Photogrammetric Modeling of Fasillar Monuments
(The Storm God Of Hittite)

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Key words: Fasillar, Beyşehir, Turkey, Close Range Photogrammetry

SUMMARY

Fasillar in about 3 thousand 500-year history of Memorial, the Battle of Kadesh took place between the Hittites and the Egyptians with the king of Hittite Muvattali perspective reveals. BC Between the Egyptians and the Hittites in 1243 with the advantage of both sides together to provide the Battle of Kadesh, was one of the important turning points of history. After the war King of the Hittites and the Egyptian pharaoh Muvattali The Kadesh Peace Treaty between 2.Ramses attribution of first written agreement in date. Fasillar of this historical monument was built in order to describe the event from the perspective of the Hittites.
In this study, we thought that is so important place and need to protect Cultural heritage. Our way protect by Photogrammetric techniques. Storm God's Hittite was laying on the hill near Fasillar village, Photogrammetric techniques will be the best way for take the data of the monument. The monument has wavy surface and we apply a new technique for photogrammetry that DSM scanner with stereo pairs , have a point cloud and surface models of monuments. Monument has been examined by digital close range photogrammetry. The main aim of this paper is to present the findings to date of the processing of DSM data of Fasillar monument the God of Hittite in Beysehir.

ÖZET
Yaklaşık 3 bin 500 yıllık geçmişi bulunan Fasıllar anıtı, Hititliler ile Mısırlılar arasında yaşanan Kadeş Savaşı'nı Hitit Kralı Muvattallinin bakış açışını gözler önüne seriyor. M.Ö 1243 yılında Hititliler ile Mısırlılar arasında yapılan her iki tarafında birbirine üstünlük sağlayamadığı Kadeş Savaşı, tarihin önemli dönüm noktalarından birisiydi. Savaş sonrası Hitit Kralı Muvattalli ve Mısır Firavunu 2. Ramses arasında yapılan Kadeş Barış Antlaşması tarihteki ilk yazılı antlaşma niteliğindedir. Fasıllar Anıtı bu tarihi olayın Hititlilerin perspektifinden anlatmak amacıyla inşa edilmiştir. Önemli bir kültürel değere sahip olan bölgenin korunması gerektiği düşünülerek Fotogrametrik tekniklerle çalışmalar yürütülmüştür. Hititlerin Fırtına Tanrı'sı, Fasıllar köyü yakınlarında bir tepenin yamacında bulunmaktadır, arazi koşullarının durumu nedeniyle belgeleme çalışmalarının en verimli olabileceği yöntem Fotogrametrik yöntemlerdir. Anıt yüzeyinin çok dalgalı bir yapıya sahip olması nedeniyle, yoğun eşleme yöntemi olarak adlandırılan en son Fotogrametrik tekniklerle, fotoğraf çiftlerinden nokta bulutlarının elde edilmesi, yüzey modelinin oluşturulması ve 3B'lu modelin elde edilmesi gerçekleştirilmiştir.

