Proc. IADIS International Conference of Applied Computing 2004, Eds. Nuno Guimaraes and Pedro Isaias, IADIS Press, Lisbon, Portugal, March 23-26, 205-212, (2004). ISBN 972-98947-3-6.

A LIGHTWEIGHT XML DRIVEN ARCHITECTURE FOR THE PRESENTATION OF VIRTUAL CULTURAL EXHIBITIONS (ARCOLITE)

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ABSTRACT

This paper describes our lightweight prototype XML based client-server architecture for creating, managing and presenting virtual cultural exhibitions. ARCOLite provides a low cost solution for museums to assemble multimedia content into an XML archive for dynamic presentation locally or over the Internet extended with virtual and augmented reality visualization.

KEYWORDS

Virtual Cultural Exhibitions, Augmented Reality, XML.

1. INTRODUCTION

Museums contain large collections of artefacts and cultural heritage information presented in different locations and using different media. Since 1998 much work and funding has been generated by diverse organizations and projects in the area of digital cultural heritage in order to provide better access to visitors. A fundamental driver for this is the need to concentrate a critical mass of resources on a core set of issues of direct interest to Europe and its citizens (Smith 2003).

A key aspect of this drive was the Information Society Technologies programme (IST 2003) within the EU's Framework Programme Five (FP5 2003) that provided considerable amounts of funding in order to support RTD projects on building prototype systems for access to, and preservation of, digital cultural content. ARCOlite is focused on Key Action III—Multimedia Content and Tool, in particular Action Line III.1.6 Virtual representation of cultural and scientific objects. Thus, ARCOLite allows museums to create, manage and present virtual museum exhibitions composed of dynamic and intelligent virtual museum artefacts.

In this paper, we describe our lightweight system (ARCOLite) in the context of a more heavyweight system (ARCO), which relies on an Oracle9i database management system and patented X-VRML technology. The Augmented Representation of Cultural Objects (ARCO) system is primarily aimed at large international museums, and offers components for digitisation, database cataloguing and visualization (ARCO 2003), (Patel 2003), i.e. as a one-stop-shop for creating virtual museum exhibitions. ARCOLite, on the other hand, eliminates several aspects of the more expensive ARCO system, e.g. the Oracle9i database and dynamic update of VRML scenes, making it more suitable for small regional museums.

The remainder of this paper is organized as follows: in section 2, the process for creating virtual exhibitions using the ARCO system is described and contrasted with a description in section 3 of the less expensive ARCOLite architecture. In sections 4 to 6 we describe in more detail ARCOLite components. Section 7 provides a discussion on future work, and finally we draw some conclusions.

2. ARCO SYSTEM OVERVIEW

ARCO is an EU funded project (ARCO 2003) aimed at providing museums with useful technologies that enable them to digitise, manage and present virtual museum artefacts in virtual cultural environments, e.g. a virtual museum exhibition. Based on these requirements, the specification of the ARCO system architecture is illustrated in Figure 1, and includes components for: content production, content management, server-side exhibition generation and client-side content visualization.

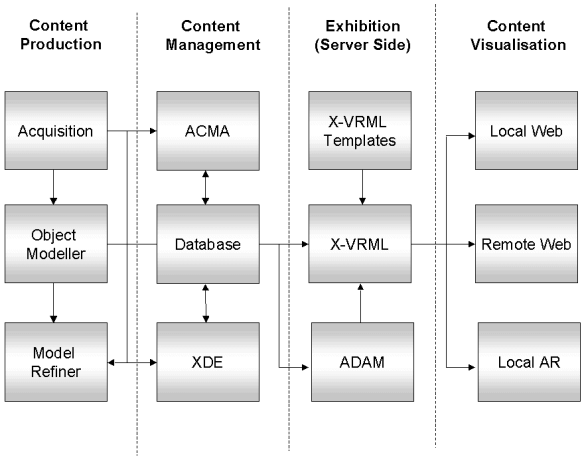

Figure 1 - Architecture of the ARCO system

In terms of content production two key tools for 3D modelling of museum artefacts have been developed: the Object Modeller (OM) and the Model Refiner (MR). The OM tool is a 3D stereo photogrammetry hardware and software system designed and implemented based on the principles of Image-based Modelling (IBM). The MR is a 3D reconstruction refinement tool based on 3ds max that complements the functionality of the OM tool.

