DISTRIBUTED VIRTUAL REALITY ENVIRONMENTS OVER WEB FOR DISTANCE EDUCATION

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Abstract

Virtual Environments for education have been discussed in various ways. While advanced multi-user educational VEs are still speculation, simpler VEs based on standard technologies have been in existence for some time. On the other hand, there is a great enthusiasm for promoting Virtual Reality as a major factor in future (and present) environments for training and education. In this paper, we discuss the concept of the Distributed Virtual Environments and the use of them in distance education applications. Next, we consider VRML technology as the key technology for building such environments and we present the basic features and functionalities of it that make it suitable for delivering VEs over the Web. In addition to this, we present some of the roles of VRML in education. Finally, we conclude with some recommendations on the construction of Virtual Reality Environments for educational purposes.

Introduction

A Distributed Virtual Environment (DVE) allows a group of geographically separated users to interact in real time. The environment in which a DVE user is immersed is three-dimensional to the eye and ear. Moving in the environment changes the user's visual and auditory perspective. Unlike a video conferencing system (where an attendee's screen shows other attendees in their own video-conferencing rooms), DVE users assemble in a virtual world - they are all seen, for example, seated together around a conference table in one room, or walking together in a virtual building. Every user of a DVE appears in the computer environment as an avatar - either a customized graphical representation, a video of the user, or some combination of both - which he or she controls.
The user, besides interacting with one another, also deals with one or more computer simulations. While in use, a DVE can change continually, in every aspect. Further, a DVE can grow dynamically by accepting contributions of objects and structures from many sources. One one hand, interactivity is a basic requirement of all virtual environments. On the other hand, distributed virtual worlds require a certain level of persistence to achieve the impression of a single shared world. Persistence is realized by distributing and synchronizing user input as well as user independent behaviour.
Virtual environments provide a way to combine the best features of real-world information navigation - memory of places and visual cues - with the best features of online navigation - fast searches and sorting and quick cross-referencing. By being able to manipulate data the same way we manipulate objects and ideas in real life, we can spend more time creating and understanding things and less time figuring out how to operate them. A well-designed environment can help us experience things in a

larger context and pick out useful information from complex systems. Environments that mirror the physical world can show us exactly what is going on and keep us informed.
Such DVE's could be used as collaboration and training tools. One can intergrate interactive learning objects into a DVE and have people learn in that environment by doing and communicating with others. Furthermore, it is possible to provide educational material in many different media formats through a virtual world, giving to the users a unique experience. One advantage of VE's could also be to provide remote access to expensive and/or specialised laboratory hardware.
The emergence of the Virtual Reality Modeling Language (VRML) as a standard method of modeling virtual reality objects and worlds coupled with the wide spread deployment of WWW browsers that support VRML allows the creation of such DVE's and the use of them through Internet. This paves the way for participation of more geographically dispersed users in multi-user virtual reality interface systems.

The VRML Technology

The aim of VRML is to bring to the Internet the advantages of 3D spaces, known in VRML as worlds whether they compromise environments or single objects (and using the file suffix .wrl). These are built to be shared between widely distributed users. VRML defines a set of objects and functions for modeling simple 3D graphics. These are known as nodes, which are arranged in hierarchies called scene graphs. There is a top-down arrangement in which nodes that are described earlier in a scene affect later ones, but this can be limited by the use of separator nodes. A VRML file is an ASCII file which is interpreted by the browser and converted into a 3D display of the described world.
VRML is designed to fit into the existing infrastructure of the Internet and the WWW. It uses existing standards wherever possible, even if those standards have some shortcomings when used with VRML. Using existing standards instead of inventing new, incompatible standards makes it mush easier for the Web developer, who can use existing tools to help create VRML content. It also makes it much easier for somebody implementing the VRML standard, since libraries of code for popular standards already exist.
VRML files may contain references to files in many other standard formats. JPEG, PNG, GIF, and MPEG files may be used as texture maps on objects. WAV and MIDI files may be used to specify sound that is emitted to the world. Files containing Java or Javascript code may be referenced and used to implement programmed behavior for the objects in the world. Each of these is an independent standard, chosen to be used with VRML because of its widespread use on the Internet.

