

DOCUMENTATION OF A HISTORICAL STREETScape WITH CLOSE RANGE DIGITAL PHOTOGRAMMETRY

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ABSTRACT:

This study explores a methodology for documentation and visualization of historic streetscapes in the context of preservation discipline, and focuses on the potential of rectified image mosaics within the context of single image rectification option of close range digital photogrammetry. Necatibey Boulevard, Izmir, Turkey, which is situated in the urban retail core of the city, is selected as the case study for testing the proposed methodology. Comparison with conventional ways of documenting historical street facades is also provided. Documenting the street facades of this mentioned urban site is a prerequisite for taking preservation decisions. Within the objective of the study, rectified image mosaic showing the present conditions of the Necatibey Boulevard and thematic representations prior to conservation decisions are produced. In turn, the historical evolution of the streetscape and the changes through time is assessed. The produced guidelines can be easily applied for documentation of historic facade series prior to conservation decisions of street rehabilitation projects. The comparison of the rectified image mosaic with 2D elevation have pointed out that the former is a realistic way for the representation of architectural details, colors and textures. The changes of the street in time are also better perceived. Moreover, the production of the digital image mosaics of the historic street facades can also be useful for production of urban databases.

1. INTRODUCTION

Heritage city is a selling point advantaged as touristic centers. Strategies for the successful downtown of the 21st century are developed (Litvin, 2005). Many contemporary municipalities of historic cities in Turkey are also working to preserve and revitalize their downtown retail cores as their architectural significance is recognized as potential magnets for touristic shopping (Orbaşlı, 2000). As a commercial and historic destination, the city of İzmir provides many attractions. The city offers large preserved historic areas at its center for both the citizens and the tourists. Documenting these areas is a prerequisite for taking conservation decisions. Another important input of a historic street rehabilitation project is the deciphering of the historical timeline of the studied street (Feilden and Jokilehto, 1993). The visualization method of the historic data should be selected correctly, in relation with the necessities of the conservation project.

1.1 Aim and Method

Today, many modern technologies and related methodologies are developed for documentation of cultural heritage. However, the selection of the most appropriate ones for the necessities of a specific case considering the necessities of the conservation project becomes more important. This paper aims to define a methodological way for producing image mosaics both for deciphering the timeline of a selected

streetscape and also for analyzing it prior to conservation decisions. This study proposes guidelines to support the decision making phase of conservation problems in 1/200 scale and explores a methodology for documentation and visualization of urban historical heritage, and focuses on façade series within the context of single image rectification option of close range digital photogrammetry. The photogrammetric principles are combined with the basic principles of architectural restoration discipline.

It is claimed that rectified image mosaics based on close range digital photogrammetric evaluations have the advantage of the reduction of the site survey time and the possibility of viewing the photorealistic details on scaled images compared to the conventional elevations drawn on the basis of tacheometric recording often used in the documentation of street facades. Thus, the result visual description of rectified image mosaic and thematic representations provide better perception of the conservation problems and useful information to the architect-restorer for conservation decisions. Thematic representations had been produced in order to test the appropriateness of the rectified image mosaic for illustrating analytic information. The proposed themes are prior to street rehabilitation projects; nevertheless, the study does not involve any conservation decision.

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The proposed guidelines can be discussed under two headings as data acquisition and data processing (Figure 1).

