VRML-Based System for a 3D Virtual Museum

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INTRODUCTION

In the last few years, because of the increasing growth of the Internet, general-purpose clients have achieved a high level of popularity for static consultation of text and pictures. This is the case of the World Wide Web (i.e., the Web browsers). Using a hypertext system, Web users can select and read in their computers information from all around the world, with no other requirement than an Internet connection and a navigation program. For a long time, the information available on the Internet has been series of written texts and 2D pictures (i.e., static information). This sort of information suited many publications, but it was highly unsatisfactory for others, like those related to objects of art, where real volume, and interactivity with the user, are of great importance. Here, the possibility of including 3D information in Web pages makes real sense.

As we become an increasingly visual society, a way to maintain heritage is to adapt museums to new times. The possibility of not only visiting and knowing the museums nearby but also enabling anybody to visit the building from their homes could be enabled. This would imply the incorporation of the virtual reality (Isdale, 1998), although today few museums allow this kind of visit via Internet. In virtual reality, human actions and experiences that interact with the real world are emulated although, obviously, with some limitations. With virtual reality the user could walk, examine and interact with the environment, in contrast to traditional media like television that present excellent graphics but lack interactivity. Although this is not a new idea, it is achieving a wider expression due to the availability of the Virtual Reality Modeling Language (VRML) (Carey, Bell, & Marrin, 1997), a widespread language for the description of 3D scenes and WWW hyperlinks (an analogy of the HTML for virtual reality).

VRML is, perhaps, most interesting for Internet users eager to discover new interesting sites in Internet, and for the people that use it like hobby, but VRML could also allow us to see a 3D artifact from any angle and perspective, to turn it in any way, and so on. In sum, we can manipulate it — something totally forbidden in a real museum.

This work deals with the design of a system which allows this interactive Web access to works of art in 3D, as a step in a research project dealing with the design and implementation of a virtual and interactive museum in 3D on the Web. Also, all the associated information like history, architectural data, archaeological data, and culture will be available at the click of a mouse.

BACKGROUND

Several museums around the world are already committed to a strong Web presence and many others will adopt one very soon. Dynamic museum leaders understood that the increasing number of internauts requires special attention from museums: Internet — and CD-ROM's — represent new media that will challenge museum communication strategies.

According to Proença, Brito, Ramalho, and Regalo (1998):

Two distinct Web approaches are being adopted by the museums. Some regard their presence on the Web as another way to publicize the museum and to promote their activities; others use the Web as a powerful resource to achieve their purposes: to conserve, to study and to display.

The most common attitude is to consider the Web as a simple sum of the different kinds of information already in use by museums — specially printed information — but gathered in a global structured way. These data include a museum description and a list of activities and collections, where a typical Web page structure contains: collections and exhibitions, visit planning and conditions, new acquisitions, projects and activities, museum organizational scheme and educational programs. Several museums on the Web follow this approach. Among them it may be worth a visit to Museo Arqueológico Nacional of Madrid (http://www.man.es/), On-line Picasso Project (www.tamu.edu/mocl/picasso/), Museo de Cera de Madrid (www.museoceramadrid.com), Asian Art Museum of San Francisco (www.asianart.org), The Museum of Modern

Art (www.moma.org) and Library of Congress Vatican Exhibit (www.ibiblio.org/expo/ vatican.exhibit/exhibit/ Main_Hall.html); this site has a good image quality, but with a traditional structure to present the exhibition themes.

Some museums demonstrate greater innovation in their Web presences: They have temporary exhibitions online, promote virtual visits and access to their databases, present technical information for museums professionals and researchers, keep available information about previous activities and exhibitions, and organize links to related sites. For these museums, the Web is also an exhibition and a presentation medium that must be integrated in the communication policy of the museum. Among them, it may be worth a visit to Musée des Beaux Arts de Montréal (www.mbam.qc.ca/ index.html), The Museum of Anthropology at University of British Columbia (www.moa.ubc.ca/Collect/moaview.html), and Museo del Prado (museoprado.mcu.es/prado/html/home.html).

