

A web-based learning environment exploiting 3D Virtual Worlds

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Abstract: - There is no doubt that during the last few years the learning process has been greatly affected by the rapidly evolving era of information and technological development. The continuously increasing pace in computer power advancement in conjunction with new Internet technologies have led to the extensive usage of multimedia and 3D graphics, resulting to new forms of visualization, distribution and presentation of training material. The objectives of this work are to present an integrated view of interactive 3D virtual worlds used in the implementation of learning activities through the web and to analyze and design an e-learning system based on the exploitation of multimedia technologies, the Internet and 3D virtual worlds. The proposed system provides learners with an interactive 3D virtual learning environment thus enabling them to participate virtually in studying and performing simulated lab experiments for a course in Computer Graphics. Some of the aforementioned system's highlights include the increased management and security capabilities of the virtual environment along with additional features offering simulation of various laboratory exercises.

Key-Words: - E-Learning, 3D virtual worlds, 3D virtual environments, virtual reality, multimedia.

1 Introduction

It is widely accepted that the recent information explosion is also challenging the teaching process that has been the same for centuries. The only aspect that has changed over time is the way students communicate and store the information – writing on stones, leaves and cloth was evolved to using slates, blackboards, books and now the electronic media. In traditional teaching the learning process is often overlooked. However, advancements in information and telecommunication technologies are fostering a shift from a teaching to a learning paradigm, contributing to the development of new training methods and mechanisms. When combined with interactive 3D virtual worlds or environments, multimedia and Internet technologies seem to extend the development limits of new training tools and e-learning techniques. For example, instead of teaching, these technologies promote learning experiences based upon a variety of interactions, the use of new means of knowledge representation and the participation of learners in the learning process.

The rapid evolution of computer networks has greatly affected the field of interactive communications while at the same time actualized the distribution of processed learning material. Following modern pedagogical approaches such as constructivism and collaborative learning, these synchronous or asynchronous interactions within the

participants can occur at any time or place providing a 24x7 hours learning environment [7]. The trainer is no longer a knowledge repository but has undertaken the role of the guiding instructor. At the same time learners are transformed from passive participants to active contributors to the learning process, encouraged to explore more so as to obtain the knowledge they seek [1] [5].

On the other hand “entering” a 3D virtual world creates an illusion of being present in an artificial world or in a remote part of the real world created by a computer, where learners can navigate within this virtual environment and “alter” it [9].

This paper addresses the issue of utilizing three dimensional virtual worlds for the implementation of learning activities through the web. Particular emphasis is placed on the features of this kind of applications especially designed for learning environments. Finally VRLAB, a similar system aiming at the delivery of a course in Computer Graphics, is elaborately proposed.

2 3D Virtual Worlds

The usage of 3D virtual worlds has set new standards in the way information is transmitted. In a system of this kind, first-person experiences are adopted and similarly applied in a virtual environment [3].

With their involvement in a virtual world learners can experience innovative situations for themselves [10], therefore acquiring knowledge through first hand experience not available in a traditional classroom. By participating in a virtual environment, learners can also have full control of time and physical laws, thus perceiving the world in various ways, from a different point of view, resulting in their becoming more adept at observing the same set of situations through different perspectives [2]. In this way, learning in a three dimensional virtual environment appears more engaging, turning out to be a most interesting and entertaining experience.

Additionally, the most distinguishing feature of these systems is that they use the technology to provide learners with new tools and facilitate their learning in an alternative, more dynamic and direct way, offering them the element of personal exploration [6] and communicating a continuous sensation of challenge.

Virtual worlds can be private and shared at the same time. In particular, Internet 3D virtual environments can be a common sharing experience promoting multiple collaboration and simultaneous interaction within the same audiovisual environment.

In addition to the advantages traditional and successful e-learning systems offer in promoting the fundamental goals of learning procedures, 3D virtual worlds seem to be able to enhance the learning process provided that they face the issue of user interface design in an effective way [8]. Having taken this into account, the proposed multimedia e-learning system bearing the name VRLAB was designed.

3 The VRLAB system

3.1 VRLAB Architecture

VRLAB is a platform which effectively combines Internet, multimedia and 3D graphics technologies so as to create an interactive e-learning environment.

In order to confront design issues, several parts of an academic course in Computer Graphics were visualized, enabling learners to virtually participate in courseware study and perform various laboratory exercises.

