

A Distributed Virtual Learning Centre in Cyberspace

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Abstract. In this paper, we present a user-friendly 3D Distributed Virtual Environment (DVE) that would be used for on-line access to educational multimedia material over the Internet. We design and develop this application and the corresponding Graphical User Interface (GUI) in the framework of the European project "Virtual European School" (VES) whose aim is to develop a comprehensive resource of teaching material for secondary school education and to provide access to this material over Internet. It is a web-based application that is being developed as a client/server architecture using standard protocols and technologies such as TCP/IP, HTTP, HTML, Java and appropriate 3D formats.

1. Introduction

Distributed Virtual Environments (DVEs) represent a rapidly expanding area of research. Most commercial VR systems provide some kind of networking, albeit often only to limited extent, and an increasing number of VR research platforms are appearing which support more sophisticated and scalable forms of distribution [2,10,11,16,17]. At the same time, the Internet has also become a viable platform for DVE deployment and DVE capabilities are entering the Web browser. For example, the Virtual Reality Modeling Language (VRML) [1,5] enables users to download interactive 3D models over the World-Wide-web. The Living Worlds standard [13] adds multi-user access capabilities to these VRML models and other extensions to VRML, such as the recommended practices for SQL database access [14], enable the development of DVEs for corporate and business applications. With standard web browsers as an execution engine for DVEs and while new networking protocols are evolving [3,4], the Internet will increasingly become the most common DVE enabler.

This paper describes the concept and implementation of a "Distributed Virtual Learning Centre" as a site in the Internet that will provide educational multimedia material. In particular, in Section 2 we first provide general information about the European project VES, in the framework of which we develop this particular application. Then, Section 3 presents the main characteristics and functionalities of the Virtual Learning Centre. Section 4 gives a detailed information about the technical issues that we deal with. Finally, in Section 5 we provide some concluding remarks and the plans for our future work.

2. Description of the VES system

The VES [12] is a system based on Internet technologies, which can distribute all kinds of electronic educational content from publishers among teachers and pupils in several countries. In principle the VES system can be seen as given in Figure 1.

