DOCUMENTATION OF CULTURAL HERITAGE BY USING DIGITAL CLOSE RANGE PHOTOGRAMETRY

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ABSTRACT:

Conservation of historical buildings and constructions, being important parts of cultural heritage, determining the historical buildings facades is one of the main operations. Historical buildings are usually characterized by irregular geometry, very complex surface. In this context, close range photogrammetry is inevitable and has been used successfully for documentation of cultural heritage for many years. Digital close range photogrammetry is currently an effective system providing both vector and raster data type. This method is also allowing metric-morphological reconstruction of cultural heritage. Besides, documentations can be archived on paper or computer. The purpose of this paper is to provide an overall view of documentation of cultural heritage by using digital close range photogrammetry. In this paper also, operational steps and general aspects of documentation of cultural heritage are presented using the Fatih Mosque documentation project data, implemented by Division of Photogrammetry and Remote Sensing, Yildiz Technical University.

1. INTRODUCTION

Photogrammetric surveys have been used for documentation of cultural heritage and restoration of historical monuments for many years. In traditional approach, stereo photographs of historical building were taken with the stereometric camera or independent metric camera. Stereo model restitution was done by using analogue or analytical stereo plotter in traditional close range photogrammetry (Kraus, 1993). Digital close range photogrammetry offers the automatic measurement process, 3D vector data, digital orthophoto and digital surface models of historical monuments comparing to the traditional approach. 3D model generation and visualization of cultural heritage can be prepared easily by using digital close range photogrammetry products.

Rectification of a single image is successfully used and well known method of digital close range photogrammetry for plane surfaces. The photographs of historical monuments, which are taken with different camera or objective, can be transformed and merged using digital close range photogrammetry. If historical monument facades have dept differences, image rectification is not useful because of image deformation. Digital orthophotos are appropriate solution for these historical monument facades, which have dept differences (Yastikli at al., 2001). Digital orthophoto is a differential rectified photograph to remove distortions caused by dept differences of monument facades. For this reason, digital orthophotos have same geometric accuracy as a line map.

Other solution for historical monument facades, which have dept differences, is stereo plotting. In many photogrammetric documentation projects, an expected final product is still 1:50 or 1:100 scaled historical monument plan. Using digital close range photogrammetry, 3D vector plan of monument facades can be prepared and plotted at any scale.

Operational steps of documentation of cultural heritage by using digital close range photogrammetry are consisted of geodetic measurement of control point and historical monument environment, photogrammetric image acquisition and stereo restitution. In this study, documentation of Fatih Mosque and its operational steps are presented by using digital close range photogrammetry, implemented by Division of Photogrammetry and Remote Sensing, Yildiz Technical University. The objective of the Fatih Mosque documentation project is preparation of 1:50 scaled plan of mosque facades. Details of these operational steps are discussed in detail using Fatih mosque documentation project.

2. GEODETIC MEASUREMENT

The measurements of historical monument environment and control points coordinates are essential work. In Fatih mosque documentation project, 1:1000 digital maps of Fatih Mosque and its environment are available (Figure 1). Especially, measurements of control points coordinates have vital importance for stereo model restitution. In general, signalised points and natural points are used as control point in close range photogrammetry.

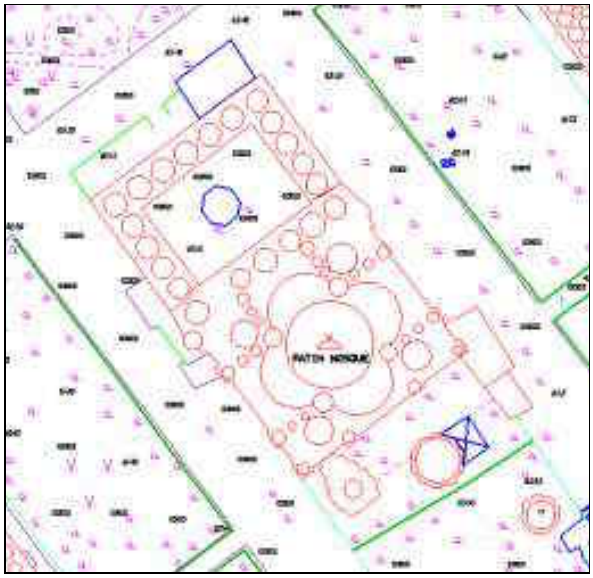

Figure 1. Digital maps of Fatih Mosque and its environment

The signalised points with size of 10 cm x 10 cm were established on Fatih mosque facades surfaces (Figure 2). In addition, natural points coordinates were measured on some region of facades. The coordinates of signalised points and natural points were measured with Topcon total station. Approximately 350 signalised control points and natural points were measured for stereo restitution. During this measurement, local coordinate frames were defined for each facade. The X-axis of coordinate frames was parallel to the facades.

