

## **DOCUMENTATION OF A VERNACULAR HOUSE WITH CLOSE-RANGE DIGITAL PHOTOGRAMMETRY**

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### **ABSTRACT:**

This study aims to present a combined documentation method that can be easily applied on the built vernacular heritage prior to establishment of appropriate conservation methodology and treatment strategy. It takes into consideration the vernacular house type of Alaçatı, İzmir, Turkey and defines the appropriate techniques to be used in the conservation aimed analytic recording process. The prismatic house masses at human scale, with plain façade orders and orthogonal plan layouts at this settlement can be recorded fast and accurately with close-range digital photogrammetry. The concepts of mapping should be utilized for the representation of analytic data. Within this frame, a 19<sup>th</sup> century house located in the urban conservation site of Alaçatı is to be presented as the case study.

### **1. INTRODUCTION**

It has been accepted that digital photogrammetric methods applied with the anxiety of architectural documentation shorten the length of field work time, require limited amount of technicians at the site and provide accurate results (Hanke et al., 2002). On the other hand, architectural representation has been used as an important depicting tool since the Renaissance (Gürer et al., 2005). Within the limits of the discipline of architectural conservation, representation of changes a building has undergone throughout its life span has been considered as a prerequisite for the soundness of the succeeding intervention decisions (Madran et al., 1999: 504). The technique of mapping has been extensively used to illustrate the changes a historical building has undergone (Fitzner and Heinrichs, 1992).

The contemporary studies on data collection, data processing and representation of architectural heritage are as follows: Most data collection and processing studies with medium budgets use close-range digital photogrammetry based on bundle method. For data processing, monoscopic digital stations are mostly preferred, because they provide accurate 3D measurements of historical buildings, and also the user does not have to be an expert. Examples of monoscopic digital stations are PhotoModeler (Toz and Duran, 2004; Arias, 2007), Microstation (Styliadis, 2006), Rolleimetric Close-range Digital Workstation (Pomaska, 1998), and Pictran (Altan et al., 1999; Bosch et al., 2005).

Within the frame of architectural restoration, conceptual representation mostly preferred at present is thematic mapping on scaled 2D drawings. On the other hand, the contemporary studies concentrating on representation techniques frequently involve 3D model construction based on the photogrammetric measurements transferred to CAD. AutoCAD is extensively used (Hirschberg, 1996; Arias, 2006; Almagro, 2005). The 3D models considering analytical visualization are at a limited extend (Santana et al., 1998; Tucci et al., 2003). It is evaluated that the 3D model is efficient for perceiving the image of a building at different periods. The conception of conservation concepts still requires graphical tools such as thematic maps.

In this paper, it is pointed out that the 2D character of the architectural representation can be continued to be used for the

conception of structural and spatial characteristics of historical buildings and their changes. Nevertheless, the potential of contemporary digital photogrammetric techniques should be made use of so that analytical representations accurate enough for guiding conservation decisions can be prepared in a short time span with reduced effort, and yet the end results are photorealistic. In short, this study aims to combine the digital photogrammetric techniques with the mapping concepts of the discipline of architectural conservation. The proposed method is tested on the entrance façade of a listed dwelling in the historical town of Alaçatı, İzmir, Turkey. The vernacular houses listed in the Conservation Plan of Alaçatı necessitate different levels of recording with respect to their different levels of treatment, ranging from routine maintenance to adaptive use. When choosing the Demiral House as the case study, the criteria taken into account were as follows: Carrying notable cultural values and contemporary socio-economic values and requiring urgent repair. The visual analysis scheme developed for the case study can be used for the documentation of similar vernacular dwellings in Alaçatı after appropriate calibration.

The method used in the recording of the selected architectural object is close-range digital photogrammetry. The representation methods preferred in this study are; thematic mapping on orthoimage and 2D scaled drawing in CAD. The rectified images and the 2D scaled drawing are overlapped in order to present the accuracy of the orthoimage. These recording and representation methods are supported with literature survey and archive research so that the analytic concepts to be illustrated are clarified. Pictran Release 4.0 is chosen as the digital workstation since it provides accurate results and it is relatively low-cost. The photographs are taken by a digital camera (Nikon D70S Digital SLR) and the coordinates of the control points are measured by a total station (Zeiss Rec Elta RL-S).

### **2. HISTORICAL AND MORPHOLOGICAL CHARACTERISTICS OF ALAÇATI**

At present, Alaçatı is a historic and touristic Aegean town located at the western coast of Anatolia. It is surrounded by Alaçatı Port at the south, İlica gulf at the north and Çeşme settlement at the northwest.

