VISUALIZATION OF PHOTOGRAMMETRIC DOCUMENTATION FOR ARCHITECTURE OF CULTURAL HERITAGE

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Working Group VI/3

KEY WORDS: architectural photogrammetry, documentation, cultural heritage, vizualization

ABSTRACT

Architectural photogrammetry provides methods and techniques for producing technical documentation of architecture of cultural heritage. Mostly used visualization of the results are still vector maps of facades, ground maps and cross sections although advances in computer technology and CAD tools enable more attractive and useful representation. Photogrammetric Department of the Institute of Geodesy, Cartography and Photogrammetry in Ljubljana, has been intensively implementing new apporaches for producing metrical documentation of monuments and is the only institution in Slovenia that has been active in both developmental and practical work in the field for the last few years. Development and researches has been focused on optimization of field measurements and development of effective technological line. Emphasis has been given on production of 3D models of building and vizualization of the models. Some in-house developed software has been produced. On the basis of thorough practical experience and knowledge a modern concept of photogrammetric close range survey is presented in the paper. The authors find out that clear procedures and good specifications are needed, knowledge transfer from photogrammetrists to consumers is appreciated, full use of 3D data is advisable. Samples of some projects are presented.

1 INTRODUCTION

The aim of architectural photogrammetry is to produce metric documentation of architecture (buildings or it's parts), which usually belongs to the national cultural heritage. Photogrammetric documentation is however only a part of documentation of cultural heritage monuments. The results of photogrammetric survey are used by other experts, mostly from humanities, that are engaged with the monument. Visualization of results is thus very important and must enable as much as possible reliable and realistic presentation of the monument.

Photogrammetric Department of the Institute of Geodesy, Cartography and Photogrammetry in Ljubljana, has been intensively implementing new apporaches for producing metrical documentation of monuments and is the only institution in Slovenia that has been active in both developmental and practical work in the field for the last few years. Development and researches has been focused on optimization of field measurements and development of effective technological line. Emphasis has been given on production of 3D models of buildings and visualization of models. In order to achieve better efficiency some in-house developed software has been produced. Some theorethical and practical considerations are discussed in the paper as well as some examples of architectural photogrammetric projects are presented as well.

2 FROM PHOTOS TO 3D MODELS

A variety of data and results is produced during photogrammetric survey. Undoubtedly, photos of the monument are the very basic and invaluable source for metric documentation. Photos could be metric or non-metric, analogue or digital. It is very important that during a field survey some measures are made (distances, plumb lines, angles, control points etc.) that are necessary for further mapping from photos. A correspondence between these measures and photos must be well defined in order to avoid gross errors in further process. Sketches of standpoints and disposition of stereopairs are made in the field. To the authors experience, the use of electronic theodolite with laser speeds up very much the measurements of control points. Especially, when the final result is a 3D model of a building, it is advisable to measure more control points in order to assure better consistency of the model.

It is very important to produce a complete technical report of the measurements and computations and to archive photos appropriately. In case that later some errors are detected, the complete procedure could be checked once again, and in the future some additional measurements of the photos could be needed for some reasons as well.

The same set of data can be visualized differently. In close range architectural applications, mostly used visualization of the results are still vector maps of facades, ground maps and cross sections although advances in computer technology and CAD tools enable more attractive and useful visualization of photogrammetric documentation.

Photogrammetric mapping in an analytical photogrammetric instrument or digital photogrammetric workstation normally provides sets of 3D coordinates and their topology. These data are most efficiently used if 3D models are produced as the final result. Further on, 3D visualization of the buildings is also much closer to human perception than 2D maps. On the other hand, production of 3D models is more time-consuming and more expensive than equivalent products in 2D, and there are still many technological problems in the production process. It must be emphasized that there are differences between 3D modeling of photogrammetric data or architectural modeling of a new building. To our experience, the buildings of cultural heritage are, as a rule, not in regular forms (facades are not vertical, lines that should be horizontal are not, etc.) due to different reasons, thus the usual CAD tools for 3D architectural designing are not always useful. At the Institute, we use AutoCAD as a platform for producing 3D models. We developed a program named ARCHOS which has implemented different options that make production of 3D models on real data set easier (e.g. we introduce a definition of geometric plane as an entity which replace a User Coordinate System).

