Digital Heritage Technology at the Archaeological Museum of Heraklion

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Abstract. This paper presents an Ambient Intelligence infrastructure that fuses state-of-the-art technologies and related applications with digital cultural resources to deliver interactive and immersive user encounters through on-site Virtual Exhibitions (VEs) which respond to the demands of 'new museology'. The practical exploitation of the concept is presented through the reformation of the exhibition spaces of the Archaeological Museum of Heraklion which is one of the most important Greek museums hosting representative artefacts from all the periods of Cretan prehistory and ancient history, covering a chronological span of over 5,500 years from the Neolithic period to Roman times.

Keywords: Information visualization · Interactive systems · Mixed reality
Augmented artefacts · Interaction with printed matter · Hand gestures
Skeletal interaction

1 Introduction

The term '**new museology**'[1] introduces a new philosophy around how museums function and a changed relationship between museums and their societies and communities, shifting attention from museum collections towards visitors [1, 2]. It encourages communication and new styles of expression, as well as **active participation**, in contrast to more traditional, collection-centered museum models [3]. New museology demands

[1] 'New museology' is a discourse around the social and political roles of museums, encouraging new communication and new styles of expression in contrast to classic, collections-centred museum models (Mairesse and Desvallées 2010). It demands that the management of heritage should be 'more open, inclusive, representative and creative' (Harrison 2013, 225).

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that the management of heritage should be more open, inclusive, representative and **creative** [4]. These developments can be argued to be part of a shift in focus from objects to ideas [5], with **language and education** now argued to have a **central position in museums** [6]. In this context, ICTs are and can further be used to enrich, transform and enhance the cultural experience.

The work reported in this paper delivers theme-specific interactive experiences aiming to communicate and shape CH in the context of CHIs. Virtual cultural assets and associated information and content (a) are combined, (b) organised appropriately to be transformed into interactive experiences, (c) displayed through suitable virtual environments and finally (d) delivered through digital platforms/devices on the basis of real-time interaction with visitors stimulating immersive experiences.

2 Background and Related Work

Virtual Museums have evolved from digital duplicates of "real" museums or simple online museums into complex communication systems, strongly connected with interaction and immersion in 3D reconstructed scenarios [7]. In such context, Virtual Museums mainly fall under one of the following categories:

Mobile Virtual Museums or Micro Museums, using Virtual Reality (VR)/ Augmented Reality (AR): Mobile applications using AR technology to explain history, architecture and or other artefacts visually, in an indoor or outdoor environment. Example applications include indoor virtual archaeology, embedded virtual reconstructions, and on-site data explorations.

On Site Interactive Installations: Multi-user environments, aimed at preserving the collective experience typical of the visit to a museum. A common characteristic is the use of 3D models reconstructing monuments, sites, landscapes, etc., which can be explored in most cases in real time, either directly or through a guide who acts as main driver of the application, usually mixed with other multimedia assets.

Web-Delivered Virtual Museums: Virtual Museums providing content through the Web. A wide variety of 3D viewers and players have been developed to provide 3D interactive applications "embedded" in browsers, activated by website exposing specific 3D content. Many of these tools are licensed as proprietary technology, charging for development tools/site license, while providing the closed player free of charge. Examples include Google Art, Inventing Europe[2], MUSEON[3], etc.

Multimedia Virtual Museums: Interactive experiences blending video, audio and interactive technologies (for examples 'DVD of Medieval Dublin: From Vikings to Tudors').

Digital Archives: Increasingly popular, as the amount of digital information increases, together with the wish of the public to gain access to information. It requires robust systems for storing information, but also intelligent tools to retrieve it. Examples

[2] http://www.inventingeurope.eu/.
[3] http://www.museon.nl/en.

of Digital Archives include **thesaurus** of terms describing a CH asset, digital repositories considering all possible different metadata schemes of its digital content, intelligent searching/browsing systems, digital archives, etc.

Although much work has been done to date, museums still hesitate towards the greater penetration of modern technology into the actual exhibition spaces to form novel hybrid experiences that merge both actual artefacts and digital information displays. In this paper an infrastructure for delivering such concepts to museums is presented, focusing on a practical exploitation of the concept at the premises of the Archaeological Museum of Heraklion.

3 System Architecture

One of the most challenging aspects of this research work is coping with the complexity of the installation at the Archeological Museum of Heraklion. It was required to produce a system architecture that could cope with the storage of knowledge, scenario building upon knowledge sources, versioning and synchronization of scenarios, scheduling of system functionality and tracking of system events for approximately 20 interactive installations across the museum. The challenge was to create a system architecture that could support these facilities in a way transparent to the museum personnel with automated handling of all systems (opening and closing systems based on schedules, changing dynamically the scenarios presented by each system based on the time schedule of each exhibit etc.).