The content management layer in ARCO offers a multimedia database management system based on two modules, the ARCO database and the ARCO Content Management Application (ACMA). The database (developed with Oracle9i) is the central repository of the ARCO system. All the content created by ARCO and external tools is stored in the database using the ACMA application. ACMA is responsible for storage, management and organization of virtual museum artefacts into collections for display in virtual museum exhibitions.

ARCO is a client-server architecture where on the server-side the X-VRML server generates an http stream from data accessed from the database and formatted according to X-VRML templates. The principle is similar to the use of XSL stylesheet; however X-VRML templates provide a means of dynamically updating VRML content during visualization. The ADAM server generates other multimedia objects.

The final part of the ARCO architecture is the visualization of the virtual museum artefacts, which are rendered by the Augmented Reality Interface (ARIF) (Wojciechowski 2003). ARIF combines web-based presentation of virtual reality (VR) and augmented reality (AR) using a web browser. The museum visitor can browse content stored in the database either remotely through the web, in a museum kiosk, or interact with the virtual museum artefacts in an AR table-top environment (Patel 2003).

An interesting component of the ARCO system is the XML Data Exchange (XDE) format. All components in the ARCO system can either read or write XML files validated by the XDE schema thus ensuring both internal component interoperability and also external interoperability.

3. ARCOLITE SYSTEM OVERVIEW

After two years developing the ARCO system, it became apparent to the authors that cultural heritage establishments, although they are willing to have such a systems operational in their museums, will always

raise the issue of price and interoperability (Miller 2003), (Cabinet Office 2003) with their current systems. In other words, they want to keep their current database systems, which their staffs are familiar with, while also cutting the cost. This is the major reason that the current ARCO prototype was analysed and a lightweight solution called ARCOLite is being developed.

To achieve a small disk and memory footprint but present a solution similar to the existing ARCO system, ARCOLite de-couples the database and the X-VRML technology (Walczak 2002), (Walczak 2003) by using more standard XML technologies (XML 2003). A virtual museum exhibition is stored as a collection of XML files, known as the XDELite repository. The visualization technologies are also considerably changed from the existing X-VRML architecture to the use of XSL templates, and X3D as a future direction. To address compatibility issues between XDELite and the ARCO database an XDE to XDELite migrator has been developed. Figure 2 illustrates the overall architecture of ARCOLite.

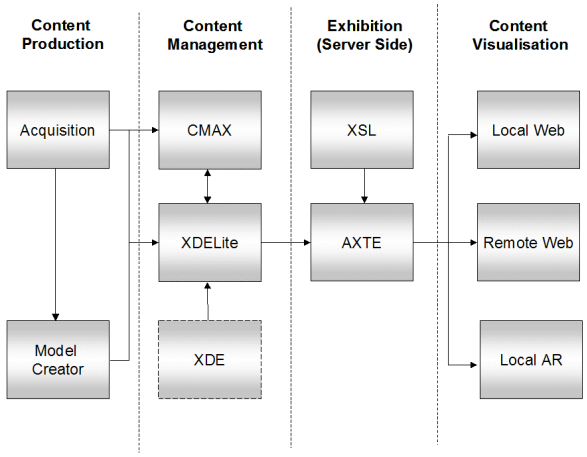

Figure 2 - Architecture of the ARCOLite System

Similar to ARCO, ARCOLite consists of four conceptual parts as illustrated in Figure 2. ARCOLite provides a 3D content generation tool, i.e. a lightweight Model Creator (MC) based on the ARCO MR but without any refiner functions.

The ARCOLite content management is based on the CMAX tool, which has two main functionalities. First, CMAX provides connectivity with external digital culture systems such as ARCO, and second, it is capable of packaging raw digital data conforming to XDELite. XDELite is the data repository of ARCOLite architecture. The first objective is realized by providing a migration tool, which applies migration XSL templates to the XDE file exported by the ARCO database to generate content packaged for presentation conforming to the ARCOLite architecture. The second objective of CMAX is to act as a tool for creating content for virtual museum exhibitions without having to use exported data from the ARCO system. The end-user can browse local or remote file systems, retrieve raw multimedia data and package this data to XDELite repository. Finally, CMAX can let users modify existing XDELite repositories.

The dynamic exhibition generation consists of designing XSL stylesheets and deploying them on the AXTE servlet context. The XSL stylesheets govern the look and feel of a virtual museum exhibition while the ARCOLite XML Transformation Engine (AXTE) servlet processes those stylesheets in order to dynamically deliver the virtual museum exhibitions to content visualization clients.

