Discover the Thracians – An Approach for Use of 2D and 3D Technologies for Digitization of Cultural Heritage in the Field of E-learning

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Abstract. Information and communication technologies (ICT) offer an easier access to and a multi-perspective view of cultural heritage artifacts and may also enrich and improve cultural heritage education through the adoption of innovative learning/teaching methods. This paper examines the different practices and opportunities for digitization of cultural artifacts with historical significance and describes the work on a pilot project concerning the development of e-learning materials in the Thracian cultural and historical heritage. The proposed method presents an approach based on a combination of 2D and 3D technologies to facilitate the overall process of digitization of individual objects. This approach not only provides greater opportunities for presenting the Thracian heritage but also new perspectives for studying it – students, scientists, PhD students will have the opportunity to work with the materials without having access to them.

Keywords: 2D technologies, 3D technologies, multimedia content, e-learning, digitization, cultural heritage, Thracians

1 Introduction

Cultural heritage education in most European countries was based for a long time on traditional teaching methods; this meant that it usually relied on face-to-face classroom lessons, on the study of printed materials (texts and images), and very seldom on watching videos [1]. In some cases the study of cultural heritage artifacts was accompanied by on-site visits where students could come directly in touch with the artifacts [2]. On the other hand, in the field of cultural heritage, knowledge sharing is one of the most essential aspects for communication activities between museum institutions that conserve and take care of cultural collections, and the public. These activities include education, research and study as well as entertainment. All of them are really precious for the spread of culture [3].

The following methods enable the researcher to examine the details that do not provide simple illustrations and allow for visualizing hypotheses about the ritual use

of objects for a more detailed semantic analysis of the actual objects and images on them. Not least, it should be stressed the possibility of rapid dissemination of scientific knowledge and hypotheses. With 2D and 3D technologies are formed and new paradigms in the humanities.

2 Digitization of Cultural Artifacts Nowadays

A large number of organizations, worldwide are promoting research into the digitization of cultural artifacts. These include the Canadian Heritage Information Network (CHIN), the Virtual Heritage Acquisition and Presentation (ViHAP3D) project in Europe, and the Salzburg Research Institute (SRI) in Austria [4]. Some museums are working in collaboration with universities to further research in digitization; in 2004, approximately 35% of museums, worldwide, had initiated developments in some form of 3D digitization of objects [5]. These include the Museum of New York, the Royal Ontario Museum, the Museum of Science Boston, and the American Museum of Natural History. Efforts to establish entire "virtual museums" include The Canadian Museum of Civilization and the National Research Council of Canada collaborating on the production of the Inuit3D Virtual museum, launched in April 2001, and the Computer Science Department of Zhejiang University developing a 3D Dunhuang cultural relic exhibition system in 2004 [6].

The field of 3D artifact digitization also extends to independent projects, and in several cases, organizations have been assigned specifically to digitize iconic monuments. A project led by Gabriele Guidi, in 2005, involved digitizing the "Plastico di Roma antica", a model of ancient Rome created in the last century. A modulated light scanner is used to provide the accuracy needed to capture the detail of the model's features. The scanner is supplemented by a triangulation scanner to capture the more intricate parts of the model [7].

In 2004, the spiral motif at England's Castlerigg stone circle in Cumbria is digitized using the noncontact techniques of laser scanning (using a Minolta 910 scanner) and ground-based remote sensing. No motif is identified through the digitization process, despite the fact that in previous years, the motif image had been observed. This indicated that the spiral is probably painted or had faded due to natural events, and is a novel application of the highly objective methods of 3D digitization to record the presence of an artifact feature [8].

In 2003, Subodh Kumar, and a team of students from the Johns Hopkins University in Baltimore, undertook the 3D scanning of ancient cuneiform tablets. Cuneiform documents exhibit writing on three-dimensional surfaces. The team aimed to provide accurate, high-resolution 3D models of these tablets for scholars' use in their research and for digital preservation of the unique historical artifacts. A laser triangulation scanner is used, using a regular grid pattern at a resolution of 0.025 mm. It was found that conclusive scanning is a challenge using current technologies [9].

The examples described are just a selection of projects that indicate the diversity of applications of 3D digitization to cultural heritage artifacts.

3 Three-dimensional (3D) digitization

3D digitization is a complex process that consists mainly of three phases: (1) Preparation, during which certain preliminary activities take place that involve the decision about the technique and methodology to be adopted as well as the place of digitization, security planning issues, etc.; (2) Digital recording, which is the main digitization process according to the plan from phase 1; (3) Data processing, which involves the modeling of the digitized object through the unification of partial scans, geometric data processing, texture data processing, texture mapping, etc. [10].