As a result of VRLAB's object-oriented design, the system follows an open architecture thus inheriting all of its benefits [4]. VRLAB consists of three layers (Figure 1):

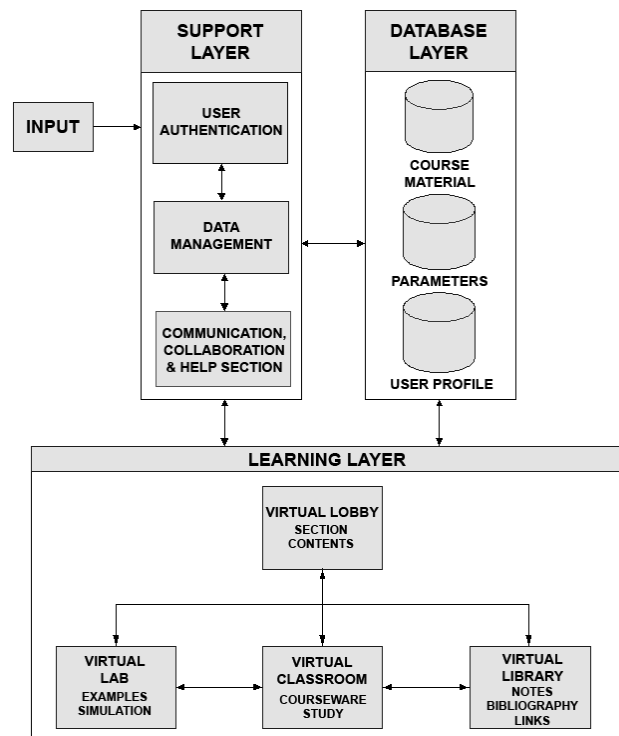


Figure1. Architecture of the VRLAB System.

- **Support Layer:** This layer is responsible for managing the participants' personal data and securing their transactions with the system. Furthermore, it coordinates the synchronous and asynchronous communication between instructors and learners or between learners themselves. The latter can communicate with each other or the instructors throughout the whole learning process by using the available communication tools ("chat", "forum").
- **Database Layer:** The storage of multimedia content used during the learning process by the learning layer takes place in this particular layer. Various data emanating from the support layer such as user profiles and participating parameters for various class users are also stored there.
- **Learning Layer:** The learning process through extended use of hypermedia and interactive 3D graphics occurs in this layer. Learning material is presented in two complementary ways; Learners can study the provided course material in either hypertext or multimedia form (text, animation, images, video). Additionally, they can exploit the 3D virtual worlds technology in order to visit four distinct virtual spaces:

- Virtual Lobby: Provides learners with information regarding the contents of their visiting section.
- Virtual Classroom: Learners enter a space resembling a lecture hall in order to attend a virtual lecture that utilizes slides and multimedia objects (animation, images, audio and video) to present the course material.
- Virtual Lab: In order to comprehend more meticulously the course content, learners can perform laboratory exercises. Through their interaction with the system, learners can actively affect the outcome of an experiment.
- Virtual Library: Learners can seek information regarding the entire course or a specific subject. Moreover, they can follow relevant web hyperlinks and locate bibliographical references.

3.2 User Interface Design

It is commonly accepted that a poorly designed interface becomes a barrier to effective learning as forcing learners to spend longer time understanding poorly usable interfaces than understanding learning content disturbs accommodation of new concepts and overall retention of what is being learnt [11]. Hence the VRLAB user interface was designed to provide learners with knowledge in a more efficient and flexible way while at the same time remaining attractive and engaging. This design was based on a pedagogical approach where the instructor designs, observes, evaluates and intervenes while learners are being taught, act on their own and experiment. Special emphasis was placed upon giving users a clear idea of content organization and system functionalities through VRLAB's navigational model. Therefore, the user interface structure remained the same throughout the application providing a consistent visual conceptual map for easy navigation. The user interface environment consists of two functional modules (Figure 2):

1. Navigational and administration module: Each screen of the VRLAB system depicts the main menu as a series of tools that enable communication between instructor and learners (both synchronous and asynchronous) thus allowing collaborative learning. There are additional tools for searching the educational material to study, supporting easy movement among the course subjects (course curriculum)

through a navigational map and viewing announcements.

