Multi-Finger Gestural Interaction with 3D Volumetric Displays

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Abstract
Volumetric displays provide interesting opportunities and challenges for 3D interaction and visualization, particularly when used in a highly interactive manner. We explore this area through the design and implementation of techniques for interactive direct manipulation of objects with a 3D volumetric display. Motion tracking of the user's fingers provides for direct gestural interaction with the virtual objects, through manipulations on and around the display's hemispheric enclosure. Our techniques leverage the unique features of volumetric displays, including a 360° viewing volume that enables manipulation from any viewpoint around the display, as well as natural and accurate perception of true depth information in the displayed 3D scene. We demonstrate our techniques within a prototype 3D geometric model building application.

CR Categories: H.5.2 [**User Interfaces**]: Interaction styles; I.3.6 **[Methodology and Techniques]**: Interaction techniques.

Keywords: volumetric display, 3D interaction, multi-finger and two-handed gestural input.

1 Introduction

Viewing imagery on volumetric displays, which generate true volumetric 3D images by actually illuminating points in 3D space, is akin to viewing physical objects in the real world. These displays typically have a 360° field of view, and the user does not have to wear hardware such as shutter glasses or head-trackers. Although these displays are now commercially available (e.g., www.actuality-systems.com), current applications tend to use them as a non-interactive output-only display device, much like one would use a printer. In order to fully leverage the unique features of these displays, however, it would be desirable if one could directly interact with and manipulate the 3D data being displayed. In this paper, we investigate interaction techniques for volumetric display interfaces, through the development of an interactive 3D geometric model building application. We explore a very direct style of interaction where the user interacts with the virtual data using direct finger manipulations on and around the enclosure surrounding the displayed 3D volumetric image (Figure 1).

Figure 1. User working with a volumetric display, with finger input tracked using a camera-based motion tracking system.

2 System Implementation

We use a 3D volumetric display which generates a 10" spherical 3D volumetric image by sweeping 198 2D image planes around the up axis. A motion tracking system is used to track the 3D positions of markers placed on the user's fingers. We combine this data with the precise topology and 3D spatial location of the display's enclosure, to simulate an enhanced touch sensitive display.

3 Interaction Techniques

For interacting in three dimensions, a variety of basic operations must be supported. We developed a set of simple hand gestures which could be used on and above the surface of the display to accomplish tasks such as file visualization and browsing, selection, translation, scaling, and rotation. We also display frequently used commands such as delete, select, and group as buttons which could be tapped on the surface of the display.

4 Conclusions

Our work explored a suite of gestural interaction techniques for use with a 3D volumetric display. To allow for high fidelity direct user input, a real-time motion capture system was used to simulate a touch-sensitive display surface, detect hover just over the surface of the display, and track user hand positions when away from the display. We believe that the techniques we presented can form the basis for highly interactive use of such displays.

Reference

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