Using Multi-user Distributed Virtual Environments in Education

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Abstract: On-line learning is one of the emerging needs of the information age. Access to education is going to become crucial for the success of our information society. Therefore a lot of potential is seen in distance learning and distributed virtual environments. The communicative character of the distributed virtual environments would allow for students and stuff to meet in social shared spaces and engage in on-line real-time seminars and tutorials. Such technologies may mitigate some of the problems of isolation that distance learning brings. This paper presents multi-user distributed virtual environments, which are designed and implemented for educational uses.

Introduction

Multi-user Distributed Virtual Environments (mDVEs) allow a group of geographically separated users to interact in real time (see Bouras Ch., & Philopoulos, A. 1998). While a simple Virtual Environment (VE) is a computer-generated simulation, which aims to provide its users with a sense of realism, an mDVE is something more. First of all in an mDVE, multiple users can interact with each other in real time, and furthermore the VE is distributed, running on several computers, which are connected by a network, using a series of client server applications (see Bouras Ch., & Philopoulos, A. 1998, and Waters, R.C. & Barrus, J.W. 1997).

There are many research projects and systems in the area of mDVEs such as DIVE and SPLINE.

The Distributed Interactive Virtual Environment (DIVE) (see Frécon, E. & Stenius, M. 1998, and DIVE) is an internet-based multi-user VR system where participants navigate in 3D space and see, meet and interact with other users and applications. DIVE supports the development of virtual environments, user interfaces and applications based on shared 3D synthetic environments. DIVE is especially tuned to multi-user applications, where several networked participants interact over a network.

Scalable Platform for Large Interactive Networked Environments SPLINE (see SPLINE) was designed and implemented by MERL researchers and provides capabilities such as multiple users, spoken interaction, computer simulations, human computer interaction, 3D graphics and sound, run-time modifiability and open Interfaces.

Furthermore there are many projects that try to introduce VR technology in education such as VIRLAN, BREVIE and VRLEARNERS.

Foreign Language Virtual Environment for Primary School Children (VIRLAN) project (see VIRLAN) aims to develop a virtual reality language learning network for primary school children throughout Europe. The main results of this project are the use of latest advances of virtual reality and multi-user environments by children in order to be able to "meet" and "communicate" in the virtual worlds, and consequently learn each other's language out of this interaction.

Virtual Reality Learning Environment for Network of Advanced Educational Multimedia Resource Centres, Museums and Schools (VRLEARNERS) project (see VRLEARNERS) has as major goal to facilitate multimedia access to Europe's cultural heritage. One of the main results of the VRLEARNERS project is the development of a collaborative virtual learning environment providing access to digital archives of European museums.

Bridging Reality and Virtuality with a Graspable User Interface (BREVIE) project (see BREVIE). The main objectives of the BREVIE project are to demonstrate the feasibility and the advantages of a new kind of learning environment for vocational training in production engineering and to establish a baseline for network supported co-operation between media developers, research institutions and media users (teachers and learners).

mDVEs have many characteristics that can be exploited in the educational procedure and especially in the distance learning. More specifically mDVEs offer a way of communication and they give a shared sense of space, presence and time (see Singhal S., Zyda M. 1999). Furthermore an mDVEs application can meet the requirements for a complete Computer Mediated Communication (CMC) system (see Candace, Chou C. 1999), such as ease to use interface, cross platform, conversation logs, indication of the presence of the attendees and multi-modal interaction.

According to an extended review on the educational uses of Virtual Reality (VR) technology (see Youngblut, Ch. 1998) most of the educational VR applications don't support multiple users and they don't provide any type of interaction between their users. More specifically almost two percent of the current applications support multiple users with very limited types of interaction between users. Furthermore, the majority of the existing applications are immersive using head mounted display (HMD) or cave display to visually immerse a user in the virtual world.

Generally speaking, immersive applications are more effective in the use of VR technology. However the main feature of educational VR applications is the interactivity and not the immersion.

Moreover, a VR application, which is designed for educational use should be suitable for widespread use and mature in the part of the technology. Considering these requirements, immersive VR technology is not mature and it is expensive. On the other hand desktop VR is more suitable for widespread use regarding the hardware and software requirements.

