Converting Commodity Head-Mounted Displays for Optical See-Through Augmented Reality

The Challenge
The current market for fully immersive virtual reality head-mounted displays is rapidly expanding, however optical see-through displays have not seen the same growth. Augmented reality head-mounted displays available on the market either use video pass-through or are limited by extremely narrow fields of view and high latency. With the need in other areas of our research for a wide field of view low latency optical see-through display, we set out to create one by utilizing recent advances in commodity virtual reality head-mounted displays.

The Approach
Designing the optics of the new display presented the first challenge, but by using rapid prototyping techniques and 3d printing, we were able to quickly test several optical designs for accuracy and feasibility. Our first design used a straight mirror with Fresnel lenses to increase the field of view, which worked well for magnifying the image, but was limited by the diameter of the lenses resulting in a maximum 35° field of view. An alternative design using a mirror curved in one dimension without any lenses was produced next. This theoretically would produce a magnified image for a wider field of view, but the difficulty of getting the proper focal length along the entire image required too much precision for the simple solution we were seeking.

Modified Oculus DK2 with curved beam splitters. For the final design, we chose to go with beam-splitter lenses curved in two dimensions provided by PhaseSpace which work well for magnifying the image and producing a wide field of view. By angling the display we are able to keep the entire plane in focus, but this introduces additional tangential distortion which must be corrected. This setup allows us to use the Oculus SDK with minimal alterations and provides a low latency, high field of view see-through head-mounted display.

Current Project Members
Henry Fuchs, Federico Gil Professor
Andrei State, Senior Research Scientist
David Dunn, Graduate Research Assistant
Kurtis Keller, Research Engineer

Acknowledgments
PhaseSpace Inc. for use of the curved beam-splitter lenses

Keywords
Augmented reality; head-mounted display; telepresence

For More Information
David Dunn
Phone (818) 254-8850
E-mail: qenops@cs.unc.edu