

Enhancements of the realXtend framework to build a Virtual Conference Room for Knowledge Transfer and Learning Purposes

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Abstract: Within the last years virtual 3D worlds have raised increasing interest by researchers, developers and communities in various application domains. Knowledge management and ICT-based learning settings in this context are in particular important in our globalized and knowledge-centered society. In this paper, we want to explore the development of a conference room in a virtual 3D world for knowledge transfer and learning purposes. To this end, we introduce the most important requirements, compare on those existing 3D systems, and outline arguments for the selected realXtend framework. This is followed by the prototype description which enables presenters to directly display the contents of their computer's screen on a presentation wall inside the virtual conference room, while interacting with the other users by means of an avatar in the virtual space. First findings and proposals for further work conclude this paper.

Introduction and Motivation

At the beginning of the 21st century, our society was influenced more than ever by rapid developing and ever-changing political, social, economical, technological and environmental situations. Society expects from citizens to adapt their knowledge and skills according to this fast changing environment. Moreover, members of our performance-oriented society, but also organizations and industry must keep pace with these changes to provide value, at least to some extent, which enables them to “survive” in the environment. Members of our modern society are faced and must keep pace with changing information, technology-enhanced communication and information access, and new forms of production and services. Consequently, this requires the willingness to cautious and life-long learning but also skills how to learn. In the light of the situations stated so far, learning strategies and objectives of expected learning outcome has significantly changed over the last hundred years. Modern learning settings focus on learning with understanding to become independent in the learning process, strengthen metacognitive skills and link knowledge in cultural context (Bransford, Brown, & Cocking, 2000; Rogers, Liddle, Chan, Doxey, & Isom, 2007).

Educational approaches have been influenced by technology but have also increasingly applied technology over the last decades, such as motion pictures, radio, television, computers and other emerging information and communication technologies (ICT). Computer assisted instruction has emerged already in the 1950s, however, the wide-spread use of internet technologies and the penetration of computers in practically every part of our life since the mid-1990s cause a significant increase in the use of computers for learning purposes in a great variety of learning settings in school, university and industry. Powerful technologies supported by rich media provide a great variety of opportunities to support, improve and even develop new concepts for learning and training activities in our society. These new technologies could have the power to support media-rich content delivery, interactivity, collaboration and communication, different instructional design approaches and students' individual learning needs, however, practical developments and implementations in learning settings most often ignore this potential. (Reiser, 2001a,b; Park & Lee, 2003; Shapiro & Niederhauser, 2003).

Learning activities and knowledge transfer processes in our modern society must successfully deal with challenging organizational, economic and technological requirements. This may be illustrated by the following examples: employees of multinational-operating companies need to exchange knowledge and collaboratively learn

and work together without spending much time and costs on travel activities. In secondary and higher education, the “traditional picture” of students has dramatically changed from local present full-time students to part time students as well as employees and citizens, even from other regions and countries, who are selectively enroll courses and participate in programs. Also teachers or experts in very specific subjects are increasingly involved in remote learning activities with students. Furthermore, research and teaching activities are becoming increasingly linked with industry from other countries or even continents (Gütl & Chang, 2008). It is our strong belief that modern technology and media can support the above outlined settings. Within the last years in particular virtual 3D worlds have raised interest by researchers, teachers, students and communities.

In general virtual 3D worlds support to recreate real world scenarios or create complete new one which are composed by static or interactive objects and avatars as the digital representatives of the users acting and interacting in the world. Such worlds may provide experience to understand concepts, explore and learn. (Chroittaro & Ranon, 2007) Some of the platforms even allow their users to build collaboratively their own objects or worlds. Furthermore, 3D worlds provides different verbal (voice and text chat both public and private) but also nonverbal (locomotion, gaze and gesture) communication channels (Johnson & Rickel, 2000) which also impacts the social presence of self and others (Blascovich, Loomis, Beall, Swinth, Hoyt, & Bailenson, 2002). Consequently, this technology raises a great interest in application domains such as gaming, e-commerce, engineering, design, architecture, medicine, education, and training (Rose, Attree, Brooks, Parslow, Penn, & Ambihapahan, 2000; Bray & Konsynski, 2007).