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1. INTRODUCTION

Historical objects are reflecting the great value which comes from history of the country backgrounds. Heritage must normally be protected by local, national or international authorities, in order to prevent its deterioration and destruction [1]. Such protection is not always as efficient as might be expected. Sometimes, it can never take place. If the case is this, there should be something to be done beforehand such as implementation of a comprehensive documentation work by the help of any conservation technique even if it is specially focused to the historical asset in interest. It can be found in several documentation and conservation techniques available in the practice [2]. These methods are capable of providing the building within a co-ordinates system [3]. The methods and equipment mainly preferred for the documentation and surveying of buildings are [4]: traditional manual methods, topographic methods, photogrammetric methods and scanning methods. Such techniques are taken in the documentation process as tools for the conservation of heritage monuments. The documentation has to be carried out prior to the building's destruction, transformation or any intervention. Related to this study, when digital photogrammetry technique is chosen as a conservation technique, it should be created 3D models and scaled orthophotos, plans, etc. The course of time, if the progressive deterioration of materials, the exhaustion of some structures and the damages caused by successive reforms, end up leading to the destruction and loss of the monuments. The 3D models, orthophotos and plans can then be used to rebuild the monument as similar as how it was before the destruction, even if in the cases of that intervention is undertaken subsequently to partial collapse of the monument. In such occasions, some materials are replaced and the restoration works are run by the engineer with respect to those plans, whose most significant criterion is accuracy. Today, measurement procedures carried out in excavated archaeological sites and for objects found at these excavation sites represent a very interesting contest where the potentialities of new digital technologies of photogrammetry can be productively expressed. But, some difficulties related to the 3D modeling from digital images can be encountered when modeling surfaces and complex archaeological structures. Several problems can also come out at any time with respect to modeling of terrain or of manmade objects. We can even meet with some problems related to the data acquisition and integration and to the automatic or semi-automatic data handling, or to new methods for data representation and exploration in general. In spite of these problems and difficulties, digital photogrammetry technique has been used successfully and proved its potentiality on providing 3D models and documentation of historical monuments and archaeological sites with successive studies in the practice. Anatolia is one of the very few special and unique places in the world that have played a cradle role for many civilizations during the every stage of human history. In Anatolia, there are plenty of historical assets, monuments, constructions, items and so on trying to stay stand on the ground or just underneath the ground and buried by soil. They all have been remained from the time of these civilizations. All those historical assets reflect life style and carry traces of their owners, user or contractors to our time from the time when those owners lived in this great Land, Anatolia. One of the great civilization left traces of their civilization in this land is Hittite community. Several historical remains from Hittites have been found especially in the region of Konya which is a great city located at the heart of Anatolia.

2. THE MONUMENT OF FASILLAR

We are not going to give historical details widely since this study is especially going to focus on creation of 3D model for the monument. The main aim of this study can be stated as building of 3D model of a very interesting and important archaeological object called as Storm God of Hittite close to Fasillar village.(Fig 1) It is a historical site remained from the Hittites' era. In our opinion, they are probability men whirling around themselves, similar to ceremonies seen in Mevlana rituals. One of these opinions assumes that arslantash and Fasillar monuments were located on Fasillar monument [9]. It was also argued that these two monuments were not representing features that follow the features on Fasillar monument [15]. In our opinion, these two monuments do not complete each other [16]. Fasillar monument is also an especially important historical asset since it was located at the intersection of the routes from the gates of Hittites opening to the West (Arzawa). Contrary to that, Fasillar was located at the intersection of the routes from the gates of Hittites opening to the South (Lukka). Therefore, such monuments are assumed as open sacred places located on these routes [16]. It is suggested that around this monument and similar should be surrounded by decoration trees and also it should be prohibited to violate such sacred places [21,22].

Fig 1: General view of Storm God of Hittite

3. MODELLING BY DIGITAL PHOTOGRAMMETRY

Basically, photogrammetry is a 3D coordinate measuring technique that uses photographs. The fundamental principle used by photogrammetry is again triangulation (Remondino, El-

Hakim, 2006). Digital close-range photogrammetry has a few decade histories and it has such a proven fact that it is a useful tool for 3D measurement and modeling in support of heritage recording. Over the past decade or so, we have witnessed a very significant growth in activity in this area and indeed in close-range photogrammetric measurement in general. A number of trends account for the broadening use of this technology. The first trend is seen in the increasing availability and suitability consumer grade digital cameras for photogrammetric applications. These cameras are ubiquitous; they have ever higher resolutions and are quite suitable for accurate measurement required in architectural and archaeological recording, forensic measurement, and engineering documentation and in numerous other application domains. A second trend is the enhanced capabilities available in 3D modeling and visualization, processes which benefit from more comprehensive measurement and imagery data. A third trend can be related to developments in photogrammetric data processing, including improved computational models, and the development of automated image measurement and photogrammetric orientation software systems designed for use with low-cost digital cameras.

