ECHOES: An Interdisciplinary Approach in Digital Reviving of Archaeo-anthropological Material

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Abstract. Drawing from the past the human remains of ancient civilizations and reviving them with the assistance of current technology is a way to shed light on history and develop communication channels between the modern world and its past. Within the framework of construction of various works of infrastructure in Greece, the archaeologists are given the unique chance to excavate in the current urban environment and unveil the archaeological relics that stand buried and silent for centuries under the modern concrete buildings and roads. Among the various archaeological findings, the ancient cemeteries are a valuable source of information about the populations that once inhabited the Greek cities. The construction of Thessaloniki's subway uncovered thousands of tombs, dated from the Hellenistic (4th c. BC) to the Ottoman period (19th c. AD). This archaeo-anthropological material becomes the research objective of a collaboration of research institutions and creative and cultural companies, with the aim to reconstruct the health of the ancient population, revive the citizens of the ancient city using the Virtual and Augmented Reality, and Serious Games technologies, and narrate their story through the design of experiential tours. This contribution outlines the multidisciplinary approach applied in the ECHOES project for the innovative presentation of the biographies of the ancient inhabitants of Thessaloniki to the current city's wide population.

Keywords: Digital Storytelling, Game Technologies, Augmented Reality, Virtual Reality, Cultural Heritage.

1 Introduction

The urban landscapes of modern Greek cities are another habitation layer on the deep stratigraphy of their subsoil. Each habitation layer consists of tangible material, architectural relics and human remains that are the characteristic traits of humans' cultural activity. The construction of the Metropolitan Railway in Thessaloniki brought to light relics of the city's Hellenistic, Roman, Byzantine and Ottoman periods as well as more than 4500 human burials. Using cutting-edge technologies in the field of paleoanthropology, such as isotopic analysis, anthropologists can reconstruct the health, diet and demography of the ancient population and observe the physical evolution through time [1]. The anthropological results combine with the archaeological elements collected during the excavation procedure that reflect the cultural context of the human living. Pottery, architectural relics, stone and metal artifacts, organic remains, such as artifacts of wood and textiles as well as food remains, compose a multidimensional context that defines and describes human culture.

This material, in order to be presented publicly, should be subjected to multi-layered interpretation procedures to uncover the multiple aspects of its subsistence, which compose the elements of its story [2]. The digitization of the material and its subsequent transformation into virtual and augmented reality experiences can be very creative and feasible for the communication of the human past. The research project "*ECHOES: Development of a methodology for the digital rEconstruction of anCient Human biOgraphiES through the study of archaeo-anthropological material*" develops innovative storytelling of the biographies of the ancient inhabitants of Thessaloniki, based on the paleoanthropological research results, and by exploiting the potentials of immersive technologies.

This contribution presents the principles that define the development process of the research project ECHOES. The scope of the paper is to outline the methodology adopted for the creation of the immersive experiences and highlight the elements that can transform the passive storytelling into an interactive story-living experience.

2 Related work

The digitization of cultural heritage made the cultural assets accessible, ensuring their openness on a global scale [3]. Technology shares a great merit of current culture's publicity. Museums and cultural stakeholders in general, develop their digital strategy with the aim to retain their audience and engage new visitors, especially among the youngest generations [4]. Within this framework, virtual and augmented reality are a predominant technological option of archaeology's digital strategy towards a more accessible and engaging storytelling [5]. Experiencing the archaeological material in a multisensory immersive environment, outside of the restricted display borders of a glass case, enhances the perception potentials of the meaning-making, as it creates connection channels not only with the tangible objects, the archaeological remains, but with their multiple cultural contexts as well, the objects' multidimensional entangled life [6].

Virtual reality is a tool for the development of full immersive artificial environments that transfer the users in space and time and create an entertaining framework of learning [7,8]. When the virtual environment refers to an archaeological site, the users may visualize the past and get engaged in a reconstructed historical scenery of high photorealism and level of immersion. These environments can be elevated due to interaction and storytelling. Sylaiou et al. provided insights in the communication potentials of the operation of virtual humans as storytellers in virtual environments, in terms of persuasion and emotional engagement [9]. However, the transformation of the experience into an active, participatory one can be achieved by the multisensory engagement of the user. A simple step towards that direction could be the handling of 3D objects in the virtual environment [10]. The gamified perspective of the cultural - archaeological-material is the experiential path to understanding the past, [11-13].