By focusing on learning and training application domain, virtual 3D worlds can support learning objectives such as experiential learning, simulation-based learning, inquiry-based learning, guided exploratory learning, community-based learning and collaborative learning (Bouras & Tsiatsos, 2006). Advantages of such world in the learn process include

- *Multiple communication channels* both verbal communication and non-verbal can improve the knowledge transfer and understanding (De Lucia, Francese, Passero and Tortora, 2008)
- *Presence* (feeling to be part of the virtual environment) could effect as suspension of disbelief and increase in motivation and productivity (Bouras & Tsiatsos, 2006)
- *Awareness* of other avatars, the environment and activities which impacts the dynamic of group communication (Bouras & Tsiatsos, 2006)
- *Facilitating collaboration* which becomes increasingly important in modern working and learning processes (Kemp & Livingstone, 2006)
- *Reducing barriers* between students, tutors and instructors (Kemp & Livingstone, 2006)
- *Belonging to a community* creates a virtual social space which can also help to improve learning (De Lucia, Francese, Passero and Tortora, 2008)

Based on the information outlined so far it is obvious that virtual 3D worlds can be applied in a wide range of applications for learning and training purposes. The authors Chittaro and Ranon (2007) define several contexts for the usage of such world according to the specific objectives of the learning setting:

- Formal education (in classroom settings or laboratory settings) in a controlled, supervised environment
- Informal education either guided or unguided in museums, zoo, and the like
- Distance learning includes self-instruction and learning settings where teachers, tutors and students are involved
- Vocational training to acquire skills and knowledge for tasks and roles in business
- Special needs education for people with physical and cognitive disabilities

Although virtual worlds have been an active research topic for a long time, technology was not ready for complex application scenarios since recent years. New interesting and powerful platforms and tools, such as Second Life, Active Worlds, Multiverse, Open Croquet, OpenSim and Sun’s 3D Wonderland, have emerged and are able to complement or even replace other knowledge transfer and learning settings. Further detail about virtual world for learning activities can be found at (CLPT, 2008).

Modern virtual worlds are seen from an optimistic viewpoint as a disruptive and transformative technology. However, in order to avoid the same pitfalls of past e-learning solutions by just applying traditional learning approaches to a new technology, research and development must consider requirements of learning settings and the characteristics and potentials of virtual 3D worlds. This has motivated the Media Lab Group of the IICM to focus as one research strand on the application of such virtual environments in various application domains and settings.

In this paper, we want to explore the development of a conference room in a virtual 3D world for knowledge transfer and learning purposes. In order to achieve this, we look at various systems and selected one based on requirements described in the next chapter. We then built a prototype of a system which enables presenters to directly display the contents of their computer's screen on a presentation wall inside the virtual conference room.

Requirements and Solution Approach

The aim of this section is to briefly outline the most important requirement given by application scenarios for knowledge transfer and e-learning a different setting. These requirements are the base not only for choosing a suitable platform but also for the prototype implementation.

The most important non-functional requirements are:

1. *Security*: We wanted the system to be usable in both commercial and academic settings. For industry it is of particular importance to be able to guarantee the confidentiality of both the material presented in the virtual world, and the voice channel used during a live presentation or training session. This requirement in general rules out hosted solutions, in particular when the hosting provider is located in a different legislation. In our case, our industry partner Sony DADC insisted on a solution where the complete environment is under their own control, protected by firewalls. Similarly, in an academic environment it is difficult for an institution to require its students to register at a third-party service. Therefore, we decided to look for a solution where we could control the complete environment, and could run the server ourselves.
2. *Flexibility*: We wanted to be flexible in the design of the conference room. This includes the graphical design, so it should be easy to modify and add pieces of equipment to the virtual world.
3. *User Experience*: We wanted a system that allows building a visually appealing, realistic conference room. The system should be fun to work with.
4. *Open-Source*: we wanted the ability to customize and add functionality to the virtual world, as the project evolves. Therefore, an open-source solution is essential.
5. *Cost*: Of course, purchasing and running the platform should be cost-effective. This requirement also favors open-source solutions.

The most important functional requirements are:

1. *Voice Chat*: The system must support (spatial) audio (also known as voice chat) as primary means of communication between avatars. This is to facilitate a natural conversation during the meeting or training session.
2. *Presentations*: The conference room must be equipped with one or (preferably) more presentation surfaces, where speakers can present material. This could be pre-compiled material such as presentations. However, even more desirable would be the ability to display arbitrary content from the presenter's computer in real time.

With these requirements in mind, we looked at suitable platforms (CLPT, 2008) to build our virtual world on, and narrowed down the list to these three:

3. *OpenSim / realXtend*: The OpenSimulator project, also known as OpenSim, is an effort to implement an open-source server for a virtual world, while remaining compatible with Second Life (so that the Second Life Viewer can be used). RealXtend is an extension of both the OpenSim server and the Second Life client, with additional functionality (see also next section). (opensimulator.org; secondlife.com; realxtend.org)
4. *Project Wonderland / MPK20*: Sun Microsystems has developed a Java-based open source toolkit for creating collaborative 3D virtual worlds called Project Wonderland. MPK20 is Sun's showcase application built on top of it, resembling a non-existing building number 20 on Sun's Menlo Park Campus. (wonderland.com; mpk20.com)
5. *OpenCroquet / Cobalt*: OpenCroquet, developed by the Croquet Consortium, is a software development kit for creating collaborative multi-user virtual world applications. Cobalt [[cobalt](http://cobalt.org)] is an NSF-sponsored

effort to develop an open-source virtual world browser and authoring toolkit application based on the Croquet technology. Unfortunately, it is currently still in a “pre-alpha” stage. (opencroquet.org)