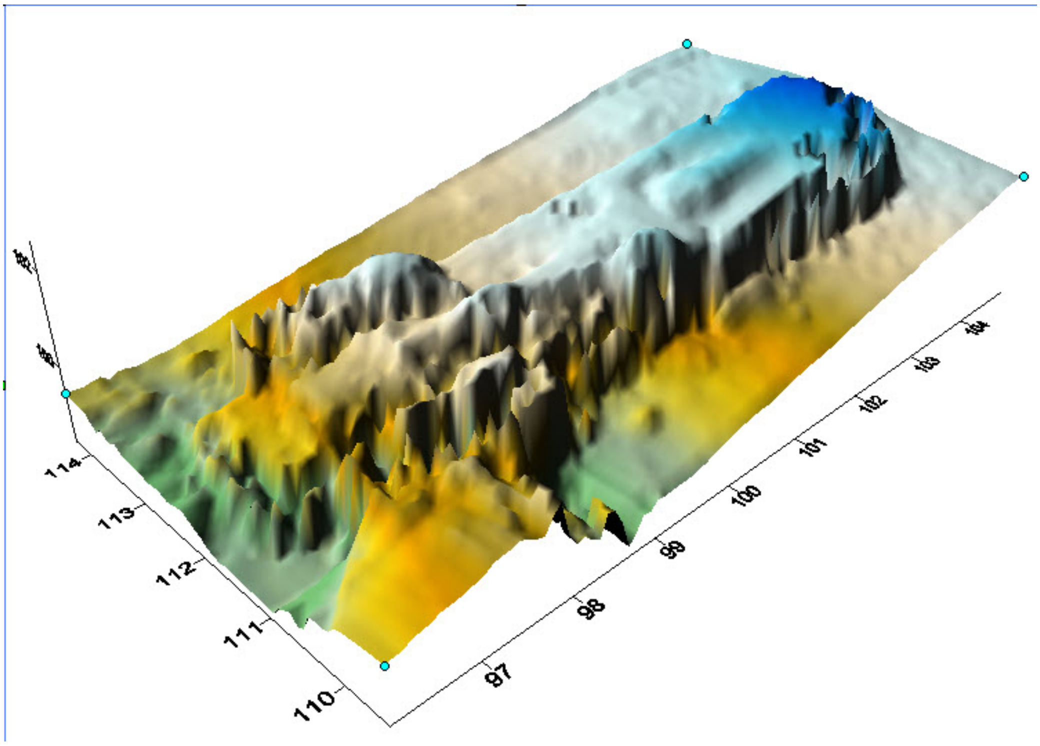


Fig 2: .Elevation Model of the Monument

3.1 Photogrammetric processing steps

In archaeological photogrammetry, we like to fulfill the goal: metric information describing the monument's construction system and its spatial layout, starting from the three-dimensional structure when the decision taken ends up with conservation, reconstruction and even documentation. Nowadays the results can be displayed in three different ways:

handmade drawings, CAD drawings, 3D visualizations and animations. The methods devised for documentation have some added disadvantages such as slowness and laboriousness, in some cases, and high cost in other cases, when acceptable results are expected. Thus, they may not be operative in some circumstances [23]. Close-range digital photogrammetry can solve those problems, because it provides reliable representations of historical structures documented in a fast, precise and inexpensive way. To apply close range photogrammetry (in such a specific project), after determining the object which is supposed to be modeled, it is necessary to design control points in a way homogenously distributed all over the facades of monument. Control points must be seen clearly and visibly in images and their coordinates (X, Y, Z) are known in a reference coordinate system most probably measured by the help of a traditional surveying technique. This system is preferably defined as its XY plane perpendicular to horizon and Z-axis towards location of cameras (and perpendicular to XY plane). Geometric positions of control points must form volume, i.e., they must not lie on only one plane, otherwise co linearity equations will not obtain reasonable solution for unknowns [24]. The process begins with the camera calibration. The camera optics are not perfect. By imaging a reference background (manually controlling points), the optics defects may be calculated and the future pictures corrected (one speaks about “idealized” pictures). Once calibration is done, one can take a pair of pictures of the object to digitize. It is of course important to work with the same objective which means that the zooming capabilities of the camera should be avoided since the calibration corresponds to only one fixed position of the zoom. To obtain a dense point cloud, one has to work on pairs. The two photos have to be taken with the same camera orientation and the translation distance of the camera between the two photographs has to be around B/H where H stands for the average distance from the camera to the object. One has to find a trade-off between the dimension of the object in the image which has to be as great as possible to benefit from the camera resolution and the object translation on the image when taking the second photo of the pair.
After determining control points, images have to be taken from different positions. It is not necessary that all control points be visible in all images, but in each image at least six control points have to be visible to solve co linearity equations since a full camera calibration with 11 parameters is necessary in the case of non-metric camera use. In this process, unknown parameters such as camera orientation angles (Omega, Fi, Kapa) and perspective center coordinates and focal length of each camera will be solved. Then, if a real point in object space was visible in more than one image, object space coordinates of that point can be computed by method of intersection. Once enough points have been marked, the orientation may be processed. It results in the camera positions for the pair of photos Finally, we have image coordinates of a specific point in all images, so it is possible to calculate ground coordinates of that point by intersection method in a least square manner. Then, the dense point cloud generation can start. This functionality is quite recent in commercial software and originates from the so called stereo matching issue (Dianchao, 2008). Figure 3 shows the obtained model which is easily textured by the colors of the pixel on the original photos. To obtain a complete 3D model, it will be necessary to repeat the process on as many pairs as needed after rotation of the object along the 3 axis depending on the geometry complexity.