## 2.1 History of the Settlement in Alaçatı

Until the 16<sup>th</sup> century, Çeşme was Anatolia's gate of foreign trade. After Ottomans conquered Chios Island in 1556; Genoese merchants, who had been living in the island, moved away. İzmir instead of Çeşme became the trading center of the region (WEB\_1, 2006).

In 1810, the Greek community who had migrated from Chios Island came to Çeşme to work in the fields of Hacı Memiş at the south of Alaçatı, and brought its own traditions and way of life, such as wine producing and cattle-breeding. The Greek population had gradually increased during the 18<sup>th</sup> and 19<sup>th</sup> centuries, and the Greek population dominated the others in the 19<sup>th</sup> century. In 1881, Alaçatı's population was 4,122; 78 of them being Turks and 4,055 of them being Greeks. In 1895, total population of Alaçatı and its surroundings was 14,977; 13,845 being Greek (Özgönül, 1996: 105).

## 2.2. Sub Regions in Alaçatı and Their Development

The first inhabited area is at the southern part of the present settlement around Hacı Memiş Mosque, today known as Hacı Memiş Quarter. The secondary inhabited area is where the neighborhoods were located around the administrative (Old Municipality Building, built in 1873) and commercial center, today known as Tokluoğlu Quarter, in the second half of the 19<sup>th</sup> century. Following the Hacı Memiş Mosque, a number of monumental buildings were built as the town developed towards the northern direction. The residential buildings were built around the mosques and churches.

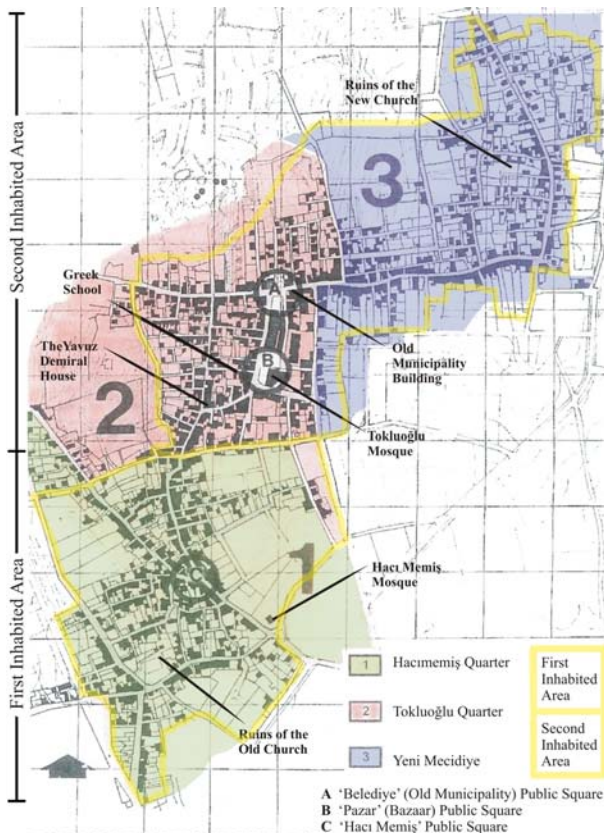


Figure 1. The development of the built areas (Alaçatı Municipality Archives, 2006)

The present built vernacular heritage dates mainly to the second half of the 19<sup>th</sup> century. After the Balkan Wars (1912) and the

Independence War (1922), some Turkish people coming from Balkans and Aegean islands were settled in Alaçatı, while the Greeks living in Alaçatı migrated to Greece.

## 2.3. Architectural Characteristics of the Vernacular Houses in Alaçatı

Most of the vernacular houses in Alaçatı are two storied and have rectangular forms. They lack front gardens and courtyards; instead have rear or side gardens and courtyards. They define a continuous order of street façades and have dwelling, producing and trading functions.

At the ground floors; there is generally a trading section containing a shop (*mağaza*), with a direct entrance from the street. The entrance hall (*taşlık*) has a staircase leading up to the first floor. It usually has a cistern underneath. In general, entrance hall and service spaces for storage, stable and toilet open to the courtyard.

At the upper floors, closed living and kitchen spaces are arranged around a small sized hall (*sofa*). The hall or one of the rooms may have balconies and projections. Open terrace is generally situated above the stable, often reached with the open air stairs at the courtyards.

The two major techniques observed in wall constructions are rubble stone masonry at every floor; and rubble stone masonry at the ground floors and timber skeleton technique on the first floors.