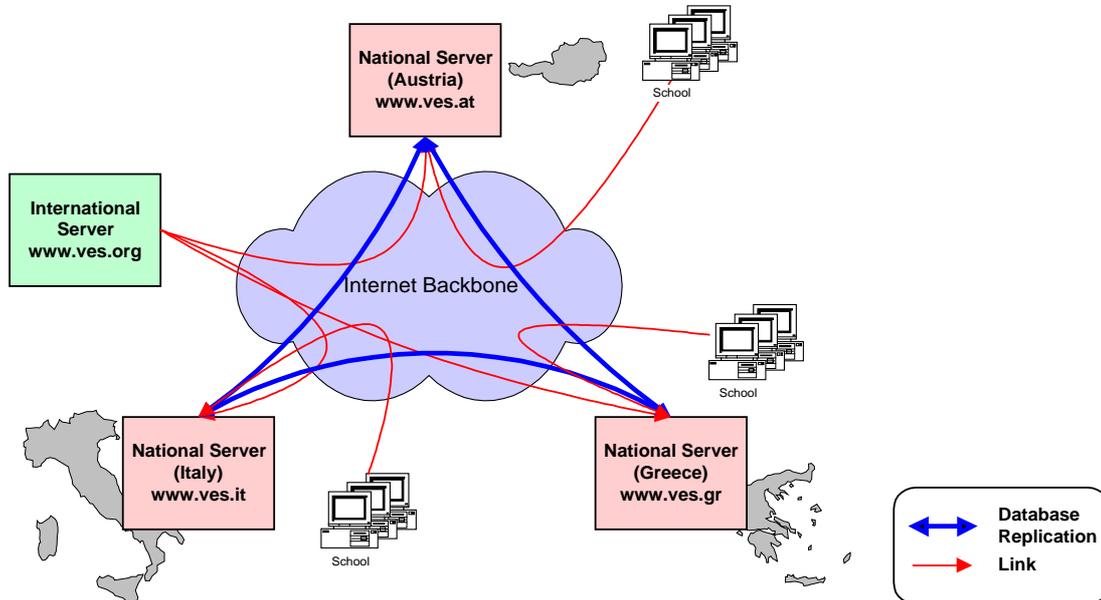


Figure 1. The Architecture of the VES system

It is a distributed server network with one international server and one national server in each participating country (Austria, Italy, Greece), which are linked together via the Internet. In each country, schools with pupils and teachers can connect to their national VES server with standard web browsers and through the appropriate interfaces are able to search for content, view it directly with the web browser and its helper applications or download it for exploiting from the local computer. On the other hand, publishers can connect to their national VES server in order to upload and maintain their content. VES is going to be a commercial system, where only registered users could have full access to the offered services.

The VES system is designed to store and distribute every kind of content, but the most important data of the system is the educational multimedia content provided by the various publishers. Basically, multimedia content is not restricted to any data type, however, the most important data type utilized is HTML pages with all referenced data (e.g. images, Java applets, JavaScript, Shockwave, etc.). Other content includes text documents, audio, video, simulations, animations, CBT courses, software, etc. In VES, all the content is organized in so called "content units". Content units represent a piece of information not divisible anymore without losing its economic or didactic significance from the publisher's point of view. In order to provide a uniform search possibility, each content unit contains a short, textual content description. This description is standardized for all content units within the VES system and is called "metadata". Finally, another kind of information in the VES system are the "composite units". Composite units are the means to group content units together, like a table of contents in a book, and are created either by the publishers or dynamically by teachers and pupils through searching processes.

The content of the VES system, as described above, is stored in appropriate servers (databases, web server, multimedia server) that compose each national server. The stored material is under constant modification, like deleting/importing of content units and the related metadata, editing of metadata of existing content units, constructing and editing composite units, thus VES is a dynamic online system for providing information. The Virtual Learning Centre and the corresponding GUI is used as the pupils' interface for the

VES system. They can use it in order to facilitate their access to the online catalogue of the offered material and to search through it.

3. The Concept of the Distributed Virtual Learning Centre

The Virtual Learning Centre represents an attempt to build a learning environment combining real life situations, educational principles, virtual reality features and WWW technologies features. The abstraction that we use for representing the stored material of the VES system is a building of an exhibition centre, where publishers have their own place to display their educational products. The centre is organized in halls, or thematic units. Each hall is organized around a learning subject, like natural sciences, art and culture, technology, foreign languages and others. Furthermore, each hall that represent a specific subject is divided in rooms, where each room represent a different learning age.

Every room of the centre access different material, but the structure of the room is the same for all. In every room, there are kiosks that represent the publishers that put material in the VES system. Every publisher has its own kiosk in every room, where it displays the material that belongs to him. In the kiosks there are entities that represent the content material of that publisher. For example, a user can go to a kiosk, select a book, open it, see the metadata information about it, that is stored in the database of the VES system, and if he is interested in this item then he can view or download the relative content unit. There is physical representation of the most recently added items in the database, while the older items are inserted in a list, which the user can browse and select to view any of these. In this way there is no need to have physical representation for every content unit that is stored.

Having this hierarchical structure, the environment of the Virtual Learning Centre becomes very easy for the user to navigate in it and find the material that he wants. In addition, the user can get used to the virtual environment after some visits and not get lost in it. Every room of the centre is a separate small file of a virtual world, reducing thus download times, and the user can go from one room to another through appropriate portals.

The Virtual Learning Centre comprises a number of other spaces characterized by function. There is an information centre where the user can get available information about the environment, the rooms and how to get there, latest news and others. Furthermore, there exist a conference room where predefined lectures, presentations, seminars and other events take place. As the VES system expands there will be and other rooms with specific functionality.

