Distributed Systems for Virtual Museums

Míriam Antón-Rodríguez
University of Valladolid, Spain

José-Fernando Díez-Higuera
University of Valladolid, Spain

Francisco-Javier Díaz-Pernas
University of Valladolid, Spain

INTRODUCTION

The Internet has meant a social revolution, changing forever the way we communicate and how we access to the information. The growing expansion of technology and the development of easier applications have given as a result the high level of popularity achieved by Internet related services, especially the World Wide Web. 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 browser. For a long time, the information available on the Internet has been a 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 (Kim, 2005; Vince, 2004), although today only a 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 software standards like VRML and X3D. VRML, virtual reality modeling language (Carey, Bell, & Marrin, 1997) is a widespread language for the description of 3D scenes and WWW hyperlinks (an analogy of the HTML for virtual reality). X3D, Extensible 3D (Web3D Consortium, 2004) is the successor of VRML, it is intended to be the universal interchange format for integrated 3D graphics and multimedia. VRML/X3D are, perhaps, most interesting to Internet users eager to discover new interesting sites on the Internet, and for the people that use it like a hobby, but those could also allow us to see a 3D artifact from any angle and perspective, to turn it in any way, manipulate it (Lepouras & Vassilakis, 2005; Petridis et al., 2005)—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—especially 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 schemes, and

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educational programs. Several museums on the Web follow this approach. Among them it may be worth a visit to the Museo Arqueológico Nacional of Madrid (http://man.mcu.es/), online Picasso Project (http://csdll.cs.tamu.edu:8080/picasso/), the Asian Art Museum of San Francisco (www.asianart.org), the Museum of Modern Art (www.moma.org), and the 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 the Musée des Beaux Arts de Montréal (www.mbam.qc.ca/en/index.html), the Museum of Anthropology at University of British Columbia (www.moa.ubc.ca/), and the Museo del Prado (http://museoprado.mcu.es/home.html).

Latest advances are becoming popular 3D (plus color) scanners, which allow the measurement of 3D artifacts such as art works (Gómez García-Bermejo, Díaz Pernas, & López Coronado, 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 an example, we may cite the Digital Michelangelo Project of the Stanford University (Levoy et al., 2000) or the acquisition of a section of the Coliseum in Rome. 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.

A few years ago, some image-based modeling and rendering techniques were developed making it possible to simulate photo-realistic environments. One of the most popular image-based modeling and rendering techniques is the virtual reality modeling language/extensible 3D (*VRML/X3D*). *VRML/X3D* (Carey et al., 1997; Web3D Consortium, 2004) became an open standard for the delivery of 3D models over the Internet. It combines both geometry and runtime behavioral descriptions into a single file that has a number of different file formats available for it. Last specifications have incorporated latest advances in security (encryption) and speed (compression) based on years of feedback from the VRML97 development community (Li & Kuo, 1998; Matsuba & Roehl, 1999; Taubin, Horn, Lazarus, & Rossignac, 1998).

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

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 the 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 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. Users may identify particular areas of interest, which may be revisited using familiar routes or accessed via browsing.

Within this framework, a distributed telecommunications system for the remote accessing of multiple virtual environments is implemented. This system is divided into the virtual worlds' systematization and the information's distribution. The objective of the virtual worlds' systematization is not only reducing the development time of new museums but extending the systems' useful life by easing the edition of those virtual worlds already deployed. The distribution of heterogeneous information among different servers gives the users the possibility of visiting multiple online museums within a same virtual reality environment (homogeneous looks) and getting in touch among them in order to contribute with their active participation in the creation of information sharing communities. The server will know at all times the location of the user inside the system to facilitate the communication between different end users. This is possible by an easy-to-use IRC software (Mutton, 2004; Oikarinen & Reed, 1993).

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