Holojackets

Semester Update: Fall 2017

December 4, 2017

Georgia Tech Vertically Integrated Projects

Georgia Tech Research Institute

Agenda

- Team Focus
- Problem Statement
- Background Research
- Team Structure
- Progress
- Conclusion/Project Plan

Team Focus

- Prototype 3D displays that allow viewing from any orientation without requiring special artifacts.

- Utilize light field displays that will allow viewers to naturally perceive 3D scenes with normal visual cues such as parallax, vergence, and focus accommodation.

Problem Statement

- End goal is to use 3D image information from light field camera to create an image on computer screen which you can look at from different angles to see different views.

What does 3D mean?

There are four major depth cues that the human brain uses to gain true 3D sensation.

Some 3D display devices can provide all of these physical depth cues, while other autostereoscopic 3D display techniques may not be able to.

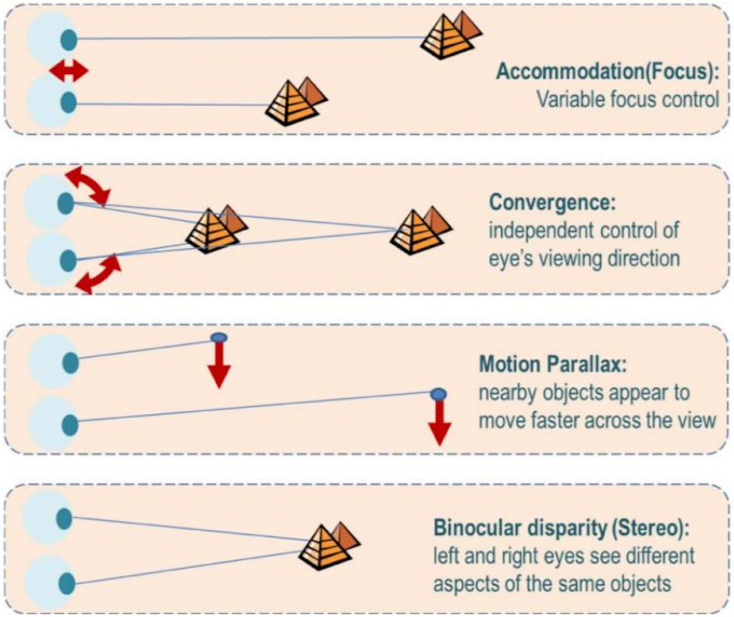


Illustration of four major physical depth cues.

What does 3D mean?

The human brain can also gain a 3D sensation by extracting psychological depth cues from 2D monocular images.

Different depth cues have different effects at different stand-off viewing distances.

It’s often difficult for a 3D display device to provide all the physical and psychological depth cues simultaneously.

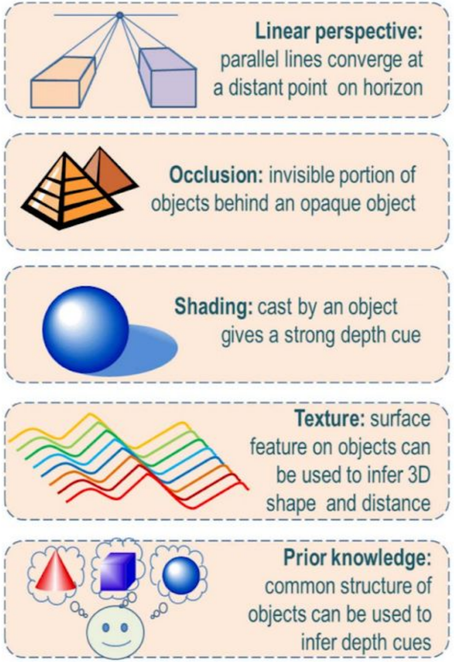


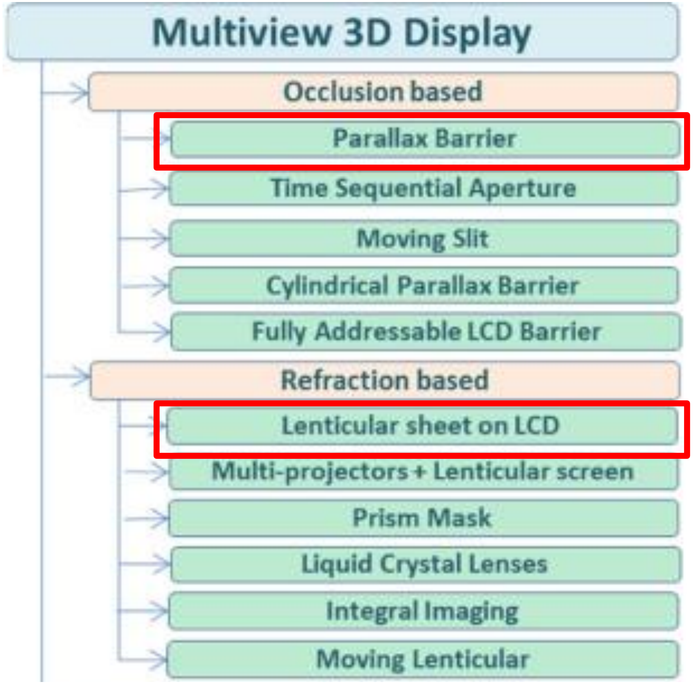
Illustration of psychological depth cues from 2D monocular images.

