

DOCUMENTATION OF THE SILHOUETTE CHANGES OF ISTANBUL USING DIGITAL PHOTOGRAMMETRIC METHODS

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ABSTRACT

Istanbul is the one of the most historical cities in the world. The Istanbul Cultural and Presence Committee in Turkey have declared some old areas of the city as an historical area for the protection of her old structure. Obtaining the silhouette of these areas is one of the steps of this protection procedure. The silhouette of the old city called historical peninsula and the both sides of Bosphorus are documented using photogrammetric methods. This documentation campaign will be repeated every three-year and silhouette changes will be controlled by the Istanbul Greater City Municipality. Rollei flex 6008 metric camera was used and pictures at predefined stations are taken and stereo models of the related areas are obtained and evaluated by Phodis ST System. The geodetic measurements for the control points are done by the quickest and reliable surveying methods. The result of the project is the scaled and defined silhouette of the area. The obtained silhouette is compared with the last one obtained before three years ago and changes are documented. The silhouette is defined for all the campaigns as the projection of the photogrammetric obtained 3D silhouette onto the plane, which is vertical to the camera direction.

1. AIM OF THE STUDY

Istanbul is the one of the most historical cities in the world. The Istanbul Cultural and Presence Committee in Turkey have declared some old areas of the city as an historical area for the protection of her old structure. Obtaining the silhouette of these areas is one of the steps of this protection procedure. The silhouette of the old city called historical peninsula and the both sides of Bosphorus are documented using photogrammetric methods. This documentation campaign will be repeated every three-year and silhouette changes will be controlled by the Istanbul Greater City Municipality using these 1/500 scaled silhouette maps. The project has been put out to tender and EMI Mapping and Information Group has acquired the adjudication under the supervision of the Photogrammetry Department of TU Istanbul. The project consists of three different steps:

- The 1/500 scaled silhouettes of the coasts of the historical peninsula using terrestrial photogrammetric methods
- The photogrammetric documentation of the historical streets and public open places
- The silhouette map production work to control the silhouette changes on the both sides of Bosphorus

2. THE SILHOUETTE FEATURES

The silhouette is a concept, which can only be fixed with predefined features. The silhouette belonging to a specific area can be obtained differently according to the predefinitions. The parameters of these definitions are the distance to the object, the height of the station and the plane, on which the silhouette are

projected. By this project, the silhouette points are obtained by means of photogrammetric methods in the object coordinate system and transferred to the Macro station to be able to be drawn. The silhouette points are then projected on to a plane, whose specifications are predefined. By this work a plane perpendicular to the direction from the object to the camera has been chosen.

3. DIGITAL PHOTOGRAMMETRIC METHOD

Digital Photogrammetric methods have greater advantages compared to analogue systems as better stability (geometry and radiometry), greater accuracy, and the ability to process images. It is also possible to display vector data in the images on the screen and to produce transformed images (rectification, orthophoto).

For these reasons, digital photogrammetric method has been chosen for the silhouette projects of Istanbul.

A detailed plan was designed for the silhouette study of the ancient part of Istanbul and according to this plan 255-control points (Figure.1) has been signalled on the Marmara and Golden Horn shore inside of the city walls. This ground control points has been measured with Total Stations and their coordinates established. And then GPS supported transformation to the land coordinate system has been realized. In this study, the photographs have been taken with Rollei flex 6008 camera on the boat from the sea. The relation between the focal length of the used camera and the image formats is shown in Figure 1. Figure 2 shows the same area taken with different focal length objectives.