In this paper is described a 3D community which is implemented in the bounds of Virtual European School (VES) project (see Bouras, Ch., et al. 1999, and VES). VES 3D community consists of mDVEs. These environments have as primary goal to provide educational material and communication facilities to students and teachers through a user-friendly 3D interface.

The described 3D community in this paper satisfies the above requirements. First of all offers multi-user interaction through chat communication and avatar representation.

In addition, the described environment is an mDVE and it has not excessive requirements from the user-side. More specifically the educational material and the virtual worlds are stored in a server and the user can reach the 3D-community trough a web browser with the use of appropriate plug-ins.

The remainder of this paper is structured as follows. In the next section we describe the VES project and the VES 3D community. We then present the functionality of 3D community. Following this, we describe some implementation issues and finally we present some concluding remarks.

VES description

VES is a European project - funded by the Educational Multimedia Task Force Initiative of the European Union - with the aim to develop a comprehensive on-line resource of teaching material for secondary school education.

The VES system architecture is based on a network of distributed multimedia databases, which acts as the data servers within the VES. One server per participating country (Austria, Italy, Greece, and Great Britain) has been installed. These servers can be accessed via a standard web browser. VES has three target groups: publishers, teachers and students/pupils. For each user group a special Web-based Graphical User Interface was designed. Publishers are provided with a supporting interface for uploading and monitoring the use of teaching material, teachers have search and compose facilities assisted by intelligent wizards while pupils access through a specifically designed interface to work with selected learning material as well as mDVEs.

In general VES system has two main technical results:

1. The implementation of a distributed multimedia database for storing the multimedia-value added teaching material and additional CBT products.
2. The development of a 3D mDVE providing pupils with a powerful tool for learning and exchanging knowledge.

This 3D mDVE is presented in this paper. Currently, the VES system and the corresponding mDVE can only be used by registered users. We have also established an alternative 3D community (see VES 3D) for testing and evaluating purposes.

VES 3D community

The 3D Community consists of 9 virtual worlds (.svr files) (see VES). The first world acts as the entry room to the whole environment and provides general information about the VES project and the three VES access points (Austria, Italy, and Greece). The second world is the hall room from where the user can reach 7 other rooms that act as workplaces to be used by teachers and students for interactive communications through 3D avatars and text chat. There are 3 rooms dedicated for national discussions (Austrian, Italian, and Greek) and four rooms dedicated for thematic subjects (Geography room, Economics room, Physics room and History room).
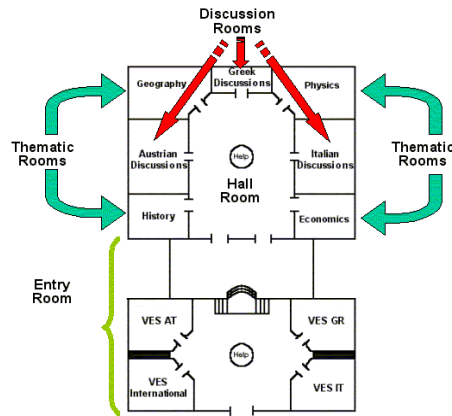In (Fig. 1) the ground plan of VES 3D community is depicted.

Figure 1: Ground plan of VES 3D community

Functionality

In order to achieve a friendly and appealing user interface, the interaction of the user with the virtual world should resemble real situations. In every virtual world, are defined certain functions and these functions are activated by certain events. These events are related with objects (active objects) and how the user interacts with them. The triggering mechanism of these events can have the following alternatives:

- When the user's avatar enters in pre-defined areas within each virtual room.
- When the user's avatar hits certain objects (collision).
- When the user clicks with the mouse over a certain object (touch).