Figure 2. The signalised points

3. PHOTOGRAMMETRIC IMAGE ACQUISITION

The stereo photographs of Fatih Mosque facades were taken in normal case with semi-metric Rolleiflex 6008 of Department of Photogrametry and Remote Sensing, Yıldız Technical University (Figure 3). The stereo photographs of some facades were taken in parallel-averted case because of limitations due to trees and other buildings (Figure 4). Two different objectives with focal length of 80 mm and 150 mm were used for photogrametric image acquisition. During to image acquisition base to distance ratio was selected between 1/7 to 1/10 for better depth interpretation. Approximately 230 photographs were taken at different scale. The whole taken images of Fatih Mosque facades have been scanned with 21 μm pixel size as RGB.

Figure 3. The normal case photograph of Fatih Mosque northeast facade

Figure 4. The parallel-averted case photograph of Fatih Mosque southeast facade

4. STEREO RESTITUTION

Stereo photogrammetric restitution is traditional approach for close range photogrammetry. In Fatih Mosque documentation project, digital photogrammetric workstation is used for stereo restitution. Stereo plotting is preferred because of dept differences on Fatih Mosque facades.

For stereo model generation and stereo plotting digital photogrammetric workstation of Department of Photogrametry and Remote Sensing, Yıldız Technical University have been used. Digital photogrammetric workstation has two separate monitors. One monitor is used for stereo display and second monitor is used for additional information and graphical user interface. Stereo viewing is achieved by liquid crystal glasses and the infrared emitter on top of the monitor. 3D pointing

device allows operator 3D digitising of stereo models (Schenk, 1999).

PHODIS ST 30 digital photogrammetry software is used for generation of stereo model of Fatih Mosque facades. The camera calibration parameters of both 80 mm focal length and 150 mm focal length objectives were defined to the program using camera calibration protocols. Inner orientation of images was performed manually for transformation of pixel coordinates to image coordinates. Sufficient numbers of tie points were measured manually for relative orientation of images. Sigma naught of relative orientation is better then 8 μm for whole stereo models. For absolute orientation measured signalised control points and natural points coordinates in local coordinate frames were used as control point. The definition of coordinate axis of control points was changed because, Y-axis corresponds to the Z-axis and Z-axis corresponds to the Y-axis in normal case close range photogrammetry. Sigma naught of absolute orientation is better then 7 mm for whole stereo models. Distribution of control points and tie points for stereo model 1 in northwest facade of Fatih Mosque is shown in Figure 5.

Figure 5. Distribution of control points and tie points for stereo model 1 in northwest facade

After generation of stereo models, detailed 3D vector plotting of facades were achieved manually by experienced operator. MicroStation(Bentley) software was used for 3D vector plotting of Fatih Mosque facades as CAD software. The examples of 3D vector plotting are shown in Figure 6 and Figure 7. 3D models of Fatih Mosque can be generated using digital images and 3D vector data. This task is out of this documentation project scope. 3D model of Fatih Mosque is also generated for the research purposes. Detailed description of this research study can be found on Yastikli at al., (2003).

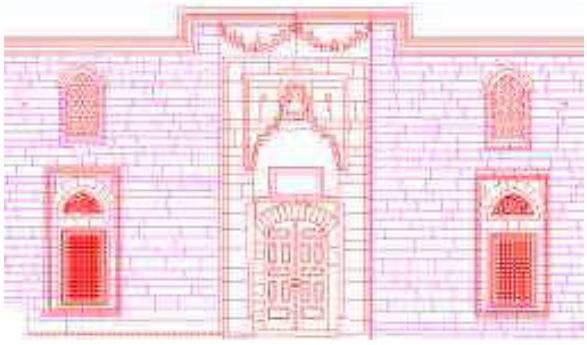

Figure 6. 3D vector plotting of Fatih Mosque northwest side

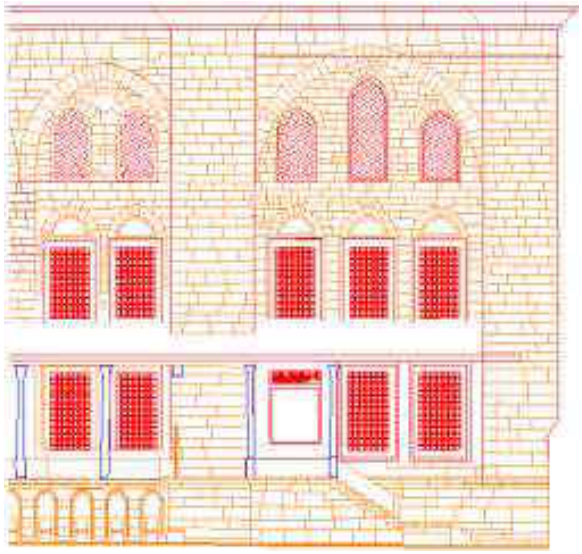

Figure 7. 3D vector plotting of Fatih Mosque southwest side

5. CONCLUSION

Close range photogrammetry has been used successfully for documentation of cultural heritage for many years. Digital close range photogrammetry is currently an effective system providing both vector and raster data type. Operational steps of documentation of cultural heritage by using digital close range photogrammetry are consisted of geodetic measurement of control point and historical monument environment, photogrammetric image acquisition and stereo restitution. In this paper, operational steps and details of Fatih Mosque documentation is presented. Digital close range photogrammetry is an effective system for documentation of cultural heritage. The products of digital lose range photogrammetry can be used for 3D model generation and visualisation of cultural heritage.

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