3D models could be produced as wireframe, surface or solid models. Different professional computer programs for visualization of models are available in the market. An efficient visualization and animation could be produced using Virtual Reality Modeling Language (VRML), since 1997 an accepted international standard for data exchange and data review in CAD systems, animations systems and programs for 3D modeling.

At its core, VRML is simply a 3D interchange format. It defines most of the commonly used semantics found in today's 3D applications such as hierarchical transformations, light sources, viewpoints, geometry, animation, fog, material properties, and texture mapping. VRML also serves as a simple, multi-platform language for publishing 3D Web pages. This is motivated by the fact that some information is best experienced three dimensionally, like architecture. Typically these types of projects require intensive interaction, animation, and user participation and exploration beyond what is capable with a page-, text-, or image-based format (i.e., HTML). VRML was designed to fit into the existing infrastructure of the Internet and the WWW. It uses existing standards wherever possible, even if those standards have some shortcomings when used with VRML. Using existing standards instead of inventing new, incompatible standards makes it much easier for the Web developer, who can use existing tools to help create VRML content. It also makes it much easier for somebody implementing the VRML standard, since libraries of code for popular standards already exist. VRML files may contain references to files in many other standard formats. JPEG, PNG, GIF, and MPEG files may be used as texture maps on objects. WAV and MIDI files may be used to specify sound that is emitted in the world. Files containing Java or JavaScript code may be referenced and used to implement programmed behavior for the objects in your worlds. Each of these is an independent standard, chosen to be used with VRML because of its widespread use on the Internet.

3 EXAMPLES

Institute of Geodesy, Cartography and Photogrammetry in Ljubljana, Slovenia, has been intensively engaged in introducing contemporary forms of photogrammetric documentation for the needs of protecting the cultural heritage in Slovenia. Most of the project were financed by the Ministry of Culture, the Cultural Heritage Office of the Republic of Slovenia, and were a part of an umbrella project entitled Surveys. Some projects were financed from the regional offices or municipalities, and the Restoration Center of Slovenia.

The basic goal of each project was to prepare photogrammetric documentation for the monument, but we also sought new and more appropriate product forms, more advanced technological solutions and improvements to the entire process. Together with the clients and conservators from regional Institutes for the Protection of the Cultural Heritage, we are building an increasingly more comprehensive system of documentation. Our development in the above mentioned projects is oriented into teamwork on projects, promotion of photogrammetry in the humanities, production of technologically advanced forms of documentation and preparation of recommendations for standards. Some recently finished projects are presented bellow. Due to limited available space, only a few graphical examples could be presented here.