3 Methodology

For the development of the ECHOES project, the research team adopted a linear methodology that connects the initial archaeological and anthropological research with the immersive experience and their incorporation into experiential city tours, through a successive interdisciplinary research approach.

3.1 The archaeological material

During the construction of the Metropolitan Railway in Thessaloniki, North Greece, the archaeologists of the Ephorate of Antiquities of Thessaloniki city excavated more than 4500 tombs, mainly scattered in the three cemeteries of the city [14]. The burial structures were situated outside the city walls, along the roads leading away from the city's gates, according to the burial practice of the ancient Greeks. Most of the tombs were found in dense arrangement, frequently overlapping and overlying one another, an indication of the long and continuous habitation of the city. The burial constructions vary according to the period but also the wealth of their owners, from simple tile-covered graves to decorated sarcophagus and monumental constructions. Pottery and glass vessels, gold, bronze and bone jewelry, coins, figurines and occasionally rare artifacts, such as the bone implements of a scribe, accompanied the dead. The richness and plurality of the archaeological material found in the cemeteries of Thessaloniki make it a unique and inexhaustible source of information about everyday life and the evolution of the city's ancient populations.

3.2 The audience research

A primary source of data defined the design process of the scenarios and the related virtual and augmented reality experiences. A front-end survey [15], conducted during the first months of the project, was addressed to three target groups of potential users: a. citizens of Thessaloniki (188 answers), b. tourists of Thessaloniki (103 answers) and c. educators of Thessaloniki's schools (98 answers). According to the survey's results,

the majority of the respondents find it very interesting to learn about the city's history and its ancient citizens as well as the archaeological remains.

In the survey, there was a separated sector regarding the relationship of the users with the technologies of VR and AR reality. Although the greater part of the respondents had a slight previous acquaintance with these technologies, they seemed willing to explore their learning and entertaining potentials. The experience of virtual narrators in multisensory environments where handling of 3D objects is possible proved to be very appealing to both locals and tourists. The overall users' perspectives can be summarized in the following: multisensory environments, interaction with objects, experiential narration.

3.3 The anthropological study

The human remains of the tombs are subject to treatment and study in the laboratory. The scope of the anthropological study of the bones is to specify the physical traits of the human skeletons and compose the biography of the dead. Based on the skeletal and dental remains, the anthropological research can estimate the age, the height and the body mass of a human skeleton, determine the sex and the nutrition habits and define any diseases and injuries, which the human skeletons may have suffered, to name a few. The study of the anatomy of the face helps researchers estimate the shape, the position and the dimensions of the facial traits. By conducting specific laboratory research, the researchers can identify the color of the eyes, the hair and the skin. The results of the above-mentioned research stages are a collection of the physical traits with which the human body can be reconstructed in a very representative level [16].

3.4 The scenarios

The data collected from the archaeological and the anthropological research are used for the design of five different plots. These plots will be transformed into immersive experiences where the users will deep into the knowledge gained by the study of the ancient cemeteries. The five scenarios are inspired by the burial elements of the selected tombs and reflect five thematic pillars, which in an overall perspective, describe aspects of the everyday life of the ancient populations of Thessaloniki. In these five experiences, the 3D reconstructed human figures are the narrators of the story, introduce the user into the thematic context of the story and orient the user in the immersive experience.

Specifically, the five immersive environments with their thematic pillars and their related scenarios are briefly as follows:

1. A port of the 3th c. BC. A story about Thessaloniki as a trade center and the city's multicultural character.
2. The scripter's office. A story about the professions in Roman Thessaloniki inspired by a scripter's tomb (1^{st}-2^{nd} c. AC).
3. 3D reconstruction of a monumental burial chamber excavated in one of the cemeteries of ancient Thessaloniki. A story about burial customs and practices.

4. The interior of a child's room. A story about breastfeeding and childhood in Roman Thessaloniki (2nd c. AC)
5. A Byzantine *triklinion.* 3D reconstruction of the dining room of a Byzantine house. A story about the food preferences and nutrition during the Byzantine period.