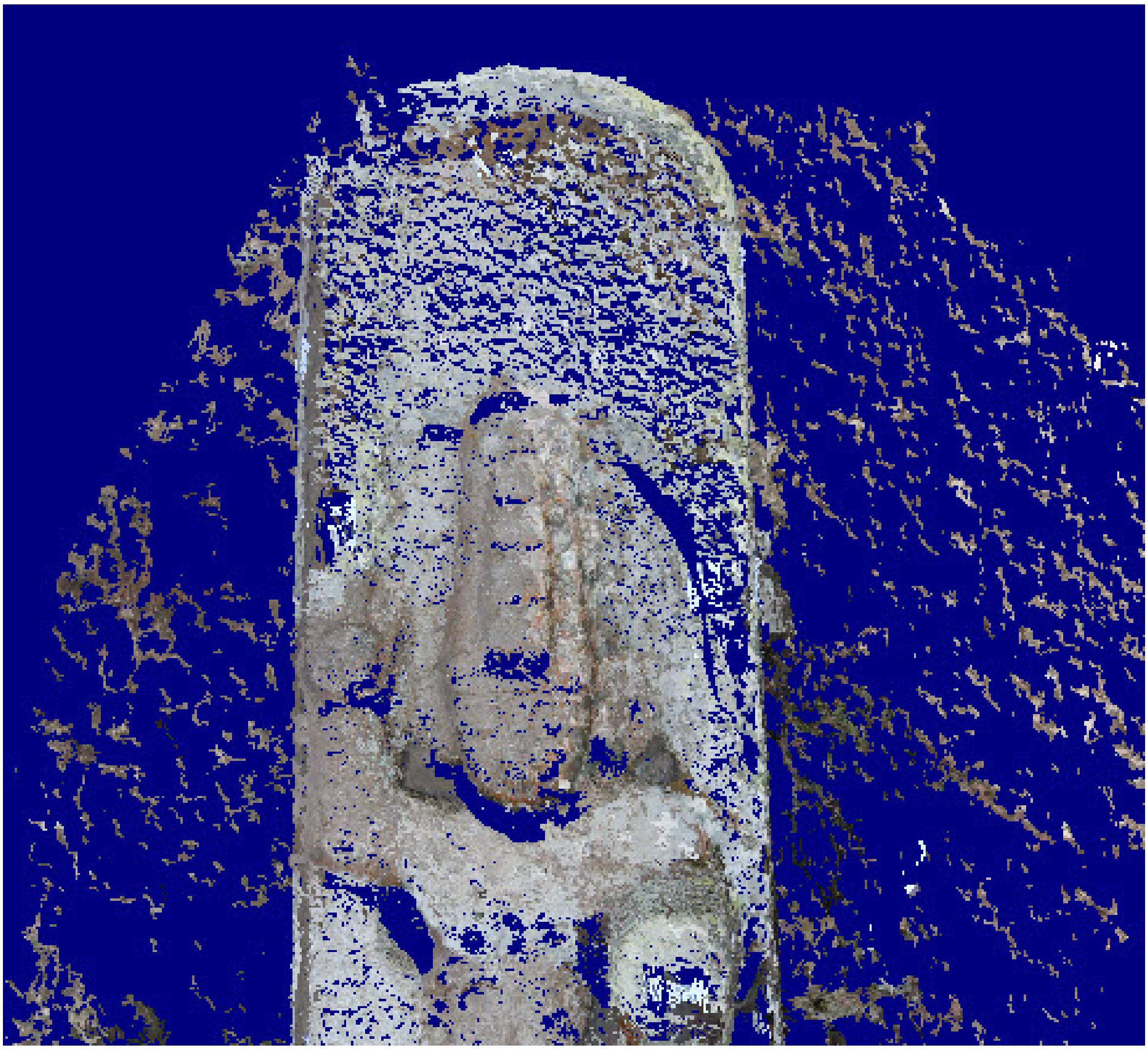


Fig 3 : Close up to the Head the God of Hittite

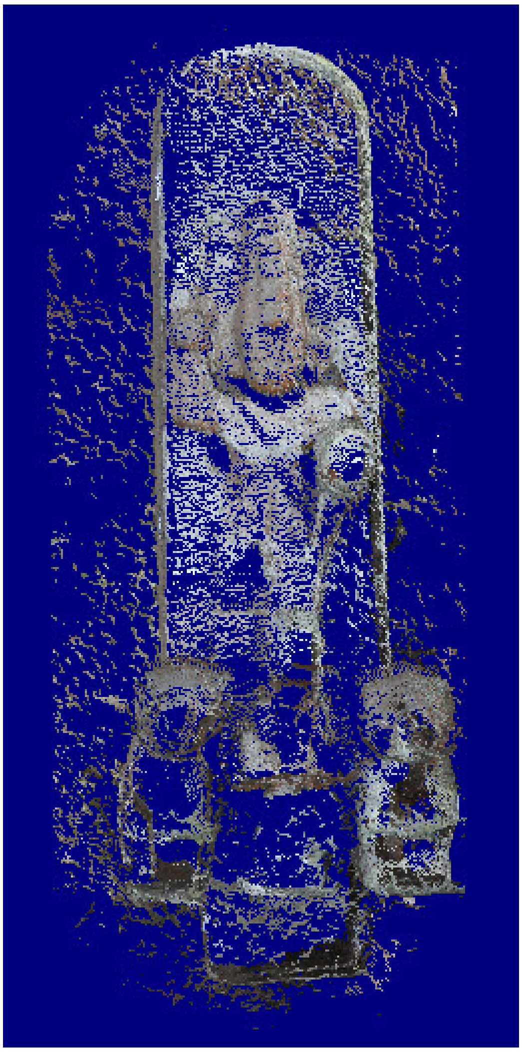


Fig 4 : Point Cloud of the Monument

4. CASE OF THE STUDY

In order to experiment the potentiality of image-based methods for the metric documentation and the 3D reconstruction of an important archaeological site such as the one studied in this project, a close-range photogrammetric survey of the monument and the surrounding details was conducted in the autumn season of 2010. The images were acquired by means of a digital camera: Samsung Digimax (5.1 M pixel). This camera had already been calibrated for previous works. So that it can directly be related to the realization of accurate metric object restitution. Otherwise, it could end up with the problem of detailed object reconstruction. The choice of this type of cameras is often justified in archaeological contexts by the cheapness, easiness and manageability in their use. A digital photogrammetric station was used as the photogrammetric system in this project. Such an instrument, capable of determining the intersection of homologue rays, is called stereo plotter. On the other hand, the photogrammetric system is based on a software package Photomodeler Pro 6, used for the digital orientation and restitution of photographs. It allows to work with images obtained either with digital and analogical cameras. The mathematic model of relation between image co-ordinates and ground co-ordinates is the co linearity condition. Orientation parameters and ground point coordinates are obtained by means of ray beam adjustment. There are two types of results: numeric, for the quality control of the results, and graphic (formats DXF, 3D Studio, RAW, VRML 1.0 and 2.0, Direct 3D, Wavefront and Iges). Field work: the control point coordinates (X, Y, Z) (Fig. 1), which allow to do the orientation, leveling and scaling processes, were determined with a reflector less Topcon GPT, 3007 total stations [25]. The control points were evenly distributed in all over the monument. Subsequently, the topographic equipment described above was used to measure the coordinates by means of a closed and orientated traverse made up by two stations. Taking of photographs: the photographs must be taken in accordance with the principles of photography and they are subject to the requirements of digital photogrammetric systems [26]. A large number of photographs were taken (both general shots and close-up shots focusing on details), because the redundancy of measurements make the detection and elimination of gross errors easier. The Samsung calibrated camera as mentioned above was used. The digital camera was mainly used to generate point cloud the monument's 3D model(Fig. 4), as well as for capturing images intended to be used as a source for photo-realistic textures.(Fig. 7) The photos should be taken considering the following points and stereo pairs: each element depicted must be contained in a minimum of two photos; the normal between photos taken from different positions will have to have optimum values of parallel so that the beam adjustments are carried out well; there must be at least 70-80% overlap between photos.

Figure 4 shows the model obtained with PMS . The mesh details can well be distinguished too.

