Telepresence in Synchronous Distance Education Sessions

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Abstract

We have developed an application to explore the use of Telepresence in synchronous Distance Education sessions. The professor and the remote group of students share three forms of collaboration that are seamlessly integrated in the application: 1) Streamed live Audio and Video 2) A tool that allows the instructor to present slides to the remote students and 3) A networked virtual environment that allows the instructors and the students to interact around a virtual object in a collaborative manner. In order to asses the pedagogical impact of the tool, an experiment is being conducted using the application in an actual Computer Graphics course at Eafit University. Half of the students meet the instructor in traditional face-to-face sessions using blackboard and PowerPoint presentations. The other half take part of distance sessions using the telepresence application. The Teaching for Understanding framework, developed by a group of researchers at the Harvard Graduate School of Education, is being used to asses the level of understanding of the students in both groups. A panel of experts grades the students levels of understanding (naive, novice, apprentice or master) in the different dimensions of understanding (method, purpose, contents and form). We aim at showing how the combination of new technologies (multimedia plus virtual reality) and an appropriate pedagogical framework (Teaching for Understanding) support synchronous distance education sessions. This paper presents preliminary results of the experiment and our conclusions after using the tool. TOPICS + KEYWORDS: e-Learning, collaboration, University, Mutlimedia, Audio and Video Streaming, Virtual Reality, Evaluation of Learning Technology Systems. PREFERENCE: Personal presentation.

Introduction

Computers are increasingly becoming an essential part of Distance Education environments. Traditional printed material is being replaced by web pages that are conveniently accessed by the students regardless of their physical location [3] [2] [10]. The use of pre-recorded video classes have become another widely used resource, due to the availability of multimedia devices (microphones, speakers, CD-ROM readers) in low-cost personal computers [1]. These technologies support asynchronous distance education settings in which each student works alone at his/her own pace and convenience.

But in many cases, syncrhonous interaction among students or among the instructor and the students is desired, in order to enhance the productivity of collaborative activities [6]. Desktop video-conferencing tools, pioneered by Carnagie Mellon University's CU-see-me, have made synchronous sessions available even to PC users connected to the Internet through telephone links.

Several Virtual Reality applications have been utilized to create educational virtual worlds in which the students and the instructors can share experiences that are related to various educational contents [7] [4] [9]. In these applications, users share a networked virtual world, which provides the illusion of a shared space in which they can collaborate.

In the work reported in this paper, we have created an application that seamlessly integrates three forms of interaction:

- video-conferencing (streamed audio and video over the Internet)
- regular slides that can be controlled by the instructor
- a shared interactive virtual environment

The rest of this paper is organized as follows. Section describes similar existing application and how the approach presented in this paper differs from them. Section describes the application in some detail. The pedagogical experiment used to validate the usefullness of the application is described in section 0.3. Section 0.3 describes the impressions provided by the users at the time of writting this paper. And finally, section 0.3 describes the conclusions and future work.

Related Work

The application built for the work reported in this paper aims at combining several forms of communication/interaction: Slide presentations, Video-conferencing (streamed audio and video) and a Shared Virtual Environment (SVE). Several applications involving SVEs and synchronous communication mechanisms have been created for several applications fields. This section describes the most representative ones and how our application differs from them.

The *NICE* project [4] was created as an immersive learning environment for children, implmemented using CAVE technologies. In *NICE*, several children could collaborate with other remotely-located children to construct and cultivate simple virtual ecosystems. Children could communicate via voice, but each participant could only see a 3D avatar of the other, lacking any facial expressions.

Freewalk [5] is an application created to study how users engage in casual meetings. Each user is represented with a pyramid. A video of the user is mapped into one of the faces of the pyramid. As users move inside the virtual world, so to their pyramids, indicating their position and direction to other participants. Voices of the participants are also sent via the network. Volume is inversely proportional to the distance between the sender and the receiver. This application simulates many aspects of real-life casual meetings. But the only possible interaction is the movement of the pyramids. Users cannot manipulate any other objects in the virtual world.

