

Head Tracking and Microlens Array Co-design for Improved 3D Display Experience

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Introduction

3D content is an emerging market seeking to aid viewer immersion in visual content. A totally immersive 3D experience requires stereoscopy, motion parallax, accommodation, and convergence. Most 3D content currently available pairs 2D displays with specialized eyewear to achieve stereoscopy. While these methods add a certain depth to the content, they encumber the viewer while lacking motion parallax, accommodation, and convergence. Accommodation and convergence are difficult phenomena to recreate with modern technology, but movement parallax can be implemented simply by tracking the current position of the viewer in relation to the display. Removing the eyewear from the equation is a more difficult endeavor, typically requiring additional technology to be added to the original 2D display. This project proposes to build a microlens array 3D display system for smartphone devices which uses head tracking to adjust the display to provide motion parallax information while still maintaining stereoscopy.

Previous work

Many attempts have been made to create 3D displays without the use of assistive glasses. Dresden University of Technology has accomplished this by projecting stereoscopic half images to different eyes using half prisms. Motion parallax is achieved in this system by mechanically shifting the half prisms and altering the image displayed when the viewer's position changes. However, the mechanical movement of this device is complicated and isn't readily available on smartphones.

Another method of glasses-free 3D display has been to use microlens arrays to control the light field incident on each eye to form a stereoscopic image. However, this method creates different viewing zones, as shown in Figure 1, making the desired image only resolvable from certain viewing angles. To overcome this, head tracking must be used to adjust the zone location depending on the viewer's position.

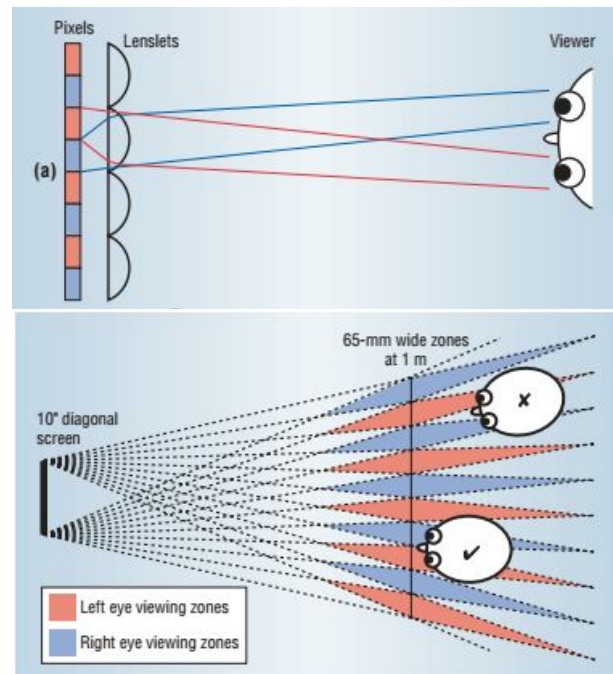


Figure 1: Illustration of creating multiple viewing angles using a microlens array (above). Viewing zones resulting from two view display (below).

Project Overview

Our project proposes building a 3D display system utilizing microlens arrays for smartphone devices which uses head tracking to provide a viewing angle independent, stereoscopic image with motion parallax. This means that as a viewer moves their head with respect to the screen, the displayed image will change to account for motion parallax and the half-image locations with respect to the lenslet array will move to adjust the viewing zones. This will create a full 3D experience, lacking only accommodation and convergence depth cues. Head tracking will be done using a front-facing camera and open source software.

Milestones and Goals:

Week 1) Display a 3D image with different viewing zones using a microlens array on an HD display.

Week 2) Sense a user's head location using head tracking.

Week 3) Apply head location information to adjust the correct viewing zone to the user's location (no Motion Parallax)

Week 4) Apply Motion Parallax to the displayed image based on viewer location.

References

- [1] K. Perlin, S. Paxia, J. Kollin, '*An AutoStereoscopic Display*' Computer Graphics, Vol 33. No.3
- [2] A. Schwerdtner, H. Heidrich, '*Dresden 3D Display*' SPIE 3295, Stereoscopic Displays and Virtual Reality Systems V, 203 (April 30 1998)
- [3] D. Lanman, D. Luebke '*Near-Eye Light Field Displays*', ACM Transactions on Graphics (SIGGRAPH Asia 2013), November 2013, Hong Kong
- [4] N. Dodgston '*Autostereoscopic 3D Displays*' IEEE Computer Volume: 38, Issue: 8, pgs 31-36.