# CSE 190: Virtual Reality Technologies

LECTURE #17: LIGHTFIELD TECHNOLOGY

# Announcements

Project 3 due this Sunday, May 31st at 11:59pm

Next Monday: Discussion with TA Andrew and instructor

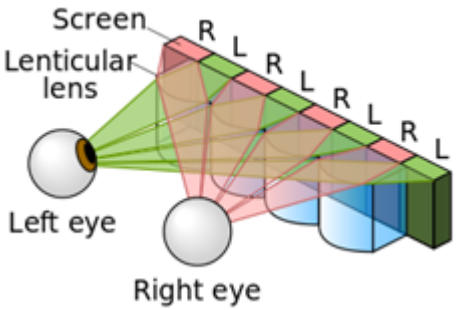
- Topic: final exam

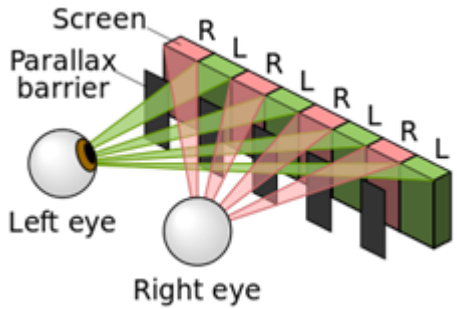
Today's VR app presentations:

- Mitchell Zhang: VRaccoon
- Kevin Thai: Nintendo LABO VR

# Reminder: Autostereo Displays

Lenticular screen




Parallax barrier

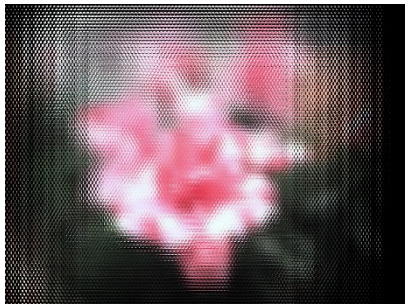
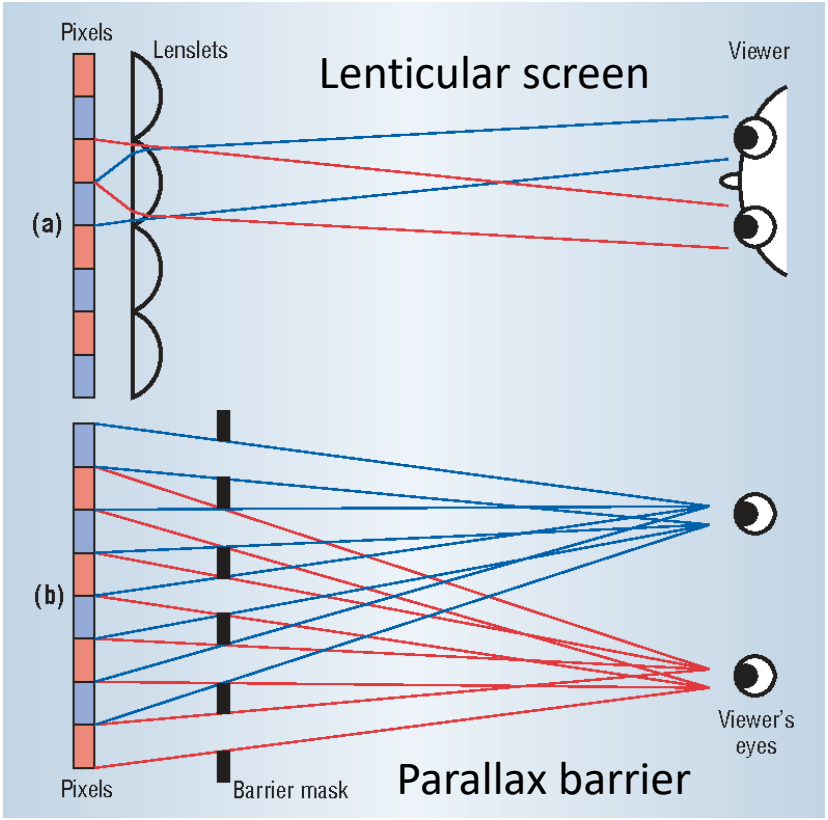
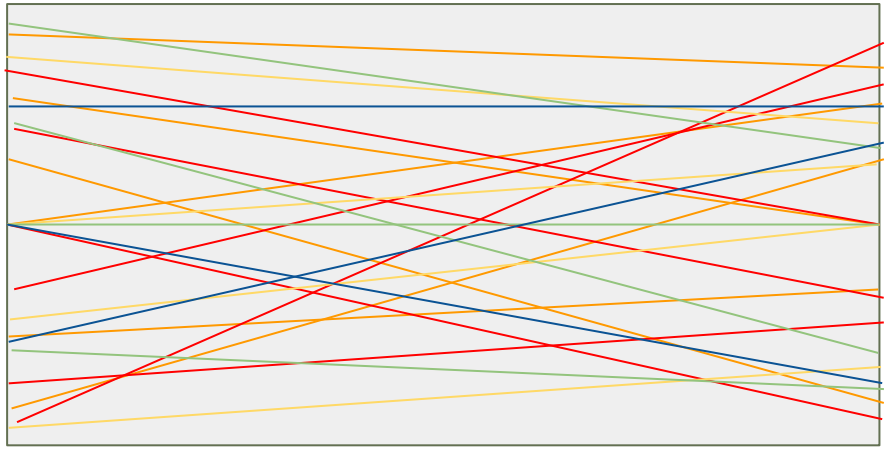