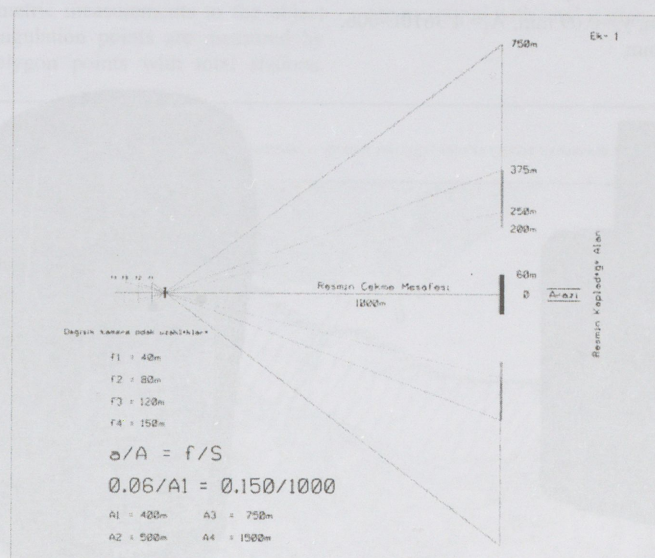


Figure 1: The relation between focal lengths and image formats

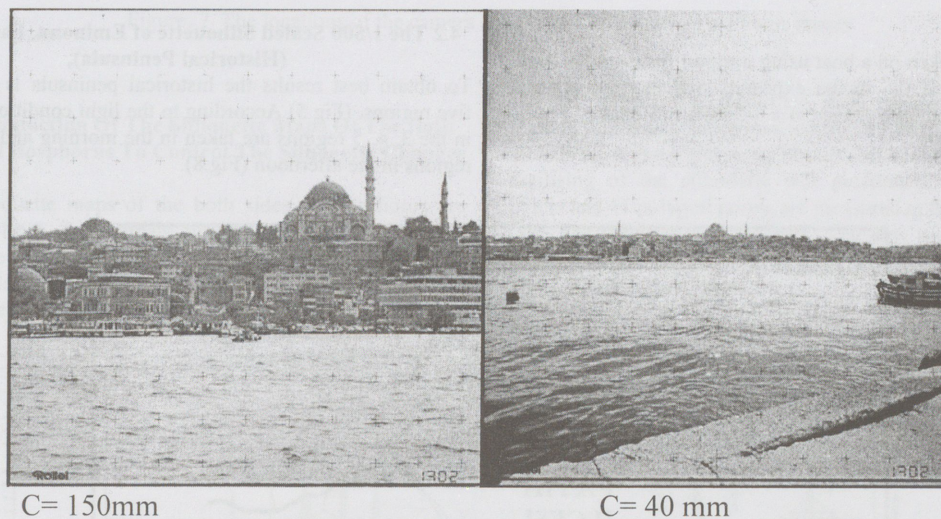


Figure 2: Images of the same area taken with different focal lengths

3. PHOTOGRAMMETRIC EVALUATION

Phodis ST Stereo Evaluation software has been used at the project. Phodis ST is software in the Zeiss PHODIS Photogrammetric Digital Image System. This software is used

- To form the digital image based stereo models,
- To visualize the stereo models on the screen with 3D floating mark,
- To draw the measurement results with stereo super imposing using Phocus, Micro station and CadMap software

The components of the system are the computer with Unix System, stereo visualisation system and the special P mouse. The source data are the digital images, camera information, control points and the model set up information.

3.1 Forming The Stereo Models

In spite of the images are taken with terrestrial cameras, the evaluation is performed using stereo evaluation software. The evaluation has been done using developed soft wares with stereo models because of the object being not a plane surface and having different y distances. The 6cm*6cm formatted images taken with terrestrial camera are scanned with 14 micron pixels in tiff format and transferred to the computer media.

4. APPLICATION

4.1 The Used Camera

Rolleiflex 6008 metric camera with Sonnar 4/150 mm-objective Fig.3 is used to obtain the silhouette. The calibration has been performed in 24.05.2002 in the factory in Germany and the calibration results are delivered with a protocol. According to this protocol the interior orientation elements are as follows:

$C = 150.89 \text{ mm}$, $x_o = -0.07 \text{ mm}$, $y_o = 0.09 \text{ mm}$, $A_1 = 4.3610\text{E}-006$,
 $A_2 = -1.4900\text{E}-009$, $R_o = 20.00 \text{ mm}$