Implementation Strategies of Multiview 3D Displays

A multiview autostereoscopic 3D display system is able to produce different images in multiple angular positions.

No special eyewear is needed.

There are numerous implementation strategies, but our team is focused in Parallax Barrier and Lenticular sheet on LCD classes.

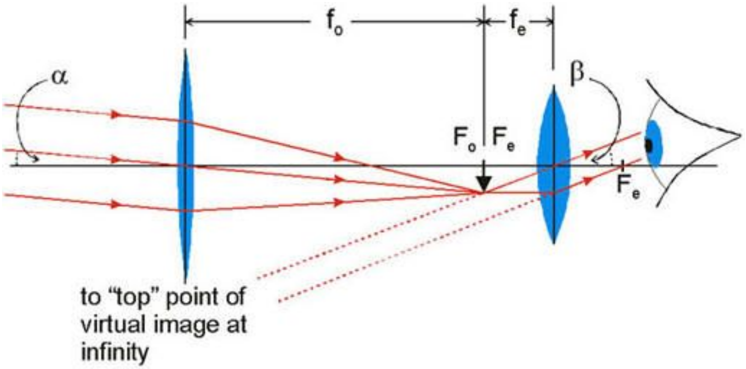


Optics Fundamentals: Ray Diagram

The line of sight principle suggests that in order to view an image of an object in a mirror, a person must sight along a line at the image of the object.

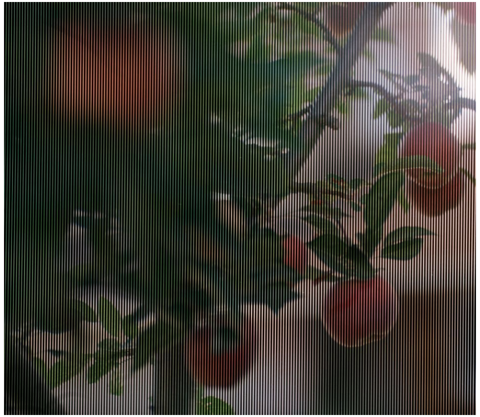
The light from the object reflects off the mirror according to the law of reflection and travels to the person's eye.

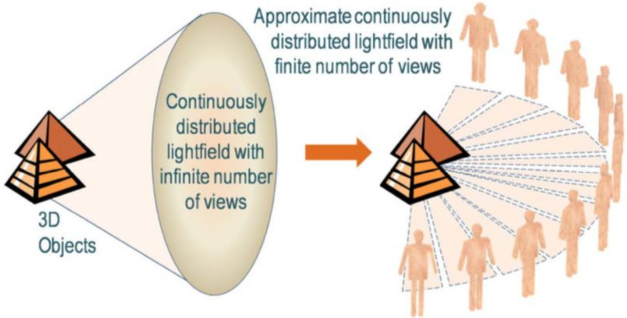
A ray diagram is a diagram that traces the path that light takes in order for a person to view a point on the image of an object.

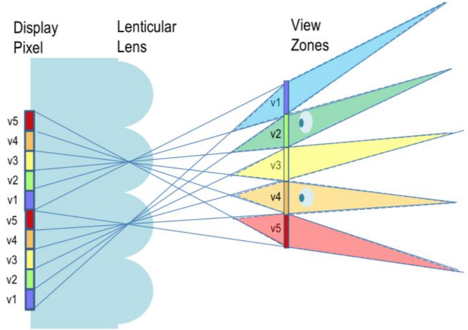


General Terminology

- Striped Images
- Multiview Displays
  - Occlusion-Based (parallax barrier)
  - Refraction-Based (lenticular)



