high, although at a cost. The application involves little site disruption, as photography and control are provided off the facade. Results can be provided rapidly, and in advance of other site works such as scaffolding. In comparison with hand survey methods, a huge volume of primary data is captured quickly. The method is generally much safer than methods of hand survey, due to its no contact nature. It is essentially a form of remote sensing, a disk to non-destructive investigation as widely recognized in the architectural conservation field (Hollis and Gibson, 1990). Direct capture of digital data is ideal for input to CAD systems. Complex layering of data does not greatly increase the cost of plotting. It allows for the direct production of three dimensional data. Again, this is becoming increasingly important in the CAD era. The stereophotography is an extremely valuable archival resource in its own right. It provides much more information than conventional pictorial photography, and gives the possibility of future assessment.

However, a matter of great importance is to recognize some limitations of the photogrammetric product. It is a complex technique, requiring the input of specialists. As such, it is often not very practical to apply on relatively small tasks. The plot quality of line drawings is not always consistent, and some forms of architecture do not plot well. The standards of accuracy and thoroughness produced can be very high, but may on occasion be too high for the project. The value for money of the product will be satisfactory, but the absolute cost in relation to the project may just be too great. It is not possible to apply photogrammetric techniques on all occasions, or even to ensure complete cover.

Digital image data may be acquired directly by a digital sensor, such as a CCD array camera, for architectural photogrammetric work. Alternatively, it may be acquired originally from a photograph and then scanned.

For the applications in architectural photogrammetry the use of cameras was for a long time determined by the use of expensive and specialized equipment (i.e. metric cameras). Depending on the restrictions due to the photogrammetric reconstruction process in former times, only metric cameras with known and constant parameters of interior orientation could be used. Their images had to fulfil special cases for the image acquisition.

Nowadays more and more image acquisition systems based on digital sensors is developed and available at reasonable prices on the market. The main advantage of these camera systems is the possibility to acquire digital images and directly process them on a computer.

2. CASE STUDY:

The study was made using the 3D model of „Popa Nan” church from Bucharest. This holy dwelling, whose patron saints are “Constantine and Helena” was built in 1910 – 1918, on the location of the ancient “Popa Nan” church which had been erected in 1719 but was greatly affected by its old age and collapsed in 1910.

The founders, the archpriest Ion Georgescu and the parish clerks Niță Berechet, Anghel Postelnicu and N. Rica of this holy building made great efforts and sacrifices and built the church using the project of the famous architect Cristofe Cerchez with the large support and contribution of the parishioners.

The March 4th 1977 earthquake caused great damage to this church: the main tower collapsed, the roof was destroyed, the walls and the interior painting got weaker.

The church was consolidated and restored with the contribution of Prof. Victor Frangulea, Ph.D., the parish church in the years 1977 – 1986, strongly supported by the parish council whose members were the parish clerks Mihai Eugen Navrea and Dodo Niculescu Berechet. The mural painting was remade by the painter Mihai Bogdan Nociulschi in the years 1986 – 1989.

The religions inauguration service was celebrated on October 29th 1989 by his holiness Teoctist, the patriarch of the Romanian Orthodox Church, together with a distinguished group of priest and deacons.

As most of orthodox churches belonging to the Byzantine style, the „Popa Nan” church has a rich interior mural painting. The iconostasis is a decorative element which separates the nave from the shrine. It is usually made of finely carved wood, generally covered with gold leaf and including icons representing Jesus, the Virgin, the Apostles and scenes from the Bible.

The measurements were taken with a TPS 800-Leica total station and processed with SIPREG software. Pictures of the site were made with a digital non-metric camera Sony DSC-H1. Laser technology instead of infrared measurements was used for acquiring the points with a $2\text{mm} \pm 2\text{ppm}$ precision. The 3D model was realised with Autodesk Map 3D, Autodesk Raster Design, AutoCAD 2007 and 3D Studio Max software.

More than 4000 points (interior and exterior) and have been measured and calculated for the 3D model. Based on their X, Y, and Z coordinates, the points were imported in Autodesk Map 3D using Civil Points menu's functions (fig.1). The digital images were inserted and referenced in Autodesk Raster Design according with the field measurements and used later as a base for digitizing the details. The 3D model was generated with solids and surfaces from measured and digitized points using the modelling capabilities of 3D Studio Max. The same

software was the rendering platform: materials and lights effects were combined for a realistic model. For the animation of the model, made also in 3D Studio Max, the motion path and the target path of the camera have been chosen as 3D helix objects. Other parameters specified in this phase were: the length of the movie, the frame rate and the file type of the movie (.wmv). In the next pictures are present the phases of 3D modelling process:

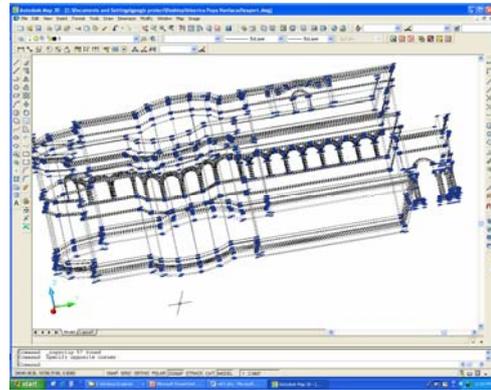


Fig 1. Import of the measured points

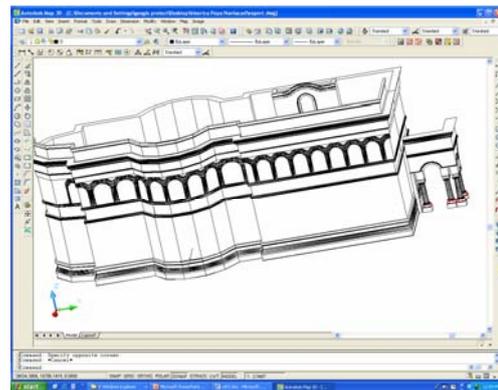


Fig 2. Surfaces and solids

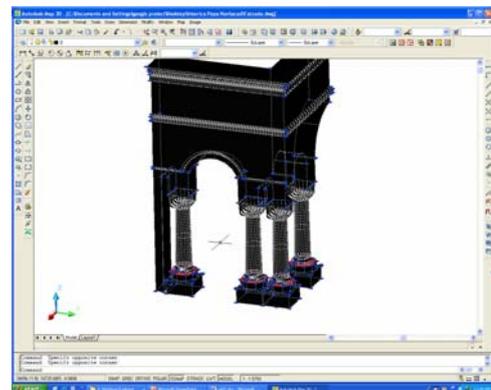


Fig 3. 3D model in AutoCAD

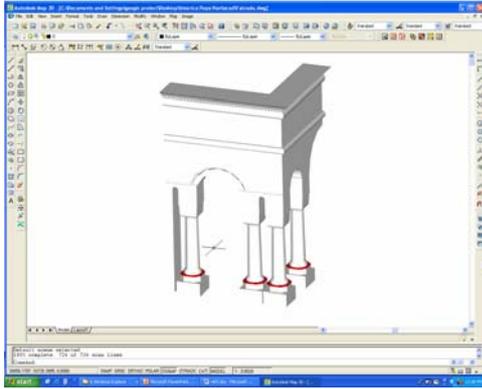


Fig 4. Rendering, materials and lights

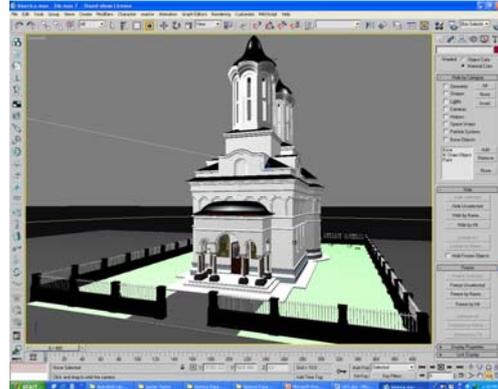


Fig 8. 3D model animation

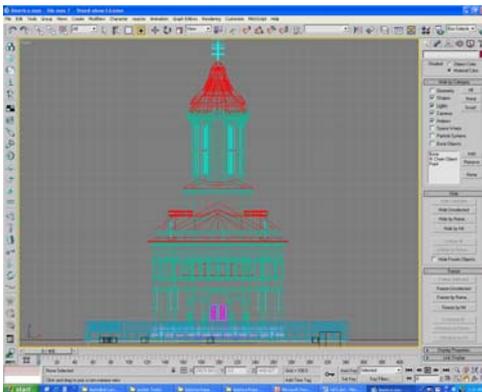


Fig 5. 3D model in 3ds max – view from the west

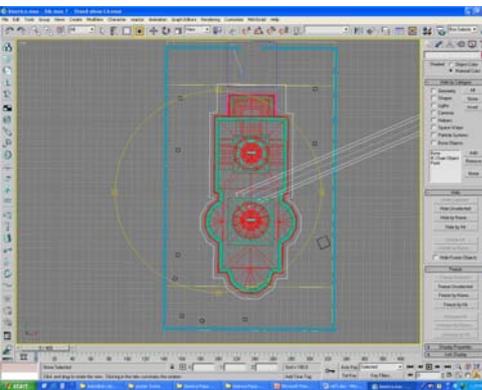


Fig 6. 3D model in 3ds max – view from the top

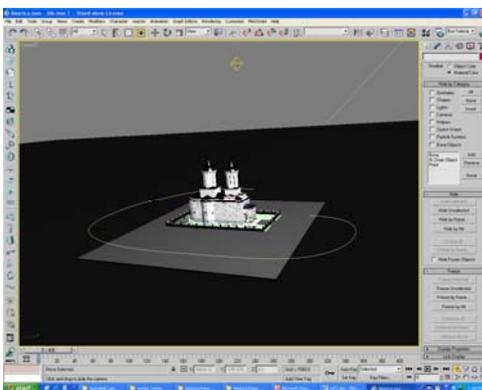


Fig 7. Camera view and light sources

3. HARDWARE EQUIPMENT AND SOFTWARE

4.



