CSE 190: Virtual Reality Technologies

LECTURE #12: LIGHTFIELD TECHNOLOGY

Announcements

Homework project 3

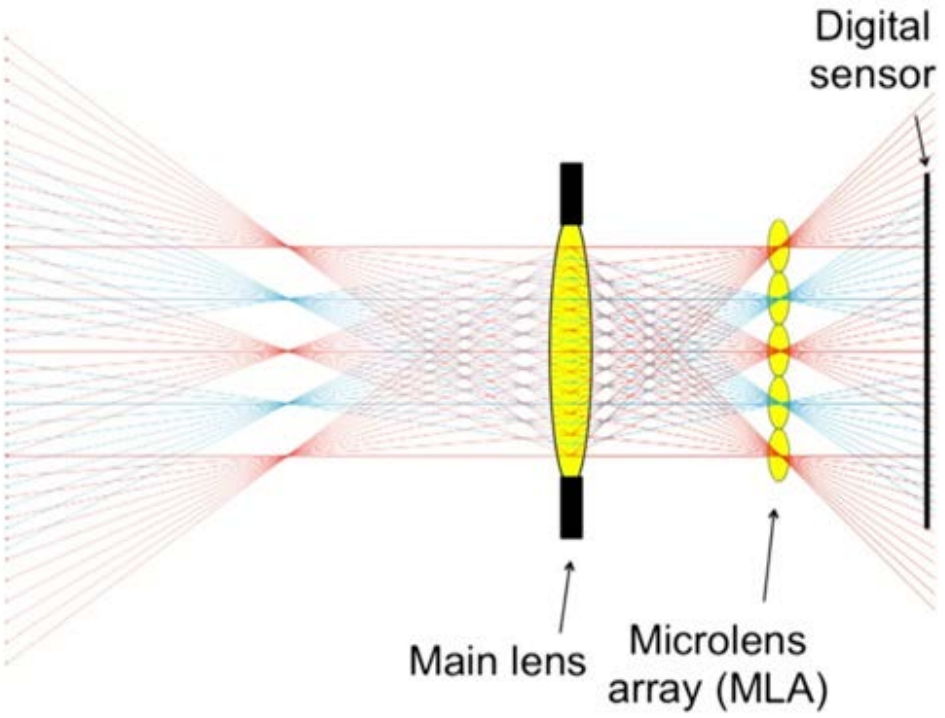
- Due Friday, May 17th at 2pm
  - To be demonstrated in VR lab B210
  - Upload code to TritonEd by 2pm

Midterm exam next Thursday, May 23rd

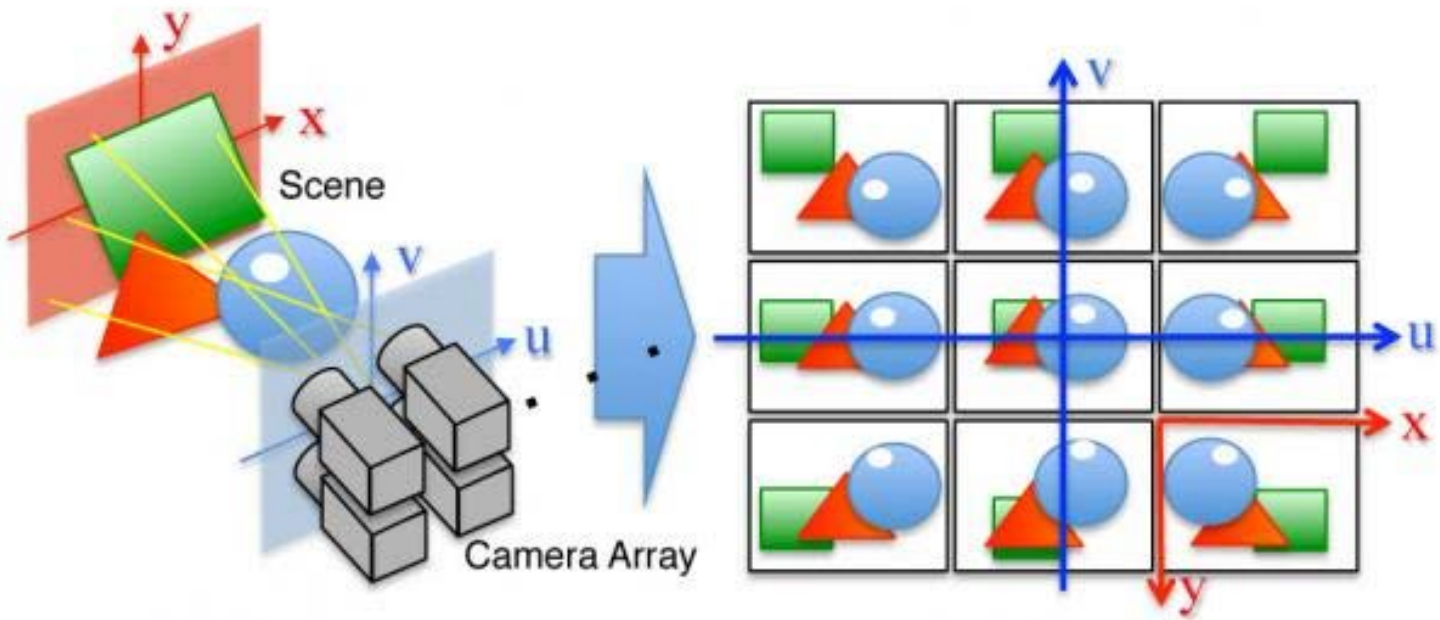
- In-class during lecture
- Closed-book
- Allowed: pen, pencil, eraser, ruler, scrap paper
- Follows the format of last two years' exams (can be found on course schedule)