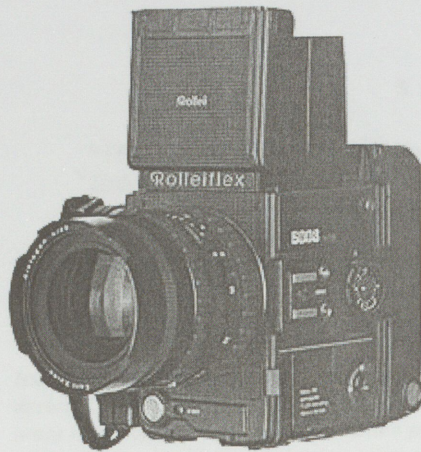


Figure 3 Rolleiflex 6008

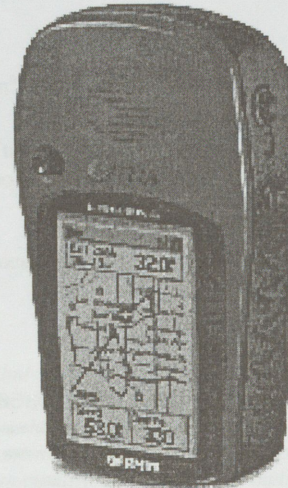


Figure 4 Etrex legend GPS device

The images are taken on a boat using a tripod fixed on the boat. The coordinates of the image exposure stations are obtained with a Etrex legend GPS device in $\pm 3\text{-}5 \text{ m}$ error limits.

4.2 The 1/500 Scaled Silhouette of Eminonu, Fatih Coastes (Historical Peninsula),

To obtain best results the historical peninsula is divided into five regions. (Fig.5) According to the light condition the images in the 3, 4, 5 regions are taken in the morning and the 1. and 2 regions in the afternoon (Fig.8).

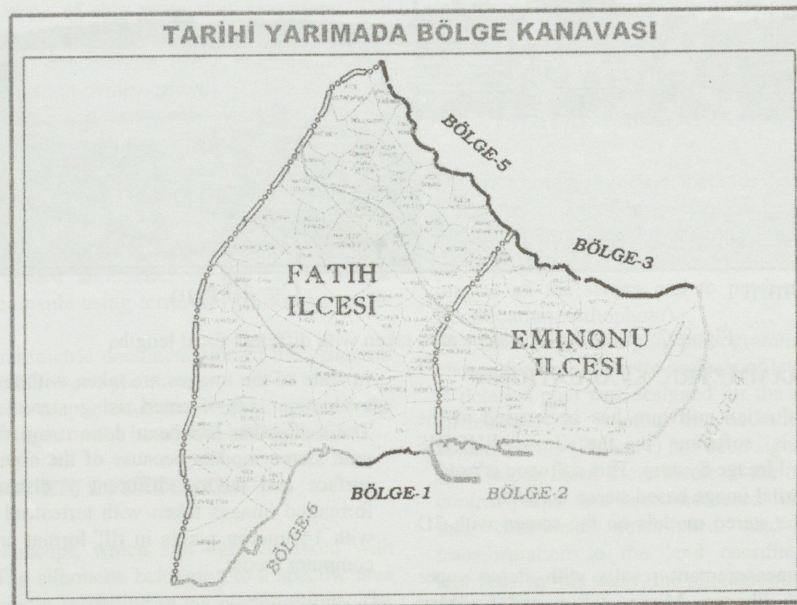


Figure 6 The five regions of the Historical Peninsula

Totally 331 images are taken for the historical peninsula. The sketch below shows the planned exposure stations of the images at the Eminonu and Fatih shores (Fig.7).

4.3 Geodetic Measurements

18 triangulation points and connected to these points 32

polygon points are established in the whole region to obtain a net to relate the photogrammetric measurements to the object coordinate system. The triangulation points are measured by means of GPS and the polygon points with total stations.

Besides 101 selected points being able to identify in the images are measured with total station.