Fig. 9 TPS 800-Leica total station

The TPS800 is equipped with a new keyboard, display and software. Various options make the TPS800 an extremely powerful instrument. The display features a high resolution and good readability under all light conditions. The software is designed to be efficient, intuitive and flexible with a very short learning time. The new software additionally features “COGO” and “Road 2D” applications. Road 2D allows the stakeout and measurement of points along a horizontal road alignment, consisting of alignment elements such as lines, curves and spirals.



Fig.10 Sony DSC-H1 camera

With a focal length range of 36 - 432 millimeters the DSC-H1 camera lets you frame distant objects with ease. Making the most of this telephoto reach, Sony's Super Steady Shot® optical image stabilization feature counteracts camera-shake to ensure sharp images. This feature also benefits low-light photography by allowing the use of longer shutter speeds with reduced risk of image blur from camera-shake. Sony's Real Imaging Processor™ circuitry is incorporated in the model for better battery efficiency, more responsiveness and high quality movie taking, while seven preset scene modes allow quick selection of the best setting for specific shooting conditions. The camera also includes a five-area, multi-point

auto focus to help you concentrate on the subject without mistakenly focusing on the background, as well as aperture/shutter priority and manual exposure modes for creative control of the image. For added convenience, the model has 32 MB of internal memory (30 MB of usable memory) and a Memory Stick® flash media slot. PictBridge™ compatibility enables prints in a flash when the camera is connected to an enabled printer.

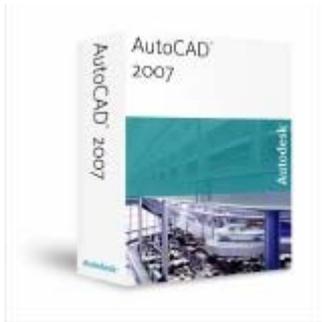


Fig.11 AutoCAD 2007 box

Using the AutoCAD 2007 Walk and Path animation tools, you can identify points of interest within a model, and then create a path, or simply walk past those points to create an animation file that can be distributed. Any user can create the animation using different visual styles or shade modes to get just the right visual effect and use these tools dynamically to take the client on an “over the shoulder” tour of the design. Thus, you can expose any flaws early in the design process, well before any problems occur in the final product.

AutoCAD 2007 incorporates the mental ray® rendering engine, the very latest in rendering technology. This powerful technology, used in Autodesk® 3ds Max® software, has been incorporated into a new user interface focused on making accurate and realistic renderings quickly and easily. This technology includes the use of preset renderings, as well as slider control that allows easy trade-off of time versus rendering quality. The new rendering, materials, and lighting enhancements make highly accurate rendered images available to any AutoCAD user, enabling anyone to achieve effects that previously required additional applications.

5. CONCLUSIONS :

By this project I wanted to demonstrate that nowadays we can use non-metrical photographs in order to create 3D models of monuments and buildings in general. It is a very efficient technique which can be used with very good results and it is also time-saving. Using the state-of-the-art digital technique we can obtain better results than when using the classical analytic technique. Perhaps there is a great potential and perspective of development in the application of this technique for the preservation of the architectural heritage (and of the entire cultural heritage).

The greatest advantage is the use of the 3D model; this gives us the possibility to extract any information we want. For example we can determine surfaces and volumes, make sections or flatten views of the object.

Another benefit is given by the fact that we did not use any photogrammetric complex software but world wide known CAD-based applications: Autodesk Map 3D, Autodesk Raster Design and AutoCAD 2007.

As it is easy to observe from our case study, the use of non-metric photos had also offered some advantages: less time in acquiring the images, high precision and wide covering of the model.

REFERENCES

References from Journals:

CIPA (*International Committee for Architectural Photogrammetry*), 1993. *Architectural photogrammetry*. Edited by S. Pieris and P.L. Prematilleke. International Council on Monuments and Sites Sri Lanka National Committee, Colombo, Sri Lanka. 204 pages.

References from books:

Atkinson, K.B. 2001 *Close Range Photogrammetry and Machine Vision*, Edited by Atkinson, K.B., formerly of Department of Geomatic Engineering University College London.

Fondelli, M., 1992. *Trattato di fotogrammetria urbana e architettonica*. Gius Laterza e Figli Spa (eds) Roma-Bari, Italia.

Hollis, M. and Gibson, C., 1990. *Surveying buildings. 3rd edition*. RICS Books, London. 237 pages.

Kasser, M. and Egels, Y., 2002. *Digital photogrammetry*. Taylor and Francis, London and New York.

Leberl, F., 1991 *The Promise of Softcopy Photogrammetry, in "Digital Photogrammetric Systems"*. Wichmann, Karlsruhe.

Turdeanu, L., 1997. *Fotogrammetrie analitică*. Edit. Academiei Române, București

References from websites:

<http://www.autodesk.com>

<http://www.leica-geosystems.com>

<http://www.sonystyle.com>