Lightfield Cameras

Micro-lens array captures light from different directions



Lightfield for 3D Image Capture



Lightfield Display

Nvidia presentation at Siggraph 2013

https://www.youtube.com/watch?time_continue=4&v=f_CkJCZ3Uxw

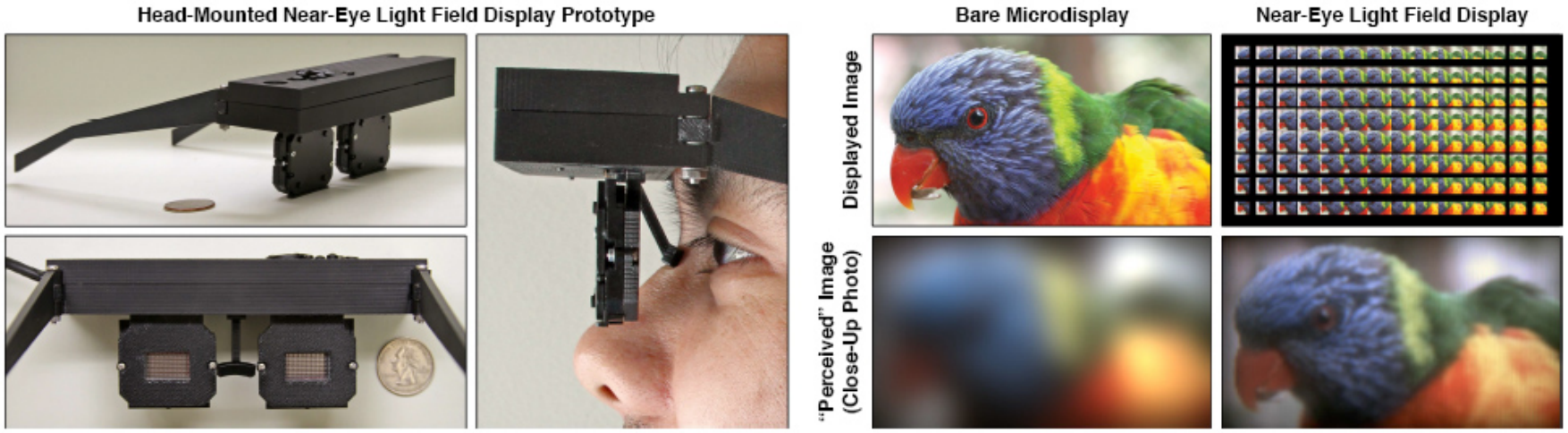


Figure 1: *Enabling thin, lightweight near-eye displays using light field displays. (Left) Our binocular near-eye display prototype comprises a pair of OLED panels covered with microlens arrays. This design enables a thin head-mounted display, since the black box containing driver electronics could be waist-mounted with longer OLED ribbon cables. (Right) Due to the limited range of human accommodation, a severely defocused image is perceived when a bare microdisplay is held close to the eye (here simulated as a close-up photograph of an OLED). Conventional near-eye displays require bulky magnifying optics to facilitate accommodation. We propose near-eye light field displays as thin, lightweight alternatives, achieving comfortable viewing by synthesizing a light field corresponding to a virtual scene located within the accommodation range (here implemented by viewing a microdisplay, depicting interlaced perspectives, through a microlens array).*

Some of the following slides are from:
The Eye and Near-Field Optics in Hololens and Magic Leap

