Augmented and Virtual Reality
Telepresence

Department of Computer Science | University of North Carolina at Chapel Hill | March 2015

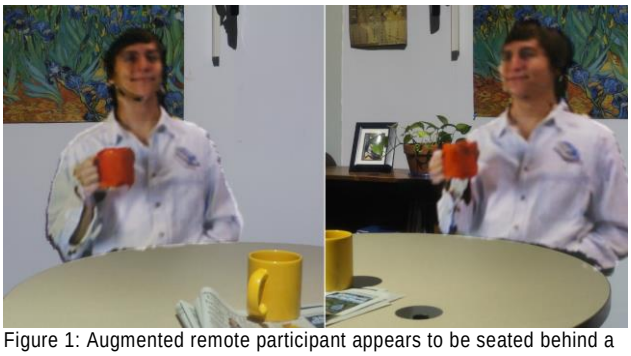

Figure 1: Augmented remote participant appears to be seated behind a local table from the viewpoint of the local participant.

Highlights

- **Telepresence system allows dynamic adjustment of integration between local and remote environments**
- **Room lighting control system allows remote imagery in see-through head worn display to appear solid and opaque**
- **Local and remote 3D scanning allows remote imagery to be convincingly integrated into local scene**

The Challenge

The goal of telepresence is to create the feeling that one is present in a remote place or co-located with a remote person. In the visual sense, past systems have created this illusion through a variety of paradigms, among them: a remote user appearing inside the local environment, a remote space appearing to extend beyond the local environment, and a local user immersed in a remote place. However, the most appropriate telepresence paradigm depends on context and may change frequently within a gathering. As an illustrative example, we imagine that an architect, located in a remote studio, addresses clients located in a meeting room. The architect first describes why a new building might benefit the clients. The clients see him sitting at an empty seat in the room and feel that he is among them, establishing trust. Next, the architect shows models of the building that he has constructed in his studio. The clients now see the architect's studio extending from one of the walls of the meeting room – they look around to assess the models while also gauging their local colleagues' interest. Finally, the architect shows them his centerpiece – the lobby. The clients are now completely immersed in the lobby of the building and each is free to inspect different aspects of the design. In the above example, a flexible telepresence system was described that continuously adapts to the most appropriate immersion mode depending on the situation. In this project, we define the requirements for such a general-purpose telepresence system (in the visual sense) and suggest how one could be built.

The Approach

In this project, we propose a general-purpose telepresence system design that can be adapted to a wide range of scenarios and present a framework for a proof-of-concept prototype.

The prototype system allows users to see remote participants and their surroundings merged into the local environment through the use of an optical see-through head-worn display. We experiment with both commercial head mounted displays (Figure 2, bottom left), and wider field of view experimental displays (Figure 2, bottom right).

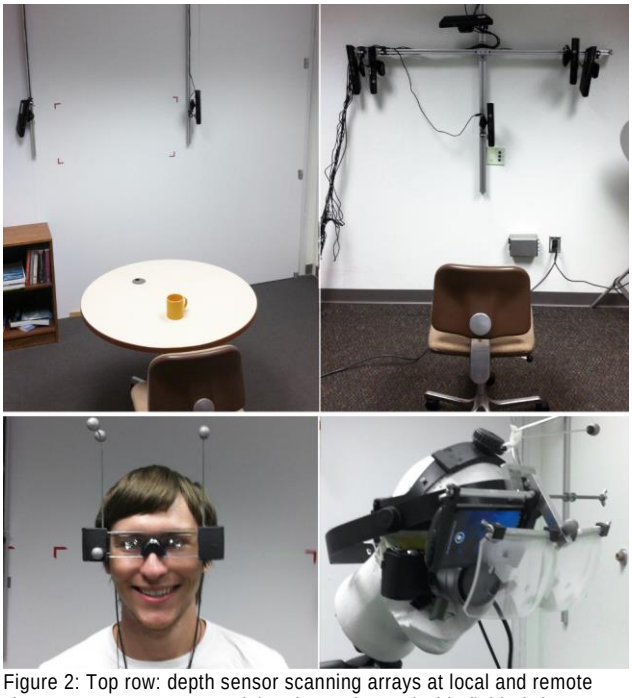

Figure 2: Top row: depth sensor scanning arrays at local and remote sites. Bottom row: commercial and experimental wide field of view displays used to display augmented imagery.

We perform real-time 3D acquisition of both the local and remote environments with array of depth cameras (Figure 2, top row). The imagery from the remote environment is geometrically merged with the local environment and rendered from the viewpoint of a head-tracked user,

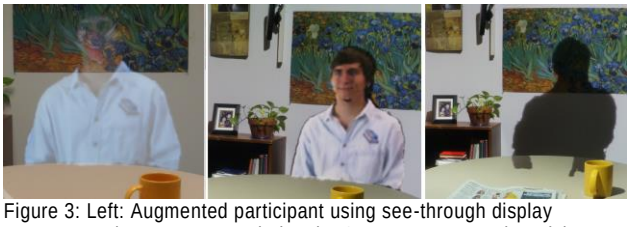

Figure 3: Left: Augmented participant using see-through display appears semi-transparent and ghostly. Center: Augmented participant using projector based lighting appears solid and opaque. Right: Controlled lighting in area of scene behind remote participant.

allowing the user to see the remote imagery from the proper perspective and with proper occlusion (Figure 1). A projector-based lighting control system is used to illuminate the local environment, rather than conventional lighting. Only parts of the environment which are not occluded by remote augmented objects are illuminated, allowing those objects to appear solid and opaque when viewed through an optical see-through head worn display (Figure 3).

Figure 4: System also supports greater levels of immersion: the remote environment appearing to extend from the local environment (left) and full immersion into the remote environment (right).

Immersion can be adjusted across the VR continuum dynamically, depending on the current needs of the telepresence session. We have experimented with rendering the remote user so that he or she appears to be *inside* the local environment (e.g. seated at a table, see Figure 1), rendering the remote user's environment so that it appears to *extend* beyond the local environment (Figure 4, left), and showing total *immersion* into the remote environment (Figure 4, right). In the prototype systems, these varying states of immersion were adjusted using simple depth based segmentation.

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Research Sponsors

The BeingThere Centre (a collaboration of UNC Chapel Hill, ETH Zurich, NTU Singapore, and the Media Development Authority of Singapore), National Science Foundation (award CNS-0751187)

Publications

Maimone, A., Yang, X., Dierk, N., State, A., Dou, M., and Fuchs, H. General-Purpose Telepresence with Head-Worn Optical See-Through Displays and Projector-Based Lighting IEEE Virtual Reality 2013 (Orlando, FL, USA, March 16-23, 2013)

Keywords

Augmented reality; virtual reality; telepresence; head-mounted display

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