AVALON [9] was created to explore the use of Networked Virtual Environments as means to support distance education. Users moved freely inside virtual worlds that were created to support specific contents of an Environmental Awareness course. Users could communicate with voice, sent over the network. The instructor could project slides in a whitebord, located in a specific part of the virtual world. Each participant was represented with a 3D avatar, but no video was sent of any participant. Users could not see each others faces. In order to compensate for the lack of video, students could choose among a set of expressions in order to communicate their status to the instructor. Expressions included: question, happy, unhappy, absent, among others. These expressions were then displayed on top of the corresponding student's avatar.

Next section explains how the application described in this paper integrates the different interaction possibilities.

Our application

The application described in this paper aims at integrating several forms of interaction, namely: slides, video-conferencing and a shared virtual environment, into a single application. The main difference with the applications described in the previous section is that each form of interaction is placed in a separate window, and the instructor decides which modality to utilize at a given moment. Swtiching among the forms of interaction is easily accomplished by clicking on a button. A typical class, using the application, includes some slide presentations and then interaction in the virtual world, performed both by the instructor and the students.

The current implementation is point-to-point. The instructor is at one end and the students (all together in a remote location) at the other. In the next implementation, each student will be located at a separate site, bandwidth permitting.

0.1 Slides

Figure 1 shows the instructor window during a slide presentation. At the right-hand side of the window the local (top) and remote (bottom) video windows are shown.

Each slide is converted into an individual graphics file that is sent to the student side when displayed by the instructor. Note the controls at the bottom of the screen, which allow the instructor to go to the first, next, previous or last slide. Slides are displayed synchronously at the students' site.

0.2 Shared Virtual Environment

Figure 2 shows the instructor window during an interaction in a shared virtual world. Note that the local and remote video windows remain in place.

The instructor can use a *telepopinter* (3D arrow) to point inside the virtual world. The instructor telepointer is commanded by a Polhemus 3D tracker, allowing for a very natural interface.

Both the instructor and the students can move their viewpoints around the shared virtual environment using the arrow keys in the keyboard. The students' point of view is represented by a red telepointer, allowing the instructor to see where they are observing the environment from.

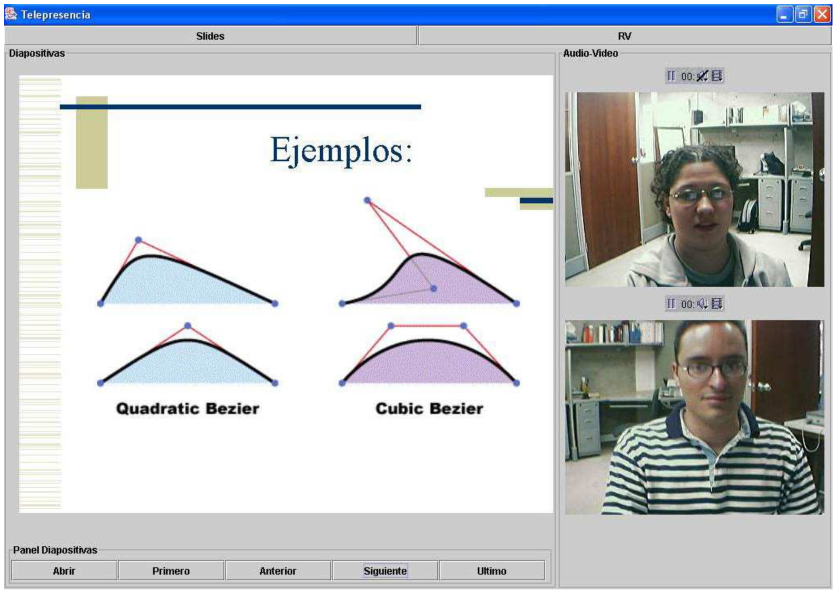

Figure 1: Instructor Window during a slide presentation.

The tool is currently being used in a Computer Graphics course at Eafit University (more on this in section 0.3). The following virtual worlds have been developed for the experiment:

- Points, lines and polygons.
- Parametric lines, curves and surfaces
- Objects as polygon meshes
- 3D transforms
- Illumination
- Textures

In each lesson, the instructor explains the theory first and then performs a demonstration inside the shared virtual environment. Students are asked then to perform similar actions, allowing them to demonstrate (and increase) their understanding.

0.3 Video and Audio

Local and remote video windows are shown at all times. Voice links are also active among the two points at all times. This allows the instructor and the students to communicate in a very natural and effefctive manner.

