

THE DESTROYED MINARET OF THE Umayyad Mosque OF ALEPPO, THE SURVEY OF THE ORIGINAL STATE

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Abstract

This paper discusses the spherical photogrammetry as a metric documentation technique applied in the field of architectural and archeological heritage. the mentioned technique can obtain dimensions and shapes of the architectural geometry which could be used to create 3D models, suitable for reconstruction and restoration. The applications shown in this paper is the survey of the Minaret of the Umayyad Mosque of Aleppo in the UNESCO heritage site of ancient city of Aleppo. The Minaret was destroyed during the current civil war, but fortunately a metric photographic documentation was effected three years before for many important monuments inside World heritage sites in Syria, and this minaret is one of them. This metric documentation could be a very useful reference for a future reconstruction or restoration of those structures.

Keywords: Photogrammetry, Survey, 3D modeling, spherical photogrammetry, panorama image-based modeling

Introduction

Syria has a huge historical and archaeological heritage thus the capital, Damascus, considered to be one of the oldest cities in the world. Six Syrian sites are part of the World Heritage Site (Ancient city of Damascus, ancient city of Aleppo, Ancient city of Basra, Ancient Villages of Northern Syria, Crac des Chevaliers and the site of Palmira). Many monuments on those sites were severely damaged since 2011 due to the civil war in Syria.

The Great Mosque of Aleppo “Umayyad Mosque”, which is one of Syrian’s most famous mosques, was declared by UNESCO Director-General Irina Bokova in 24th of April 2013 for the destruction of its minaret during the clashes in the northern part of Aleppo city. This year, 2013, all of the Syrian sites are listed as World Heritage in Danger. Many panoramic photographs were captured during the visit of G. Fangi to Syria in 2010. Those photographs are used by us now to get a metric documentation using the spherical photogrammetry to produce 3D models refers to their situation before the civil war.

Main Text

The Photogrammetry is the science, and art, of determining the size and shape of objects as a consequence of analyzing images recorded on film or electronic media²²¹. The close range form of the photogrammetry is very useful for fast, economic and accurate documentation for the heritage. The advantage of using the photogrammetry for the survey is that the data acquisition is fast and simple, and the extraction of the metric information or the restitution can be done in any time after that. Many photogrammetric techniques are in use

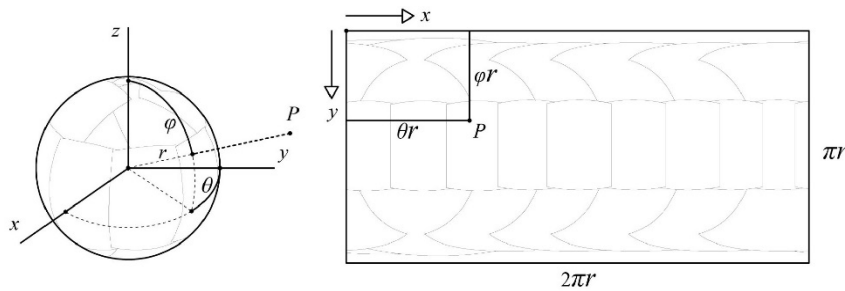
221 J.G.Fryer, 1996

today but they are different from many point of view. The spherical photogrammetry is one of those techniques and one of the fastest documentation techniques applied for huge monuments and sites it is developed by G. Fangi.