4. Technical Features

Several issues should be considered in the development of virtual environments, in particular user interfaces and supporting architectures [6,7]. In our case, through the development process we have 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 thorough 3D space, manipulating objects, browsing html pages or viewing content units). While designing the Virtual Learning Centre the following issues were taken into consideration.

4.1. The creation of the virtual worlds

The tool that we use for building the virtual worlds is Superscape VRT [15] 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 behaviours 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 Viscap 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 behavioural 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 behaviour to objects. Furthermore, SCL gives us the ability to make HTTP requests to a web server and open files for reading or writing.

4.2. Virtual world - database interaction

Our main consideration is to make the Virtual Learning Centre a dynamic environment that will represent the content of the VES system and will reflect all the changes that are made to it. This approach requires a mechanism for employing a variety of database functionality within the virtual worlds. Our solution is based on a thin client model where requests and processes are executed on the server and not on the client (users machine) and can be seen as given in Figure 2.

In certain objects in a virtual world we attach SCL programs that make HTTP requests to the web server for documents that contain the appropriate information. When the web server gets the request for a document, looks up the configuration parameters, finds out that the document is not a static document residing on the disk, but a live document generated by a Java servlet [8,9], and forwards the request to the servlet. Then, the servlet establishes a connection to the database server through the appropriate JDBC driver [8,9], executes the required actions and returns the results to the object of the virtual world. Finally, the object is able through the suitable SCL commands to present the obtained information into the virtual world. An alternative way is to invoke the appropriate servlet from the SCL code with a URL of the form : `http://server_host_name/servlet/<servlet URL>`, where the `<servlet URL>` is a regular URL that points to the location of the servlet. In this way, we can pass arguments to the servlet as part of URL in form `name/value` pairs into the query string portion of the URL.

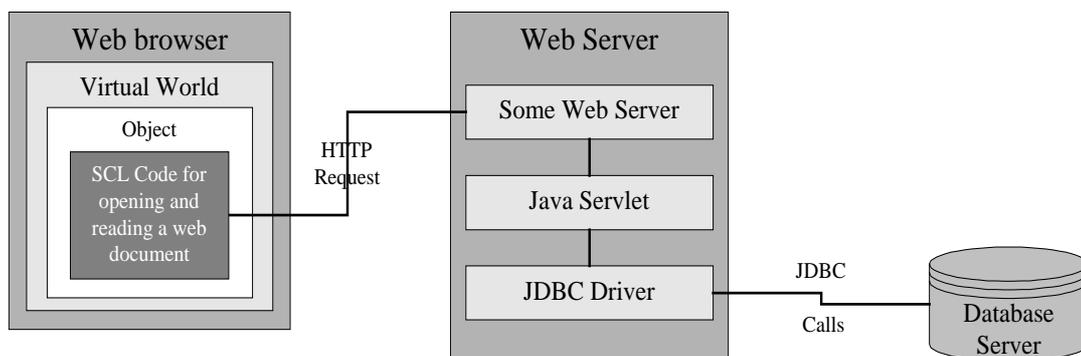


Figure 2. Virtual world - database interaction

For example, such an object could be a book that represents a specific content unit that a publisher has placed in the VES database. When a user triggers that book, the above mechanism would be activated and the metadata information for that content unit would be presented to the user. The user then would be able to choose whether to view or download that content unit or not.

4.3. User Interface

The user interface of the Virtual Learning Centre is based on standard, up-to-date web browsers (Internet Explorer 4.0 or Netscape 4.0 and above) and the 3D environments are

viewable with the appropriate 3D browser (Viscape). In order to have an integrated and interactive user interface we divide the browser's window into several different frames where each one has its own functionality. Thus, one frame is used for embedding the 3D worlds, another is used for displaying information messages to the user and the rest display a console of buttons which give the user the ability to interact with the virtual worlds. For example, there is a function that gives the user the ability to see in a plan view where is located every time and find his way to other rooms. Also, the user can switch viewpoints, take predefined paths, or view certain simulations of specific tasks in the world. At every time, the user can obtain help about the environment and how to use it. All the above actions are created with the suitable JavaScript/VBScript [8] scripts of the Viscape external interface [15]. Finally, the content units that the user selects to view are displayed in a separate window so that the main console is always visible, avoiding in this way continuous back and forward actions.