To achieve this objective, a distributed architecture was designed and implemented that addresses all the aforementioned requirements. In order to be able to administer the large amount of digital information stored and facilitated by the interactive installations, a centralized storage was set-up that has the required capacity to handle storage of digitized 2D artefacts, 3D models, video content, presentations, interactive animations and textual knowledge in structured ontology-based format. The centralized storage also supports versioning and automated backup of these assets for further protection. Having taken the decision to incorporate a centralized cloud based scheme for content storage, it was required to create a mechanism for manipulating content and creating complex content structures to be facilitated by interactive applications. This was delivered through a content management system capable of producing, scheduling and versioning scenarios, as well as dynamic installation management and control. On top of this architecture several interactive technologies are used to offer immersive experiences including skeleton tracking, gesture/posture recognition, lateral touch detection and localization. Based on this infrastructure, specific scenarios in the museum are implemented via specialized interactive applications such as:

Multimedia Viewer: Allows the reproduction of multimedia presentations with structured content (scripts) and control of multimedia content, including images, videos, descriptive texts, MS Power Point presentations, applications, mini games, etc.

Multimedia Content Enhancer: Capable of rendering content to extremely large displays (video walls).

3D Objects Renderer: a control for rendering specified 3D models (scene graphs). The control can be simply embedded into internet browsers (e.g. IE) or .NET applications allowing users to interact using multi-touch devices.

Object Stream Visualizer: Comprises a collection of keywords, images and video thumbnails displayed on a very large touch screen.

Wall Game Presenter: presents a game scenario based on full body tracking using gamification technologies for keeping scores, calculating game levels etc.

Timeline Renderer: an application presenting an interactive timeline. Information is organized in the form of a tunnel in which users can navigate and explore different time periods and events.

Papyrus Renderer: a container that can present the content of a thematic category in the form of an interactive papyrus using an infinite multi-touch enabled canvas supporting dynamic embedding media elements through the CMS.

4 Universal Content Management for All Interactive Installation of the Archaeological Museum

The Content Management System coordinates a large amount of systems simultaneously, as the user is able to manage the content of each system remotely, as well as to define a variety of operating scenarios concerning which system will operate, when (i.e. which days of the year) and which content scenario will be presented. It is the most important component in the presented workflow, mainly because it controls everything that happens within the system from content management to scenario building and application delivery and scheduling (see Fig. 1). Using the CMS a number of low level facilities are offered in order to administer content, including versioning facilities and building interactive scenarios. Through the Installation Manager, it is possible to control what is happening in each installation and access its time schedule. Museum curators can control for each installation of the museum the interactive application that will be executed, for which time slot and days, what is the scenario that will be loaded for this application and what is the reusable interaction modality to be used for receiving input.

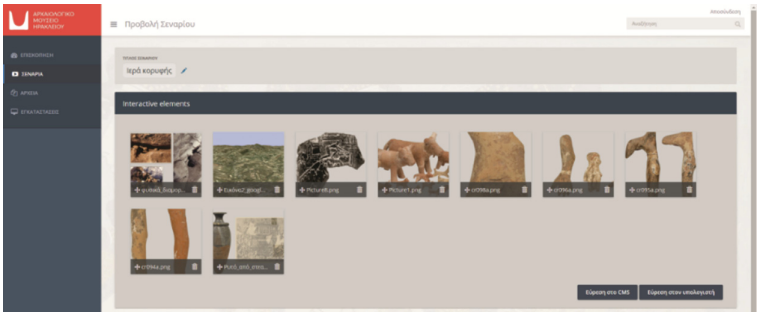

Fig. 1. Building a scenario using the CMS

5 Virtual Tour at the Archaeological Museum of Heraklion

The Heraklion Archaeological Museum is one of the largest and most important museums in Greece, and among the most important museums in Europe. It hosts representative artefacts from all the periods of Cretan prehistory and ancient history, covering a chronological span of over 5,500 years from the Neolithic period to Roman times. The Minoan collection contains unique examples of Minoan art, many of them true masterpieces. The installation of interactive exhibits at the premises of the Archaeological Museum of Heraklion covers the most important thematic categories of the museum. Interactive systems are scattered within the museum and occupy physical spaces where digital technology is used to "accompany" and "explain" physical exhibits and antiquities. A major challenge from a technological perspective was to automate all the functionality of the digital exhibits and integrate installations in an unobtrusive way within the museums architecture and rooms structure.

The Museum welcomes the visitors with a video wall consisting of 8 monitors accompanied by an artistic board depicting a simulation of the Minoan labyrinth and a design plan of the facilities. The video wall presents multimedia content related to the most important exhibits of the museum presented in chronological sequence, corresponding to the exhibition tour. Graphic designs smoothen the transitions between exhibits in order to give a pleasant overview of the exhibition (Fig. 2).