1/ Panorama of the Roman theater in the Ancient city of Basra

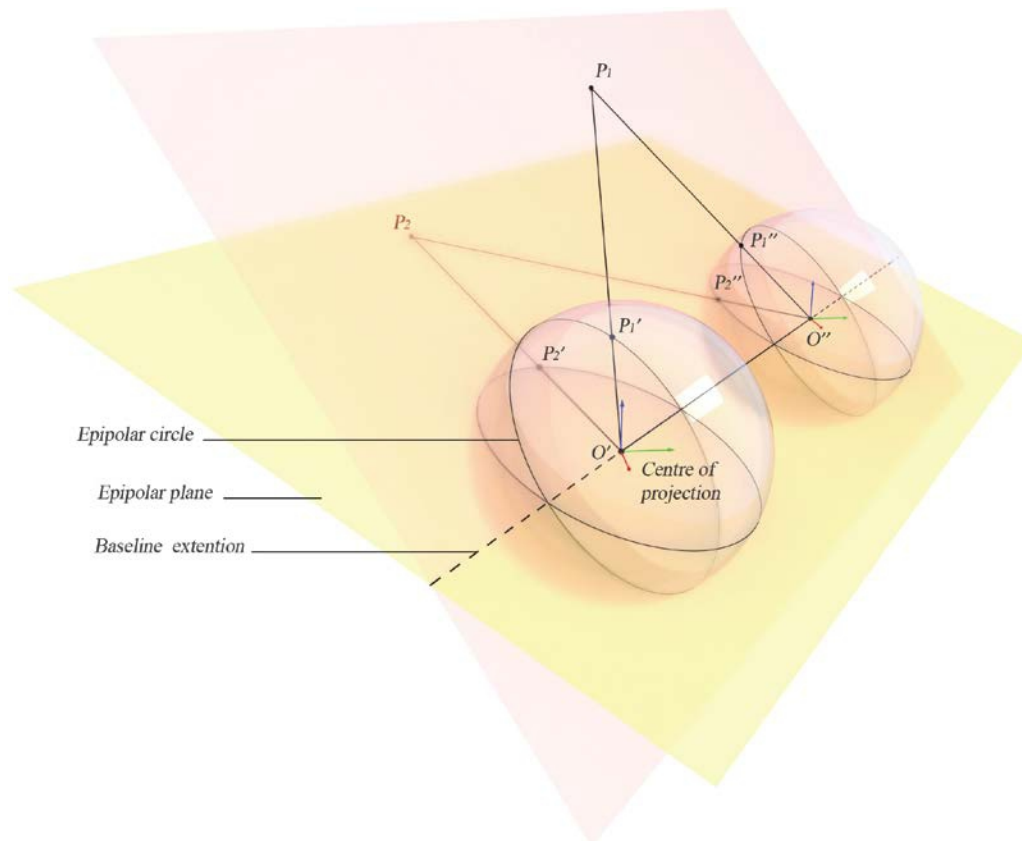
The multi-image panoramic photo is series of digital images are taken from the same point of view to cover up to 360°. The images are stuck using commercial software and projected on a sphere. The sphere is then mapped in a plane, with the so-called longitude-latitude projection or equirectangular projection. It has a great metric value for many reasons: 1. it is easy to transform between spherical coordinates system and Cartesian coordinates system; 2. it is unlimited as resolution and depends only on the used lens; 3. it has up to 360° as field of view which can cover the entire surrounding environment.



2/ Multi-image panoramic photo and equirectangular projection, transformation between spherical and planar (equirectangular) coordinates.

When we have more than one panoramic image it is possible to obtain 3D data. The first step in photogrammetry is the orientation of the panoramic photos. The orientation is an important phase of the process to define the position and rotation of all panoramas; they have to be oriented with a block bundle adjustment²²² and one measurement at least is needed to give the survey model the right scale.

²²² Gabriele Fangi, Carla Nardinocchi. Photogrammetric processing of spherical Panoramas - The Photogrammetric Record 28(143): 293–311 (September 2013) DOI: 10.1111/phor.12031 pg. 293- 311 © 2013 The Remote Sensing and Photogrammetry Society and John Wiley & Sons Ltd