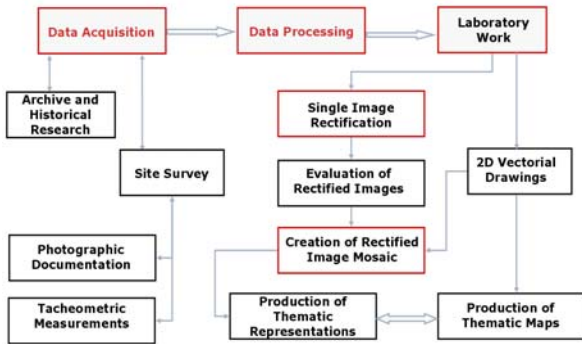


Figure 1. Information flow chart

Firstly, photographic documentation considering the principles of single image rectification was carried out. The photographs of each plane of the façades were taken as parallel to the facade as possible. A tripod was used to increase the quality of the photographs and to align the camera accurately. The upper parts of the façades were photographed from the buildings at the opposite side so that the vertical tilt could be minimized. Totally, 96 photographs were taken for the eastern facade of the Necatibey Boulevard. At the same time, tacheometric measurements were made with a reflectorless total station. The distance to the object, the height of the station and the plane are important parameters in the photogrammetric documentation. The surveying network had been adjusted in a local reference system. Approximately seven control points were measured for each photograph. Natural points such as a window corner, end of a crack or a corner of a casing, etc. were used as control points. Archive and historical research was carried out as the second part of data acquisition. In turn, the historical timeline of the street would be determined. The historical research focuses on 19th and 20th centuries in which the present buildings in the case study area were constructed. The information on the buildings which are not present today was gathered from the written documents.

After all the data needed had been collected; they were evaluated in the laboratory. Single image rectification was made with Pictran photogrammetric evaluation software as the first step of data processing. Afterwards, the rectified images were evaluated. At the same time, 2D graphics were produced in order to complete the skyline curvilinear surfaces such as domes and towers which can not be rectified. As the result, the rectified image mosaic showing the present conditions of Necatibey Boulevard was produced. Moreover, themes were represented on the rectified image mosaic. Both the rectified image mosaic and thematic representations were vectorized in order to obtain conventional 2D drawings. The result descriptions were compared with each other and the advantages and disadvantages of the proposed methodology are discussed.

The tools used in the study can be summarized as follows: Nikon D70 Digital SLR camera whose 28 mm lens was calibrated, Topcon GPT-7005i electronic tacheometer are the tools that were used for site survey. Turning to laboratory work, Topcon Link control point management software, Pictran Release 4 photogrammetric software which is a

Windows based software that translates control points and photographs to 3D models and also rectifies images, AutoCAD 2007, and Adobe Photoshop CS2 are the tools that were used.

1.2 Literature Review

Previous researches on the techniques of documentation, especially the ones focusing on the documentation of historic street façades have been evaluated. Within this context, the literature review can be discussed in three main groups: Firstly, there are studies that make use of combined techniques for heritage documentation, in which the digital photogrammetry, direct and indirect methodologies were utilized (Amorim, 2007; Ballabeni, et al. 2007). Also, the studies which consider on the integration of different geometrical data are also evaluated within the context of conservation projects. The techniques of laser scanning, topographic survey and photogrammetric survey are combined for documentation of a historic city center (Oreni, et al. 2007). Secondly, some other studies make use of photogrammetric technique for documentation of historical city silhouettes; however, the emphasis is on urban scale as 1/500 (Külür, et al. 2003). As the last, there are studies consider on the adoption of spatial and non spatial data into GIS (Erdem, et al. 2003; Nayci et al. 2003). The attempt of integrating the technological developments and the necessities of urban development projects in order to define a documentation method specific to heritage data has been found valid. However, the emphasis is on 1/1000 and 1/500 scales.

2. THE CASE STUDY AREA

The case study street, Necatibey Boulevard, which is between Fevzipaşa and Gazi Osman Paşa Boulevards in Izmir in Turkey, is situated in the urban retail core of the city. Its eastern facade between the Mimar Kemalettin Street, which has been declared as the fashion center of the 21st century of Izmir, and Gazi Boulevard was selected to test the proposed methodology.

