The ARC Display: An Augmented Reality Visualization Center

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1. Introduction

In this demonstration, we introduce members of the research community to the possibility of visualization with the ARC Display. The ARC Display represents a significant advancement towards our vision of wearable displays for multi-modal augmented reality systems [1]. The ARC Display currently provides a unique theatre for stereoscopic viewing of computer-generated objects. Moreover, users within the environment may be tracked using commercially available tracking systems. In our environment, we are using custom designed probes built on the Polaris optical tracking system.

In this brief summary, we shall detail the components of the ARC Display, describe the applications to be demonstrated, and discuss various aspects of the system.

2. ARC Display Components

The ARC Display currently consists of a custom-designed head-mounted projective display (HMPD), a curved retroreflective wall, an optical tracking system, custom designed optical tracking probes, and a Linux-based PC.

The HMPD, which was designed in the ODALab, is a lightweight helmet that provides stereoscopic images to the user [2]. The HMPD takes advantage of a revolutionary set of lightweight optics, which allows for a 52º binocular field of view with optics that weigh 8g per eye. It projects a left and right eye image into the environment using a 50/50 beam splitter. The images are returned to the eyes of the user by the retroreflective wall. The stereo images can be rendered to appear over a range of 0.5 to 6 meters. Moreover, if a real object (such as the hand of the user) is placed between the HMPD and the wall, virtual objects can be occluded. The resolution of the HMPD is currently 640x480, which yields a visual acuity of about 3.5 arc minutes. This is a limitation imposed only because of the LCDs available at the time of manufacture. Higher resolution miniature displays are currently being implemented.

The curved display wall is 7 feet high and 10 feet wide and made up of removable retroreflective panels. The special panels cause light rays which hit the wall to reflect in the direction that they came from. The retroreflective material affixed to the wall is manufactured by 3M and is pliable enough to be attached to clothing while still maintaining its retroreflective properties.

Within the ARC display, 3D models are correctly rendered to the user's point of view using the transformations supplied by a Northern Digital Inc. Polaris tracking system. The position and orientation of objects within the environment are tracked using collections of infrared LEDs called tracking probes. The system is able to track three distinct objects at an update rate of 20Hz with an accuracy of 0.35 mm and a repeatability of 0.2 mm. The current head tracking probe, which was designed in the ODALab, is able to track the head of the user through greater than 270º in azimuth and 90º of elevation, with an accuracy in orientation of 0.6º [3][4].

The computer that runs the entire application is a PC with commercially available components. The processor speed is 1.7 GHz and the operating system is Red Hat Linux 7.2. The graphics card is a GeForce4 that allows dual independent display.

3. Applications to be Demonstrated

The demonstration will show high-resolution 3D medical models, the superimposition of real and virtual objects, panoramic scene visualization, and a remote collaborative application.

Regarding the high-resolution models, 3D models of the mandible and bronchial tubes from the Visible Human Dataset are utilized [5]. The models are provided by Celina Imielinska of Columbia University Medical School as part of a collaborative research effort. The mandible model is 295,273 polygons and is rendered at a rate of 40 frames per second. The tracheal and bronchial tubes are 752,332 polygons and rendered at 16 frames per second. Both models are textured.

The dynamic capability of the system is demonstrated by superimposing a virtual cube on a real cube and examining the results from different positions and orientations. The field of view of the HMPD and the superiority of the curved wall are best appreciated through the display of a panoramic scene that corresponds to the dimensions of the wall.

Finally, we demonstrate the collaborative capability of the system between the ARC Display driven by a laptop and another laptop. We run a server application on the laptop driving the ARC Display. Then, using a LAN connection, we start a client program on the other laptop which can be thought of as a simulated remote Linux PC. The high-resolution graphics are displayed on both machines, with the ability to manipulate the models from either the server or client. Color and various attributes of the objects, such as the viewpoint and the size, can be dynamically manipulated.

4. Discussion

There are many unique aspects of the ARC Display. One of the most impressive aspects is that the ARC Display is a fully deployable augmented reality system. The retroreflective wall is completely collapsible and the HMPD is light enough to be easily transported. A major advantage of the HMPD is that users can see their own body along with the virtual world. This reduces the disorientation often encountered in other head-mounted displays [6]. Also, the HMPD allows for multiple users in the environment with no crosstalk between users.

The system is used as part of a larger research effort for endotracheal intubation training that will not be demonstrated at this time. For more information, visit our web site at http://odalab.ucf.edu.

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