2. Learning procedure module: A metaphor of a 3D six-floor building is used in order to represent the Computer Graphics course. The hierarchical structure of course subjects is highlighted in this way as each floor corresponds to a didactic unit, accompanied by a brief description which appears below the 3D building.

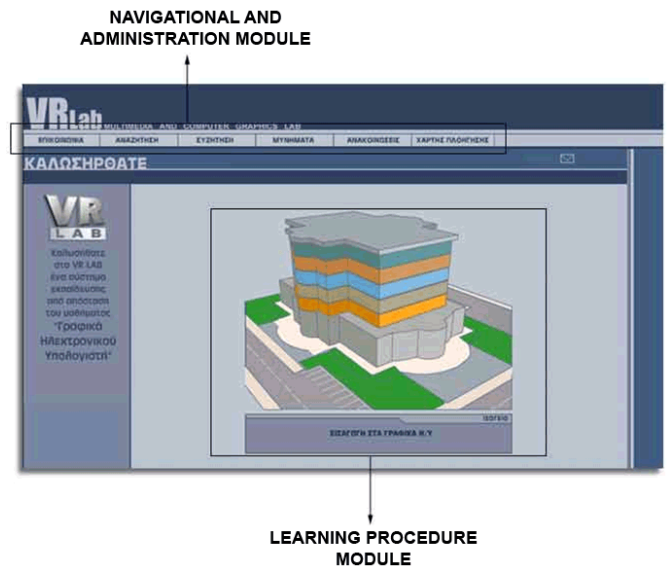


Figure 2. VRLAB's functional modules.

Hypermediality allows the presentation of learning material through different channels (audio, video, textual) wherever applicable, while user interface consistency helps learners to easily adjust in each course section. (Figure 3).



Figure 3. Navigation layout

3.3 Virtual environment of VRLAB

Administration of virtual environment settings is available at all times through a series of setting tools ("camera selection", "lighting adjustment", "volume control", "navigation help") (Figure 4).

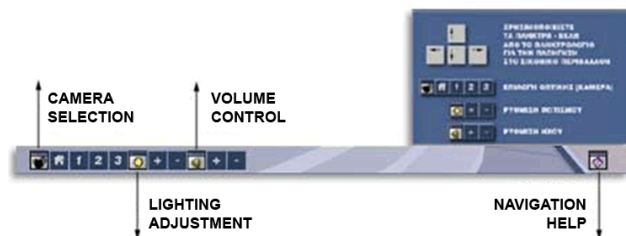


Figure 4. Virtual environment settings panel.

Navigation between virtual spaces occurs through the use of the control panel (Figure 5). Each course subject is represented by a ground plan of the virtual building's corresponding floor alongside a description of its contents. Navigation on different subjects can be performed by clicking on the appropriate floor.

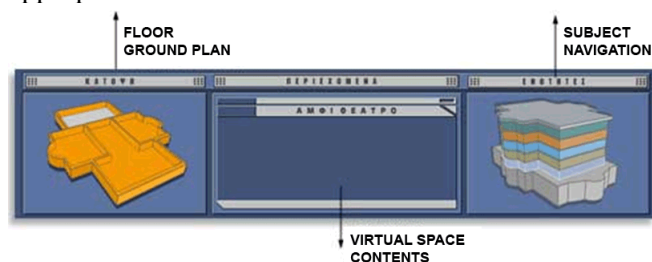


Figure 5. Navigation in the 3D virtual environment.

4 Conclusions

Learning environments based on the exploitation of 3D graphics should not be seen as yet another alternative form of communication between learners and computers, but rather as a new "vehicle" for education; it provides an easy and flexible interaction suited to catch learners' interest by giving them an active role in a dynamic learning environment based on exploration and constructing knowledge. Nevertheless, designing an educational 3D virtual environment should focus on visualizing course material in a way that satisfies learning needs instead of becoming a burden. The latter could occur if sensory channels are overloaded or hypermedia links are overused, also considering that the student is not expert of the learning domain. Additionally, both maintenance and enhancement of administration, security and control mechanisms constitute a substantial factor in ensuring the support of learning procedures. Finally, another important issue arises from the available network

infrastructure which still does not permit development of complex internet virtual reality and multimedia e-learning applications due to bandwidth limitations. However, regarding the recent growth of broadband connections, it is almost certain that in the near future the exploitation of virtual reality and multimedia technologies will change completely the way training is performed with the use of e-learning systems.

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