ARCO—An Architecture for Digitization, Management and Presentation of Virtual Exhibitions

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Abstract

A complete tool chain starting with stereo photogrammetry based digitization of artefacts, their refinement, collection and management with other multimedia data, and visualization using virtual and augmented reality is presented. Our system provides a one-stop-solution for museums to create, manage and present both content and context for virtual exhibitions. Interoperability and standards are also key features of our system allowing both small and large museums to build a bespoke system suited to their needs.

1. Introduction

The concept of using virtual exhibitions in museums has been around for many years. Museums are keen on presenting their collections in a more appealing and exciting manner using the Internet to attract visitors both virtually and into the physical museum site. Recent surveys show that about 35% of museums have already started developments with some form of 3D presentation of objects [4].

Requirements related to the development of augmented reality (AR) applications in the Cultural Heritage field have been well documented [3]. Many museum applications based on VRML have been developed for the web [1][5][6]. An example of an interactive virtual exhibition is the Meta-Museum visualized guide system based on AR [2]. Another simple museum AR system is the automated tour guide, which superimposes audio on the world based on the location of the user [7].

The European Union has also funded many research projects in the field of cultural heritage and archaeology. For example, the SHAPE project [8] applies AR to the field of archaeology to educate visitors about the artefacts and their history. The 3DMURALE project [9] is developing and using 3D multimedia tools to record, reconstruct, encode and visualize archaeological ruins in VR. In the Ename 974 project [10] visitors can enter a specially designed on-site kiosk where real-time video images and architectural reconstructions are superimposed, and visitors can control the video camera and display images using a touch screen. The ARCHEOGUIDE project [11] provides an interactive AR guide for the visualization of outdoor archaeological sites. Similar to ARCHEOGUIDE is the LIFEPLUS project which additionally encompasses real-time 3D simulations of ancient fauna and flora [12].

The main advantage of the ARCO system over the projects described above are that ARCO offers a complete museum focused solution that can be configured for museum needs—we can build bespoke museum systems from interoperable ARCO components. But more importantly, ARCO offers methods for digitization, management and presentation of heritage artefacts in virtual exhibitions based on well understood metaphors that are also interactive and appealing [13].

2. ARCO System Overview

The ARCO functionality mention above defines the specification of the system architecture, illustrated in Figure 1. For the content production process ARCO provides two tools for 3D modelling of museum artefacts: the Object Modeller (OM) and the Model Refiner (MR). The OM tool is a 3D stereo photogrammetry system based on the principles of Image-based Modelling. The MR tool is a 3D reconstruction refinement tool based on the *3ds max* framework that complements the OM tool. Note that content production also includes acquiring other multimedia data such as images, movies, etc. for input to the content management process.

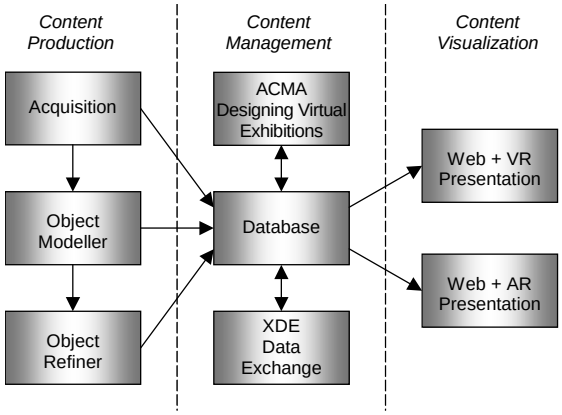

Figure 1: ARCO System Architecture

For the content management process ARCO provides a multimedia database management system based on Oracle9i and the ARCO content Management Application (ACMA). The database is the central component of the ARCO system in that it stores, manages and organises virtual artefacts into collections for display in virtual exhibitions.

The final part of the ARCO architecture is the content visualization process. The visualization of the virtual museum artefacts is performed by VR and AR browser. These browsers combine Web-based form of presentation with either VR or AR virtual exhibitions.