*Image without autostereo filter*



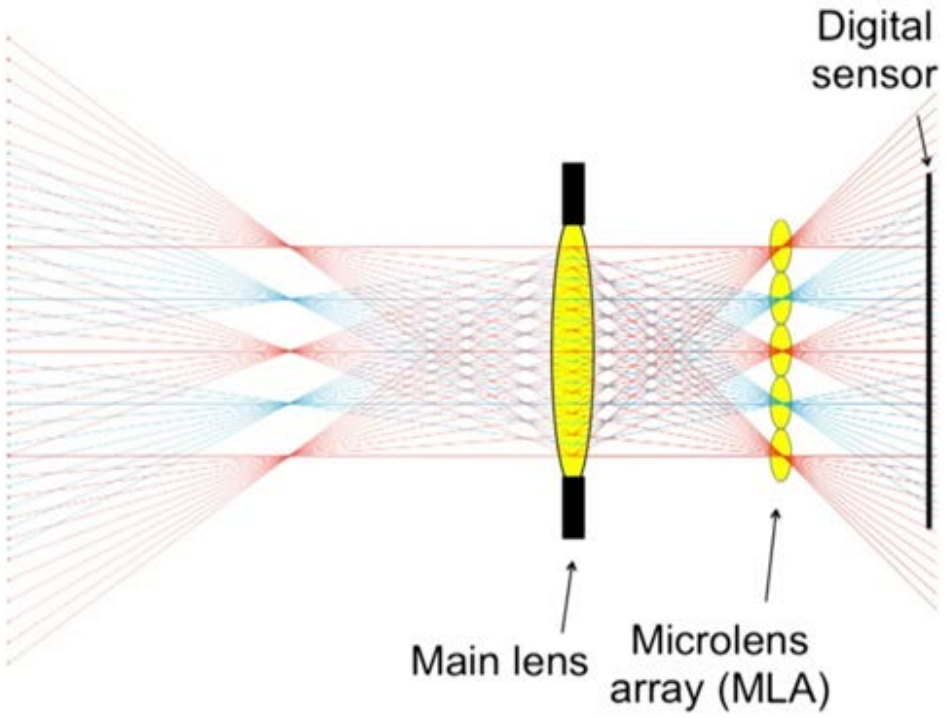
# What is a Light Field?