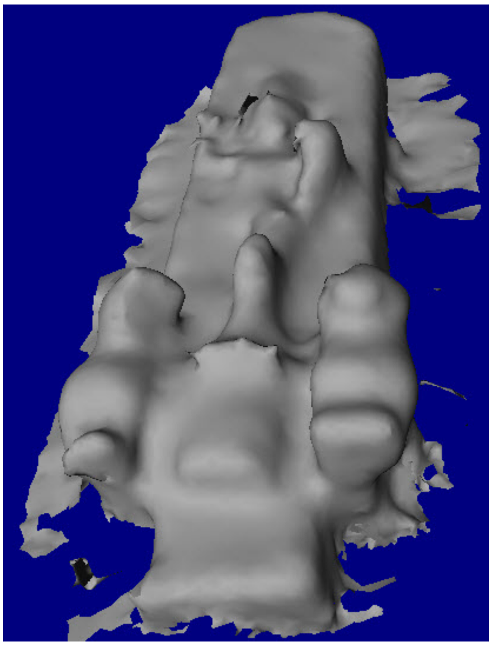
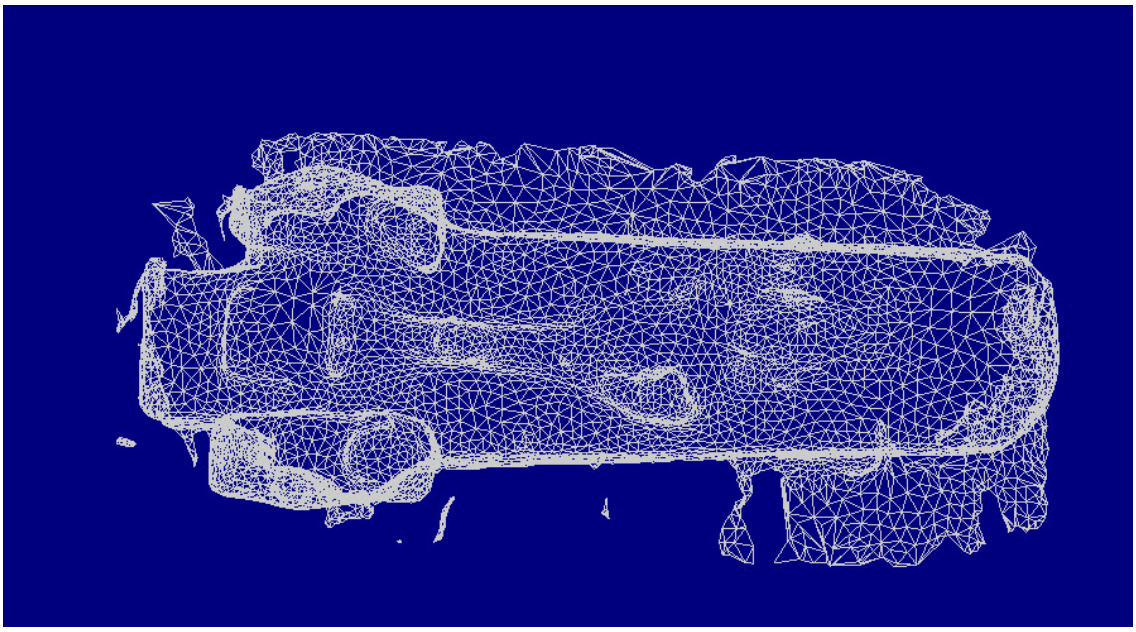


