Constructing Virtual Environments for Real Time E-learning

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Aabstract:

This article provides an overview of using current Virtual Reality (VR) technology to construct Virtual Environments (VE) for real time based E-learning. It briefly reviews the research and the technologies for E-learning applications. It presents a Virtual Reality-based E-learning framework example that aims to facilitate the construction of realistic and interactive virtual learning environments. In the example, the system uses innovative techniques for constructing virtual learning environments for selected teaching purpose. The article also describes the technical requirements and methods of implementing the system.

Keywords:

E-learning, Virtual Reality, Virtual Environment, Interactivity, Image mapping

1. Introduction

Electronic learning (E-learning) is gaining an educational foothold all over the world. The availability of Web-enabling technologies has already had a tremendous influence on the success of E-learning (Cross, 2004). However, currently the contents of many E-learning systems rely heavily on text and multimedia technologies, like audio, video, images, streaming technology, and animation, and do not leave much interactivity to the users (Cross, 2004). This makes it difficult to demonstrate real concepts. Virtual reality (Korosec and Holobar, 2002) and image mapping technology provide a solution to this particular problem that E-learning is facing. Virtual reality offers highly interactive human-computer interfaces, which embodies the characteristic of interaction between real and virtual worlds (Raper and Camara, 1999) (Johnson and Moher, 2002). It offers E-learning users a large amount of interactivity, which could not be experienced before. Image mapping technology uses images to replace sophisticated 3D geometries (Tsai, 2003) (Chiricota, 2003). This makes transferring vivid virtual learning contents over the Internet easier and practical because image mapping significantly reduces the file size of VR objects and hence the environments without affecting the interactivity.

2. Related work

Due to the tremendous growth of the Internet and the World Wide Web (WWW), E-learning is gaining an educational foothold all over the world. It disseminates information, transfers data and conveys knowledge (Ouyang and Zhao, 2002) (www.widelearning.com). Content sent over the Internet can be classified as information, knowledge, skill and experience. According to this classification, current E-learning systems can be classified as theoretical and experimental E-learning systems based on the information type. Most E-learning systems nowadays are regarded as theoretical systems. This is because they still largely rely on moving text to the web. (www.learningcircuits.org). Skill and experience can only be obtained through practice and interactivity, which are the essential features for experimental E-learning systems. Many E-learning systems added large quantity of multimedia to gain these effects. These multimedia technologies include video, audio, images, flash animations, stream and media etc (Hashimi and Guvenli, 2001). Though these can describe learning content in a way better than sole text, they do not provide interactivity, which is regarded as necessary by the authors to gain skill and experience over the Internet. To solve this and make the online curriculum more interactive, Virtual Reality (VR) has been introduced. Virtual reality, as a

mature technology, focuses on three main research domains; they are immersive VR, semi-immersive VR and desktop VR. Application on E-learning falls into the domain of desktop VR.
During the last few years several projects have been devoted to providing a broad base of E-learning over the World Wide Web. Notably, at the MIT the OpenCourseWare initiative has acted as stimulator to similar projects all over the world (ocw.mit.edu).
In Germany, a desktop VR system-VEST-Lab was designed for safety training in chemistry laboratories by Zayas (Zayas, 2001). The training scenarios included prevention and investigation of accidents, identification of safety hazards and response to emergency situations. VEST-Lab represented objects and environments with a high level of realism in terms of the appearance of objects and the scale and proportion of the simulated environment. This high level of detail was created from scratch and all came in extremely large file sizes, which vividly represented the detail of chemistry laboratory. This made it impractical to be published over the Internet even for broadband users. In the field of Geo-information and Earth Sciences several projects have been carried out to utilise the potentials of Virtual reality and WWW technology (Sester and Katterfeld, 2004). One of these projects is the "Virtual Landscape" of the "E-learning-Academic Network" (ELAN) in Lower Saxony, Germany. The project aims to develop a Virtual E-learning environment for students in Earth Sciences, such as Geodesy, Geo-informatics, Geography, Landscape Planning as well as students in Applied Computer Science. Disciplines mentioned above were integrated in the form of text-based units, enhanced by animations, interactive illustrations and assessments. This system is currently under construction.