The content visualization part consists of the ARIFLite visualization client. ARIFLite consists of three visualization domains: the Local Web, the Remote Web and the Local AR domain. The Local Web and Remote Web clients consist of a typical embedded web browser, e.g. Internet Explorer on Windows platforms. Any other standard XHTML compliant browser on any platform is also capable of rendering Local Web and Remote Web content. Just as for the ARCO system, the ARCOLite Local Web visualization domain provides a web presentation extending into VR and AR within a museum environment, whereas the Remote Web renders over the Internet. The web browser used is responsible for rendering web content available from AXTE through the server. Both the Local Web and Remote Web are extended into the Local AR visualization domain which retrieves virtual museum artefacts from AXTE and renders them on a table-top AR environment.

4. CONTENT MANAGEMENT APPLICATON FOR XDELITE (CMAX)

The first prototype of CMAX has been developed and tested. The migration tool (XDE to XDELite translator) has been developed and is ready for integrating into CMAX, but can also run as a standalone tool in console mode. The XDE to XDELite migrator can also be plugged into the ARCO system to allow direct export of XDELite. Both ARCO and ARCOLite will require other migratory tools or translators to allow external interoperability with other museum database systems. The XDE to XDELite migrator accepts as parameters the exported XDE file from the ARCO system, the migration template (written in XSL) and any further presentation domain packaging templates (also written in XSL) and generates a corresponding XDELite repository conforming to XDELite schema, along with any presentation domain files that contain associated multimedia data. In future, this will be embedded into CMAX as a point-and-click functionality. Figure 3 illustrates a screenshot of the XDE to XDELite migrator run from the console.

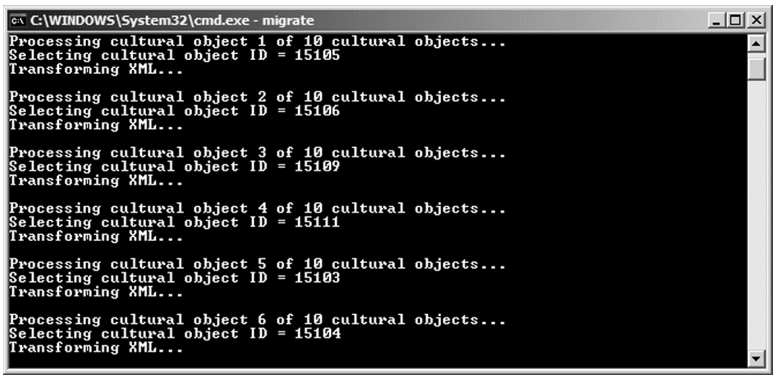

Figure 3 – XDE to XDELite migrator in console mode

Figure 4 illustrates a screenshot of the first prototype of CMAX. The CMAX interface consists of a toolbar that provides the main functionality to the user such as deleting, inserting metadata elements, editing new media object metadata, displaying more information on specific metadata, etc. The left panel is used to manage media objects associated with a virtual museum artefact. The top right panel is an editor for the cultural object metadata, and the bottom right panel is used edit media object metadata (Mourkoussis 2003).