The functionalities of VRML

The latest version of VRML, also known as Moving Worlds, provides, as its name suggests, for the introduction of action in the modelled world. Either objects in the world can act and react to each other under program control, or they can respond to the user's actions in some way. For educational purposes, this will in many cases be essential. The features that Moving Worlds currently includes, most of which are likely to remain, are:

- International character sets for text can be displayed using UTF-8 encoding.
- A set of new nodes has been added to increase the realism in models that are intended to represent the outdoor world around. It will be possible to create ground and sky backdrops, adding distant mountains and clouds, for instance. The effect of distance can be further enhanced with fog effects. In addition, there will also be the option of defining an irregular terrain rather than being constrained to a flat ground plane.
- Sound generating nodes will also enhance the sense of realism.
- New sensor nodes will set off certain events when one enters specific areas, or click on certain objects. So, for example, as the viewer approaches an object it can be triggered to start some action or make a noise.

- Collision detection ensures that objects can act as if solid. That is, the user, will not go through walls and floors.
- Script nodes allow for the animation of objects in the world and the interaction of the world with other applications, for example databases.
- Multi-user environments. There are many approaches to creating multi-user worlds, and the Moving Worlds aims to provide the functionality required for these, but without dictating which approach is to be used.

It is obvious that the VRML technology has all the features and functionalities that are suitable for creating an interactive DVE. There is already a series of virtual worlds being made available, experimenting with increasing functionality, mostly based on the VRML format. They include either scripting and construction facilities, or additional communication, be it textual, audio or even video. Most of these take VRML models and allow them to be used within multi-user shared environments. These shared worlds, based on VRML, will be very important in the future. The ability for students to not only visit another VRML to explore it, but also to possibly meet its authors is very exciting. In the educational sector, it will remain the case that much learning is achieved through student-student and stuff-student communication and social wolds can facilitate this.

The role of VRML in education

VRML, along with the Internet in general, offers a number of attractive features for the education sector:

- It has cross-platform compatibility.
- Much of the software for creating VRML content can be downloaded for free.
- As VRML sits upon existing World Wide Web tools, existing student knowledge of these is applicable, easing use.

As a medium for education & research

The Internet generally is being proposed as a means to facilitate both teaching and research in the educational sector. Indeed this is the most obvious role for VRML. Three-D content can be created and distributed to one's own students, or made more widely available to learners across the globe. There are plenty of obvious applications for educational simulators in a number of fields: physics, planetary exploration, archaeology, biology, and chemistry all can benefit greatly from better visualization technologies. The point of these systems is not necessarily the amount of things that can be done with them but the fact that students can have the power to create them on their own and can find it fun and motivating to do so. Any textbook or course materials that have 3-D graphics, such as architecture and engineering, may benefit from VRML. If the course materials, or the research papers, require multiple drawing of a 3D object or space, then clearly VRML will give benefits.
More abstract representation -that is, data visualisation- is also increasingly supported. Data visualisation can be easily supported in that the objects can use the Anchor node to point to textual, tabular material describing the data in other forms. This ability will extends the range of subjects that can benefit from VRML to include those that deal not with spatial objects, but call upon quantative data that can be spatially represented, such as the social sciences.

As a collaborative medium

One of the longer-term, but possibly most exciting, opportunities lies in the educational use of the shared spaces for distance teaching and project collaboration. The communicative worlds similar to those discribed above, would allow for students and stuff to engage in distributed meetings, seminars and tutorials. A number of trials using this existing technologies are being tried.
Increasingly the Universities seek to adapt, supporting learning-for-life, in addition to more conventional students. Such technologies may mitigate some of the problems of isolation that distance learning brings. The students not only access course materials, but also meet in social spaces to discuss them with stuff and fellow students.

Collaborative virtual environments provide gathering grounds for new communities and types of interactions, and they give people a voice like they have never had before. We can share experiences and visions and learn to understand the other person's point of view. We can attend concerts, act in plays, and attend classes with an international audience. As long as people have something to say to somebody else, they can say it online.

Conclusion

The aim of VRML as an Internet-based technology is to make the three-dimensional worlds and objects as accessible to as wide a public as possible. The models created must be able to be seen on a range of machines that are readily available to the average user. Speeds of network transmission for models also pose another problem. So for the immediate future it is likely that we must satisfy ourselves with simple (that is, small) models. The models must, therefore, serve other purposes to be effective and useful.

The construction of Virtual Environments should be seen as a design problem in the broadest sense. VR projects with an educational remit should recall at all times the criteria of educational effectiveness. The drawbacks as well as the advantages of various aspects should be evaluated, including the effects of concretising information, of appropriateness of spatial metaphors and of the interface. Regarding shared worlds, they should be invastigated to support distance tutoring and research, but with caution to ensure that the social grouping effect of actual meeting is not lost. They should supplement real tutorial and seminars, not replace them.

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