3. System framework

The virtual E-learning system described in this paper uses (1) VR and image mapping technology, (2) database technology, and (3) Internet technology to establish a web-based VE system for managing E-learning scenarios. The authors have designed essential and critical links and interfaces between these different parts. This realized the interactivity and hence formed the research framework for this project. The virtual objects that form the virtual E-learning scenarios, together with their associated mapping images are saved in the database. This database is associated with the website which is designed to present the objects and scenarios. The elements can be managed through the website. Figure 1 shows an overview of the system.

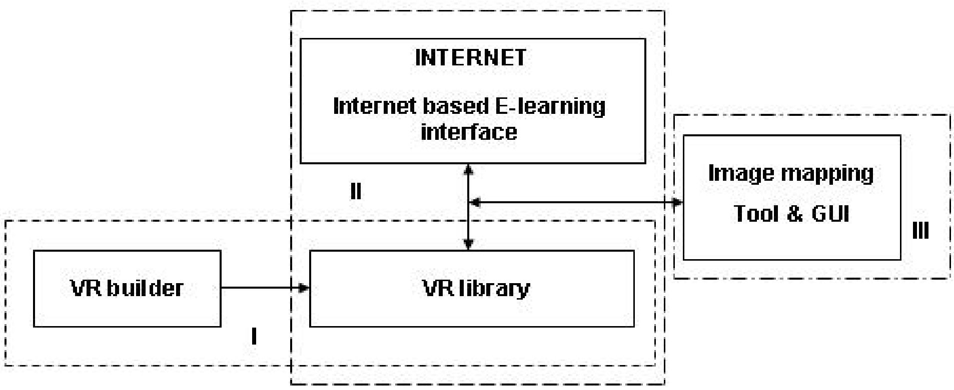

Figure 1 Framework of Web-based Virtual E-learning system

In Figure 1, module **I** contains the VR library and VR builder. VR object library holds objects that can be retrieved to construct the virtual learning scenario, and VR builder is the main component for the system visualization, which includes rendering VR object and interpreting VE construction data. Objects and environments are saved in VRML format, whose script nature and text format enables VR objects and environment to be transmitted over the Internet like normal HTML code (www.w3.org). This part provides the user with a virtual space and near real-time experiences.

Module **II** contains the VR library and the Internet-based E-learning interface. The VR library delivers a top-down central administration for VR objects, environments and mapping textures. The Internet Based E-learning Interface is a HTML based website generated by ASP (Active Server Pages) (Evjen and Hanselman, 2005), which integrates a VR browser, and is used by the learner to view and manipulate objects and environments. This interface connects the library, which enables objects and environments to be managed through the website.

Module **III** is the Image Mapping Tools and Graphic User Interface (GUI). The image mapping tools were developed using an algorithm (Wright, 2000) and 3DS MAX (Murdock, 2005). Images are mapped onto different objects to replace the sophisticated geometry. This method optimizes the size of 3D objects and hence the scenarios (Chiricota, 2003) (Ouyang, 2004) because images replace several megabyte of VRML code. This method does not require high specification computer, and it reduces the time needed to transfer file over the Internet.

Images are warped before mapping. This was realized using algorithms and commercially available software. A Multi-level B-Spline Approximation (MBA) (Lee and Wolberg, 1997) was adopted to warp images based on objects' geometrical features. The shortcoming of this method includes heavy computation and pixel loss, because one single image does not provide enough pixels to cover both the sides and front of a 3D object.

In such a situation, composing two or more images into one would be ideal for this project. Images are composed by using commercial software, for instance Photoshop. This method merges two or more images together to fit the geometry. The basic method is to deform the side image first, then compose it with the front image, and eliminate the boundary in between to form the mapping image, as shown in Figure 2.

4. System construction

In this example, "How to Construct a Computer Network" was chosen as the example to demonstrate the idea of using image mapping and VR technology to build up an experimental E-learning system.

All the virtual objects and scenarios were built in 3DS MAX, and saved in the VR library in VRML format. All objects and scenarios were simplified in geometric details by reducing their number of primitive objects which can be replaced by images. Images are deformed by the image mapping tools developed for this project and Photoshop to match the objects' geometrical feature, which makes simple geometries look pretty similar to the real objects. A corresponding website has been built using ASP and connected with the library to realize online deployment of the scenarios and objects. Figure 3 shows the scenario created for the example. This scenario contains several objects and they are all mapped with images. Users can (1) wander through the 3D scene, (2) control VR objects and view them in terms of their physical layout from different angles by using periphery hardware equipment such as a mouse or keyboard, (3) administrate objects and scenarios over the network. Further functionalities for interactive objects manipulation, including the reconfiguration of (1) texture mapping and (2) global or local illumination conditions are currently under development. The implementation will be detailed in a future publication.