3/ The epipolar Geometry of two panoramic photos

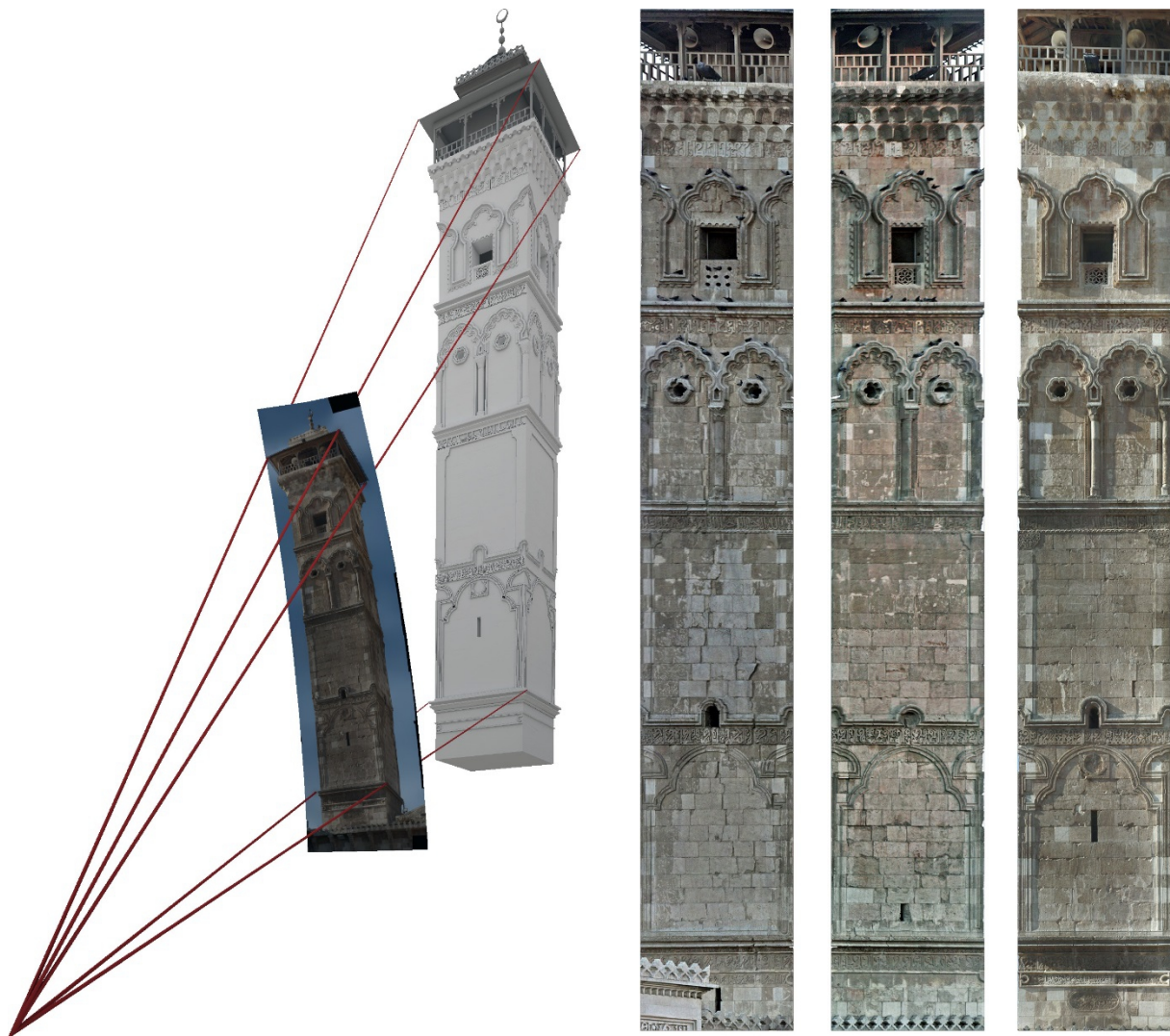
We applied this technique for the orientation of the Great Mosque of Aleppo's panoramas which was created by the Umayyad Caliphs. It is one of the world heritage sites since 1986. Its minaret, dating back to 1090, was created during the Seljuk period. It was an icon of Aleppo City for nearly thousand years, and after the reports of the complete destruction of the minaret of the Umayyad mosque of Aleppo we started to survey the minaret by means of spherical photogrammetry crating the 3D model using the high resolution panoramic photos.



4/ The situation of the Umayyad mosque of Aleppo before and during the war

About 550 photos were used to create 25 panoramas with different focal length (50 mm-200 mm). The best panoramas were chosen for the orientation, then using the orientation parameters which are six for every image, (three coordinates of the centre and three rotation angles), it was possible to create the main volume of the minaret. The depth was obtained by intersection in space using more than one panorama for every point. Therefore, the next step

was projecting the photos using spherical texture mapping in the virtual space. The obtained textured model was a rectification of the elevations of minaret in 3D space which could be itself an important metric result.



5/ Image Rectification using the 3D model and spherical mapping of panoramic photos

The details were modeled on the main minaret body in correspondence with the image projections using the so called Interactive Panoramic Image-Based Modeling method to use the 3d modeler as survey instrument. It exploits the geometrical constraints to simplify and speed the modeling. It is based on the recognition of the geometrical elements of the surveyed architecture. It is ideal technique for the architectural representation, because it produce a low-poly model rich of high resolution maps texture. Therefore, the result model make this architecture easy to read for the architect, restorer.



6/ The wireframe, shaded and textured model

The high resolution images were useful to create many details of the minaret as the relief writings which were very high. The high resolution of the panoramas is due to the focal length of the used lens which was 200 mm, but the use of such high focal length lenses involves many photos to create a single panorama.



7/ A detail of the facade of the minaret from the textured 3D model (orthographic rendering)

Conclusion

Close range photogrammetry techniques in general are very useful in emergency cases, they are fast in data acquiring, economic and produce a high accuracy textured 3d Model. Spherical photogrammetry in particular has many more advantages as the use of very high resolution image to create detailed model and the 360° FOV. The interactive Image-based modeling can be combined with the spherical photogrammetry result to a fast restitution method which can produce a high resolution textured 3D model.

Now we are working on the documentation of many other Syrian heritage sites to create metric references to a possible future restoration of those monuments. We have a partial metric photographic documentation of Basra, Palmira, Crac des Chevaliers, Umayyad Mosque of Damascus and Aleppo citadel.

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