The end user is able to browse content stored in the database either remotely through the web, in a museum kiosk, or to interact with the virtual objects in an AR table-top environment using either a simple monitor display or HMD. The ARCO system is based on the data model [14] illustrated in Figure 2.

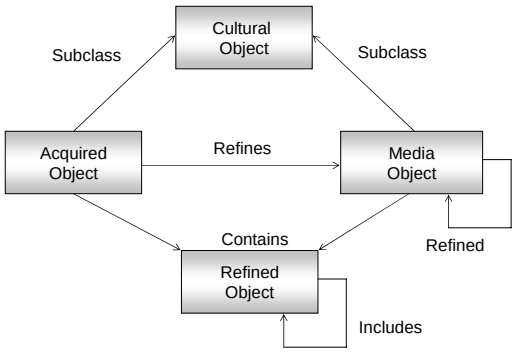

Figure 2: ARCO Data Model

A key element of the ARCO system is the specification of an appropriate metadata element set that underpins both the heritage and technical aspects of ARCO. We need both to describe museum artefacts and the technical processes that transform the artefacts from the physical to the virtual. Accordingly, we have designed a metadata element set called AMS [14], called the ARCO Metadata Schema.

3. Virtual Museum Exhibitions

Virtual museum artefacts are displayed as virtual exhibitions through three presentation domains: *WEB_LOCAL* for use on local web-based displays inside museums, *WEB_REMOTE* for use on the Internet, and *WEB_AR* for use in AR presentations.

The ARCO system provides two main kinds of user interfaces for browsing cultural heritage exhibitions: *Web-based interfaces* and *Augmented Reality interfaces*, see sections 3.1 and 3.2

3.1. Virtual Reality Exhibitions

In the Web-based interface a user can browse information presented in a form of 3D VRML virtual galleries or 2D Web pages with embedded multimedia objects. The Web-based interface requires a standard Web browser such as Internet Explorer with a VRML plug-in. This kind of user interface can be used both on local displays inside a museum (*WEB_LOCAL*) and remotely on the Internet (*WEB_REMOTE*).

An example visualization of virtual exhibitions in a Web browser is presented in Figure 3. This visualization consists of Web pages with embedded 3D VRML models and other multimedia objects and can be used remotely over the Internet. Users can browse the hierarchy of virtual exhibitions and virtual museum artefacts by clicking on appropriate icons at the top of the page.

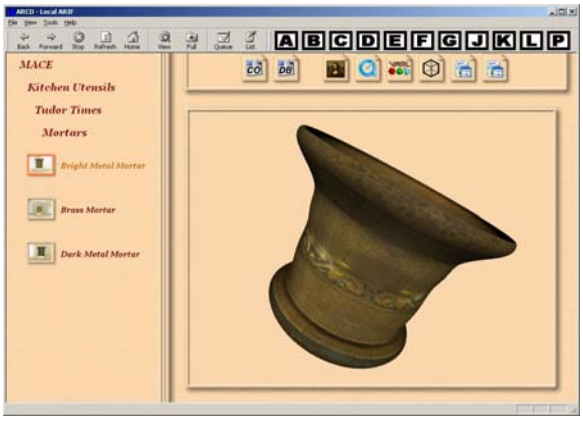

Figure 3: Web-based visualization

Virtual exhibitions can also be visualized in the Web browser in a form of 3D galleries, see Figure 4. In this visualization, users can browse objects simply by walking along the 3D room, which is a reconstruction of a real gallery—an exhibition corridor in the Victoria and Albert Museum in London.

