Photogrammetric Modeling of Monuments Eflatunpınar (Lilac-Coloured Spring)

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SUMMARY

Lilac-Coloured Spring monument the shores of Lake Beyşehir, within the limits of the town of Konya, dated to the late Hittite about B.C1300 years, and in particular a monument containing the remains of an archaeological field.

In this study, have a point cloud and surface models of monuments, which is located in Beyşehir district of Konya in Turkey, has been examined by digital close range photogrammetry. PhotoModeler (Eos Systems, Inc. Canada) Scanner includes new skills in a module called Dense Surface Modeling (DSM). The DSM generating from photo pairs great number of 3D point clouds, this automatically creating a point cloud same as laser scanning technique. The DSM technology needs minimum two images (stereo pair) by digital cameras for create the three-dimensional (3D) model. Camera setup is an important factor for capturing high-accuracy data because several pairs of synchronized digital cameras are needed to capture the images for craniofacial area of subject. As a result, a research was figure out creating the monument with high-accuracy point cloud. This paper provides a detailed discussion of how to using photogrammetric scanners for the monuments, the procedures to process stereo-pair images and the evaluation of the 3D model visualization reconstruction using photo-based scanned data.

ÖZET

Eflatunpınar Beyşehir Gölü kıyısında , Konya ilçesi sınırları içerisinde, yaklaşık M.Ö.1300 yıllarına tarihlendirilen Geç Hitit kalıntılarının ve özellikle de bir anıtın bulunduğu bir arkeolojik alandır (höyük). Bu çalışmada yersel fotogrametri ile nokta bulutu ve anıtın yüzey modeli elde edilmiştir. Photomodeler yazılımı (Eos Systems, Inc Kanada) Yoğun Yüzey Modelleme (DSM) ismiyle fotogrametrik yöntemler kullanarak resim çiftlerinden nokta bulutları üretimini sağlamaktadır. Çok sayıda 3B'lu koordinatlara sahip nokta bulutları elde edilmektedir. DSM teknolojisi 3B'lu (3D) model oluşturmak için dijital kameralar ile en az iki resme (stereo çift) gereksinim duyar. Senkronize dijital kameraların ayarlarının iyi olması ve ilgili bölgeye ait birkaç çift resme gereksinim duyulur. Çünkü yüksek doğrulukta veri elde etmek için bu özellikler önemli faktörlerdir. Sonuç olarak, araştırmanın amacı yüksek doğrulukta nokta bulutu ile anıtın bir modelini oluşturmaktır. Bu metinde fotoğraf temelli tarama verilerinin 3B'lu görsel modelinin oluşturulmasının, değerlendirmenin ve resim çiftleriyle işlem adımlarının ve de anıtlar için fotogrametrinin kullanılabilirliği ayrıntılı olarak ifade edilmektedir.

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1. INTRODUCTION

3D modeling is a challenge in both photogrammetry and computer vision when dealing with complex objects and sites. Moreover, rigorous 3D modeling requires no extrapolation of data sets. It means that the project has to be carefully planned and executed independently of the surveying techniques and methods to document the archaeological site. With the progressive introduction of active techniques such as the terrestrial laser scanning for the documentation of cultural heritage in the last decade, there is a general trend of replacing image-based photogrammetry by range-based photogrammetry. It can be quickly scrutinized after checking the large amount of papers dealing with laser scanning not only in scientific meetings but also in journals. Integration of both laser scanning and image-based photogrammetry is recommended to get highly accurate texturing in archaeological documentation (Al-kheder et al, 2009; Navarro et al, 2009; Lerma et al, 2010), not only with visible images but also with thermal infrared images (Cabrelles et al, 2009).
There are places and sites around the world where it is hardly recommended to carry heavy, large or even expensive equipment. However, digital cameras are extremely portable and easy to use. This paper addresses the topic of 3D photorealistic modeling of a freestanding monument (Fig. 1)

Fig:1

2. WORKFLOW

2.1 Data Acquisition

A total of 21 images were captured, including normal and convergent imagery, as well as 4 stereo pairs for the 6 sides of the monument(Fig. 2).