Fig 5 : Details of The Monument



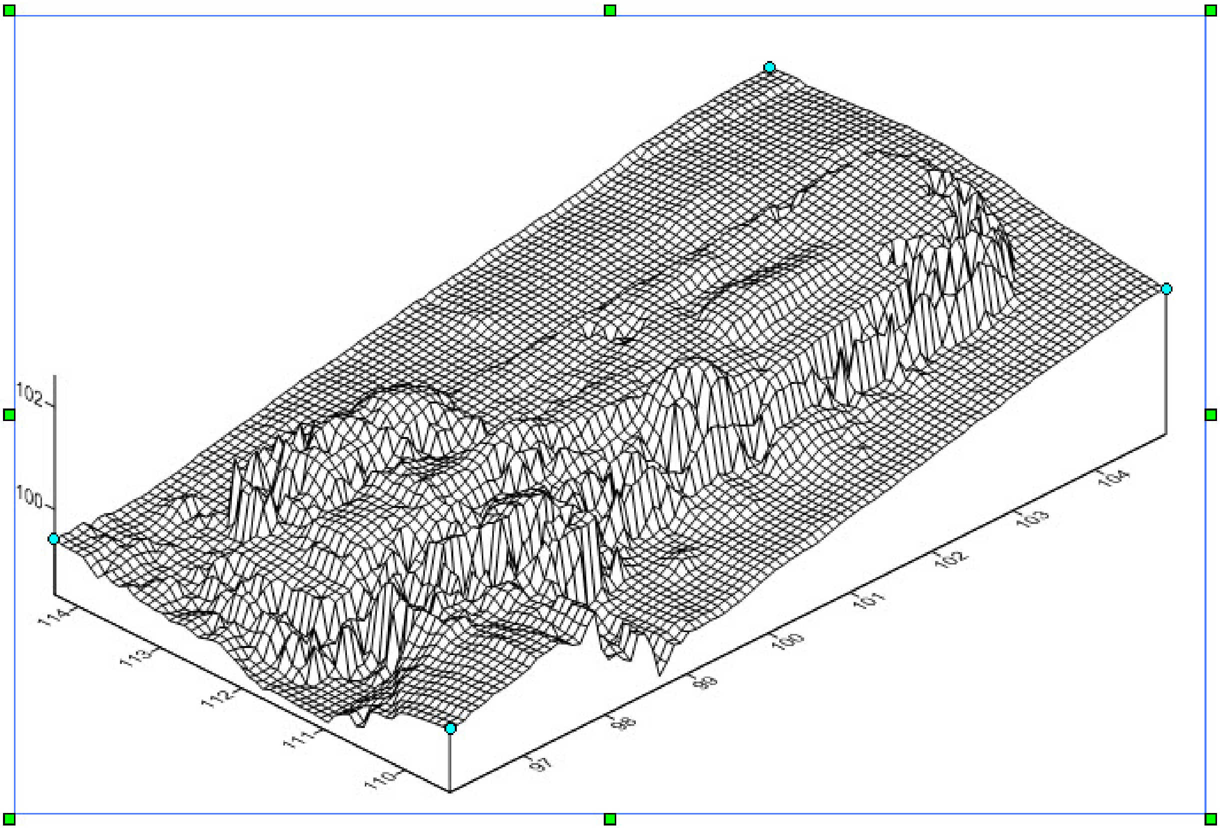


Fig 6 : Wireframe Models

Fig 7 : Photorealistic Texture Models

5. CONCLUSION

In this paper we showed that 3D modeling is now fully available at low cost and with great efficiency to the community of the archaeologists. 3D model shown below were produced by the monoscopic digital photogrammetric system used (up to a few years ago, only stereoscopic analytical systems were available). The proposed digital system works on all kinds of personal computers and the most commonly used operating systems. The low investment required to tune the equipment up makes digital systems the best option available [29]. Orthophotos of the monument facade was created by the software used. Then 3D rendering of the monument was created with photo-realistic textures as shown in Fig. 7. These textures have been implemented starting from the photographic shots of the object. The results obtained clearly show the advantages the method has. Information is continuous and homogenous for the whole of the model analyzed. There is another interesting advantage: the amount and kind of information to be extracted is a decision that can be made in the lab phase. Therefore, in this phase, tasks are adapted to each and every need. This implies greater flexibility, since these actions do not condition fieldwork. On the other hand, one can always go back to the photogrammetric digital files of the building in order to complete any information missing. Collecting data on a regular basis will enable us to trace the evolution of the pathologies being studied through time. Digital photogrammetric systems allow the use of conventional digital cameras and consequently lower costs (about 600 D) [30], which is a novelty with regard to analytical photogrammetric systems and photogrammetric analogical cameras. The shots taken using the digital camera were directly transferred and processed. The calibration of the Samsung Digimax digital camera was carried out in order to improve the quality of the numeric and graphic results, determining its aberrations (focal length, principal point and lens radial distortion). The digital photogrammetric system used also allows the use of non-calibrated cameras. In this case, the system carries out self-calibration for each of the pictures used. Due to the characteristics of the Photomodeler Pro 6 monoscopic digital photogrammetric system, the tasks required for generating the 3D models were performed by people with very little training, thanks to the user-friendliness of the system [31].. The total number of points handled for generating the models was 150 tie points. Lab work was carried out by one person for a week. The relative orientation of the photogram's is done after marking in different pictures series of points common to at least two shots. We decided not to include any more points since that would have meant increasing the amount of work with no bearing or increase in accuracy. Absolute orientationwas carried out by means of the points measured using topographical methods. From this phase onwards, the photogrammetric station enables us to know the spatial co-ordinates of any point and therefore any distance or magnitude. To conclude with the topics of comparison, though it is difficult to give a final answer, we think that PMS is very adapted to the world of cultural heritage: indeed the taking of photographs should not raise any particular difficulty, the system is adaptable to any object dimension (from tiny fragment to whole buildings as shown in Hullo et al., 2009),

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