A function describing the radiance of light at every point (x, y, z) in space, in every direction ($\theta$, $\phi$)

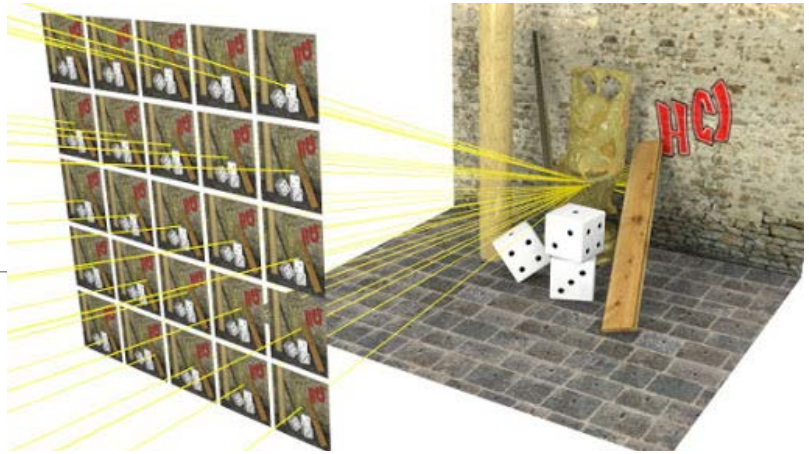


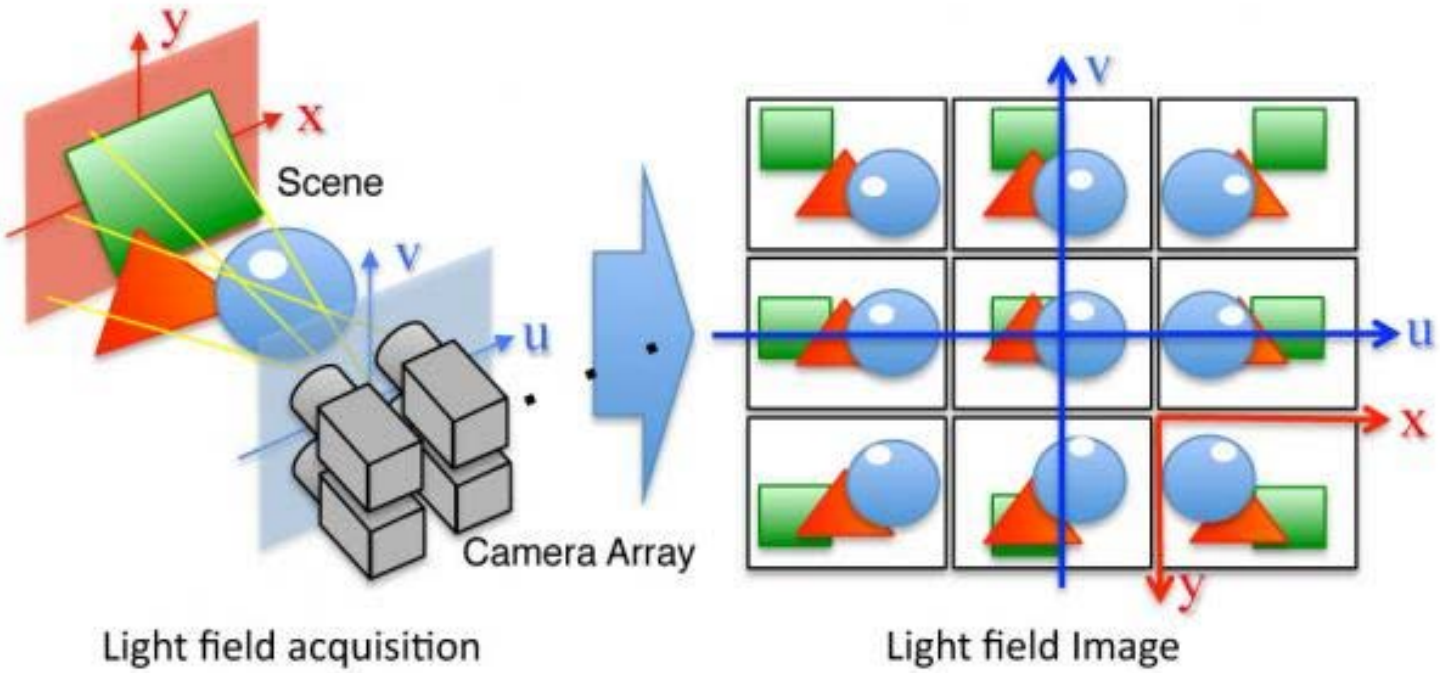
# Lightfield Cameras

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

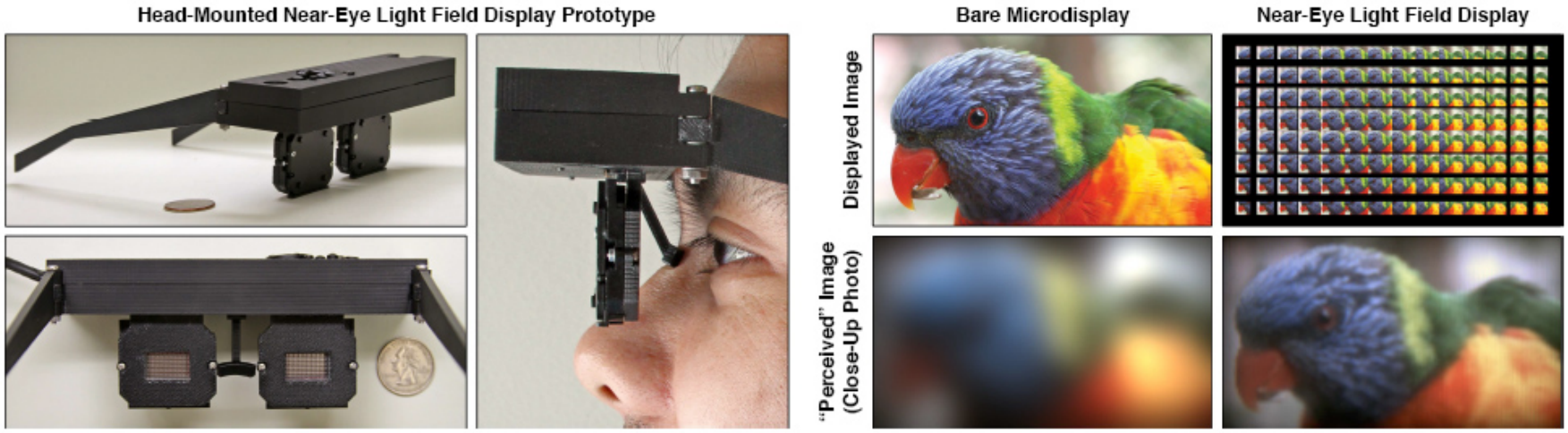



**Figure 1:** *Enabling thin, lightweight near-eye displays using light