The past 20 years have seen the development of different 3D data acquisition technologies. These include acoustic position trackers, close range photogrammetry, coordinate measurement machines (CMM), holography, laser scanners, magnetic position trackers, and touch probes. The methods of digitization available can be broadly classified as contact or noncontact (mechanical or optical) techniques [11].

In the project "Discover the Thracians" we used a method known as *Shape from silhouette*. This technique is based on multiple photographic capturing of the object from different viewing angles, and deducing the geometry from the object's silhouettes (Fig. 1). This is, actually, an old idea originating back to 1960 when Francois Villeme discovered a method called photo-sculpturing: 24 photographs covering the surface of the object are taken and are projected onto clay. This method regained interest about 50 years later with the advent of computers.

Recent improvements of this method use texture information to correct or enhance geometry with very interesting results in terms of the final recorded geometry. Shape from silhouette is an automated process with high productivity and relatively low cost. As of this moment it is very popular. It can capture both geometry and texture. It is portable and easy to use [12].

Fig. 1. Discover the Thracians - the photo shoot phase

4 Combining 2D and 3D objects

In the pilot project "Discover the Thracians" we present Thracian treasure found in Letnitsa, Lovech. The treasure was discovered accidentally in 1963 in the courtyard of the farm village of Letnitsa. The workers stumbled upon a large bronze vessel lid in the ground upside down. When they turned it, they saw that the court is full of small silver objects with images. The find is known in science as Letnitsa treasure. Besides bronze vessel the treasure contains bridle ornament and trims horse trappings. Treasure is interpreted as a symbolic sacrifice of a horse.

Regarding learning purposes the main goal was to present more clearly the original layout of the objects which were a common decoration of horse trappings. That led us to the idea of a combination of 2D and 3D approaches. Separate 3D digitization of each subject was found impossible – the treasure is stored in the National History Museum of Bulgaria and for this purpose should trigger a complex bureaucratic procedure for required permits – something that would probably take months or a year. In fact, for our purposes, we did not need a 3D digitizing of each object. We came to the concept to locate two-dimensional images of individual artifacts from treasure on the 3D image of a horse figure. Fortunately, we had wonderful pictures of the treasure, made by photographer Nikolai Genov. So we gently crop all objects and "glue" them on previously digitized 3D shape of a horse (a process described in the previous section). Figure 2 presents the result. 3D object allows students to examine fully the presumable original location of all artifacts from the treasure. In the project, on a separate screen there is given an opportunity to examine details and individual close-ups, accompanied by appropriate descriptions.

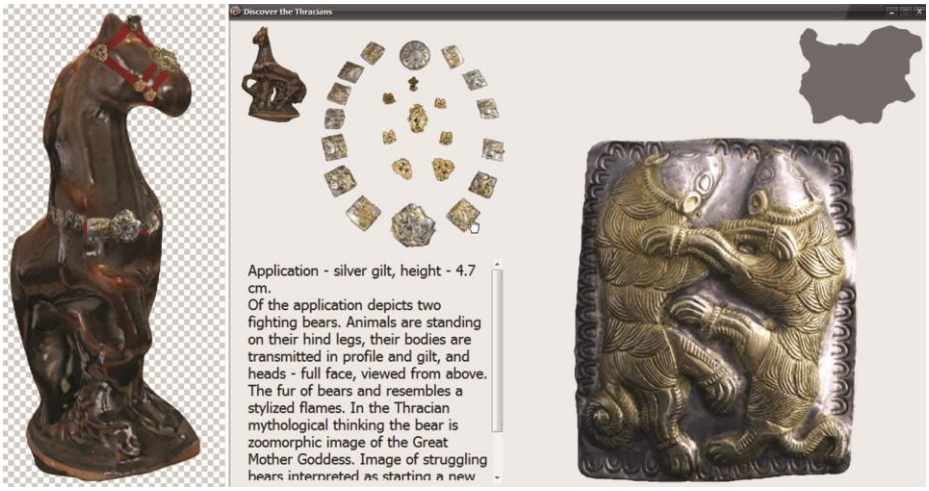

Fig. 2. Combination of 2D photos and 3D object and close-ups of artifacts

5 Conclusions

The paper presents unusual approach to virtual presentation of objects of cultural heritage, combining traditional 2D techniques (based on separate photos) with 3D object. The proposed method is suitable in cases where it is necessary to illustrate more clearly the original purpose and functionality of individual objects - knowledge which can hardly be transmitted only by visiting the museum and view the sites there, or viewing pictures. The approach is quite inexpensive and requires much less time compared to full 3D digitization.

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