We decided for OpenSim, because of its compatibility with the Second Life virtual world (where we already had a good deal of experience with), stability, and broad adoption. Because OpenSim in its current version (0.3) did not support voice chat, we used the realXtend framework (both server and viewer), which do support spatial audio.

realXtend at a Glance

realXtend is an extension to Opensim, developed by a community of open-source developers, mostly from Finland. It extends Opensim (and Second Life) in a number of ways:

- It features a more realistic rendering engine OGRE, which can also render geometry meshes.
- An additional avatar generator gives the users more freedom in creating avatars, including the ability to use arbitrary meshes imported from other software for the creation of free-form non-humanoid avatars.
- An avatar fitting room to define the clothing of the avatar
- Integration of the *FaceGen* tool for creating avatars with the real face of the human (facegen)
- The ability to define multiple media textures per parcel (OpenSim and Second Life are restricted to one per parcel)
- Developers can use Python in addition to the Linden Scripting Language (LSL) for scripting objects.
- Voice Chat

According to the information available on the realXtend home page, it should be possible to integrate live streaming from a presenter’s desktop using the VNC protocol (Richardson, Stafford-Fraser, Wood, & Hopper, 1998). However, in reality this functionality did not work, so we decided to simulate it for our prototype implementation, as described below.

System Overview

The system consists of the following parts (see Figure 1):

1. *Virtual World Server*: This is the RealExtend server running in Grid Mode, so that it can be connected to other OpenSim-based servers. In this mode, the server really consists of the following six server processes (all of which connect to a database not explicitly shown in Figure 1):
 - a. *User Server*: Manages the user accounts, and is required for authentication during login to the virtual world.
 - b. *Grid Server*: Manages the communication between the server components and other servers in a grid.
 - c. *Asset Server*: Manages and stores the assets (e.g. textures, objects) of the virtual world.
 - d. *Inventory Server*: Keeps track of the relationship between assets and users, i.e. which asset belongs to which user. A global inventory keeps track of objects that can be accessed by all users.
 - e. *Messaging Server*: responsible for the chat functionality
 - f. *Region Server*: Manages the region itself, i.e. a 256 x 256 meter patch of virtual land. This is the most complex server, as it keeps track of the interactions of avatars with the virtual world, as well as the physics of objects. It also executes the scripts that may be running inside objects. A region server may be connected to the own grid server (servers a – e), but also to a different grid hosted by somebody else.
2. *Administration Interface*: To simplify administration of a grid (e.g. managing users and regions), we used the *Redux* web interface (redux), running on a standard Apache + PHP web server.

3. *Virtual World Client*: This is the realXtend Client (Version 0.3) used by the users to connect to the virtual world. This is the user interface shown in Figure 2.
4. *Presenter's Screen*: This is the screen of the presenter's computer, the contents of which should be presented to the users in the virtual world. In order to achieve this, the presenter's computer runs a VNC Server.
5. *Presenter's Interface*: This is again a web server (Apache + PHP) running the presenter's web interface shown in Figure 3. It connects to the *Presenter's Screen* and via the VNC protocol, grabs a picture (or consecutive pictures) of the current screen contents, and uploads this picture on the HTTP server. From this HTTP server the *Virtual World Client* can directly fetch it and display it as a texture on an object in the virtual conference room.

The virtual world itself consists of three rooms: A lobby, and two meeting rooms called "blue" and "red". The "blue" room has one presentation screen, while the "red" room has two. To achieve the latter, we make use of an extension of the realXtend framework compared to Second Life and OpenSim: Second Life and OpenSim allow one texture per parcel to be replaced by external content fetched from a so-called MediaURL. This means that there can only be one external texture (such as our presentation screen) per room (assuming one room correspond to one parcel). In contrast, realXtend enables any object to replace its textures by external content, irrespective of the parcel. This is achieved by the `rexSetTextMediaURL` script command, a realXtend extension to the Linden Scripting Language (LSL). In addition, both rooms have secondary presentation screens, so that the presenter's avatar can face the audience and still monitor what is being shown on the main screen(s) (see Figure 2).