By using one of this ways, we can have an interactive environment where the user is able to navigate and perform certain activities. An example of the thematic room functionality is shown at (Fig. 2).
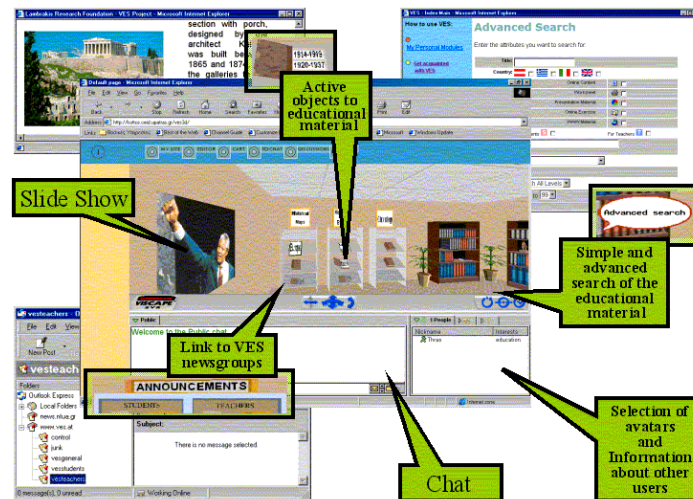

Figure 2: Thematic room functionality

In the following sections we describe functions that were designed in the virtual worlds.

Information providing

The main concept here is that a virtual environment should provide information, which is more appropriate for 3D realization. Alternative ways of presenting information within the virtual environment has been exploited. These are the following: Information that is represented by certain 3D objects, information that is displayed in 2D within the 3D environment (for example, slide presentations, images, computer monitors, etc.) and information in HTML format that is displayed in a new window and has nothing to do with the 3D environment (e.g. external resources, educational content units, educational composite units).

Access to VES web-site's functions

In order to give the possibility to the user to access the VES services through the mDVE, certain objects are used. These objects link to the services and can be activated by clicking on them. In this way pupils and students get acquainted with the VES system in a more friendly and interactive way.

Presentation of thematic material

The virtual environment provides an alternative way of finding educational content and educational composite units for a specific thematic area in the VES database. This way resembles a real life situation in order to be easy for the users. The thematic material is presented in the specified thematic rooms with the help of the bookshelves and the corresponding books.

Help

Certain help within the virtual worlds is provided to the users. By this, we mean all the assistant information that is represented in the 3D environment.
This help functionality exists in both worlds through the following:
- Navigational aids through several viewpoints and predefined tours. The user could be able to take a virtual tour that would guide him/her to the main functions of the virtual world.
- Hints. As the mouse passes over some objects it changes to a hand. Holding the mouse over, this object would display a tooltip giving to the user more information about the object.
- A help desk where is positioned an avatar resembling a secretary that when the user goes near, this avatar gives help hints in a speech bubble or a text label.

Animations

The 3D environment provides certain animations in order to be more attractive and interesting to explore. However, certain care was taken with the number and the functionality of them, because too many and complicated animations (e.g. walking people, sound players, etc.) can frustrate the user. In addition to this, it must be noted that the animations within a virtual world can increase the size of the file thus leading to long download times. Having this in mind the following animations are implemented and used:
- Slide presentation (maximum one in each virtual world)
- Moving humans that will assist the user in a certain way (maximum one in each virtual world)
- Predefined path – tour (maximum one in each virtual world).

Chat facility

Users can engage in real-time chat conversations, which are supported in various ways. Public chat allows one to speak or listen to everybody within a venue at the same time. Private chats can also be initiated anytime with other users. Members can also whisper quick private messages to other members.

Implementation Issues

Several issues have been considered in the development of the distributed virtual environments, in particular user interfaces and supporting architectures (see Bouras Ch., & Philopoulos, A. 1998, and Youngblut, Ch. 1998). In our case, through the development process we had to deal with several substantial technology related questions, e.g.: finding an appropriate compromise between the desire to design a sophisticated 3D environment and the demands (e.g. reasonable response time, minimum hardware and software needs for the user); creating solutions for the interaction of the virtual worlds and the databases of the VES system and the representation of the obtained information; integrating varied actions modes within the environment (e.g. wandering through 3D space, manipulating objects, browsing html pages or viewing content units). While designing the 3D Community the main issues that were taken into consideration are the creation of 3D worlds, the multi-user interaction and the user interface layout.

The creation of 3D worlds

The implementation of 3D worlds is based on Superscape VRT (see Bouras, Ch., et al. 1998, and Superscape) which is a 3D authoring studio for PCs. The 3D file format of VRT worlds is SVR, which is a compressed binary file that contains all the geometry, textures, sounds and behaviors needed for the interactive 3D world, in a highly compact and encoded form, giving short download times and rapid worlds start-up. The 3D browser that displays 3D worlds made with VRT on the WWW is called Viscape (see Superscape) and it is freely available as an ActiveX control for Microsoft Internet Explorer or plug-in for Netscape Navigator.