ANDREW JONES, NUMAIR KHAN, AND ELEANOR TURSMAN
BROWN UNIVERSITY

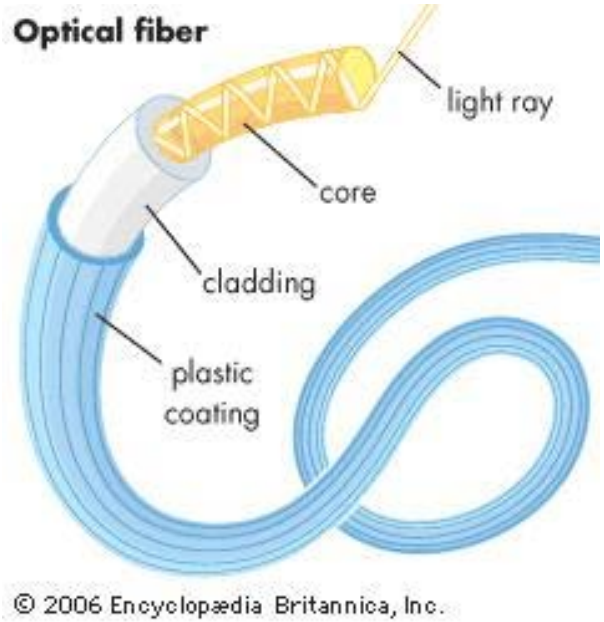
Waveguides

What: tool that controls movement of EM or sound waves while restricting power loss over travel time

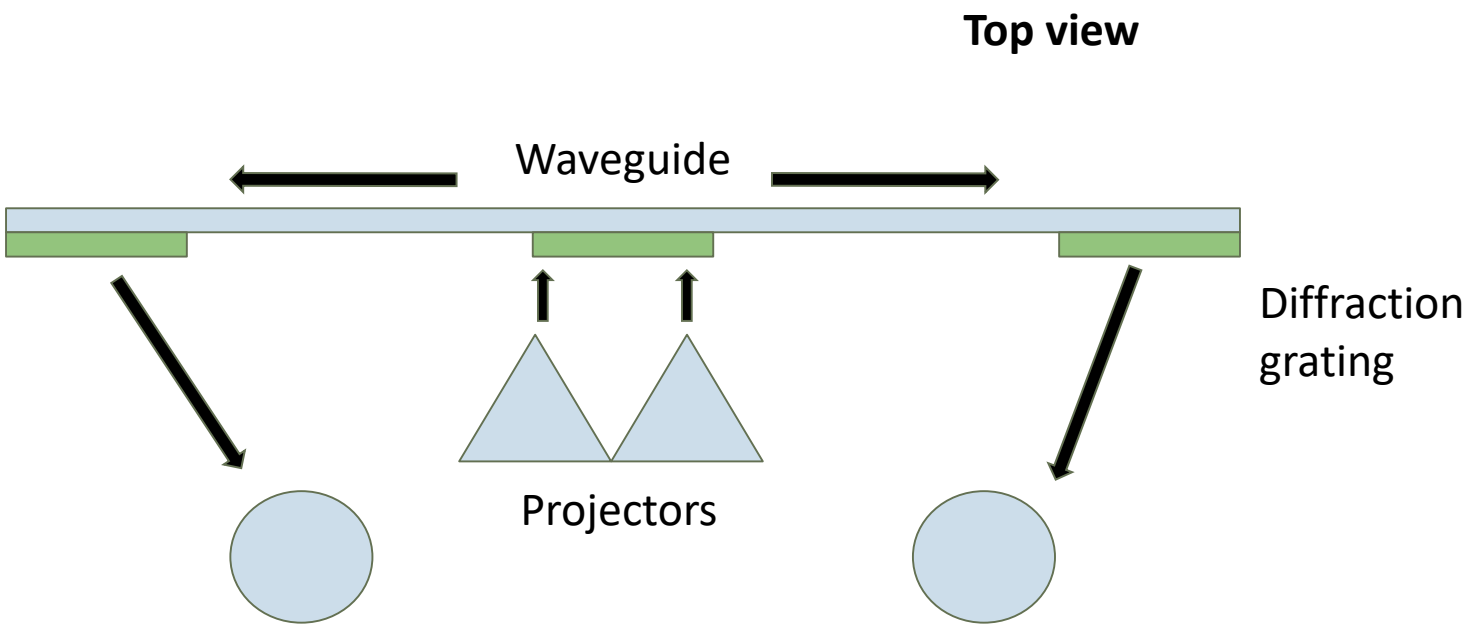
Types:

- Different shapes
- Diffractive
- Holographic
- Polarized
- Reflective, etc.