5. Concluding Remarks and Future Work

The Virtual Learning Centre represents an attempt to explore new educational applications of virtual environments, as well as the integration of VR technology with databases for the development of innovative business applications on WWW. The development of this application gives us the opportunity to deal with many interesting technical issues, concerning the creation and usage of virtual environments and shared spaces.

The design of the Virtual Learning Center as well as the platform that was chosen for the development provide the means for a relatively easy and quick enrichment of the interface and the services that this application has to offer. Our first plan is to make the Virtual Learning Centre a multi-user environment, where interested users can communicate and collaborate through educational activities. In addition, our goal for the next stage is to deploy appropriate mechanisms for electronic copyright management and pay-per-view billing, as well as to find ways to track down users' activities in the DVE, in order to make it a trusted commercial system. Finally, we will devote effort in finding automated ways to expand the Virtual Learning Centre with more spaces and content.

References

- [1] A. L. Ames, D. R. Nadeau, J. L. Moreland. VRML 2.0 Sourcebook, ISBN: 0471165077, 2nd Edition, John Wiley & Sons, 1996.
- [2] W. Broll. Extending VRML to Support Collaborative Virtual Environments, German National Research Center For Information Technology, 1996.
- [3] D. Brutzman, M. Macedonia, M. Zyda. Internetwork Infrastructure Requirements for Virtual Environments, Computer Science Department, Naval Postgraduate School, 1995.
- [4] D. Brutzman, M. Zyda, K. Watsen, and M. Macedonia. Virtual Reality Transfer Protocol (vrtp) Design Rationale, WET ICE'97: Proceedings of the IEEE Sixth Workshops on Enabling Technologies: Infrastructure for Collaborative Enterprises, IEEE, Cambridge, Massachusetts, 1997.
- [5] R. Carey and G. Bell. The Annotated VRML97 Reference Manual, 1997.
- [6] S. Davis, A. Huxor, J. Lansdown. The DESIGN of Virtual Environments with particular reference to VRML, Centre for Electronic arts, Middlesex University, 1996.
- [7] C. Hand. Some User Interface Issues for Hypermedia Virtual Environments, Position Paper for the Workshop on Virtual Environments and the WWW, Fifth International World-Wide-Web Conference, 1996.
- [8] E. Ladd, Jim O'Donnell, *et al.*. Platinum Edition: Using HTML 3.2, Java 1.1, and CGI, ISBN: 0-7897-0932-5, Que Corporation, 1996.
- [9] M. Morrison, *et al.* . Java 1.1 Unleashed, 3rd Edition, Samsnet.
- [10] B. Roehl. Distributed Virtual Reality: An Overview, The Proceedings of VRML'95 Conference, 1995.

- [11] D. Snowdon, C. Greenhalgh, S. Benford, A. Bullock, C. Brown. A Review of Distributed Architectures for Networked Virtual Reality, Department of Computer Science, University of Nottingham.
- [12] VES - The Virtual European School. ANNEX I - Project Programme, January 1998.
- [13] VRML Architecture Group. Living Worlds: Concepts and Context, February 1997.
- [14] VRML Architecture Group. Proposal for a VRML Informative Annex, February 1998.
- [15] VRT for Windows - User Guide, Superscape VR plc.
- [16] R. Waters, D. Anderson, J. Barrus. Diamond Park and Spline: A Social Virtual Reality System with 3D Animation, Spoken Interaction and Runtime Modifiability, Mitsubishi Electric Research Laboratory, 1996.
- [17] M. Wike and R. Hawkes. Distributed Virtual Environments and VRML: an Event-based Architecture, In Proceedings of the Seventh International WWW Conference, Brisbane, Australia, 1998.