2.1 Historical Evolution of the Case Study Area

Izmir is an important harbor city of East Mediterranean which has preserved its importance through the centuries (Baykara, 1974). Starting with the 17th century, international trade played role in the rapid development of Izmir. The city became a major spot for foreign merchants (Kuban, 2001). Many of these merchants, known as Levantines, settled in the city (Baykara, 1974). In the 19th century, Izmir became a rapidly developing harbor city. At the same time, the old harbor had been filled in and the trade center had been enlarged to fill this new zone. The city's architectural character changed a lot in this period (Kuban, 2001). After the infill of the harbor, the historical commercial center extended to the case study area (Atay, 1995). Especially, after the second half the 19th century, Levantines and the minorities dealing with commerce erected their commercial buildings, houses and religious buildings at the north of Kemeraltı on the coastal area (Kuban, 2001). After the great fire of Izmir in 1922, a new urban plan is prepared. This zone of the city was replanned and the commercial core of the city started to be constructed (Bilsel, 1996). The case study area and its close-by surrounding was one of the important public spaces in the new urban plan. Many commercial buildings

representing the architectural characteristics of the period were constructed in this zone (Kuyulu, 2000).

2.2 Present Architectural Characteristics of the Case Study Area

Today, the selected streetscape and its surrounding consist of commercial buildings dating 1920s, which represent the architectural characteristics of Early Turkish Republican period, and then 1950s onwards (Figure 2). Especially the ones constructed in 1920s are valuable with their architectural characteristics; however, some alterations and conversions are identified on the façades because of the unconscious usage and the change of the lifestyles.



Figure 2. Necatibey Boulevard as viewed from Mimar Kemalettin Street

3. GUIDELINES

The findings of this documentation process were evaluated and discussed under three main headings as guidelines for data acquisition, guidelines for data processing, and guidelines for evaluating the case study. The guidelines that should be followed in each process are pointed out.

3.1 Guidelines for Data Acquisition

The process of data acquisition constitutes phases of site survey in which photographic documentation and tacheometric measurements are made, and archive and historical research (See Section 1.1).

Photographic documentation is the first part of the site survey. Photographs must be taken considering the principles of single image rectification. While shooting the photographs, the following points should be considered: A calibrated camera should be used. An advanced digital camera is recommended. The number of photographs required for the production of rectified image mosaic should be decided. The scale of the photograph is important. So, the maximum shooting distance should be decided. Tilts should be avoided as much as possible. In other words, photographs which are parallel to the façade surface are desired. It is better to shoot with a tripod because a better quality can be achieved. Slightly overlapping photographs are desired. Every façade plane at different depths should be shot separately.

The second part of the site survey is tacheometric measurements. The following points should be considered

during tacheometric works: Electronic tacheometer should be set up in appropriate position according to façade planes. To have an accurate result, minimum 4 control points for each photograph of a single plane must be measured. Natural points such as a window corner or end of a crack or corner of a casing can be used as control points. Special importance should be given for homogenous distribution of these control points. The surveying network should be adjusted in order to create a local reference system (Figure 3).



Figure 3. Station points used during tacheometric measurements

The second part of the data acquisition is archive and historical research. The history of the single buildings on the selected streetscape and historical evolution of the case study area must be investigated. In this context, following steps were followed within the study. Published material in periodicals and books were gathered. The Archives of the İzmir Number One Regional Conservation Council of Cultural and Natural Wealth, and Konak Municipality were used to reach historical documents such as inventory sheets, images and old measured drawings.

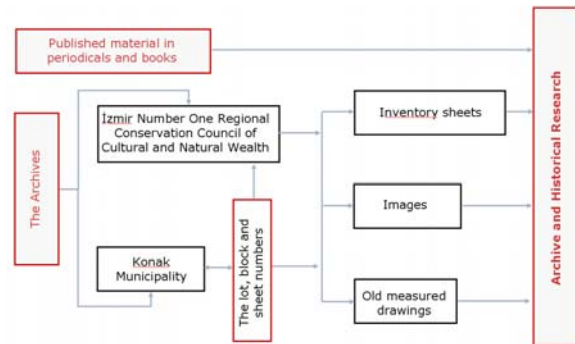


Figure 4. Information flow of archive and historical research

3.2 Guidelines for Data Processing

After gathering all the data needed, they should be evaluated in the laboratory. As the first step, both 3D point data and the photographs must be transferred to the main computer, and then they should be evaluated with the use of Topcon Link

control point management software and Pictran photogrammetric software. Secondly, images should be rectified one by one and saved as “jpeg” files. The rectified images should be evaluated in Adobe Photoshop and the ones which are truly rectified must be selected. Thirdly, the rectified images belonging to a single façade should be scaled and brought together. These rectified images must be stitched according to the skyline and the relations between architectural elements. Then, the skyline and curvilinear surfaces could be illustrated with 2D drawings; so graphics should be produced in AutoCAD. By this way, the rectified image mosaic can be completed.

