Presence in a Distributed Virtual Environment for Cooperative Visualization

Juan Casanueva and Edwin Blake
jcasanue@cs.uct.ac.za edwin@cs.uct.ac.za
Collaborative Visual Computing Laboratory
Department of Computer Science
University of Cape Town

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Abstract

With the fast development of computer networks and computer graphics technology, Collaborative Virtual Environments are becoming a feasible way to address computer-supported activities, and open the way to new forms of Computer-Supported Collaborative Work (CSCW). Collaborative Virtual Environments involve the use of a distributed architecture, and virtual reality to create a 'shared' sense of space where users located in different physical locations can interact. In this paper we explore the issue of 'presence' in a Cooperative Virtual Environment, that is providing the participants with a sense of being present in the virtual environment and having a real feeling that they are cooperating with real people.

Keywords: Presence in Collaborative Virtual Environments, Distributed Systems, CSCW, Personal Communications Systems.

1 Introduction

Using Virtual Reality technology for collaborative work, involving multiple users spread over a wide geographical area, is becoming a feasible way to address Computer Supported Collaborative Work [1]. However, in order for such a system to be successful, it needs to provide the participants with a sense of presence, in other words with a sense of being present in the virtual environment.

There are a number of factors which contribute to a high sense of presence in a virtual environment. The more obvious ones are high graphics update rate, low latency, and high degree of interactivity [2]. But since the environment is shared by a number of participants, the sense of presence can be increased by providing appropriate tool and techniques to facilitate interaction and collaboration in such an environment.

In this paper we explore the issue of 'presence' in a Cooperative Virtual Environment, that is, the extent to which participants experience the virtual environment as real and useful and the extent to which they regard the other participants as being really present in the environment. We present a preliminary exploration into means to increase the sense of presence in a distributed virtual environment.

2 Distributed architecture

In order to investigate the presence in a distributed virtual environment, we have developed a prototype of such a system. This prototype is intended to be a test bed to investigate different techniques to increase the sense of presence and support collaboration in such an environment.

The system uses a *distributed model* [3] as the communication model. Here, each program maintains its own local copy of the database as well as performing the rendering. When a program makes a change to its database, a message is sent to the other programs so that they update their local databases. This distribution model is much more scalable that the *client-server* model, where a central server has a centralized database and thus the server becomes a bottleneck [3].

In order to reduce the number of connections and thus the number of messages being sent, we use UDP multicasting [3, 4, 5, 6].

Since UDP multicasting is an unreliable protocol, the system also has a TCP/IP server which provides reliable stream communications. In other words, the system provides different degrees of reliability to gain better real time performance.

3 Enhancing the sense of presence

In this section we present a preliminary exploration of ways in which presence might be enhanced in a cooperative virtual environment.

Presence might be increased by providing collaboration support within the virtual environment, which includes supporting mutual awareness between the different participants, supporting communication between group members, and supporting interaction between participants.

3.1 Mutual awareness

In order to support mutual awareness in a virtual environment, issues such as participant location, participant or group identity, participant attitudes, availability etc, must be addressed [7, 8]. These issues are addressed by using virtual representations of participants or *avatars* [9, 10].

In a multi-user Virtual Environment, a user's avatar signals the presence of that user to any other users who are currently in the environment. There are several pieces of information that the avatars convey in order to aid mutual awareness:

- Presence: The avatar indicates its owner's presence in the Virtual Environment.
- Identity: The avatar indicates that it represents a user, and not any other object in the environment.
- Viewpoint: The avatar conveys the user's current viewpoint, which helps convey what the user is looking at and hence interested in.

In order to address the question of knowing who are you collaborating with, the systems keeps a menu of all the participants collaborating in the virtual world.

3.2 Navigation

There are two types of navigation metaphors which are used by the system for individual navigation: The *walk* metaphor, which allows the user to move forward and backwards, and to turn left and right. The *fly*

metaphor, which allows the participants to move their heading vector in any direction, and fly around the world

Navigation in the virtual world is facilitated by providing a 'global' maps, which is a 2D map of the world seen from the top. This map indicate the current position of the participants, as well as the positions of all the objects in the virtual world.

3.3 Group interaction

The participants can interact with the environment by picking objects and moving them around. Objects are selected by clicking on them. The currently selected object is shows in red to the participant which has selected it, and can be moved around the world.

The system implements a simple ownership mechanism: If a participant clicks on an objects which is owned by no one, he becomes the owner of the object. Other participants cannot select this object until the owner releases the selected object. In other words, a participant cannot select objects which are owned by other participants.

Communication in its simplest form is provided by a text based chat interface where users can type messages.

4 Future Work

There are a lot of important unresolved issues concerning presence in a virtual environment. These issues include (a) the definition of presence, (b) how to measure presence, (c) which factors enhance presence, (d) the relation of presence to work performance.

In order to enhance presence in a virtual environment, issues such as providing movements and gestures to the participant's avatars are important. Providing behaviour to avatars require investigating issues such as how to control the avatar's gestures (i.e. the transparency of the interface, the response time, the immediacy of avatar movements). This could include using avatar gestures and facial expressions as a mean to convey visual cues to other participants. In other words this implies using body language to communicate.

An even further improvement over the communicative behaviour of avatars will be to releave the user of having to control the avatar's parameters, by automating the process. The avatar's gestures would have to be tied to the information being conveyed. The main issue is how can the relevant avatar gestures be extracted from the user's message.

Improving communication between participants by providing audio capabilities can be used to enhance the sense of presence in the environment.

5 Summary

The aim of this project is to develop a prototype of a 'non-immersive' distributed virtual environment to provide a preliminary exploration on 'presence' in a virtual environment. The system uses a distributed model which replicates the database at each client, and uses multicast communications to communicate state changes between the different clients.

Such a prototype is used to investigate the issue of presence in a distributed virtual environment, that is what does it take for the cooperating participants to have a real feeling of being present in the environ-

ment and being working with real people. We have presented a preliminary exploration of some issues which might increase the sense of presence in the virtual environment. These include mutual awareness, navigation, communication and thus collaboration in a multi-user virtual environment.

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