Pinlight Displays: Wide Field of View Augmented Reality Eyeglasses

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

Figure 1: Prototype glasses offering a field of view of 100° diagonal in a package resembling eyeglasses.

Highlights

- **Achieved both compact, eyeglasses-like form factor and wide field of FOV (>100°) in a single near-eye display design**
- **Computational display approach allows many parameters of display (e.g. eyebox position) to be controlled in software**
- **Approach proven using prototype displays demonstrated publicly**

The Challenge

Augmented reality (AR) offers a tantalizing vision for the future. Imagine leaving home to proceed along directions placed neatly on the sidewalk; along the way, a glance across the street yields the menu for a cafe, prompting us to stop and share coffee with a remote friend apparently seated across the table. In this example, we imagine casually harnessing graphics with meaningful spatial connections to the world, at a moment's notice and at many moments throughout the day. We imagine computer graphics transitioning from a distinctly external entity into a part of human vision. Realizing this dream requires advances in many disciplines – low latency rendering, tracking, application development, mobile computing, localization, networking – but perhaps the most fundamental problem is obtaining a suitable display.

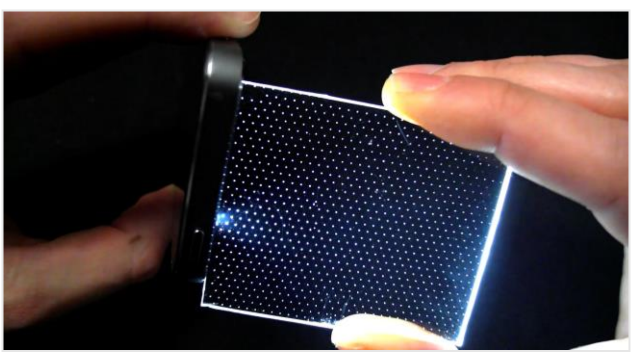

Figure 2: An array of point light sources are created by edge illuminating an etched plastic sheet with one or more LEDs.

A display that satisfies the long-term potential envisioned for AR must satisfy two key requirements. A wide field of view is needed as a synthetic object or information overlay registered to the world may over time appear anywhere in a viewer's field of view as the viewer moves and may fill an arbitrarily large portion of the viewer's field of view. The display should also be non-encumbering; a display intended for casual and extended use must be ready to use in an instant, must be comfortable, and must not interfere with other tasks when not being used. Recent developments in commercial optical see-through near-eye displays show attractive form factors (e.g. Lumus DK-32), but with fields of view of 40° or less. Existing wide field of view displays are much bulkier than ordinary eyeglasses. In contrast, we present a novel optical see-through near-eye display design that provides a wide field of view and supports a compact and lightweight form factor that approaches ordinary eyeglasses.

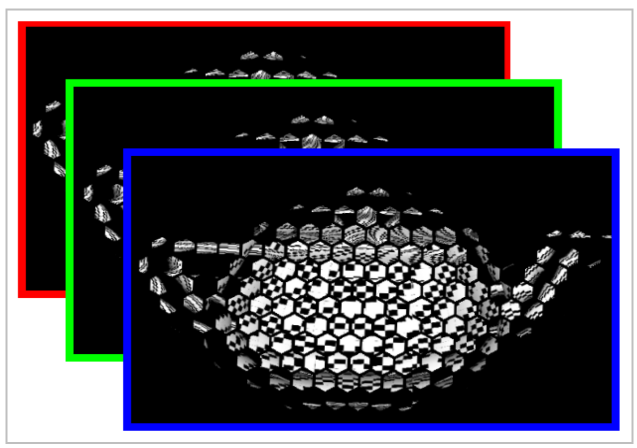

Figure 3: The pattern displayed an LCD panel is the desired image projected through each of the point light sources.

The Approach

We present a novel design for an optical see-through augmented reality display that offers a wide field of view and supports a compact form factor approaching ordinary eyeglasses. Instead of conventional optics, our design uses only two simple hardware components: an LCD panel and an array of point light sources (implemented as an edge-lit, etched acrylic sheet, see Figure 2) placed directly in front of the eye, out of focus.

We code the point light sources through the LCD to form miniature see-through projectors. A virtual aperture encoded on the LCD allows the projectors to be tiled, creating an arbitrarily wide field of view. Software rearranges the target augmented image into tiled sub-images sent to the display (see Figure 3), which appear as the correct image when observed out of the viewer's accommodation range. We evaluated the design space of tiled point light projectors with an emphasis on increasing spatial resolution through the use of eye tracking. We demonstrate feasibility through software simulations and a real-time, human viewable prototype display that offers a >100° diagonal field of view (see Figure 4) in the form factor of large glasses (see Figure 1). Various display parameters, e.g. eyebox position can be controlled in software.

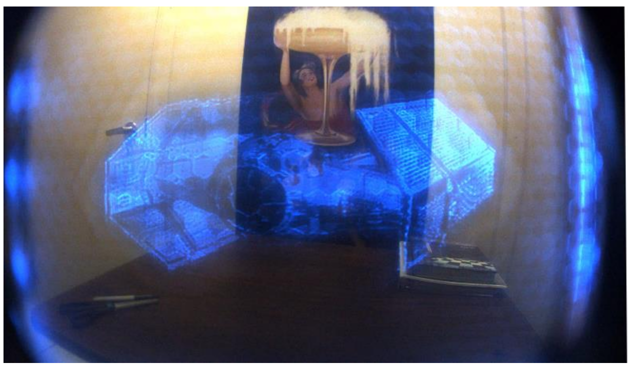

Figure 4: Sample results from prototype display showing 110°. (Ship model by Staffan Norling.)

Project Members

Andrew Maimone Graduate Research Assistant
Kishore Rathinavel Graduate Research Assistant
Kurtis Keller Research Associate and Engineer
Henry Fuchs Federico Gil Distinguished Professor

External Collaborators

Douglas Lanman Senior Research Scientist (NVIDIA, now Oculus)
David Luebke Director of Research (NVIDIA)

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Publications

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Keywords

Augmented reality; head-mounted display; stereoscopic display; computational displays

For More Information

Henry Fuchs
E-mail: fuchs@cs.unc.edu