Collaboration in Parallel Worlds

Ashutosh Morde, Jun Hou , S. Kicha Ganapathy, Carlos Correa, Allan Krebs, Lawrence Rabiner
Rutgers University
CAIP
96 Frelinghuysen Road, NJ 08855
1-732-445-0551
{amorde, junhou, skg, cdcorrea, krebs, lrr}@caip.rutgers.edu

ABSTRACT
We present a novel paradigm for human to human asymmetric collaboration. There is a need for people at geographically separate locations to seamlessly collaborate in real time as if they are physically co-located. In our system one user (novice) works in the real world and the other user (expert) works in a parallel virtual world. They are assisted in this task by an Intelligent Agent (IA) with considerable knowledge about the environment. Current tele-collaboration systems deal primarily with collaboration purely in the real or virtual worlds. The use of a combination of virtual and real worlds allows us to leverage the advantages from both the worlds.

Categories and Subject Descriptors
H.3.4 [**Information Storage and Retrieval**]: Systems and Software - Distributed systems; H.5.1 [**Information Interfaces and Presentation**]: Multimedia Information Systems - Artificial, augmented, and virtual realities; H.5.3 [**Information Interfaces and Presentation**]: Group and Organization Interfaces - Computer-supported cooperative work.

General Terms
Algorithms, Design, Experimentation, Human Factors.

Keywords
Augmented Reality, Virtual Reality, Collaboration, Registration, Intelligent Agents, Distributed Systems.

1. INTRODUCTION
Advances in virtual reality and 3-dimensional object modeling and visualization in the 1990's have led to the proliferation of a range of highly flexible software tools for the creation of a virtual world. Many applications in AR and tele-collaboration have utilized these tools effectively. While the quality of the visual images in these systems is impressive, the resulting scenarios are primarily virtual and pre-defined and for most part lack a connection to the real-world, to which the user(s) must react and respond, possibly in real-time. These systems are thus highly limited in their ability to help solve real-world problems requiring collaboration across a distance.

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In [1] we proposed the notion of asymmetric collaboration. The goal of our work is two fold: (1) to develop the principles and the relevant technologies that enable the creation of realistic shared synthetic environments so that real-world participants from geographically separated places can effectively collaborate to accomplish a desired task through real time interaction, and, (2) to test and validate the applicability of these ideas by building a test bed consisting of a complex working system.

Figure 1 shows a scenario involving an expert and a novice, engaged in a sophisticated task that requires object handling and manipulation. The novice works in the real world augmented with multi-modal information provided by both the expert and a computer agent working together in a parallel virtual world. The novice is mobile and interacts directly with the environment and indirectly with the remote expert through portable, wireless, and minimally intrusive interfaces. On the other hand, the expert uses powerful immersive interfaces to navigate, interact, and control the virtual models in order to guide the novice. This proposed system differs from traditional virtual reality systems in that the end user (the novice) works in the real world, not a virtual one that exists only in the computer.

2. CHESS SCENARIO
The chess domain scenario demonstrates the concept of asymmetric collaboration. In this game the two remote users play chess over a standard IP network. One is a novice who plays black pieces in the real world, and the other is an expert who plays the virtual white pieces on the computer. The novice only manipulates black pieces, but he can see the expert's virtual white chess pieces superimposed onto his chessboard through the Head Mounted Display (HMD) while the expert can see chess pieces of both colors in his virtual world. A static overhead camera infers the chess moves made by the novice. An IA assists the novice in playing the game and also acts as the referee.

2.1 Experimental Setup
The novice sees the world captured by a lightweight ¼" Toshiba lipstick camera with a diagonal FOV 34° through a HMD. A regular webcam mounted over the chessboard is used to monitor the novice's moves. The novice is also equipped with a microphone headset to carry on a dialog with the remote expert as well as with the intelligent agent that will be assisting him. The remote expert plays the on a desktop and is also equipped with a microphone headset. The communication between the participants and the IA is through the DISCIPLE [2] middleware over a standard IP network.

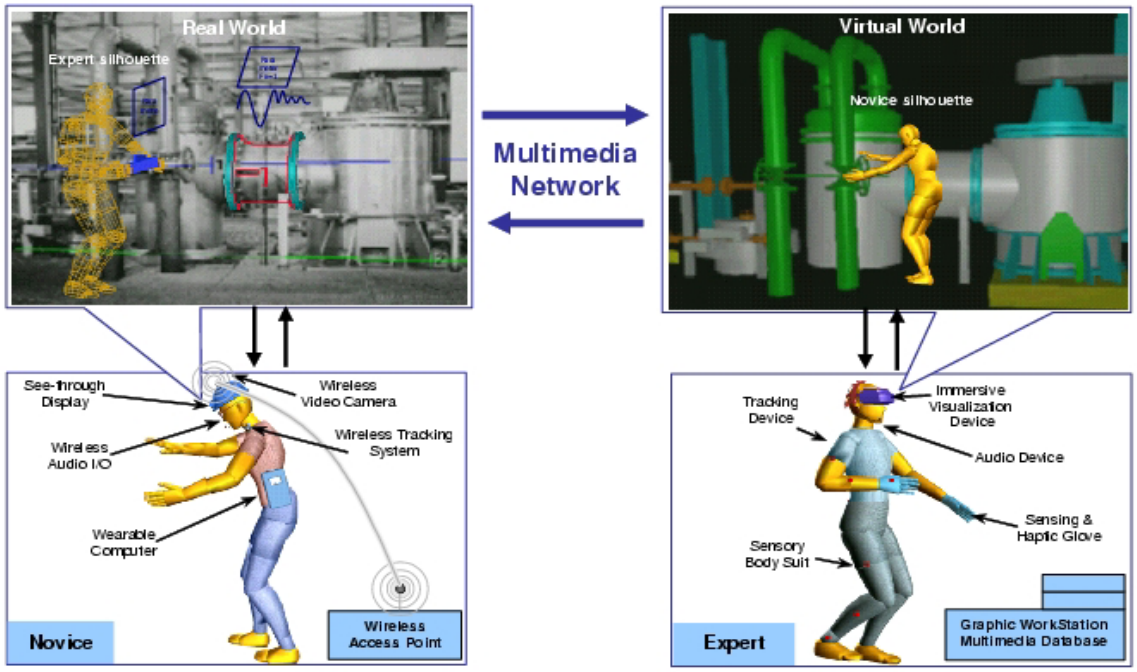

Figure 1 Collaboration Overview

The chessboard is laid out for a single user only, the novice, who will be playing black. The novice's view of the chessboard through the HMD is augmented by the system. He sees the virtual white pieces overlaid in the correct locations as shown in Figure 2. The virtual pieces remain correctly registered even if there is partial occlusion of the chessboard or any head movement. Figure 3 illustrates the expert's view of the chessboard in the virtual world. The novice interacts with the IA through a speech interface. In response to an experts move the novice can ask the IA for a possible move. The IA is aware of all the interaction

Figure 2 Augmented Reality view for the novice

between the novice and the expert and the moves made by them. Besides helping the novice the IA acts as the referee of the game verifying moves made by either users.

Figure 3 Virtual Reality view for the expert

3. REFERENCES

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