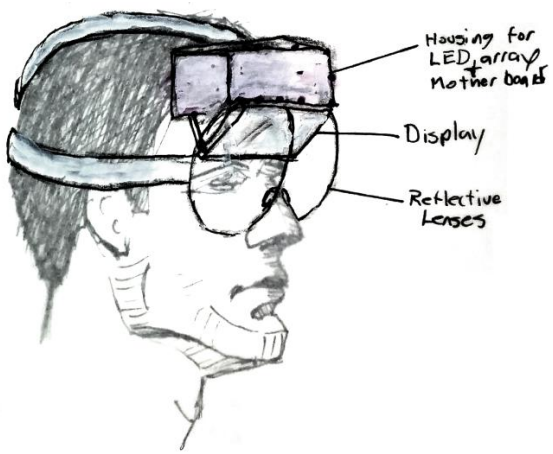
Converting Commodity Head-Mounted Displays for Optical See-Through Augmented Reality

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

The Challenge

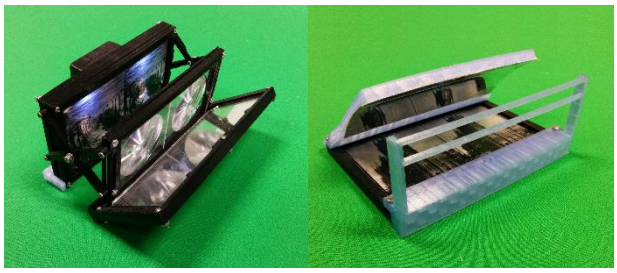
The current market for fully immersive virtual reality head-mounted displays is rapidly expanding, however optical see-through displays have not seen the same growth. Augmented reality head-mounted displays available on the market either use video pass-through or are limited by extremely narrow fields 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.



A concept drawing for optical see-through augmented reality display.

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.



3D printed optical design prototypes. Left: straight mirror, Fresnel lens. Right: curved mirror, no lens.

Highlights

- **Project disassembles an Oculus Rift DK2 into components used to build an optical see-through head-mounted display.**
- **Project achieves wide field of view and low latency augmented reality display.**

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.

Final design incorporating the curved beam-splitter lenses with screen and tracking sensors from Rift DK2.

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Acknowledgments

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

Keywords

Augmented reality; head-mounted display; telepresence

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