The rectified image mosaic is also found as a sufficient underlay for illustrating thematic information. In this frame; the themes to be presented should be decided. The example given here shows the themes proposed in this study as restitution phases and intervention decisions. Then, the related concepts should be classified. Here is another example given for intervention decisions as, elements that should be removed, elements that should be redesigned and elements that should be added. As the last step, the selected thematic concepts should be illustrated on the rectified image mosaic.

3.3 Guidelines for Evaluating the Case Study

Within the context of a conservation aimed documentation, values and problems specific to a case study should be put forward on the basis of the gathered and processed data (Orbaşlı, 2008). These are as follows for the studied street.

The present image of Necatibey Boulevard is valuable with its architectural characteristics; however, loss of original elements, alteration of original openings, and addition of unqualified masses and elements indicate the conservation problems.

The alteration analysis shows that renewal of the double storied Early Republican buildings with multi story ones at the center of the studied streetscape, alteration of the proportions of the openings on the ground floor and some element additions are the major alterations that have changed the scale of the area. The present banners of the shops, the external units of the air conditioners and unqualified iron railing at the windows of upper floors indicate the minor alterations.

Within the light of the alteration analysis, and archive and historical research, historical reconstructions of the streetscape are generated. So, the timeline of the streetscape can be defined in three phases as; Today, 1960s and 1930s (Figure 5).

These historical reconstructions show that the buildings constructed in 1920s and at the beginning of 1930s are mostly two or three storied ones representing the characteristics of First Nationalist Architectural Style. In 1950s and 1960s, the ones in lots numbered 16 and 17 in block numbered 957 were demolished and modern multi-storey ones were constructed in these lots. It can be said that the element alterations mentioned before have taken place after 1960s in the recent years.



Figure 5. The timeline of the streetscape

In addition, on all façades excluding Kısmet Khan, which is recently restored, there are elements; that are proposed to be removed such as banners, external units of air conditioners and iron railings and there are openings that are proposed to be redesigned. Moreover, for the streetscape, new elements should be designed such as outdoor signs, street lightings in order to create a continuum at the entire façade series.

3.4 Assessment of the Guidelines

The findings of each step are evaluated within the context of conservation aimed historic street façade documentation. The following guidelines are considered important:

Four or five control points are sufficient for rectification of a single image. Nevertheless, additional 3D point measurements were made in this study. These points were used in order to control the precision of rectified image mosaic. The additional 3D point data proved that the rectified image mosaic is adequate for documentation in 1/200 scale.

In image rectification; the photographs with unavoidable amounts of tilt are rectified with less precision when it is compared to the photographs with a small amount of tilt.

Another problem is the difference in light values in each rectified image. This sometimes led to different brightness problem on a single facade. The adjustments of the rectified images were evaluated in Adobe Photoshop; however, a limited correction could be made since large amounts of corrections in hue or saturation give way to an unrealistic image. It should be noted that one should choose rainy or cloudy days for photographic documentation in order to have a homogenous rectified image mosaic.

A combined image is created for the façades consist of planes belonging to different depths by a single rectified image. It was duplicated, the related parts were defined and cropped in Adobe Photoshop and set in appropriate positions on the façade. These positions were redefined with coordinates gathered by tacheometric measurements. Then, missing parts on the base image were in filled by a well matched color

Completing the skyline was necessary with 2D drawings produced in AutoCAD, since the masses composing the

skyline can not be conveniently photographed for rectification. The 2D drawings were also used for curvilinear surfaces which could not be rectified such as domes and cylindrical mass. The dimensional information of these parts was gathered by tacheometric measurements.

