

Haptic Collaboration with Augmented Reality

Matt Adcock, Matthew Hutchins, Chris Gunn
CSIRO ICT Centre, Australia
{matt.adcock, matthew.hutchins, chris.gunn}@csiro.au

Abstract

We describe a (face-to-face) collaborative environment that provides a coherent mix of real world video, computer haptics, graphics and audio. This system is a test-bed for investigating new collaborative affordances and behaviours.

1. Collaborative Haptics and AR

Our project goal is to develop a system that can provide a combination of haptic interaction, 3D computer graphics and auditory display to support collaborative tasks such as design, mentoring and data exploration.

The majority of haptic/graphic system configurations are designed for single user experiences. Usually they consist of a haptic device sitting next to a computer monitor. For a more co-located configuration, we have combined our PHANToM haptic devices with stereo shutter glasses and a mirror [Stevenson et al. 1999] (see Fig. 1).

Collaborative haptic applications have now started to emerge [Basdogan et al. 2000; Gunn et al. 2003]. However, the majority of these systems have been targeted at tele-collaborative rather than face-to-face situations.

We believe that Augmented Reality (AR) technologies are well suited to enabling haptic applications to be developed to support and enhance face-to-face collaborative tasks.

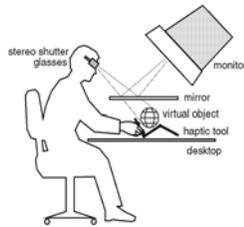


Figure 1. The CSIRO Haptic Workbench.

2. The CSIRO Collaborative Haptic Toolkit

The Reachin API (formerly Magma) [Stevenson et al. 1999] was created in order to better integrate haptics and graphics rendering. It is based on a haptic/graphic scene-graph that borrows a lot of its structure from VRML.

Last year at SIGGRAPH, Gunn et al. [2003] described a Collaborative Haptics Toolkit extension to the Reachin API. This Toolkit contains a 'Plausible Physics' simulation that mediates interactions between users and objects and also direct interactions between users.

In an example surgical training application, an instructor can 'grasp' the student's tool to haptically guide it while the student feels the force of the instructor's guiding hand. Similarly, the instructor feels any resistance caused by the student. They can also collaboratively push, stretch, pull the objects (organ and tools) around the scene, with attached objects stretching and moving accordingly. They converse through a separate voice link.

A problem arises when using two Haptic Workbenches in the same room: the two participants are still visually 'cut off' from

each other and they can not use any unmediated communication except for the occasional shouting between workbenches.

3. Haptics with the ARToolKit

The ARToolKit allows developers to include vision-based marker tracking in their applications. It is primarily used to render virtual objects in such a way that they are perceived to be co-located with specific fiducial markers. Inversely, it is also capable of tracking the camera location with respect to the marker

We have developed a new Reachin-compatible node that encapsulates the ARToolKit routines needed for camera tracking [Adcock et al. 2003]. This allows us to 'break free' from the workbench configuration. Fig. 2 shows an example in which use a marker on the desk as a reference for the placement of the virtual objects. Here, we have offset the two real haptic styli from the virtual ones.

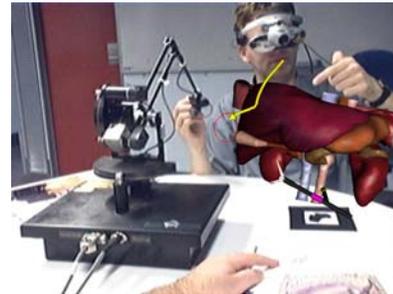


Figure 2. Collaborating with medical reference data (from the point of view of one of the two collaborators)

4. Conclusion

We have created a collaborative environment in which users can interact with virtual objects and each other, while maintaining most of their unmediated communication abilities. This system is acting as a test-bed for investigating collaboration affordances and behaviours.

5. References

- ADCOCK, M., HUTCHINS, M. and GUNN, C. 2003. "Augmented Reality Haptics: Using ARToolKit for Display of Haptic Applications" ART 03, the Second ARToolkit Workshop. ARTOOLKIT (http://www.hitl.washington.edu/research/shared_space/download/)
- BASDOGAN, C., HO, C., SRINIVASAN, M. A. and SLATER, M. 2000. "An experimental study on the role of touch in shared virtual environments." *ACM Transactions on Computer-Human Interactions* 7(4): 443-460.
- GUNN, C., HUTCHINS, M., ADCOCK, M. and HAWKINS, R. 2001. "Trans-World Haptic Collaboration", in *ACM SIGGRAPH 2003, Conference Abstracts and Applications*, San Diego.
- REACHIN TECHNOLOGIES AB (<http://www.reachin.se>)
- STEVENSON, D., SMITH, K., VELDKAMP, P., MCLAUGHLIN, J., GUNN, C. and DIXON, M. 1999. "Haptic Workbench: A Multisensory Virtual Environment", *the Engineering Reality of Virtual Reality, Electronic Imaging '99*, San Jose.