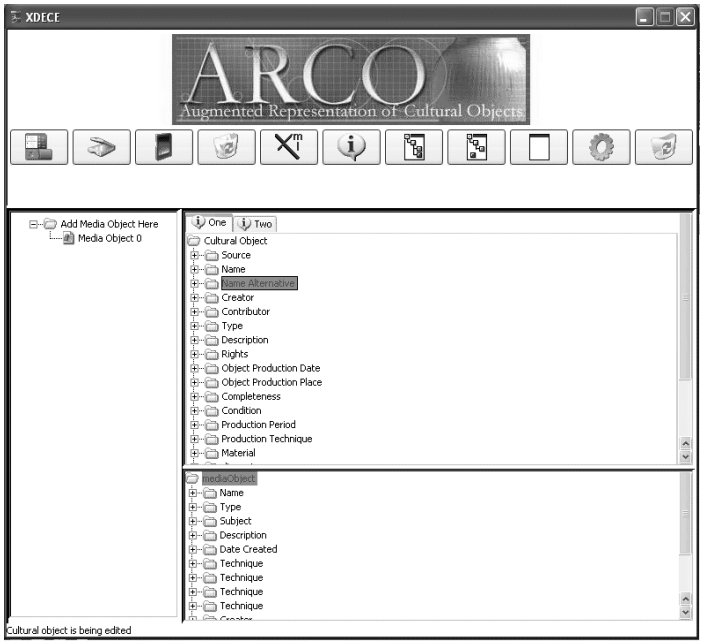

Figure 4 – First prototype of CMAX

5. ARCOLITE XML TRANSFORMATION ENGINE (AXTE)

AXTE can be conceptualised as a group of servlets that is responsible for delivering dynamic multimedia content to the ARIFLite interface. Currently, AXTE is implemented with a single servlet called XView that serves dynamic virtual museum artefacts (3D objects, pictures and other multimedia data) to remote or local web domains. For different application domains other servlets may be added to serve other specialized presentation domains such an AR quiz, e.g. an ARQuizView servlet. AXTE is currently deployed on Apache Tomcat 4.1.29 JSP/Servlet container (Apache Tomcat 2003). Figure 5 illustrates the internal architecture of XView.

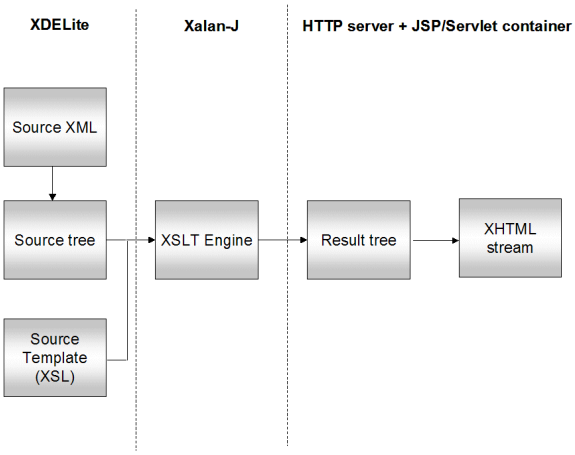

Figure 5 – Architecture of XView (AXTE)

The XDELite XML file is converted to an XML source document object model (DOM) source tree. The XSLT engine applies the XSL templates on this source tree to generate a result tree, which is then serialised to an XHTML stream and sent to any XHTML compliant browser.

6. AUGMENTED REALITY INTERFACE LITE (ARIFLITE)

The objective of the ARIFLite interface is to allow museums to differentiate three different visualization scenarios depending on the targeted end-user: Local Web, Remote Web and Local AR. Currently, the local and remote Web presentation domains have fully functional prototypes ready. The virtual museum artefact served by AXTE can be visualized in any XHTML compliant browser. An example of a virtual museum artefact served from the XDELite repository through the AXTE servlet to a remote Web browser using Mozilla 1.5 is illustrated in Figure 6. Note, a virtual museum exhibition (several virtual museum artefacts) is organised as several related Local or Remote Web pages presented similar to that illustrated in Figure 6. In this example Remote Web Browser you can see the virtual museum artefact just happens to contain a metadata description, a picture of the physical artefact and drop down menus giving links to a 3D VRML model of the artefact, and other multimedia content. The layout of the browser pages (virtual museum exhibition) is determined by XSL stylesheets, so for example a Local Web version of the same virtual museum artefact can be easily changed to a Remote Web version by using a different XSL stylesheet. Note Figure 6 illustrates all possible multimedia components of a virtual museum artefact that can be rendered to the web page. In reality, a museum would select a subset of multimedia components according to some learning context, thus the XSL stylesheet would be simpler to write and stylistically more elegant.