## 2.4. The Yavuz Demiral House

The house documented in this study is a late 19<sup>th</sup> century building located at the secondary inhabited area in Tokluoğlu Quarter. It is close to Pazar Public Square. It stands out with its corner location, having two façades oriented to Mektep Main Street and Mithat Paşa Main Street.

It is a two-storied vernacular house with a single prismatic mass, while there are fairly new houses constructed to both sides of it. It is a second degree listed building with the decision of İzmir Number 1 Conservation Council of Natural and Cultural Properties dated 1988. Among the other Alaçatı houses, it stands out with its corner position and without courtyard scheme. At present, the house is abandoned.



Figure 2. The Mektep Street and the Yavuz Demiral House (Şahin, 2006)

The ground floor of the house is a type that is directly entered from the street. At the east, there is an entrance door opening to an entrance hall. Here, there is a wooden staircase leading up to the living section. At the west, there is a large space used as a shop in the past. It has an entrance door flanked by window openings at its sides on each of the exterior façades. It contains a fireplace and an access to the entrance hall. The first floor is divided into a hall having a bay window to the main street, and

three spaces surrounding the hall. Posts of the partition walls are present only. There is a fireplace and a staircase leading up to the roof.

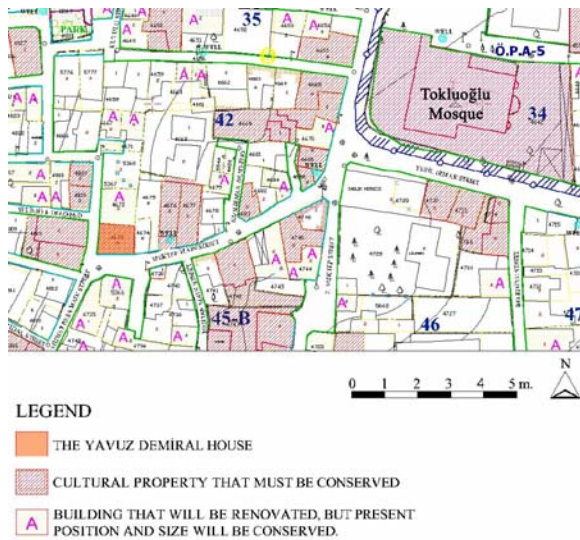


Figure 3. The near-by environment of the Yavuz Demiral house illustrated in the Alaçatı Urban Conservation Plan (Alaçatı Municipality Archives, 2006)

At the ground floor, the entrance doors of the shop are two-leaf, wooden and arched with stone casings. The windows are two-leaf, wooden and arched with stone casings and wooden shutters. The main entrance door is a two-leaf, iron door with a head window decorated with ironwork. At the first floor, there are wooden windows with vertical sashes. The bay window is carried by timber beams and supported by iron bars. Wooden eaves and the hipped roof covered with Turkish tiles are the other façade elements.

When structural characteristics and elements of the house are considered; rubble and cut stone masonry, and thick plaster are observed at the ground floor walls. At the first floor walls, timber skeleton system and tuff stone as infill material are used. Horizontal wood beams and planks form the flooring system. There are wood lintels on the wooden windows. Timber posts for the partition walls at the first floor and rubble stone foundation are observed. The staircase is wooden.

### 3. DOCUMENTATION OF THE CASE STUDY

The documentation phase is divided into two stages; the field work and laboratory work.

#### 3.1. Field Work

The detailed field work can be divided into two as photographic and topographic works.

##### 3.1.1. Photographic Works

The 3D measurement aimed photographs are taken considering the principles of bundle method (Hanke et al., 2002). The rectification aimed photographs are taken considering the following points: Photographing each architectural element separately, shooting parallel to the façade, slightly overlapping the photographs, and using a ladder for the upper zone.

##### 3.1.2. Topographic Works

Two points opposite the western and eastern corners of the house have been defined. The measured control points are noted down on the printed photographs of the façade. The issues in the selection of the control points are homogeneous distribution and visibility of each point on two or more images.

#### 3.2. Laboratory Work

The information collected in the field work is processed to obtain the scaled elevation drawing, the orthoimage and thematic maps. It can be divided into two phases as photogrammetric evaluation and representation works.

##### 3.2.1. Photogrammetric Evaluation Works

The 3D coordinates of the points are measured with the help of the photogrammetric evaluation software (Pictran), and the results of the measurements are transferred to CAD environment (AutoCAD).