For AR applications: use diffractive or holographic techniques



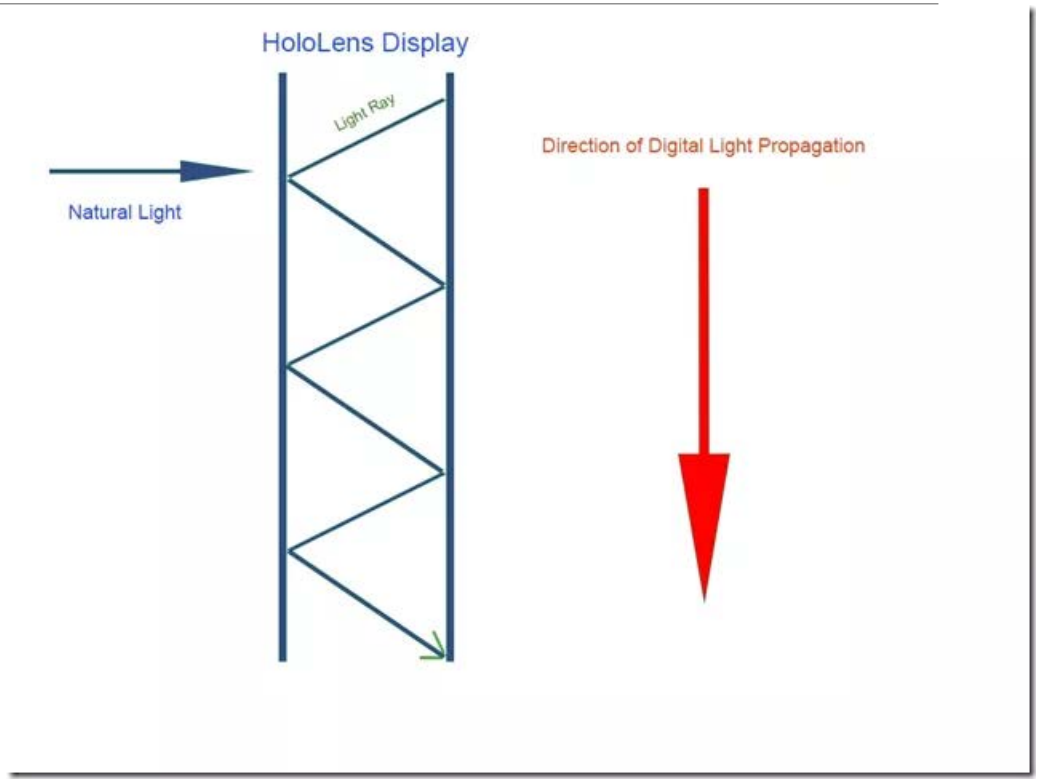
Hololens



Hololens — Waveguide

Lens = planar (holographic/diffractive) waveguide

Total internal reflection



http://www.imaginativeuniversal.com/blog/post/2015/10/17/how-hololens-displays-work.aspx

Hololens — Diffractive extraction

Three diffractive elements for RGB

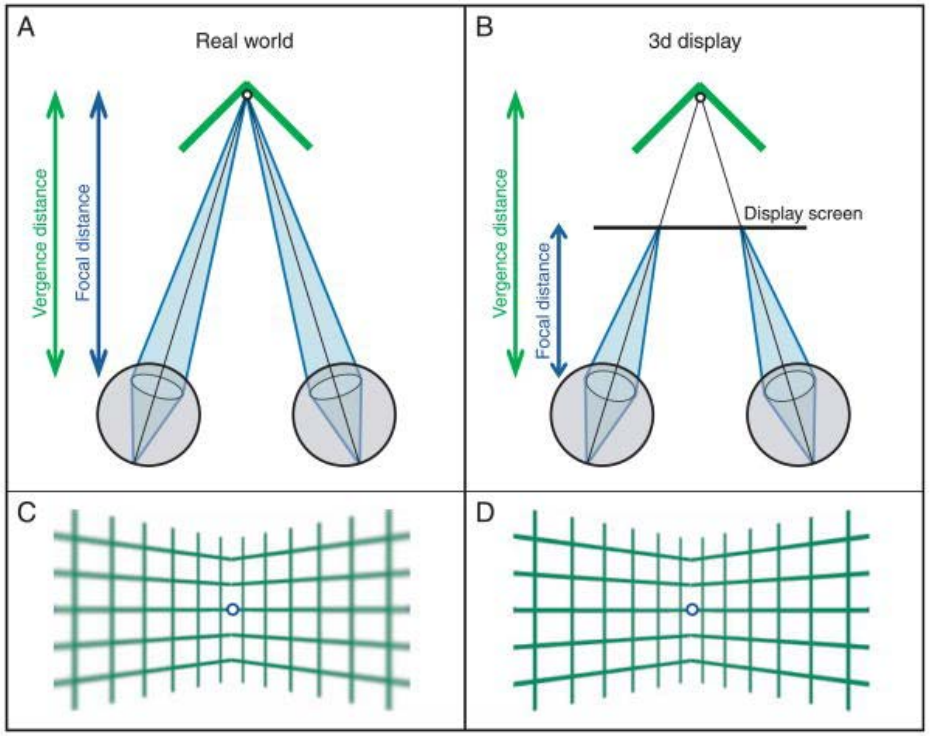
https://mspoweruser.com/secrets-of-hololens-optics-revealed/