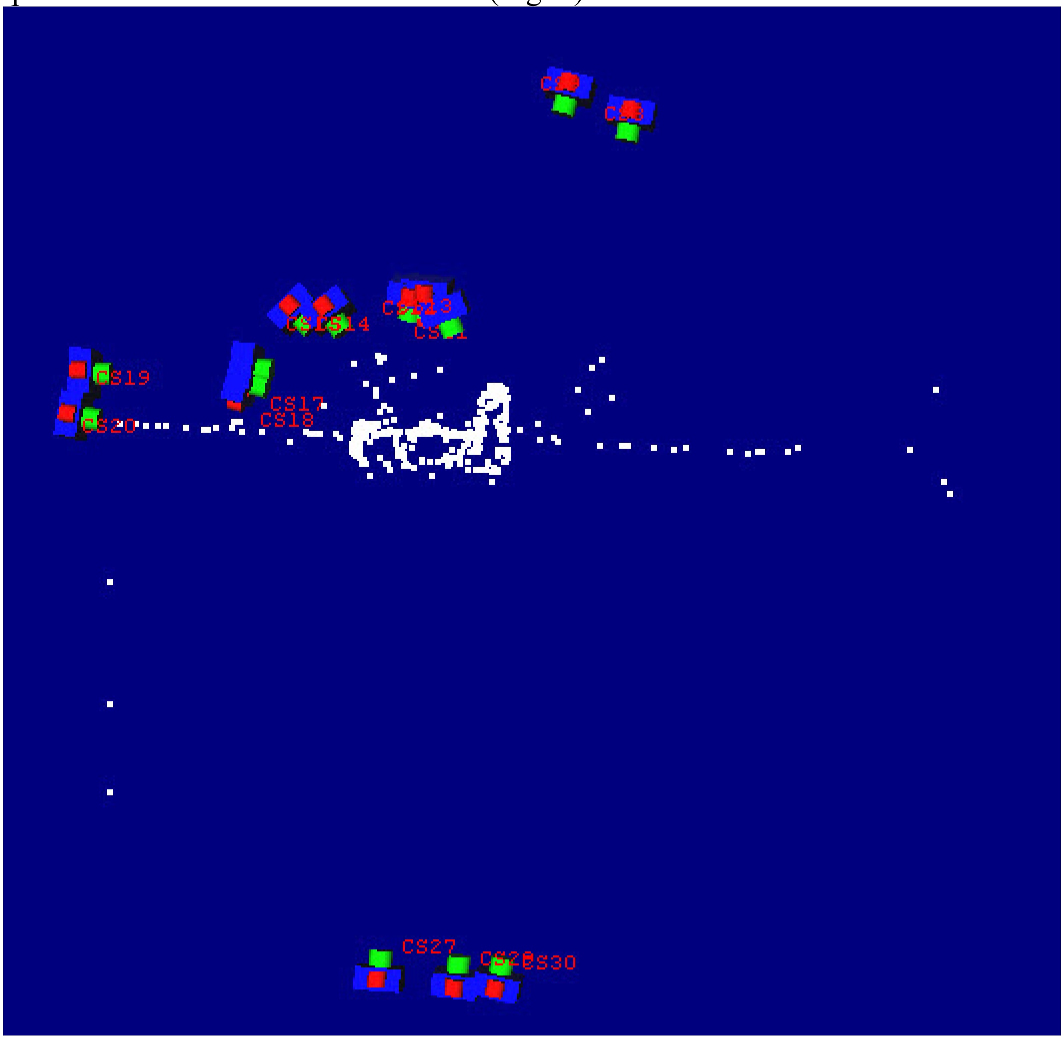

Figure 2. Camera shots around the monument

Images were taken considering that two photogrammetric steps were going to be carried out to yield the 3D point clouds of Eflatunpınar on the one hand, self-calibration bundle adjustment; on the other, stereo image matching. In addition, 32 ground control points were measured to transfer the scale and the orientation of the monument in object space.

2.2 Calibration

To achieve maximum reliability in the results, the whole block of images is adjusted using the well-known self-calibration bundle adjustment method. The solution included 7 additional parameters (2 principal point offsets, 1 principal distance, 3 radial distortion parameters and 1 decentring distortion parameter) for the digital camera Samsung Digimax S500 5.1 MP. Cam positions is very important for define the camera parameters.(Figure 3)