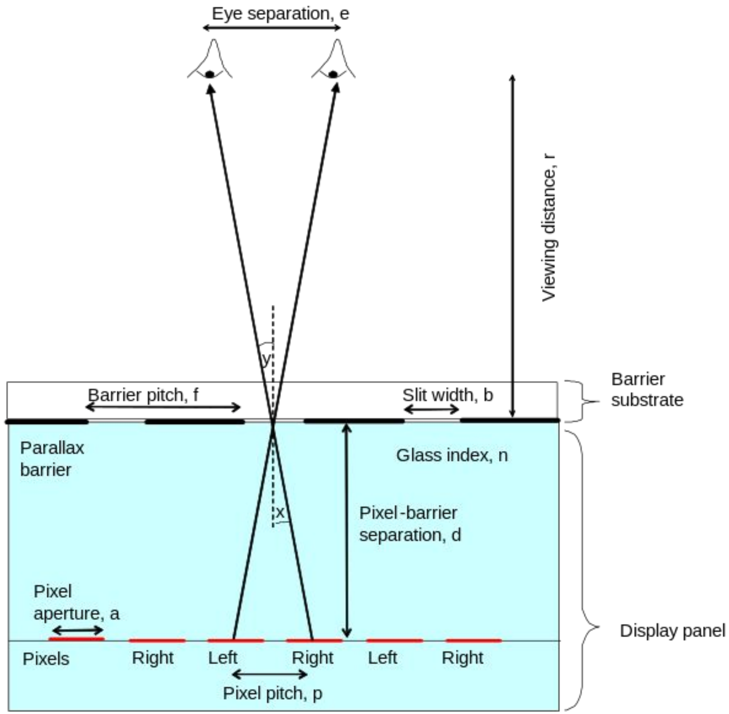




Optics Fundamentals: Parallax Barrier Diagram

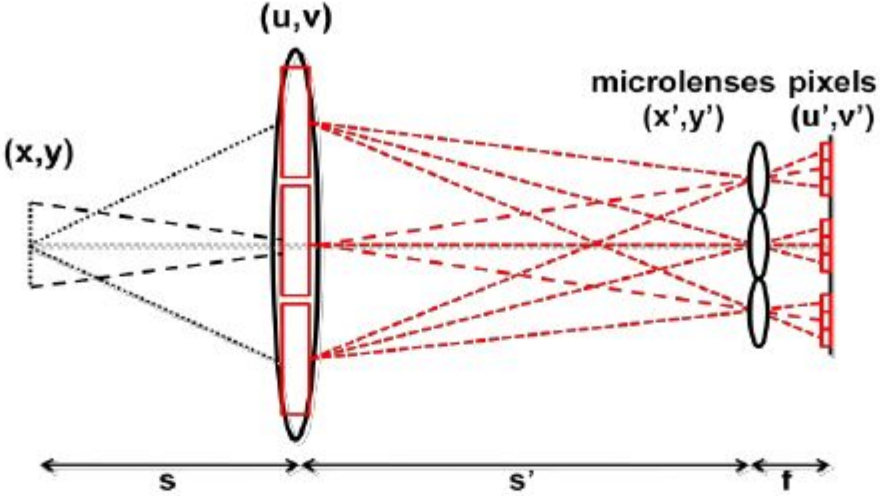
Pixel aperture, pixel pitch, and pixel-barrier separation is needed to find the barrier pitch and slit width.

Application of **solid angle** is required.



