Asymmetric Collaboration through Tele-presence

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ABSTRACT
A heterogeneous distributed system that enables people in geographically separate locations to share a common workspace is presented. In particular, the applicability of such a system to the notion of asymmetric collaboration is illustrated by a chess scenario. 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.

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
In [1] we presented the general notion of asymmetric collaboration which takes advantage of the benefits of both virtual and augmented reality. In asymmetric collaboration there are both augmented and virtual reality users, in parallel worlds, working towards a common goal. An augmented reality (AR) user can interact with the environment and manipulate it while a virtual reality (VR) user can observe and evaluate the models of the same environment offline providing valuable assistance. The VR user is not restricted by the view of the AR user moreover he has access to more comprehensive datasets enabling him to better analyze the task. This framework allows multiple people to share a common workspace facilitating a free flow of ideas and solutions.

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A chess scenario involving an expert and a novice is chosen to illustrate the idea of asymmetric collaboration. The novice plays with real pieces while the expert plays on the laptop with virtual pieces. The current system integrates all the components required to make tele-presence possible. The novice sees the augmented environment through a Head Mounted Display (HMD) while the expert has a virtual reality replica of the game. Speech recognition and text to speech synthesis makes natural interaction between the novice and the IA possible.

The demo requires space for three laptops (for the two novices and the expert) and the space for the chessboard. There will be two sets of novice interfaces; one will be fixed on a dummy head while the other can be tried on by the visitors. The setup for the novice includes a HMD with attached lipstick camera and their control units. The expert setup consists only of the laptop. Other equipment includes the tripod for the dummy head and the overhead camera with its own tripod.

2. CHESS SCENARIO
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 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.

The demo consists of a novice playing with black pieces and an expert playing with white pieces. The novice plays in the real world with the chessboard having only black pieces. He sees the world through a HMD. The chessboard is augmented with the

Figure 1 Augmented Reality view for the novice

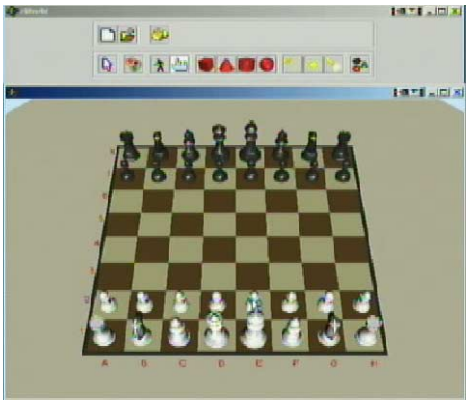

Figure 2 Virtual Reality view for the expert

expert's virtual white pieces by the system. The virtual pieces are anchored in the correct positions even as the novice moves his head and there is partial occlusion of the chessboard. The augmented view of the novice is illustrated in figure 1. The expert plays the game with a replica of the chessboard layout on the laptop as shown in figure 2.

The novice interacts with an 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 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. Any movement of pieces made by either player is reflected in the view of the other player. Any virtual white pieces captured by black are immediately removed from the chessboard while the IA ensures that the novice removes any captured black pieces before the game can continue.

3. REFERENCES

[1] Ganapathy S. K., Morde, A., Agudelo, A., Tele-collaboration in Parallel Worlds. In *Proceedings of the 2003 ACM SIGMM workshop on Experiential Telepresence (ETP '03)* (Berkeley, California, Nov 7, 2003). ACM Press, New York, NY, 2003, 67-69.

[2] Marsic, I., An Architecture for Heterogeneous Groupware Applications. In *Proceedings of the 23rd IEEE/ACM International Conference on Software Engineering (ICSE '01)* (Toronto, Canada, May 12-19, 2001), IEEE Computer Society, Washington, DC, 2001, 475-484.