Some of the environmental elements such as parked cars, people, trees and street lightings can cause the problem of hidden areas; nevertheless, one can perceive the environmental characteristics better than the surrounding elements are also involved in the rectified image mosaic. The photographs gathered as the result of photographic survey were assessed according to the size of hidden areas in each. Then, the ones in which the angle of shots minimize these areas were selected. In the stage of production of rectified image mosaic, the environmental elements such as trees and cars were completed when there was discontinuity in the mosaic. So, the angle should be taken into consideration, while shooting the photographs for minimizing these hidden areas during photographic survey.

The rectified image mosaic should be evaluated with reference to the concepts of the discipline of architectural conservation. In turn, conservation values and problems can be clarified.

Comparison of the rectified image mosaic with 2D elevation proved that the visual information comprehended in the mosaic is realistic data. The architectural details, materials, colors and textures are presented in rectified image mosaic while 2D elevation has an abstract description. The thematic information illustrated on the rectified image mosaic gives way to the better perception of the themes (Figure 6). At the same time, the timeline of the streetscape can also be better understood with the realistic media that is produced.



Figure 6. Comparison of the thematic representation of intervention decisions with 2D thematic drawing

The advantages and disadvantages of the proposed methodology are best understood with the comparison made between the proposed photogrammetric and the conventional tacheometric works used for documentation of historic street façades. Same amount of people (2 people for site survey, and 1 person for laboratory work) is needed for both proposed photogrammetric and conventional tacheometric work; however, the required time is less in photogrammetric works (64 hours) than it is in tacheometric works (98 hours).

4. DISCUSSION AND CONCLUSION

This study was carried out in order to explore a methodology for documentation and visualization of historic facade series within the context of single image rectification option of close range digital photogrammetry. Rectified image mosaics deciphering the timeline of a selected streetscape, Necatibey Boulevard, and thematic representations prior to conservation decisions are produced. The principles, advantages and disadvantages of the proposed methodology are defined.

Amount of control points, light conditions of the photographs, planes at different depth, skyline, curvilinear surfaces and hidden areas are the critical points to be considered while documenting a historic streetscape with conservation aim.

The result representation of today; namely, the rectified image mosaic includes qualitative information such as architectural details, color and texture. 2D scaled drawing is also provided by vectorization of the rectified image mosaic. This vectorization is made for comparison. It has shown that the 2D scaled drawing is only an abstract description of the streetscape. Thematic representations are visual documents in which the data gathered by site survey, historical and archive research are systematically illustrated. In this framework, these were produced in order to analyze and decipher the studied streetscape. These representations, when evaluated together with archive and historical research results have given way to the following assessments: The proposed themes in this study provide better perception of the timeline of the street and demonstrate clues prior to conservation decisions. The representation of alteration analysis and conservation interventions on the rectified image mosaic proved a stable and realistic image of today. The documentation of the alterations of the Necatibey Boulevard has provided useful insights for succeeding preservation decisions. Thematic maps on 2D elevation were also produced. The comparison of the thematic maps on the 2D elevation with the thematic representations on the image mosaic have pointed out that the latter is a realistic way.

In conclusion, the proposed guidelines in the study can be easily applied for documentation of historic street façades prior to intervention decisions of street rehabilitation projects. The produced representations can be used for various types of works such as managing facade treatments, an input for a comprehensive preservation plan, providing a virtual tour for researchers such as art historians, historians, architects, psychologists and cultural tourists. Moreover, photogrammetric documentation of historic street silhouettes with single image rectification has the advantage of obtaining all data in digital format. The production of the digital image mosaics of the historic street façades can also be useful for production of urban databases. In turn, the management of conservation data will become easier compared to data stored with conventional techniques. Lessons can be taken from this study so that preservation attempts of some other historic streets especially in urban cores can be guided. Nevertheless, the proposed methodology may be criticized from the aspect of the time. It consumes a lot of time for learning the contemporary instruments and softwares, and solving their technical problems. In fact this time is taken from the architect-restorer's design time. As a result, an architect-restorer should conserve his/her abilities in conventional techniques, while he/she is continuously learning the modern

ones so that he/she can balance their advantages in relation with the necessities of the case.

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