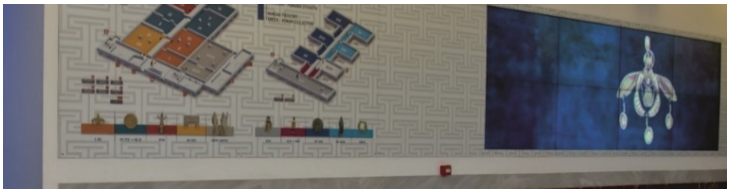

Fig. 2. Museum entrance, video presentation with the most important exhibits

The tour of the archaeological exhibits begins as visitors enter Hall no. II (Fig. 3a left). A screen embedded into the wall presents multimedia content related to the theme of the room, the Peak Sanctuaries. Physical environments of the sanctuaries, architectural conformation, dedicators, offerings and references of cult activity in modern times are illustrated. Proceeding to Hall no. VI (Fig. 3b), a presentation related to the theme "Music, dance, sports and spectacles" accompanies the room. In both halls, the **Multimedia Viewer** application is used together with the **Skeleton Tracking** and **Gesture/Posture recognition** interaction modality. Visitors may interact from distance and control the system with gestures.

Fig. 3. a. Left: Hall II "Peak Sanctuaries", b. Right: Hall VI "Music · Dance · Sports · Spectacles"

Hall No. V hosts two information kiosks (Fig. 4 left) displaying information about Minoan Diet, Minoan Architecture, Minoan Writing & Sealing and Minoan Technology (see Fig. 4 right). The info kiosks provide information categorized in the form of augmented digital book, enriched with additional features, through multiple touch screens. Each thematic contains texts, images, videos, 3D models or micro-games. Text may comprise hyperlinks which provide further information with related multi-media content through a pop-up window. The Papyrus renderer is used by the kiosks that integrate via the scenarios 3D objects Renderer, in order to offer interaction with 3D models. An edutainment micro-game is dedicated to provide information within two scenarios: the construction of a clay pot, and the construction of a bronze tool. Both scenarios unroll with the presence of a schematic human figure which users may manipulate through specific touch interactions.

Fig. 4. Left: Information kiosks located in hall V, Right: Minoan Diet, Minoan Architecture, Minoan Writing & Sealing, Minoan Technology

At the ground floor two other interactive systems are hosted. The system depicted in Fig. 5a presents multimedia content focused on the conservation of antiquities over time. The Multimedia Viewer application shell is used together with the Skeleton Tracking and Gesture/Posture recognition interaction modality. At the right side of the area (Fig. 5b) an interactive game provides visitors with an innovative experience of edutainment as they control the game using their "virtual" shadows projected on the display. The "virtual" shadow follows body movements as users stand in front of the screen. Minoan ancient objects have to be separated following specific criteria, such as material, usage, date, etc. The Wall game presenter application is used together with Skeleton Tracking and Gesture recognition interaction modalities.

Fig. 5. a. Left: Video presentation of the conservation of antiquities, b. Right: Entertainment game with interaction from distance

Proceeding to the first floor of the Museum, visitors get to learn about "Minoan thalassocracy" (Fig. 6a) and more specifically about the influence of prehistoric Crete in ancient times and the spread of Minoans around the Aegean Sea through descriptions of archaeological sites and objects, as well as reports of the Archaeological Secretariat concerning the tradition and the society of Cretans. In Hall XIV visitors are able to navigate through a multiple touch screen that provides information in the form of a constant flow of images and words. Accordingly, at the opposite aisle XXV, another touch screen presents information about "Daedalus & Icarus: The first flight and thereafter" (Fig. 6b). The Object stream visualizer is employed by both displays together with the embedded touch capabilities of the display.

Fig. 6. a. Left: Hall XIV "Minoan Thalassocracy", b. Right: Hall XXV "Daedalus & Icarus"

The conference room, in the first floor, hosts an interactive system that presents time-related information on a large scale display, while user interaction is achieved through remote gesturing. The system ensures a rich and immersive user experience, while providing information in a clear and unambiguous manner, and is suitable for the infotainment domain, which combines information and entertainment. The information presented from the system is focused on the history of archaeological research and excavations in Crete through the establishment, operation and recent renovation of the Archaeological Museum of Heraklion, emphasizing key events. The Timeline renderer application shell is used in this installation together with the Skeleton Tracking and Gesture/Posture recognition interaction modalities. Content is synchronized in the form of scenarios by the CMS client.

6 Conclusion

This paper has presented the technological infrastructure deployed at the museum together with the specific interaction technologies and information systems used to blend digital information with the museum visiting experience. For this purpose technology is used to augment the information presented by museum exhibition to form novel experiences that blend physical artefacts with digital information rooted in new museology paradigm. The reformed exhibition is experienced, since 2015, by hundreds thousands visitors of the museum each year.

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