Latest advances are becoming popular 3D (plus color) scanners, which allow the measurement of 3D artifacts such as art works (Gómez, Díaz & López, 1997; Rocchini, Cignoni, Montani, Pingi & Scopigno, 2001). After measuring, a 3D plus color model from the real object can be obtained. 3D scanning technology has been adopted in a number of recent projects in the framework of cultural heritage. Just to give some examples, we may cite the Digital Michelangelo Project of the Stanford University (Levoy et al., 2000) , the acquisition of a Michelangelo's Pietá by a team of the IBM T.J. Watson Research Center (Rushmeier, Bernardini, Mittleman & Taubin, 1998) , or the acquisition of a section of the Coliseum in Rome (Gaiani et al., 2000) . Unfortunately, a detailed 3D (plus color) model of a free form object usually requires a great amount of data. This data can hardly pass through the Web, even when using compression. Therefore, additional reduction of transmission requirements is desirable.

Recently developed image-based modeling and rendering techniques (Chen, 1995; Chen & Williams, 1993) have made it possible to simulate photo-realistic environments. Two of the most popular image-based modeling and rendering techniques are Apple's QuickTime VR and the Virtual Reality Modeling Language (VRML). QuickTime VR (Chen, 1995) has its roots in branching movies, for example, the movie-map (Lippman, 1980), the Digital Video Interactive (DVI) (Riply, 1989), and the "Virtual Museum" (Miller et al., 1992). QuickTime VR uses cylindrical panoramic images to compose a virtual environment, therefore provides users an immersive experience. However, it only allows panoramic views at separate positions. Recently, the Virtual Reality Modeling Language (VRML) (Carey et al., 1997) became a standard file format for the delivery of 3D models over the Internet. Subsequently, many efforts have been made to effectively compress and progressively transmit the VRML files over the Internet (Deering, 1995; Li & Kuo, 1998; Matsuba & Roehl, 1999; Taubin, Horn, Lazarus, & Rossignac, 1998).

Using these techniques, some systems allow to see art works in 3D (Cignoni, Montani, Rocchini, & Scopigno, 2001), while others allow a virtual walk through the rooms of some real building as The Virtual Living Kinka Kuji Tempers (Refsland, Ojika, & Berry, 2000), some reconstructed scenario as the Historic Villages of Shirakawa-go (Hirayu, Ojika, & Kijima, 2000) or some imaginary buildings as Virtual Museum of Helsinki (www.virtualhelsinki.net/museum) and Virtual Museum of Art (www.elpais.com.uy/muva).

The main feature of our system is that users may walk through a three-dimensional (3D) representation of the whole Fabio Neri's Palace, the building where Museum of Valladolid is located, viewing its collections, and seeing pictures in 2D and archaeological objects in 3D, together with information about them. To allow all of this, an architecture of interactive dynamic Web pages has been designed (Díez-Higuera & Díaz-Pernas, 2002). In order to capture 3D information, we have used the Laser Acquisition System developed by the Industrial Telematic Group of Telecommunications Engineering School of Valladolid (Gómez et al., 1997). These data, together with 2D images and information files, are compressed and stored in a remote server, and can be retrieved over the Internet. Rather than transmitting a high-resolution object, our system at the client end allows users to selectively retrieve images at specific resolutions. This selective retrieval is achieved by implementing a client-server communication protocol. Information is accessed through intuitive exploration of the site, and therefore, each session varies depending on both the participant and the path chosen. In this manner, the visitor becomes familiar with the virtual museum, in much the same way as they would become familiar with the physical museum. User may identify particular areas of interest, which may be revisited using familiar routes or accessed via browsing.

DESCRIPTION OF THE SYSTEM

Figure 1 shows the general architecture of the system. It has two main parts: the Dynamic Web pages system, based on the *Microsoft Internet Information Server*, which embraces the virtual visit to the 3D Museum and the access to data and its visualization in 3D; and the platform of telematic services, which implements the server-client architecture, allowing the transmission of three-dimensional and colorimetric data of the objects in several resolutions.