3.1 Lake of Bled

On the western edge of the Julian Alps lies Bled, with its picturesque island in the middle of the lake. The town and its surroundings have been an international summer resort for centuries. A small island in the lake has some important cultural heritage building (a church is built on archaeological site) thus a quality technical documentation was needed. A 3D model of topography of the island and of it's buildings has been produced from geodetic and photogrammetric survey (Figure 1). Original documentation was prepared in AutoCAD r 14 and then transformed into VRML format. A 3D model of the complete lake and it's surrounding was produced in more generalized form as well.
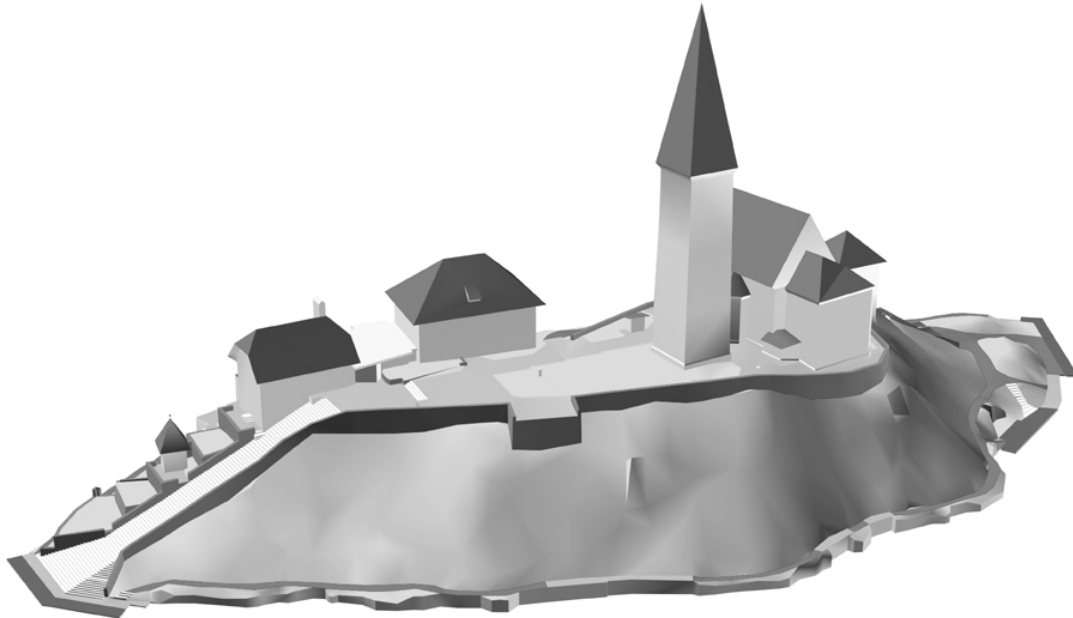
Figure 1. Lake of Bled – a 3D model of the island

3.2 Dome of Ljubljana

Dome of Ljubljana (cathedral of St. Nikolaj) is an important Slovenian baroque church. The central market in Ljubljana takes place in the vicinity of the church, which is surrounded with other buildings as well. The disposition for photogrammetric survey is difficult and a lot of traffic is all the time around the church. Thus, field measurement were accomplished during weekends and nights.

Very detailed technical documentation was produced for the church in different phases: a 3D model of the exterior and interior, maps of all facades and interior walls, digital orthophotos of frescos, many horizontal and vertical cross section, etc. Here, a 3D model of the exterior of the church (Figure 2), a vector map of a cross section of the church (Figure 3), which was produced from the 3D model and an orthophoto of a fresco (Figure 4) are presented.

A 3D model serves as a spatial reference and assures consistency of different kind of technical documentation of the church. More detailed compilation of the interior will be produced in the future (decoration, furniture, etc.). New documentation could be easily added to the existing one.

Figure 2. A 3D model of the Dome of Ljubljana

Figure 3. Vector map of a cross section of the Dome

Figure 4. Orthophoto of a fresco in the Dome

3.3 Rotunda Carmine in Koper

The central building, now known as the Rotunda of Our Lady of Mount Carmel or the Carmine Rotunda, stands on the northern side of the Cathedral of Koper. The building ranks as one of the town's oldest architectural monuments, since it was once a part of a former Romanesque church complex, which included a basilica with a crypt and baptistery. For restoration purposes, a detailed photogrammetric survey of the exterior as well as the interior of the building has been produced (Figure 5). The responsible conservator collected data on the phases of construction and on the historical development of the building, and a virtual model of the development of the monument in four stylistic periods (Romanesque, Gothic, Baroque and Forlati's presentation) has been produced as well.