Hololens keeping every object in focus:

Magic Leap

- What makes Magic Leap's display unique?
  - It resolves the vergence-accommodation conflict

Vergence-Accommodation Conflict



Hoffman, D. M., Girshick, A. R., Akeley, K., & Banks, M. S. (2008). Vergence–accommodation conflicts hinder visual performance and cause visual fatigue. *Journal of Vision*, *8*(3), 33.1–3330. http://doi.org/10.1167/8.3.33

Magic Leap & Vergence-Accommodation

- ~20% patents directly relate to accommodation
  - ~51% to optics

Magic Leap & Vergence-Accommodation

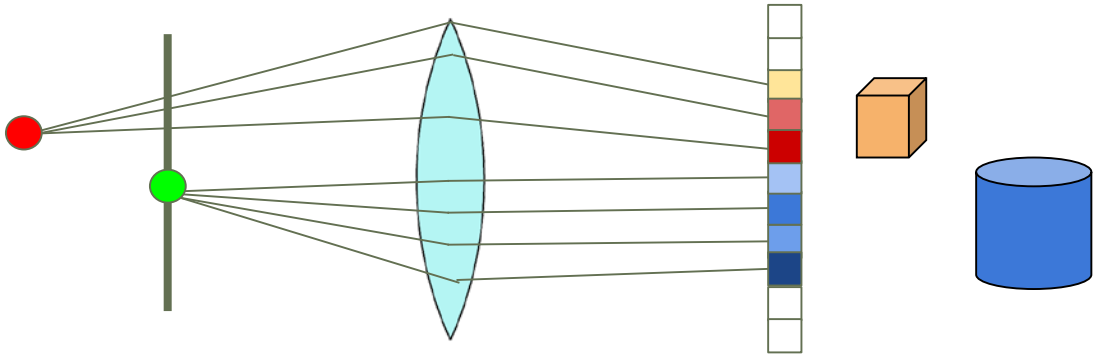
- Reviews & Interviews

  “Magic Leap’s solution is an optical system that creates the illusion of depth in such a way that your eyes focus far for far things, and near for near, and will converge or diverge at the correct distances”

  - *Wired Magazine*

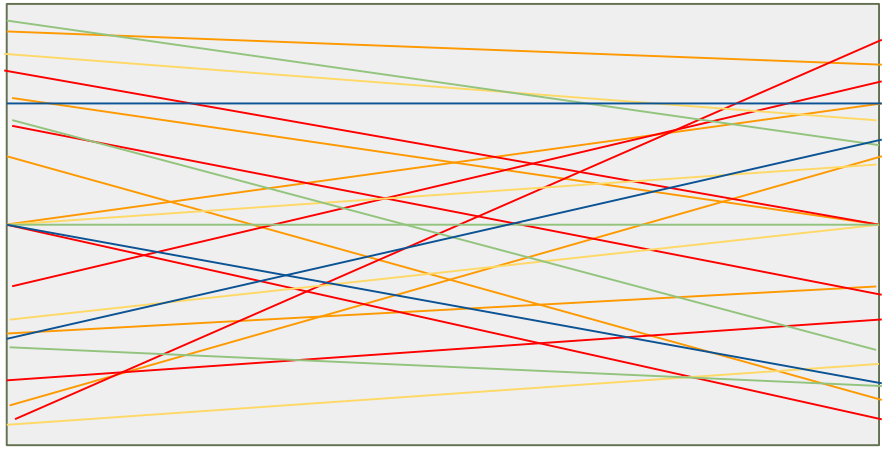
How Would it Work?

- Generate a light field in the eye-box
- *Virtual* rays will be indistinguishable from *real* rays



What is a Light Field?

A function describing the radiance of light at every point (x, y, z) in space, in every direction (θ, ϕ)



Required Hardware

- Diffraction Optical Elements
- Reflectors
- Optical fibers
- Mini-projectors
- Eye-tracking