##### 3.2.2. Representation Works

The main representation methods used in this study are 2D scaled elevation drawing and thematic mapping on the orthoimage.

###### 3.2.2.1. Forming the Orthoimage

Rectified images of the studied façade are brought together in Photoshop, and the orthoimage is created. For the scaling of the orthoimage, 3D measurements of a limited number of points (approximately 4 points for each photograph) are transferred from Pictran to CAD, and then to Photoshop.



Figure 4. An original photograph and its orthoimage



Figure 5. The orthoimage of the southern façade, overlapped with the 2D scaled drawing

The roof, which is an inclined surface, is not rectified since it is not shot parallel to its plane. Similarly, the eaves are not rectified because they are not viewed close to the center of any parallel photograph (Hanke et al., 2002). So, they all appear



white in color. Therefore, they are filled with realistic colors so that the façade can be perceived as a unity. The sky and the ground are also represented with realistic in-fills so that the gap effect is avoided. Nevertheless, the textures of the filled in parts and the rectified ones can be differentiated in close inspection.

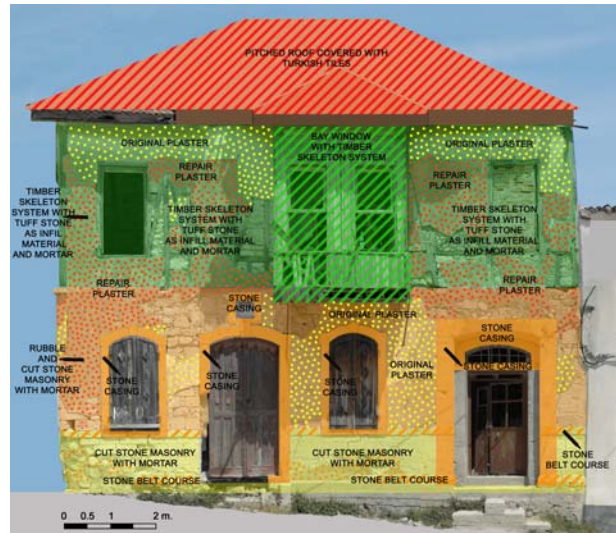
### 3.2.2.2. Forming the Thematic Maps

The legends of the thematic maps are determined as “Spaces and Architectural Elements” (Figure 6), “Structural Characteristics” (Figure 7), “Alterations” (Figure 8) and “Structural Failures and Material Deteriorations” (Figure 9). The analytic concepts, their graphic codes and detail photographs for each theme are gathered on separate tables. Then, the orthoimage is processed for each theme separately in the image evaluation software (Photoshop) and the thematic maps are produced.



- |  |  |  |
|--|--|--|
| <b>SPACES</b>  |  |  |
| Shop (1)   |  |  |
| Entrance hall (2)  |  |  |
| Living section (3)   |  |  |
| <b>ELEMENTS</b>  |  |  |
| Turkish tiles (4)  |  |  |
| Wooden eaves (4)   |  |  |
| <b>Doors</b>   |  |  |
| Two-leaf, wooden, arched doors with stone casings (5)  |  |  |
| Two-leaf, iron, rectangular door having a stone arched head window decorated with ironwork (6) |  |  |
| <b>Windows</b>   |  |  |
| Two-leaf, wooden, arched windows with stone casings and wooden shutters (6)                    |  |  |
| Wooden, rectangular sash windows with wooden frames (7)  |  |  |
| Small sized, square top window (7)   |  |  |
| Wooden bay window (7)  |  |  |
| Concrete stairs (7)  |  |  |

Figure 6. Analysis of Spaces and Architectural Elements



### WALLS

#### First floor walls:

- |  |  |  |
|--|--|--|
|  | Timber skeleton system with tuff stone as infill material and mortar (1)                         |  |
|  | Plaster layer on the exterior façades of the walls   |  |
|  | Original plaster layer (2)   |  |
|  | Repair plaster layer (2)   |  |
|  | Bay window with timber skeleton system - carried by timber beams, supported by iron brackets (3) |  |