3.5 Immersive historical environments

Experiential tours with augmented reality. Based on the above-mentioned predefined scenarios, the research team will develop augmented reality experiences, which the users will have access to, through portable devices (tablets). The interdisciplinary research team of the ECHOES project consists of tour guides among other experts, who will design walking tours thematically oriented to the five scenarios. When wandering around the city's streets, the users will be able to spot locations that are depicted on a map as points of interest. These points, when activated, will augment the projection of 3D cultural assets (tombs, artifacts) that have been excavated during the construction of the METRO Railway and are being recovered with soil under the modern city. The augmented reality experiences enable the connecting channels between the modern and the past urban environment, the visible and the hidden cultural material of the city's history.

Storytelling in virtual environments. The virtual experience starts with an initial, introductory level, where the user enters the virtual wagon of a modern railway and interacts with the five figures that represent the five biographies. The figures, after they introduce themselves, lead the user to their linked environment, like a variety of different virtual rooms narrating the five scenarios. Initially, these figures are a blurred form, with no clear physical characteristics. The user explores the virtual environment, interacts with the artifacts, acquires the information material and as reward, the blurred form reveals its physical traits. Consequently, the mission of each level is the user to manage to conclude its experience with the revealing of the reconstructed figure. Thus, the user will witness the biography's actual characteristics, the color of its hair or of its eyes for instance, the amount of the phenotypic characteristics that have been attributed to them according to the anthropological research results.

The above-mentioned five scenarios will be developed to the five virtual experiences. Each experience is a virtual representation of a historical environment, except the tomb experience (Scenario 3) which is a virtual reconstruction of a monumental tomb. In this case, the user will be able to enter the tomb chamber, experience the interior of a beautifully decorated burial space where five people were buried in three different periods. One of these buried is the narrator biography of the experience. The artifacts found in the tombs will be interaction objects. By handling these 3D objects, the users gain access to the information tanks and manage to accomplish the game missions.

4 Discussion

Modern cities are the diverse accumulation of the tangible material of past cultures. The visible archaeological remains, apart from tourist attractions, are the witnesses of the time passing and of the evolution of the city's character. However, they are just a small, indicative part of the archaeological material left by the successive habitation activity. The majority of the tangible cultural material remains buried in layers under the modern buildings. The construction of works of infrastructure, such as of the METRO Railway, is a unique opportunity for the archaeologists to dig the past layers and unveil the cultural material from the loads of soils that have covered them through time. Among the archaeological material, the human remains reflect the most the multiple character and the course of evolution of the ancient populations. The anthropological study of the ancient skeletons found in the various ancient cemeteries is a valuable and irreplaceable source of information about the demography, the physical traits and evolution of the ancient humans. This anthropological aspect completes the cultural context of human remains, along with the tangible assets that escort the dead to the next life.

Following the excavation, the archaeological services transfer the human remains found in tombs to the anthropology and conservation laboratories. Covering properly the rest of the archaeological material, such as the burial constructions or the buildings' foundations, is a common procedure for the completion of the infrastructure works. These relics remain silent under the modern cities and invisible by the modern citizens and the tourists. With the assistance of technological tools, these relics can be brought to light and reconnect with the human parts in artificial reconstructed contexts. Reconstructions are a popular way to communicate the past [17], visualizing what the user cannot see, but as far as sophisticated they are, they must tell the story as it was, trying not to evoke misinformation [18]. This can be the basic guideline for the virtual and augmented reconstructions of historical environments, created for the purposes of learning and understanding.

The sufficient documentation of the cultural material can lead to a productive meaning making and subsequently, to a meaningful and comprehensive storytelling. Immersive technologies managed to interfere into the digital transformation of cultural heritage and offer the potentials of engaging, participatory experiences, with the assistance of serious games mechanisms. This holistic perspective of cultural material can pave the path to a more accessible cultural heritage. It requires an interdisciplinary approach that ensures the interpretative and communicative quality of the final representations.

5 Conclusion

The purpose of this contribution is to describe the methodology adopted for the development of the immersive experiences of the ECHOES project. Even if the development of the project is still in progress, this paper is an opportunity to highlight the principles and the guidelines that defined the project's strategy. The core of ECHOES project is the efficient dissemination of the archaeological and anthropological research results

through the visualization and gamification of the historical content and context. It became clear that the exploitation of cutting-edge technologies in the presentation of the cultural material could enhance its interpretative potentials and create efficient communication channels. Immersive technologies, such as virtual and augmented reality, make cultural assets accessible and transform passive storytelling into engaging experiences. Concisely an interdisciplinary approach of the archaeological material can make modern locals and tourists view their ancestors and the way they shaped the historical transformation of modern cities.

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