VRT has also a purpose-built behavioral control language, called Superscape Control Language (SCL) which is based on the C language. SCL is a compiled language and each program consists of a list of commands that are executed, in order, every frame. We use SCL to write simple programs that create links to other pages and add intelligence, animation and other specific behavior to objects. Furthermore, SCL gives us the ability to make HTTP requests to a web server and open files for reading or writing.

Multi-user interaction

The implementation of multi-user virtual environments is based on the use of blaxxun Community platform (see Blaxxun): blaxxun community server and blaxxun client. blaxxun Community Server consists of five software modules, and offers instant messaging, chat, message boards, calendars, 3D locations, 3D navigation, 3D and 2D avatars, friends lists, objects trading, agents, voice, homesteading, incentive systems, roles and access rights. Moreover, it includes administration interfaces that are required to operate and maintain the application.

Furthermore blaxxun Community Server is well suited for the implementation of mDVEs because it offers scalability, customizability, extensibility, and openness.

The main features of blaxxun community platform that are used in VES 3D community in combination with Superscape VRT are the representation and motion of avatars, the chat facility, and some shared events. For the implementation of shared events the "proximity" and "hit" events of Superscape VRT are used. With these events an event (e.g. animation) is triggered by a user in all other virtual environments.

User Interface Layout

An important issue in the design phase was how the whole mDVE application is combined with the existing interface of the VES system and how the user interface layout of the mDVE application looks like. After some proposed interface layouts and their evaluation from teachers, pupils and preceptors the implemented user interface layout is decided to be as depicted in the (Fig. 3).

This layout consists of the following frames:
- Frame 1: This frame could be used to display the top frame of the existing VES web site and give the user the ability to navigate within the available different services.
- Frame 2: Here is displayed a menu of the needed buttons for certain actions that have to do with the mDVE.
- Frame 3: Here is displayed the virtual world through the Viscape plug-in.
- Frame 4: This frame is used for the chat interface through the blaxxun plug-in.
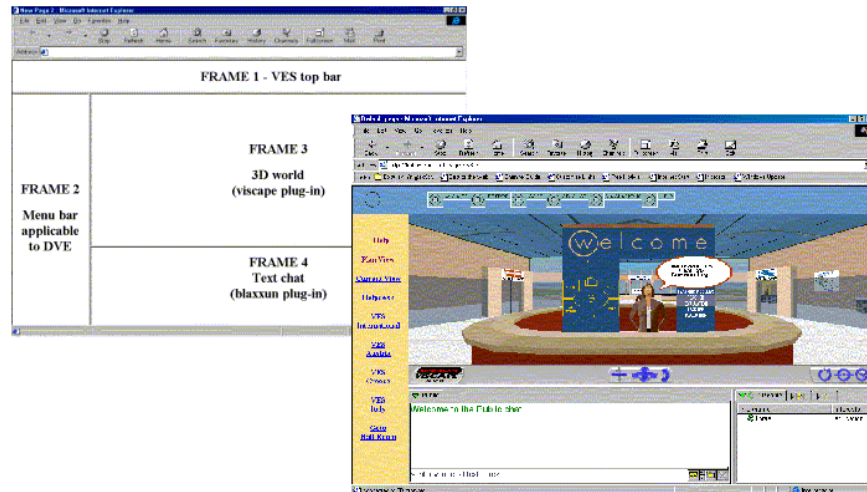
Figure 3: User Interface Layout

Conclusion

The described mDVE represents the result of our work to offer educational applications with the use of virtual environments. The development of this application has given us the opportunity to deal with many interesting technical issues, concerning the creation and usage of multi-user virtual environments. In addition to the technical issues that we have encountered, the educational issues that may come up while using this application may be even more interesting and help us use in a more efficient way the new ways of communication and interaction that distributed virtual reality technologies offer. In order to evaluate this environment, we have distributed evaluation sheets to teacher, pupils and schools.

Our next step in the process of developing this mDVE is the amendment of the current environment according to teachers and students evaluation results in order to a more suitable educational environment.

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