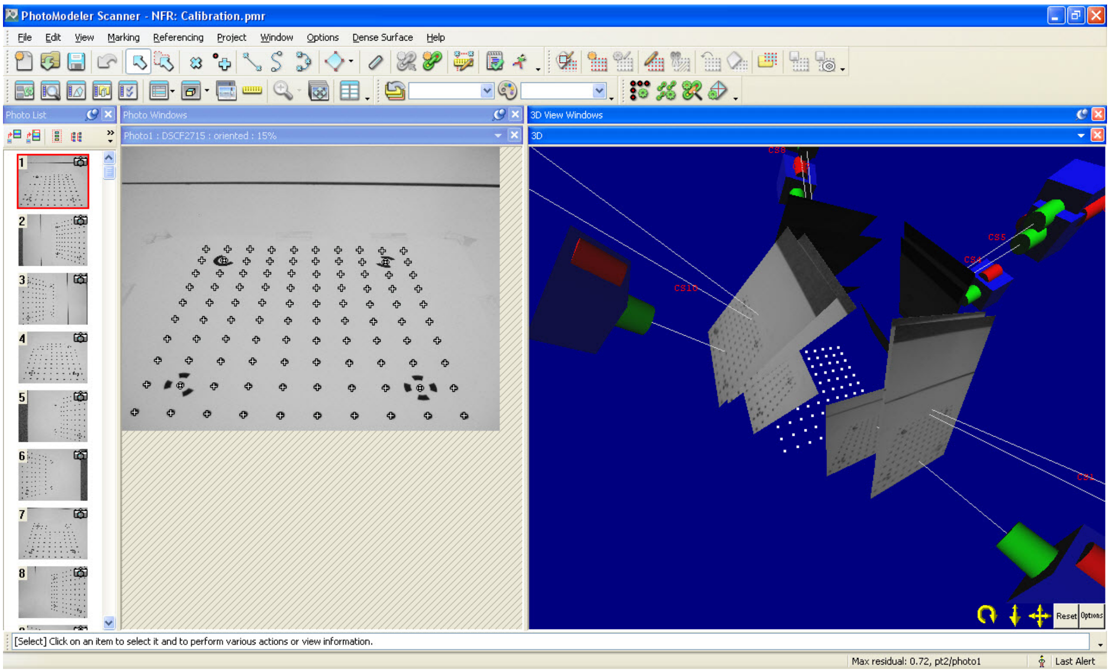

Figure 3 : Camera Calibration and Camera Positions

2.3 3D Transformation

First determine the relative orientation all of the block of images, 32 ground control points and check points around the tomb are identified to determine the 3D transformation for the project into object space.

2.4 Dense Image Matching

All the parameters are in the same reference system defined by the ground control points, dense stereo matching is used to reconstruction the surface of the monument from the stereo pairs. The output of the image matching is normally a dense point cloud for the interested area; it can also be used to determine a depth map (Schouteden et al, 2001). It can be the whole overlapping area or just a small piece that can be used to determine the right set of parameters for the matching. In addition, the area of interest can be affective selected in order to speed up the matching.

Candidates for conjugate features between images fulfill at least two criteria: first, cross-correlation coefficient above a predefined threshold; second, distance to the epipolar constraint bellow a predefined threshold (Heike, 1997).

Fig: 3
Stereo pair with the selected area for matching on the left image (top)

The ill-conditioned problem of matching has to be always present. There exist alternatives to reduce the effect of matching ambiguities or wrong conjugate features such as the ordering, the parallax and the gradient of parallax constraints. Furthermore, the pyramidal estimation scheme is highly recommended to deal with large disparities.

2.5 Filtering of Outliers or Gross Errors

Due to the aforementioned problem of the ill-conditioned matching, filtering is required to delete wrong estimates i.e. 3D coordinates in object space.
In the approach presented herein two threshold filters are applied: first, a distance filter that is used to delete points away the main surface; second, an angular filter to delete points away the parallax angle.

2.6 Meshing Steps

Meshing is the next step used to cover the whole 3D model of the monument. A triangulated irregular network (TIN) following a Delaunay triangulation was used to cover the whole Eflatunpınar .As the area is on top of the monument, there exist a large amount of unfilled triangles as well as occlusions from only one stereo pair. It could be solved either using more stereo pairs from different attitudes, or using wide-baseline setups (Helmut, 2008).

2.7 Photorealistic Texturing

A 3D realistic model is an object model where the texture information is taken from images (Dorffner and Forkert, 1998). Photo models usually known as photorealistic models. The visibility analysis should always be performed in order to determine which triangles are intersected by the rays between each raster point and the projection centre. Fig. 4 displays a close-up view of the whereas Eflatunpınar. Fig. 5 displays a general view of the high resolution 3D photo model.

Figure 4. Close-up view of the photorealistic model

Figure 5. Point Cloud model of the North side of Eflatunpınar

3. CONCLUSIONS

At the end of this project, photogrammetry ensures a well solution for generate a high quality of photorealistic model and this benefits can provide a well-documentation for preserving complex heritage sites. The image-based photogrammetric is suitable for off-the-self digital cameras and yields maximum quality with multiple overlapping images taken around the monument. It requires good estimates for both the interior and the exterior orientation parameters. Results show that it is possible, on the one hand, to build up highly accurate 3D models with conventional cameras on the other, to drape high quality textures from the most convenient positions around the monument with good light. The light is the most important for texture model cover and the same angle of the sunlight will be the best thing than have a part of shadows part of photos. This can require that have to capture photos different hours when the sun have different angle on the monument. Further accuracy need to use synchronous camera systems and to use tripod will help for have a good capturing image.
The photogrammetric approach based on imagery acquired with digital cameras can be considered a serious alternative to other much more expensive approaches mainly based on range-based devices such as terrestrial laser scanners. It can be successfully used to record archaeological monuments and sites. On the other hand, it can also be used to complement 3D projects that might mainly require laser scanning as a first choice. The digital 3D model of the monument can helps in future preservation work such as reconstruction and renovation. It is beneficial to have this real 3D environment model to act as the guideline to responsible authority as reference for better documentation planning and tourism purposes.

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BIOGRAPHICAL NOTES

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