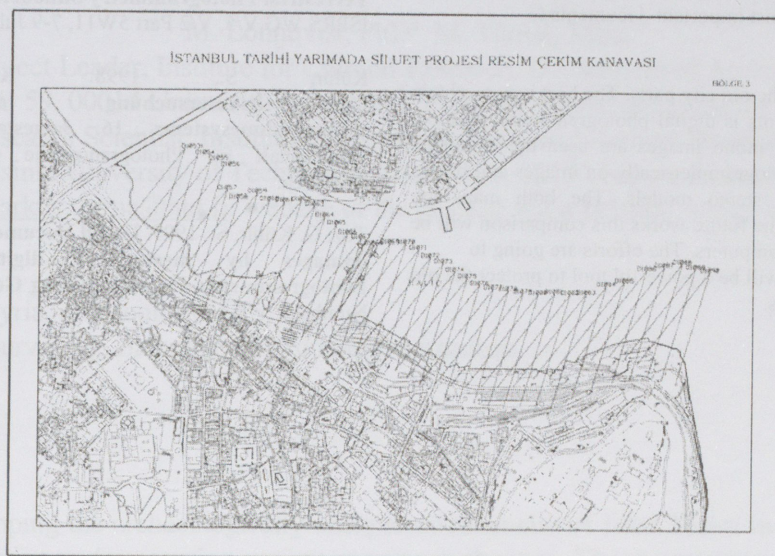


Figure. 7 The locations of the camera stations at the Eminonu and Fatih shores

4.4 The Production Of The Silhouette Maps Of The Both Sides Of Bosphorus To Control The Silhouette Changes

The first silhouette maps of the both sides of Bosphorus are produced in 1998. To compare the silhouette maps the same conditions are followed. Therefore for the new maps the object distance is selected as the same of the former maps as 750-1000 m. The selected objective for this work was a Sonnar 4/ 150 mm

and the camera was Rolleiflex 6008 metric. Bosphorus was divided into four regions and totally 559 images are taken. 439 models are formed and using Phodis software three-dimensional digitising of the silhouette was performed. 19 triangulation points and 41 polygon points are measured at this regions and GPS and total stations are used. The new produced maps are coincided with the 1998 dated maps and the silhouette changes are obtained and digitised.

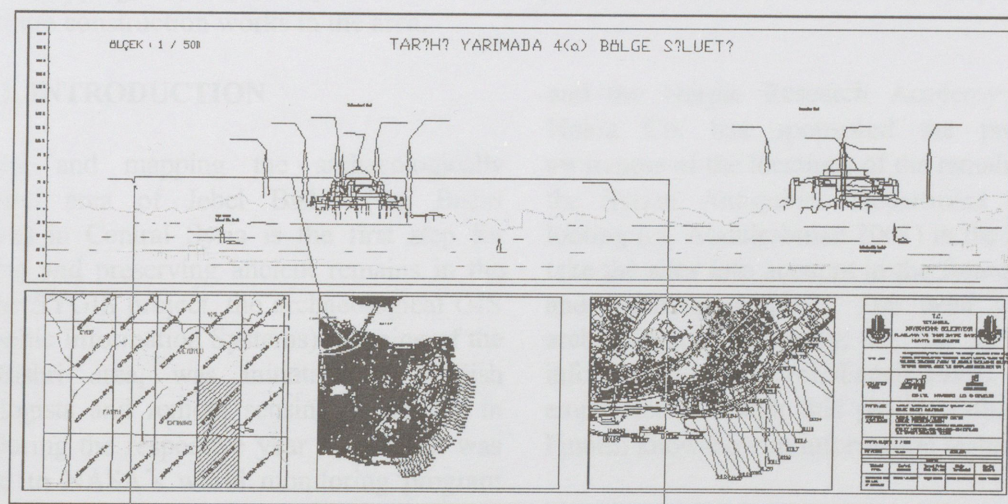


Figure. 8 A map of the Silhouette of the historical Peninsula

5. CONCLUSIONS

Istanbul is one of most important cities in the world and therefore was always the focus of the people. The first silhouette project was produced in 1998 and the second in 2003. These projects are the most important documents to

protect the structure of the old city parts. The best way to obtain these important documents is digital photogrammetric method. By the first project the mono images are used the silhouette points are measured photogrammetrically on images and by the second project on the stereo models. The both maps are compared manually, in the future works this comparison will be done automatically by computers. The efforts are going to this direction. And this will be a powerful tool to protect the old structure of ancient cities.

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