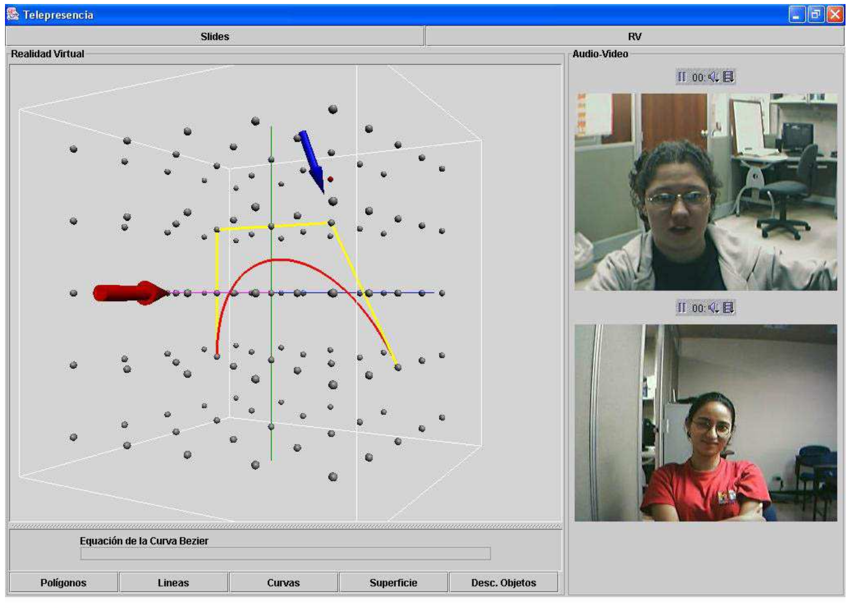

Figure 2: Instructor Window during a collaborative interaction in the shared virtual environment

Pedagogical Validation

In order to measure the effectiveness of the tool in an actual learning environment, an experiment is being conducted. Half of the students in a Computer Graphics course at EAFIT University receive the course face-to-face using traditional tools (Overhead projection slides and blackboard). The other half use the tool in a simulated "distance" environment. The instructor is in one place of the campus and students are in a different block, in a normal classroom. Both places are linked through the campus local area network. The output of the application is projected into a large screen on the students side.

The Teaching for Understanding (TFU) Framework [11], developed at the Harvard Graduate School of Education, is being used to measure the levels of understanding reaached by each group. Both groups have been asked to create an application, to be used by a company or a research group, in order to solve any problem. Each stduent's understanding is being graded by the the levels of understanding defined by the TFU framework (Naive, Novice, Apprentice, Master). Understanding is also measured along the four dimensions proposed by TFU (Knowledge, Methods, Purposes and Forms).

Current Results

Students in the experimental group have reported their experience using the tool...

Based on the current results, we observe that the tool can increase the levels of understanding attained by the students, along the dimensions of understanding proposed by TFU as follows:

- **Knowledge** La herramienta muestra el concepto formal (a la manera de frmulas) y su expresion concreta (lo que se muestra en el mundo virtual). La herramienta ayuda a avanzar en el proceso de la experiencia concreta (ellos hacen cosas en la herramienta) hacia la representacin grfica (cuando ven lo que ocurre en el SVE) hacia la parte simblica (las ecuaciones) (*July*, buscar referencia bibliogrfica).
- **Methods** *July*
- **Purpose** *July*
- **Form** *July*

So far students have reported positive experiences using the tool. ... *July* (3 comentarios de estudiantes con su afirmacion de la herramienta).

For this reason, we expect to find the levels of understanding obtained by the experimental (distance) group to be at least the same as those reached by the control (face-to-face) group.

Conclusions

From a technical perspective, we will next concentrate on two aspects. First, exploring how the application behaves when running over telephone links. Slow links might imply using Quality-of-service techniques in order to assign more resources to different modalities (voice, video or virtual reality) at different times, as proposed in [8]. Second, allowing students to be at different places. This will imply moving from a point-to-point architecture into some form of broadcast or multicast.

On the pedagogical side, we plan to perform another experiment isolating the effect of the telepresence tool. For this purpose, two distance learning environments will be used. Traditional web-based tools will be used by the control group and the telepresence tool will be used by the experimental group.

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