4-Dimensional Views

- Left Right
- Up down

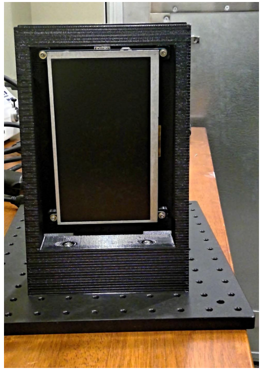


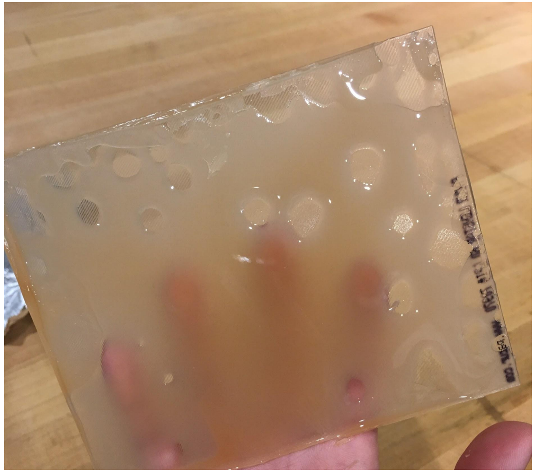
HoloJackets Sub-teams

Images
Algorithms

Display
Parallax
Barrier

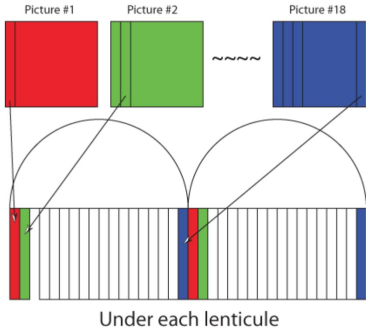
Lens
Micro-Optics

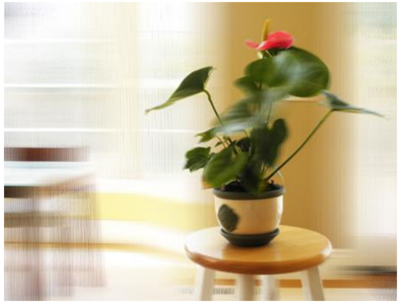




Interlacing Photos: Algorithms

- Photos from an online source were manually interlaced in Adobe Photoshop to create an image that would create parallax when aligned under a lenticular sheet
  - The final product was made to be centered around the foreground object which minimized the amount of parallax created by the lenticular sheet
- Interface Control Document (ICD) was drafted to outline an interlacing program
- A Python program was made to eliminate the need for manual interlacing



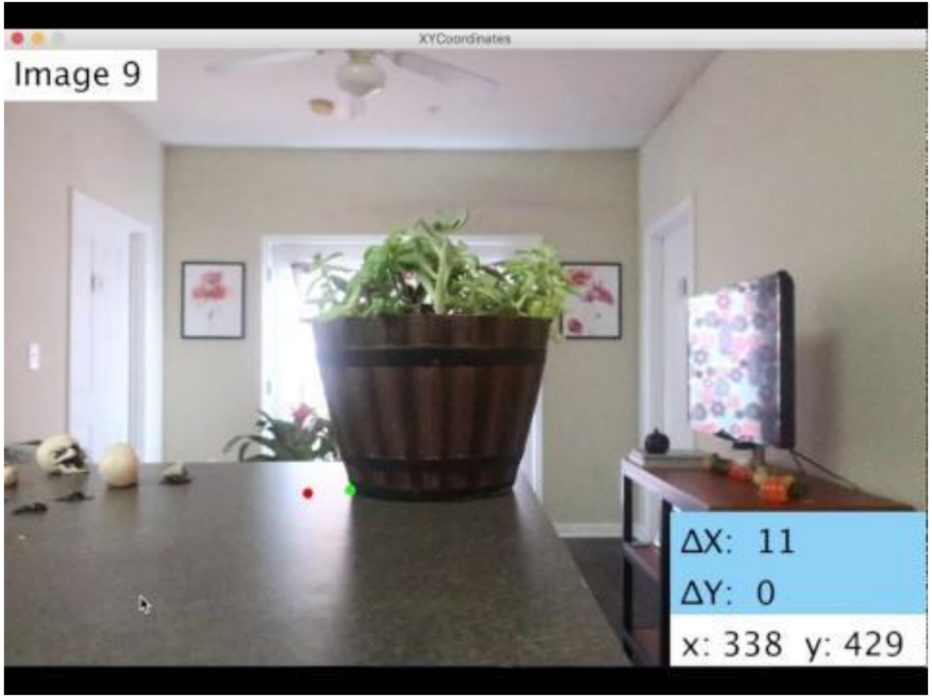


The final interlaced image

Collecting Image Data: Algorithms

- Needed to create original image data that could be used be when prototyping 3D displays
- Pictures taken using a sliding bar, but there is obvious movement in the Y-axis that would distort lenticular imaging -- presents a problem

Manually Tracking the X and Y Coordinates: Algorithms



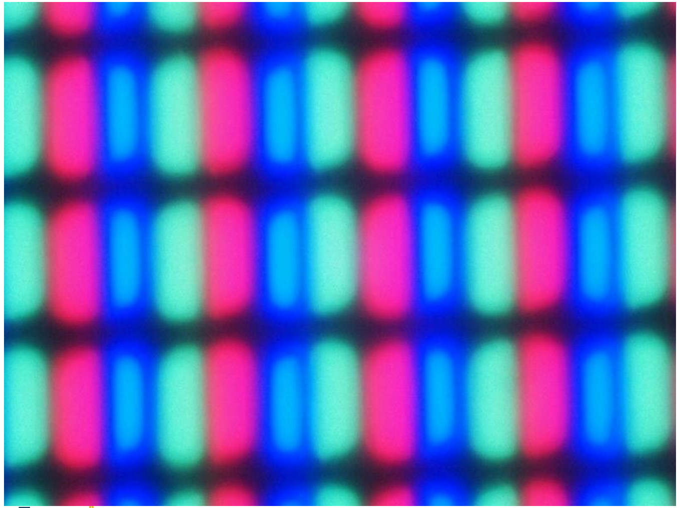
- Program in a flexible software sketchbook called Processing, that has the ability to convert script code into sketches
  - setup()
  - draw()
- Tracked the bottom left corner of the plant's pot, since there is a notable difference between the lighting and dark color of the pot