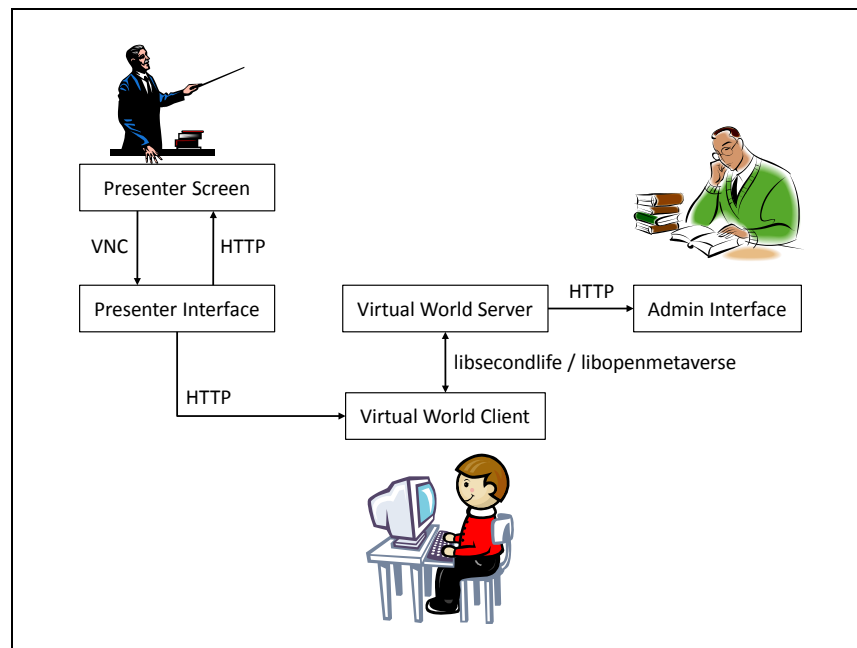


Figure 1: System Architecture



Figure 2: Red conference room with two main presentation screens and the two monitor screens

Before the presentation, presenters need to connect to the Presenter's Interface using a Web browser, and enter the IP address and password of their VNC server (see Figure 3).

ReXCC - RealXtend Control Center
 Change settings for the **red** conferencingroom
Please make sure, there is nobody using this room at the moment, while you are attempting to change settings!
 Sometimes it is useful to clear the cache of your browser (If if you get a snapshot that is not corresponding to the expected result)

[a link to nowhere logout](#)

To bring your presentation into RealXtend, VNC is used (the computer from which the presentation will be streamed, needs a [VNC-server-software](#) installed). At the moment the presentation won't be vnc-like video-stream of your desktop, but screenshots of your desktop (due to video handling problem).
 To enable this feature, the ip-address of your VNC-server is required. [Here](#) you can test, if the ip is reachable.

IP-Address of VNC-Server:

If the server is password secured enter this password in the next line. It must have a minimum length of 6 and a maximum length of 8 characters or numbers!!
 Password of VNC-Server:

would you like to test your configuration? Then tick off the checkbox!

If you can see a snapshot of your current desktop, your settings were right!

Figure 3: Presenter's Interface

After that, presenters can take snapshots of their screen and send it to the virtual world in two modes:

1. The first operating mode is to touch the monitor display in the virtual conference room. This event is handled by a script in the display object, which sends an HTTP request to the Presenter's Interface. This triggers a call to the `vncsnapshot` program, which takes a picture of the presenter's screen and makes it available at a specified URL in JPEG format. The script in the object sets the `textureMediaURL` of the virtual presentation screen (and corresponding monitor) to this URL, which in turn triggers the clients of the users to fetch this picture from the HTTP server and display it as a texture on the presentation screen (and corresponding monitor). In other words, whenever the presenters touch the monitor, the presentation screen is updated to display whatever is on the presenter's screen (after a small delay of about 2 seconds).
2. In the second mode, the process just described is done automatically every n seconds. The presenters do not have to touch anything, but can just present as usual and automatically, the contents of their screen can be seen in the virtual world (after a small delay)

Tests have shown that this works best in a 2-screen setup, where the presenter runs the virtual world client on one screen, and shows the presentation on the second screen (or second computer).

Conclusions and Future Work

The current system is a proof of concept. The software used (realXtend 0.3) was rather unstable and rather sensitive to the type of computer (more precisely: graphics hardware) used. Therefore, we could not yet conduct an evaluation with real students. We hope that future releases will become more stable, at which time we can really use and evaluate this system in a larger scale.

The concept of the Presenter's Interface and taking the snapshots can also be ported to the Second Life virtual world, which is much more stable, but can only show one presentation screen per room.

We will also make similar experiments in Sun's Project Wonderland and OpenCroquet / Cobalt, and will compare them with the realXtend solution presented in this paper.

Acknowledgements

The authors gratefully acknowledge Margit Riedl and Stefan Bachleitner, both students at Graz University of Technology, for their design and development effort of the prototype system, which contributes valuable input for this paper, and thank the developers of realXtend for their work. Support from Sony DADC and Styria Media AG is gratefully acknowledged.

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