Figure 5. A 3D model of Rotunda Carmine in Koper

3.4 Cloisters in Cistercian Monastry in Sticna

Three-dimensional presentation of cloisters is a difficult task. For Cistercian monastery in Sticna, a 3D surface model of the whole exterior of the building complex was produced first, and later complemented with a 3D wireframe and surface model of the cloister (Figure 6). As all the measurements were done in the same coordinate system it was easy to add new documentation into the existing model.
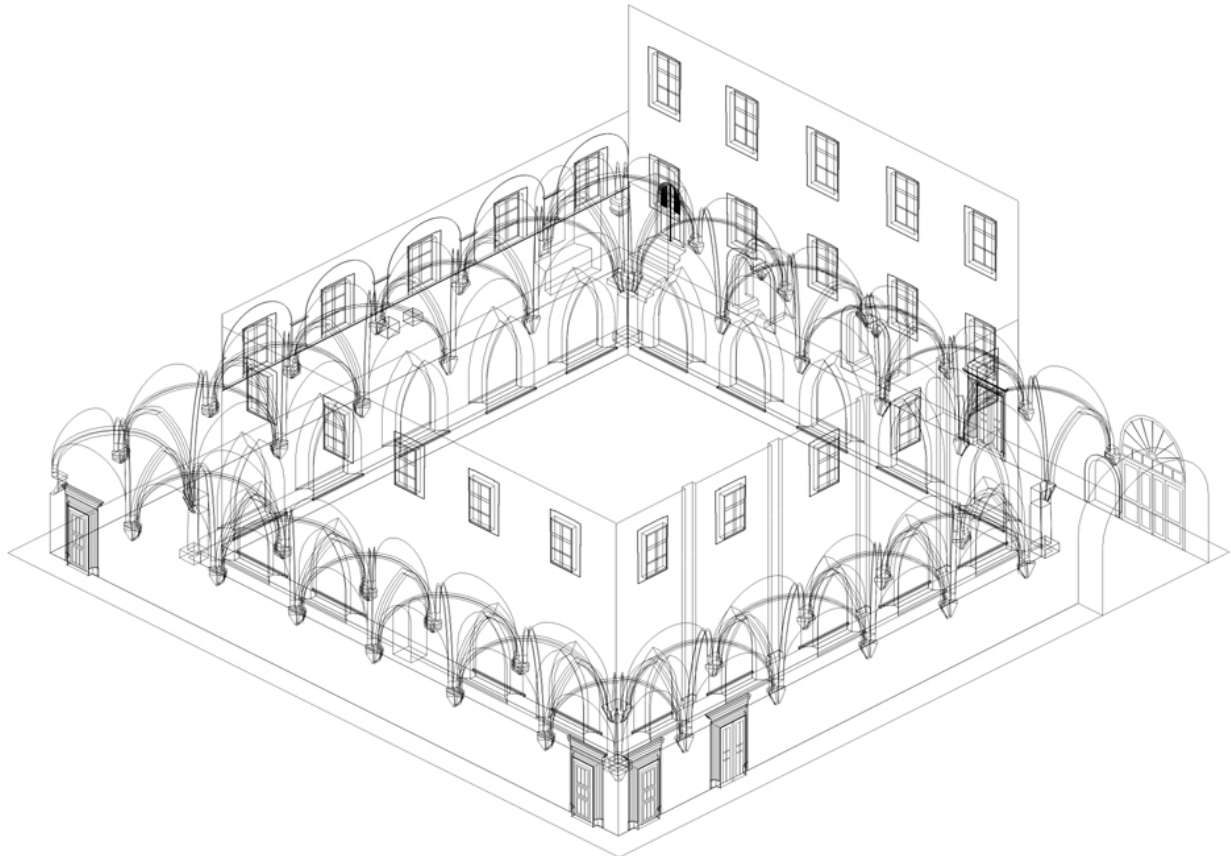

Figure 6. A 3D wireframe model of a cloister in Cistercian Monastery in Sticna

4 CONCLUSIONS

Recent advances in computer technology offer very effective tools for visualization of photogrammetric documentation. In the complete photogrammetric process it is very important to optimize all phases, from field measurements to the final results. Modern concept of photogrammetric close range survey basis on clear procedures, good specifications, knowledge transfer from photogrammetrists to users of the documentation and last but not least, full use of 3D photogrammetric data.

Especially, the authors find a VRML format for presenting 3D models very useful. Regarding visualization of models, in presented projects so far we did not take all visualization advantages of VRML format, like photo-texturing of surfaces, walk-through model, etc. This remains a challenge for our next projects.

We must be aware that photogrammetric documentation is not produced only for today's needs but also for the future, when new technologies will enable more attractive visualization. However, a good 3D photogrammetric database is a source for producing virtual reality of the monuments.

ACKNOWLEDGEMENTS

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