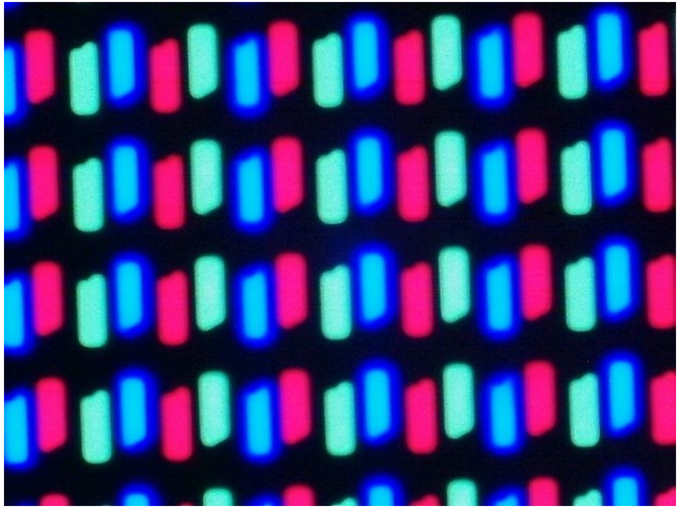
Progress: Parallax Barrier

- Measure display characteristics:
  - pixel pitch, pixel size, physical dimensions, display depths
- Learned image software using ImageJ to measure display characteristics
- Tool acquisition & training:
  - Microscope
  - Calipers
- Device acquisition:
  - raspberry pi - 800 & 1024 resolution
  - Inkjet printer

Display Characteristics

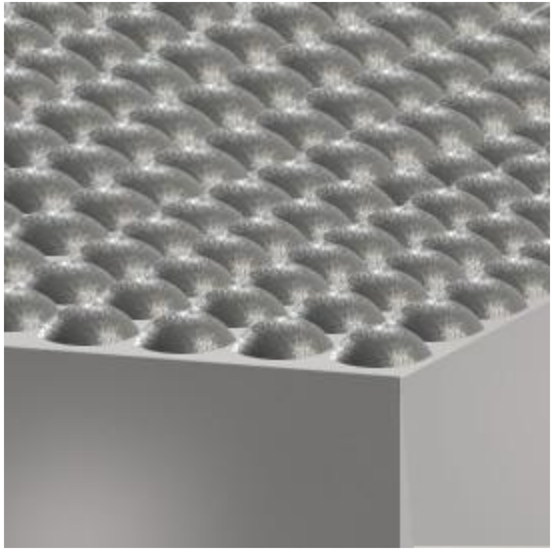
Characteristics:	800x400 display	1024x680 display
Thickness	.719557 mm	.66433 mm
Pixel Pitch	.166 mm	.136 mm



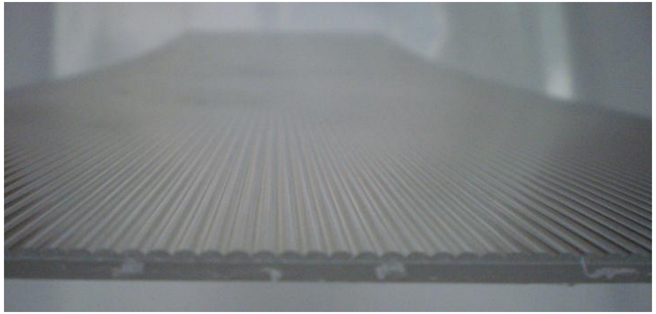


Progress: Micro-Optics

- Goal: Fabricate microlenses that will project a 3D display.

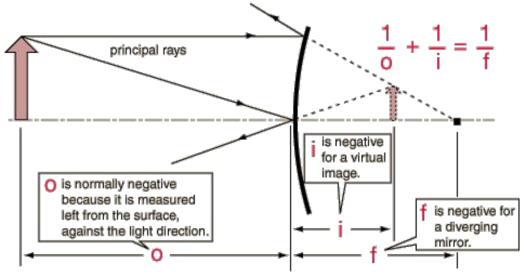


- What are lenticular lens (bottom)?
- How do they compare to our end goal lens (right)?