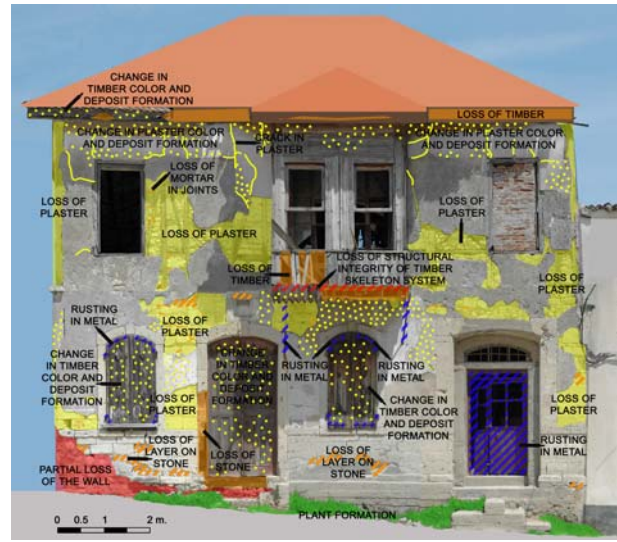
#### Ground floor walls:

- |  |  |  |
|--|--|--|
|  | Rubble and cut stone masonry with Mortar (4)                                 |  |
|  | Cut stone masonry with mortar (5)  |  |
|  | Plaster layer on the exterior façades of the walls                           |  |
|  | Original plaster layer (2)   |  |
|  | Repair plaster layer (2)   |  |
|  | Stone casings at the windows, stone arches on top of the window openings (6) |  |
|  | Stone casings at the doors, stone arches on top of the door openings (6)     |  |
|  | Stone belt course (7)  |  |

### ROOF

- |  |  |  |
|--|--|--|
|  | Hipped roof covered with Turkish tiles (8) |  |
|--|--|--|

Figure 7. Analysis of Structural Characteristics



**VACANT SPACES**

- Shop
- Entrance hall
- Living section

**TOTALLY MISSING ELEMENTS**



Door

**PARTIALLY MISSING ELEMENTS**



Eaves (1)



Wall



Casing



Window: Frame / Sash / Glazing (2)



Wooden elements on window shutters and bay window (3)



Stone belt course (4)



Threshold

**ADDITIONAL ELEMENTS**



Iron door



Concrete column (5)



Concrete casing (5)



Concrete basement wall (5)



Concrete stairs (5)



Concrete threshold (5)



Infill in window opening (6)



**STRUCTURAL FAILURES**



Partial loss of the wall (1)



Loss of structural integrity of timber skeleton system (bay window) (2)

**MATERIAL DETERIORATIONS**



**Stone:**  
Loss of stone (3)



Loss of layer on stone (4)



Change in stone color and deposit formation



**Mortar:**  
Loss of mortar in joints (5)



**Timber:**  
Loss of timber (6)



Change in timber color and deposit formation (3)



**Plaster:**  
Loss of plaster (5)



Crack in plaster (7)



Change in plaster color and deposit formation (7)



**Metal:**  
Rusting in metal (8)



Plant formation (9)



Figure 8. Analysis of Alterations

Figure 9. Analysis of Structural Failures and Material Deteriorations

**3.2.2.3. Preparing the Elevation Drawing**

The three-dimensional measurements exported from Pictran are opened in AutoCAD 2004, and the entrance elevation is drawn.

#### 4. SUMMARY AND CONCLUSIONS

For all recording levels, an initial photographic recording is a prerequisite. Depending on the operational needs of each house, the record should be detailed. The Yavuz Demiral House selected as the case study has conservation priority among the other listed houses within the settlement because of its highly damaged structural system due to abandonment. It requires both comprehensive structural interventions and installation of an appropriate use since it has been empty for fifty years. The documentation method developed for the case study can be easily adapted to other listed houses that have fewer problems at the discussed urban site, after appropriate calibration.

At the end of the documentation phase, rectified images, an orthoimage, a scaled elevation drawing and thematic maps have been prepared. Taking into account a number of photographs (8 photographs) for a single façade (11x8 m.) gave way to the production of an accurate orthoimage, since the perspective of each architectural element could be controlled. The scaled elevation drawing was used to demonstrate the accuracy of the orthoimage. The thematic maps provide sufficient visual analyses for the guiding of conservation decisions.

Consequently, this study has proposed an adequate combination of contemporary documentation techniques of built heritage so that architect-conservators can easily adapt this indispensable data in their conservation projects. The opportunities of close-range digital photogrammetry, the advantages of image evaluation softwares and the concepts of mapping were all moulded together. Compared to the frequently applied recording techniques such as hand and topographic measurements, and thematic maps on scaled drawings used frequently at present; the proposed combined documentation method saves field work time. The end results are more realistic and accurate enough for guiding the conservation decisions. All the presentation documents are aimed to support the treatment approaches, the value judgments, intervention decisions and the following application phase.

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