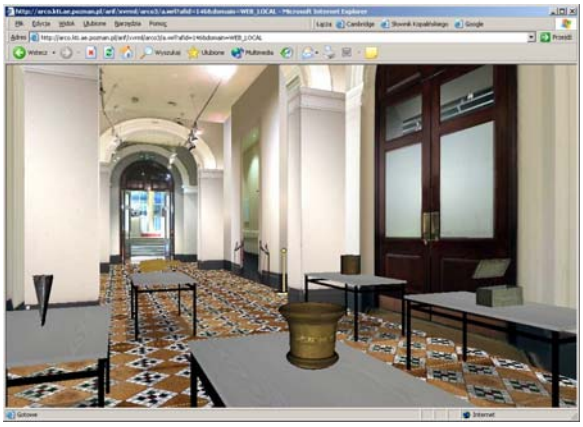

Figure 4: Example 3D virtual exhibitions

3.2. Augmented Reality Exhibitions

To enable visualization of selected objects in an AR environment an AR application has been developed. The AR application is used instead of a typical Web browser used in the Web-based interfaces. The AR application integrates two components: a Web browser and an AR browser. For the AR visualization a camera and a set of physical markers placed in a real environment is used. Video captured by the camera is passed on to the AR browser that overlays virtual representations of virtual museum artefacts using the markers for object positioning [15].

Users can interact with the displayed objects using both the markers and standard input devices, such as the SpaceMouse®. In the first method, a user can manipulate a marker in front of a camera as it is presented in Figure 5 and look at an overlaid objects from different angles and distances. This is a natural and intuitive method of interaction with virtual objects.

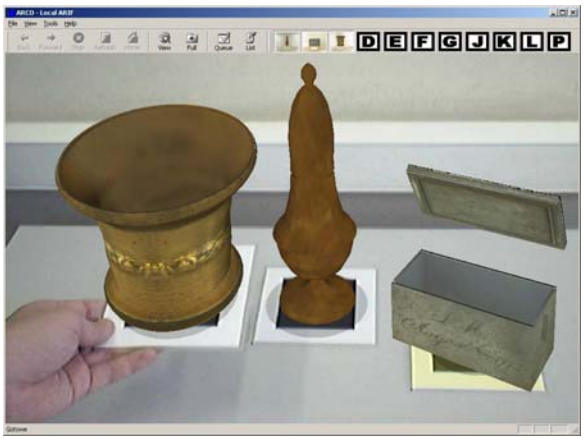

Figure 5: Real scene augmented with superimposed virtual models

The content and layout of the visualized scenes are determined by visualization templates that define which components of a virtual museum artefact are composed into one VRML scene. One of the important goals of the ARCO system is presenting virtual museum artefacts in an attractive manner that would make people, especially children, more interested in cultural heritage. ARCO enables museum curators to build interactive learning scenarios, where visitors can gain information not only by browsing it, but also by answering series of questions presented in the form of a quiz. As an example, we have implemented an interactive AR quiz based on Fishbourne Roman Palace [16], illustrated Figure 6.

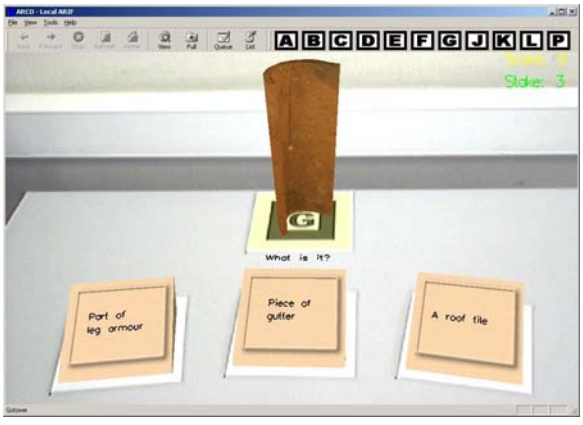

Figure 6: Example quiz scene

In this quiz we use one of the markers to display the virtual museum artefact and a question, and three more markers to display potential answers. The user then chooses an answer, and depending on whether the answer is correct or not, an appropriate response in the AR scene appears, see Figure 7.

Figure 7: Wrong and correct answers

4. Conclusions

The ARCO system provides a complete solution for digitization, management and presentation of virtual museum exhibitions. We have addressed digital acquisition, storage, management and visualization in interactive VR and AR interfaces by adopting a component based approach. Furthermore, mixing and matching of individual components is supported through the use of XML for interoperability purposes. A system such as ARCO has the potential to revolutionise the use of computer-based systems in museums in the future, so that they are no longer regarded as mere tools for cataloguing purposes, but rather as ways of engaging and enhancing the experience of their users.

5. Acknowledgments

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