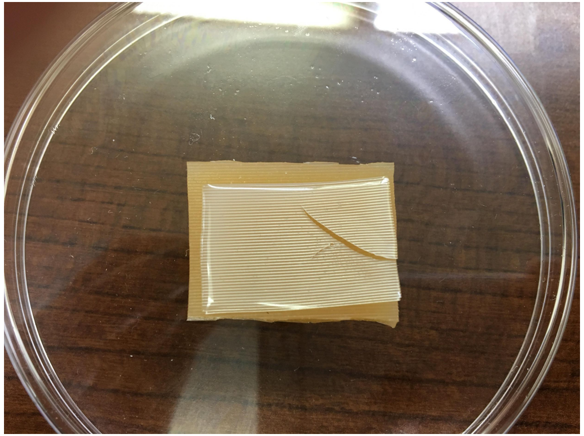
Micro-Optics: Clean Room Training

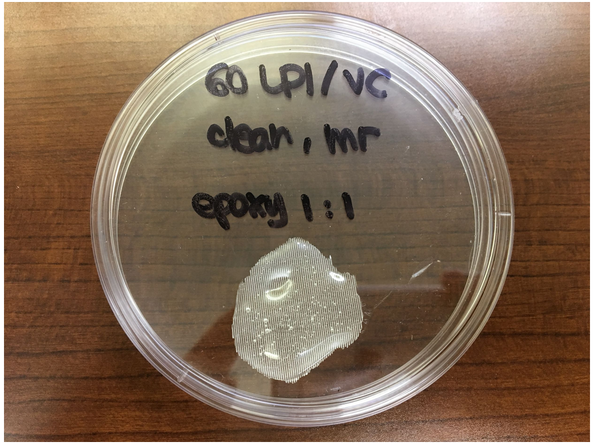
- Clean room training
  - Spin Coater
  - Spray Coater
  - Mask Aligner
  - Profilometer
  - Hot Plate
- Focal length calculation sheet

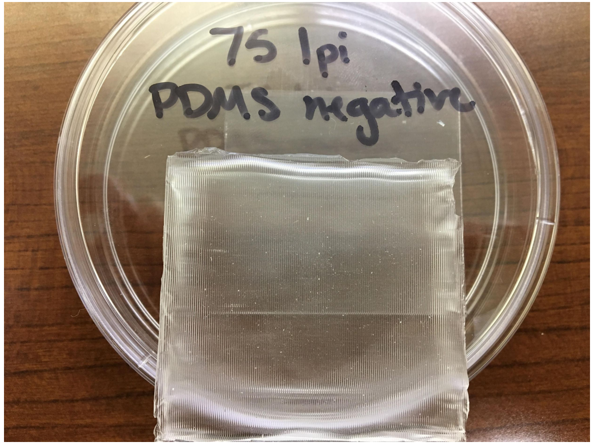


Micro-Optics: Masters

- Urethane Rubber Compound
- Epoxy Resin
- PDMS







- Vacuum Chamber

Path Forward: Algorithms

- Experiment with different images and interlacing to observe the effects on parallax
- Drive a smartphone display from the Raspberry Pi -- convert to HDMI
  - Possible device: OnePlus One www.oneplus.net
    - Size: 5.5 inch
    - Resolution: 1080p
    - USB-C to HDMI

Path Forward: Algorithms

- Or find a high resolution display that is designed to work with the Raspberry Pi to mitigate the complexity of driving a smartphone from a microcontroller
    - Possible device: Elecrow HDMI LED Display for Raspberry Pi www.elecrow.com/elecrow-11-6-inch-1920x1080-hdmi-1080p-led-display-for-raspberry-pi.html
        - Size: 11.6 inch
        - Resolution: 1080p
        - HDMI