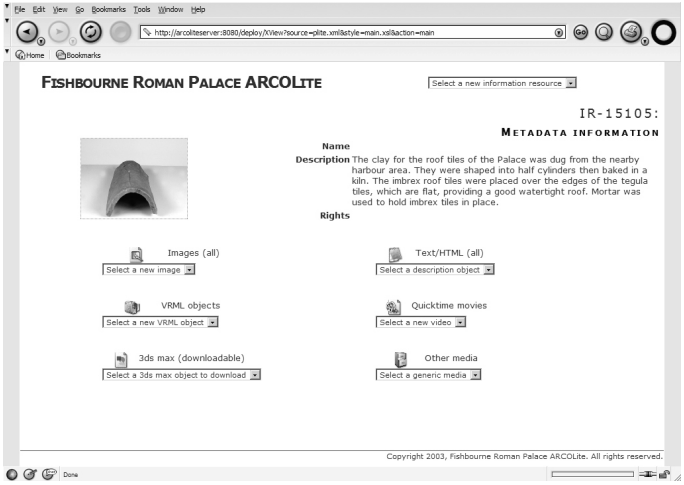

Figure 6 – Remote Web presentation in a browser

7. FUTURE WORK

An integrated version of ARIFLite containing an XHTML compliant browser and an AR environment is under development. Currently, the AR application has been developed and integrated into ARCO ARIF and demonstrated at several conference and museum events (MACE 2003, VAST 2003, Wojciechowski 2003). We estimate that the AR application will be integrated into ARIFLite early in 2004. An interactive AR table-top interface environment offers museum visitors a unique visualization experience of 3D representations of cultural objects in a table-top environment. Figure 7 illustrates a screenshot that demonstrates the concept of table-top AR as implemented in ARIF in the ARCO architecture. Here we can see the same virtual artefact (3D VRML model) as depicted in the picture on the browser in Figure 6, but set in the context of a quiz or game where the user has to guess what the artefact is—the user got the right answer.

When integrated into ARIFLite this application would be served from the ARQuizView servlet. This particular AR application has been implemented so that it switches visualization between the Remote or Local Web browser and the AR application, and also provides several buttons for assigning virtual artefacts to markers in the AR application (Wojciechowski 2003). This AR interface also allows users to interact in a natural way using a set of special designed marker cards in real time (Kato 2000).

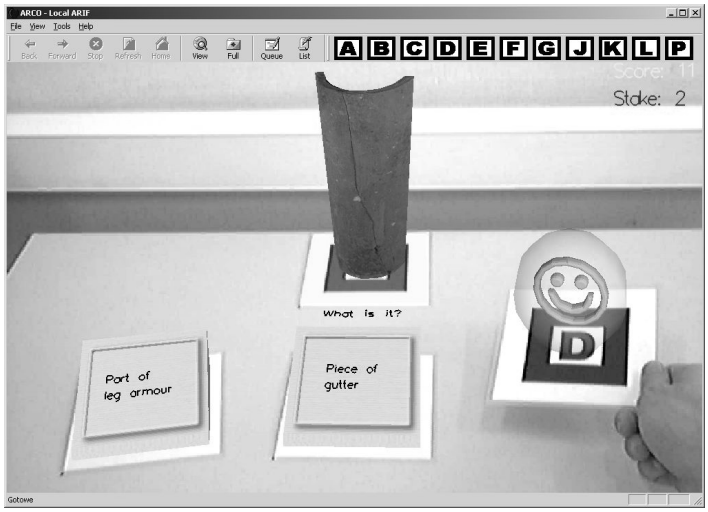

Figure 7 - AR environment with a VRML object from the virtual museum artefact interacting in a quiz

8. CONCLUSION

The ARCOLite system aims to provide a cheap but complete solution for creation, management and presentation of virtual museum exhibitions. ARCOLite offers components based on XML standards, metadata standards (Dublin Core) and industry standards such as 3ds max for 3D VRML model creation. Museums are offered components that allow them to create 3D content and package this with other multimedia content using CMAX. Further, virtual museum exhibitions can be exported from ARCO as an XDE instance and ported into XDELite. ARCOLite offers the XDELite repository and associated XML technologies (AXTE with its servlets, e.g. XVIEW) and XSL stylesheet formatting. ARCOLite eliminates the Oracle9i database, which saves on cost, while still allowing museums to build virtual museum exhibitions. The difference being that the ARCO database (Oracle9i) can store many exhibitions and offers many other features such as security, etc. The ARCOLite system stores different exhibitions in a network or local file system and has to rely on standard file system security. We think this is a minor problem for small regional museums. Further, ARCOLite is cross platform on the server-side. Other than that, ARCOLite is designed to offer much of the functionality and flexibility of the ARCO system at a much reduced cost.

ACKNOWLEDGEMENTS

This research was funded by the EU IST Framework V programme, Key Action III-Multimedia Content and Tools, Augmented Representation of Cultural Objects (ARCO) project IST-2000-28336. We also would like to acknowledge Rajeshwar Singh Anand from University of Sussex for implementation of the first prototype of CMAX, and acknowledge Rafal Wojciechowski who implemented the first prototype Local AR ARIF as a Marie Curie Fellow at the University of Sussex.

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