



VIRTUAL TOURS OF HISTORICAL AND ARTISTIC HERITAGE IN THE PROVINCE OF CACERES

RECORRIDOS VIRTUALES DEL PATRIMONIO HISTÓRICO ARTÍSTICO EN LA PROVINCIA DE CACERES

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Abstract:

The 3D visualization of historical-artistic heritage in the province of Cáceres is an essential tool for touristic promotion. To this end, a methodology is offered based on the application of panoramic spherical photography and terrestrial laser scanner (TLS). The general aim is the creation of geometric representations of sites of cultural interest by the visualization of spherical scenarios and the application of 3D modelling techniques. Particular aims include the geometric cataloguing and acquisition of this artistic heritage and the development of an interactive tool for tourists. A hypermedia atlas is created in which 3D spherical scenarios is visualized displaying videos obtained from the point of clouds and ASCII format downloadable 3D models are made freely available. Other benefits of this project are gains in the knowledge and assessment of the cultural heritage in Cáceres.

Key words: geometric characterisation, 3D modelling, historical-artistic heritage, tourism promotion, atlas hypermedia

Resumen:

La visualización 3D del patrimonio histórico-artístico en la provincia de Cáceres, es una herramienta esencial para su promoción turística. Con este fin, se ofrece una metodología basada en la fotografía panorámica esférica y el uso del láser escáner. Como objetivo general se realiza la caracterización geométrica de los Bienes de Interés Cultural, mediante técnicas de visualización de escenarios esféricos y generación de modelado 3D. Los objetivos particulares son catalogar y adquirir de forma geométrica este patrimonio y desarrollar una herramienta interactiva de consulta. Por ello, se crea un atlas hypermedia donde visualizar escenarios fotográficos tridimensionales, videos a partir de las nubes de puntos e incluso su descarga en formato ASCII, todo de forma gratuita. Otros beneficios del proyecto son el conocimiento y la puesta en valor del patrimonio de Cáceres.

Palabras clave: caracterización geométrica, modelado 3D, patrimonio histórico-artístico, promoción turística, atlas hypermedia

1. Introduction

Any attempt at promotion of tourism of architectural and archaeological heritage needs “the withdrawal of information” (Ismagilova *et al.* 2014) and the geometry of the constructed reality must be obtained, meaning a topographical survey that rigorously documents its current state (Rua and Gil 2014). Depending on the agents promoting tourism, the degree of detail required may vary (Ramos and Remondino 2015).

The purpose of this work is to establish a methodology for the geometric characterization of historical heritage by means of the combination of different methods of study, measurement, test and analysis, to be used as a basis for touristic promotion.

Compared with common modelling methods, the virtual panoramic view has the advantages of economy and simplicity. Moreover, the requirements for data acquisition are not strict and the resulting panoramic roam is vivid and smooth (Feng *et al.* 2014; He 2015).

Precisely, one such use is the promotion of tourism (Beeton 2015), the aim of which is to promote tourism through the generation of virtual tours from panoramic photographs, which it does with great effect (Alja'am 2010; Wu *et al.* 2014).

On the other hand, terrestrial laser scanning (TLS) has become a powerful technology for 3D object information acquisition, since it permits the use of dense high accuracy 3D terrain information. Nowadays, TLS is often

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used for object modelling in geographic information systems in various fields such as civil engineering and archaeology (Xu *et al.* 2015). The latter of these fields highlights the work intended for the conservation of cultural heritage (Fanti *et al.* 2013; Calin *et al.* 2015).

2. Materials and methods

2.1. Study area

There were made virtual tours in 31 municipalities of the 62 monuments of cultural interest: Abadía, Alcántara, Alcuéscar, Aldea del Cano, Almoharín, Arroyo de la Luz, Baños de Montemayor, Bohonal de Ibor, Brozas, Cabezuela del Valle, Cáceres, Coria, Cuacos de Yuste, Galisteo, Garganta la Olla, Garrovillas de Alconétar, Gata, Guadalupe, Jaraíz de la Vera, Malpartida de Cáceres, Oliva de Plasencia, Pasarón de la Vera, Piornal, Plasencia, Robledillo de Gata, Santa Cruz de la Sierra, Trujillo, Valencia de Alcántara, Valverde de la Vera and Villanueva de la Vera and Zarza de Granadilla.

2.2. Materials

A Canon EOS 5D Mark III camera was used to capture photographs, capable of capturing 22 megapixels with a lens with a focal curvature of 15 mm. In addition, the tripod Manfrotto 303PH with an espherical ball VR was used too. Panoweaver Professional 7 software was used to join photographs and Tourweaver 6.50 to generate spherical photographic scenes.

Furthermore, in order to obtain the 3D models, two types of laser scanner were used: 1) Leica LC10 with an accuracy of 4 mm on the measurement of the distance from point clouds located between 1-50 meters and 2) Faro Focus 3DS120 with an error of 2 mm to a range of 0.6 - 130 m.