- Make use of a motorized slider track to control camera movement

Path Forward: Parallax Barrier

Short Term

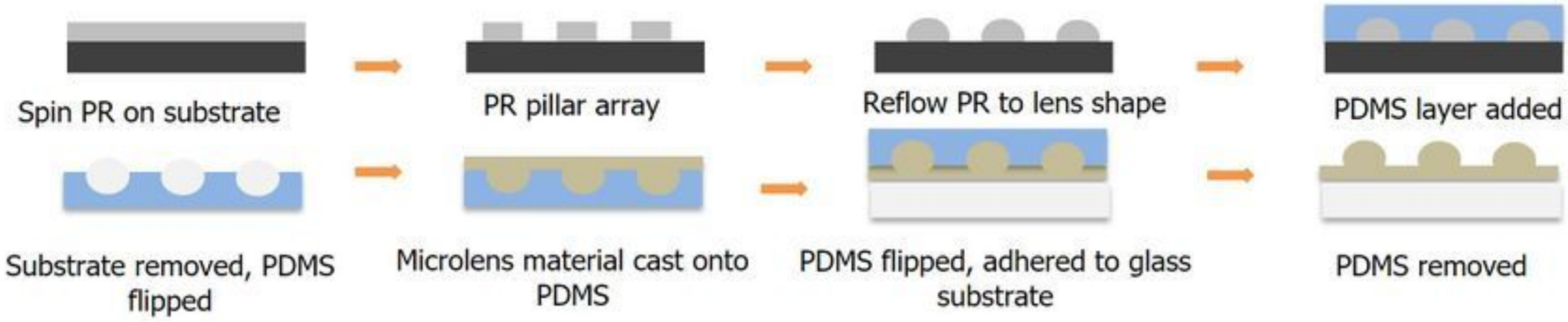
- Find the speculation of the Inkjet Printer
- Print and create sample parallax barriers on transparent film
- Test barriers with different gaps (from display’s screen to barrier)

Long Term

- Emulate Implementation of Autostereoscopic Displays experiment using Dell monitors
- Implement parallax barrier on the display of a handheld cellphone

Path Forward: Micro Optics

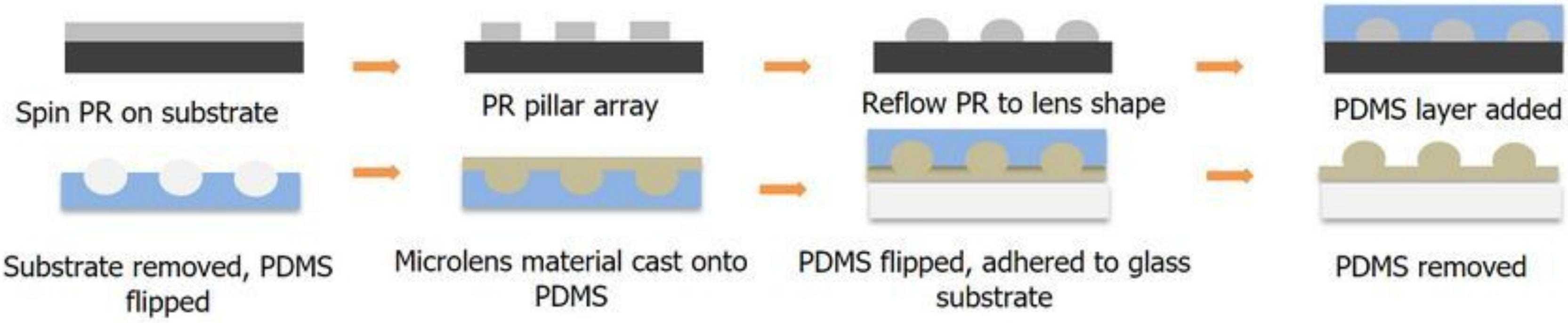
- Fabricate microlenses in the clean rooms using this method:



- Continue experimenting with various materials

Path Forward: Micro Optics

- Fabricate microlenses in the clean rooms using this method:



- Continue experimenting with various materials

Conclusion and Path Forward

Conclusion:

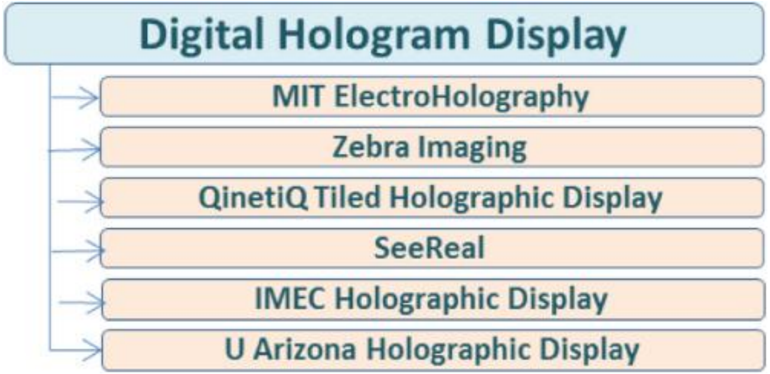
- Molds for lenses have been created
- Calculations and specifications for Parallax Barrier completed
- Image data created
- Lenticular sheets utilized
- Basics are all covered