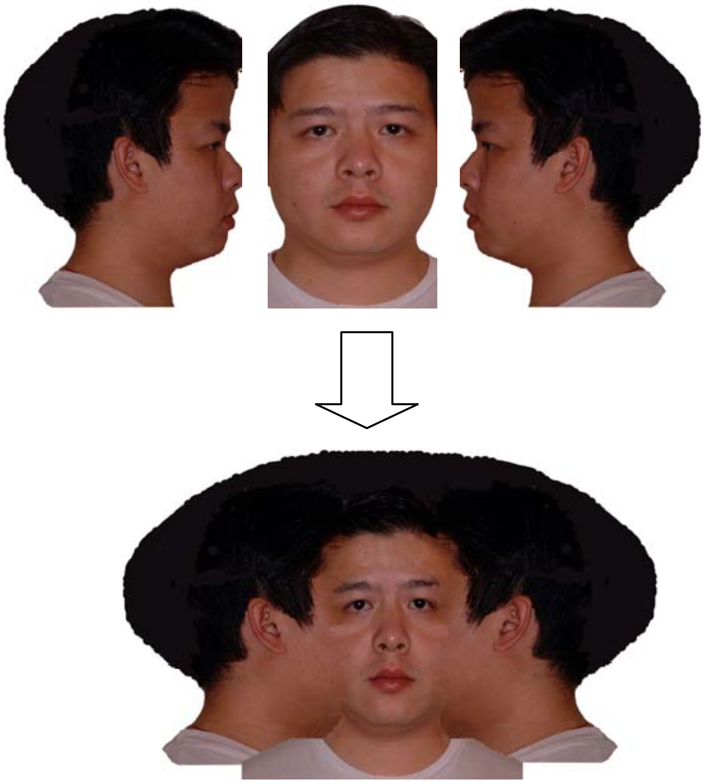

Figure 2 Deformed images and result of mapping

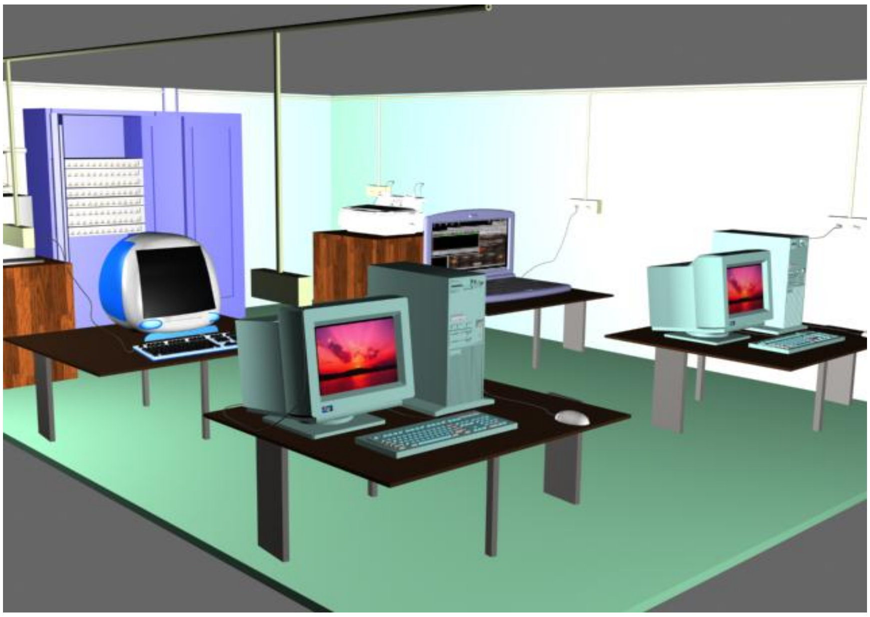

Figure 3 Image mapped objects and scene

5. Conclusion

This paper has presented an example of an E-learning system based on virtual environments. In this system, virtual reality technology and image mapping have been used to construct the experimental E-learning system. Mapping images onto complex surface reduced the file size of virtual objects and scenarios, and enabled them to be easily transferred over the Internet. Moreover, the virtual reality technology provides the end user with a higher level of interactivity, which enabled the system deliver not only information and knowledge as most E-learning systems do, but also some practical experience.

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