The Leica Cyclone Model 7.4 software was used to unload the 3D point cloud. In addition, the Trimble RealWorks software was used for the management and exploitation of these clouds.

2.3. Method

The method carried out follows the next lines of work:

Acquisition of aerial and terrestrial images: The acquisition of aerial images was crucial to the location of each of the monuments of cultural interest examined. Regarding the capture of terrestrial images, it was used the Manfrotto 303PH tripod and the "VR" spherical ball, designed for the computerized creation of virtual scenes from digital panoramic images.

The camera was mounted on the tripod and positioned over the nodal point before taking the spherical panoramic setting so as to obtain a panoramic scene. Several sequences must be taken from different horizontal angles, in our case, 18 shots with a separation of 24°. In addition, we took a photograph of the zenith and another of the tripod to complete the stage.

Generation of panoramic photographs and virtual tours: Once the photographs had been obtained, EasyPano Panoweaver 7 Professional software was used to join the photographs in one single panoramic photo. After,

this was then transformed into a cubic panoramic photo. Finally, a Flash file was generated.

To generate the final configuration of a virtual tours presentation, we used Tourweaver 6.50 Professional software. Once different spherical panoramic photographs have been created, it processes an assembly of all of them to facilitate the virtual interactive immersion of the user. Each spherical view contains a text indicating the municipality in which it is located and its name and its historical information.

Acquisition of geometric information: For the study, the structures of the monuments of cultural interest had to be represented in 3D. Terrestrial laser scanning was capable of carrying out the topographic surveys swiftly and efficiently with an accuracy of within a few millimetres, always using a vertical field of view with a breadth of 270 degrees and a horizontal plane of 360 degrees. 50,000 points were thus captured per second.

The following tasks were then performed: the location and number of data to be collected were planned, and the optimal scanning resolution to represent the monument in detail was determined.

Processing of 3D point clouds: The alignment of the clouds of points was performed first. Using the methodology of resection of targets, which consists of scanning the same targets form different positions, a minimum of three targets were scanned. As each cloud is expressed in its local system, there must be at least three homologous points between neighbouring point clouds. Each consecutive pair of point clouds is oriented with three common targets in order to provide a set of orientation-related parameters.

The alignment of each of the clouds of points is based on the calculated transformation solution. This solution produces the 3D transformation that leads to the following equation Eq. (1):

$$\begin{bmatrix} X' \\ Y' \\ Z' \end{bmatrix} = \begin{bmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{bmatrix} + \begin{bmatrix} 1 & -\Delta k & \Delta \varphi \\ \Delta k & 1 & -\Delta \omega \\ -\Delta \varphi & \Delta \omega & 1 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix} \quad (1)$$

where:

- (X', Y', Z') are the coordinates in the new frame.
- (X, Y, Z) are the coordinates of the entry framework.
- (ΔX , ΔY , ΔZ) and (φ , k , ω) are the parameters of relative orientation.

The alignment will be refined through an iterative process of adjustment by minimum squares in order to reduce the error. After that, the Leica Cyclone 7.4 software showed us the results of the adjustment.

Subsequently, it automatically cleaned and segmented the point clouds. Therefore, everything that was not needed for the job (the noise) was removed, like all points whose depth was outside the separation distance between the laser scanner and the measured object or points that did not define the model itself, such as people crossing during measurement, or trees.

Registration and integration of models: The next phase of the work was to set up the union of the scans. Trimble RealWorks program was used to perform the union of

scans. Then, using this same software, videos were generated from the clouds of points obtained.

3. Results

Once all spherical photographic scenarios and 3D points clouds had been obtained, there were uploaded to the Internet. For this purpose the following web page was created for use as a hypermedia atlas: <http://158.49.247.14/caceresvirtual/>.

The information can be accessed in different ways using the menu, on which not only can we select the municipality, but also the point of cultural interest we want to display. In that way, the videos and spherical scenes will be viewed. The most intuitive way for the user to access the information, however, is to interact with the map of the province of Cáceres appearing on screen.

4. Conclusions

We think it is necessary to facilitate the knowledge and appreciation of cultural heritage of Cáceres using free

software and creating a highly accurate 3D geometric model. The transfer of project results to institutions and educational, scientific, and social entities is motivated by the commitment to share between research teams and public agencies for its development. The website created as a result of the investigation should be incorporated other smaller towns of Cáceres to make viable the possibility of the growth of our project. Moreover, the results not only contribute to improving decisions regarding future restorations, but also respond to the challenges of preserving the quality of these artistic testimonies.

Acknowledgements

The present developed work was developed under the 2013 Plan of Initiation to Research of the University of Extremadura within the Program Orientated at Projects of Initiation to the Research called Action VIIIth. The program was financed by the provincial government in Cáceres. We also thank the Junta de Extremadura for providing the aerial images.

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