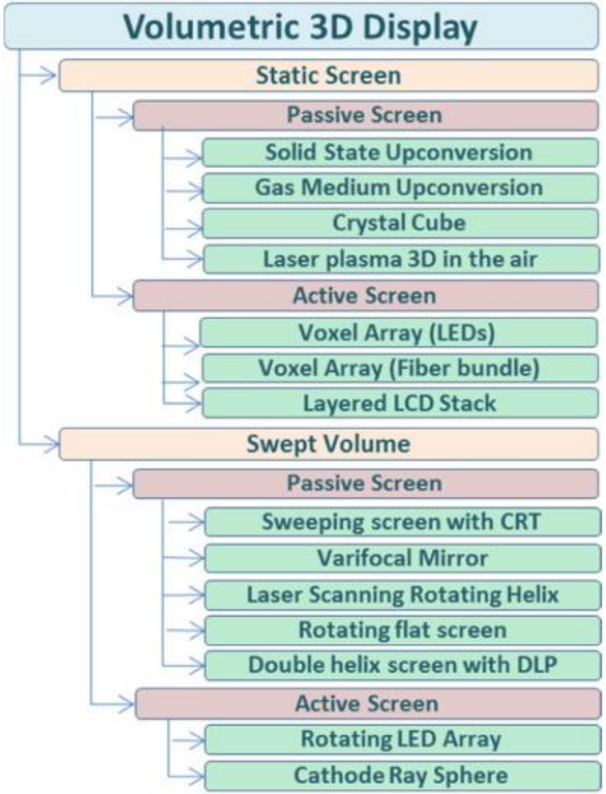
What's to come:

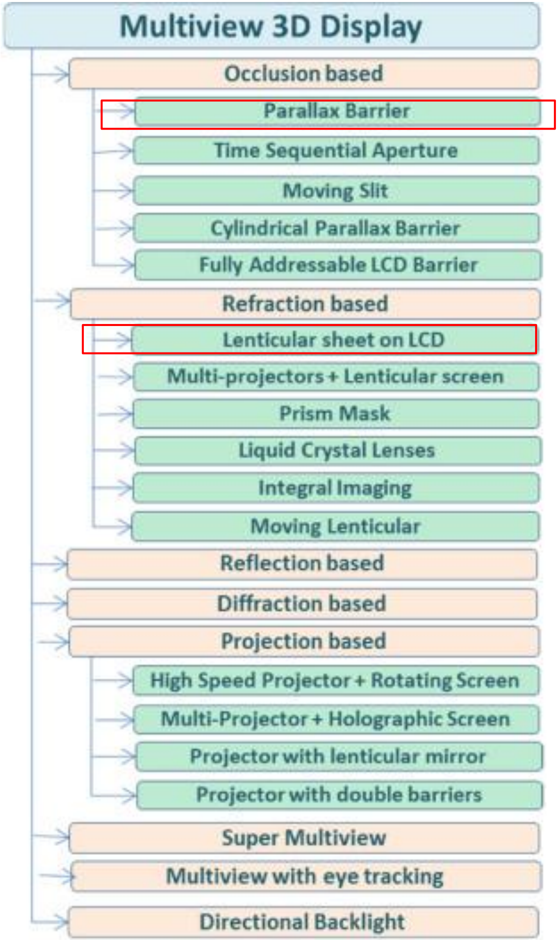
- Creating and testing
- Experiment with various parameters
- Experiment with new materials
- Using the track that was planned for us to move the camera in perfect intervals with no change in Y direction
- Driving a high resolution display from the Raspberry Pi

Thank You

Optics Fundamentals-Types of Displays




Volumetric 3D Display
Static Screen
Passive Screen
Solid State Upconversion
Gas Medium Upconversion
Crystal Cube
Laser plasma 3D in the air
Active Screen
Voxel Array (LEDs)
Voxel Array (Fiber bundle)
Layered LCD Stack
Swept Volume
Passive Screen
Sweeping screen with CRT
Varifocal Mirror
Laser Scanning Rotating Helix
Rotating flat screen
Double helix screen with DLP
Active Screen
Rotating LED Array
Cathode Ray Sphere


Multiview 3D Display
Occlusion based
Parallax Barrier
Time Sequential Aperture
Moving Slit
Cylindrical Parallax Barrier
Fully Addressable LCD Barrier
Refraction based
Lenticular sheet on LCD
Multi-projectors + Lenticular screen
Prism Mask
Liquid Crystal Lenses
Integral Imaging
Moving Lenticular
Reflection based
Diffraction based
Projection based
High Speed Projector + Rotating Screen
Multi-Projector + Holographic Screen
Projector with lenticular mirror
Projector with double barriers
Super Multiview
Multiview with eye tracking
Directional Backlight