field displays. (Left) Our binocular near-eye display prototype comprises a pair of OLED panels covered with microlens arrays. This design enables a thin head-mounted display, since the black box containing driver electronics could 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

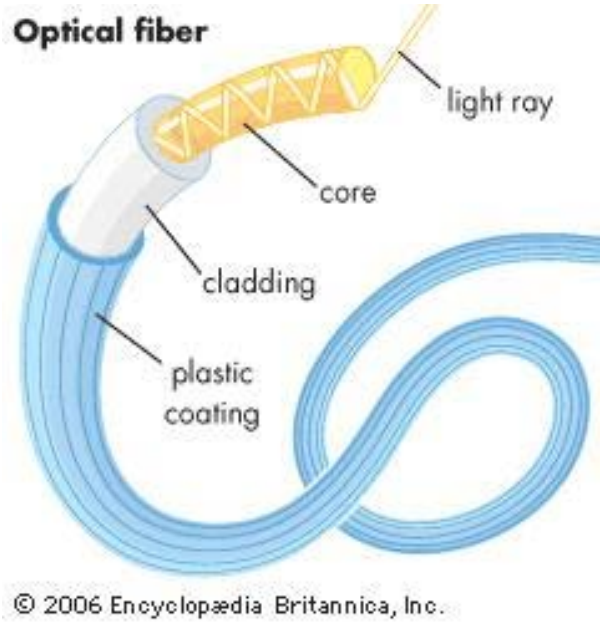
# Waveguides

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

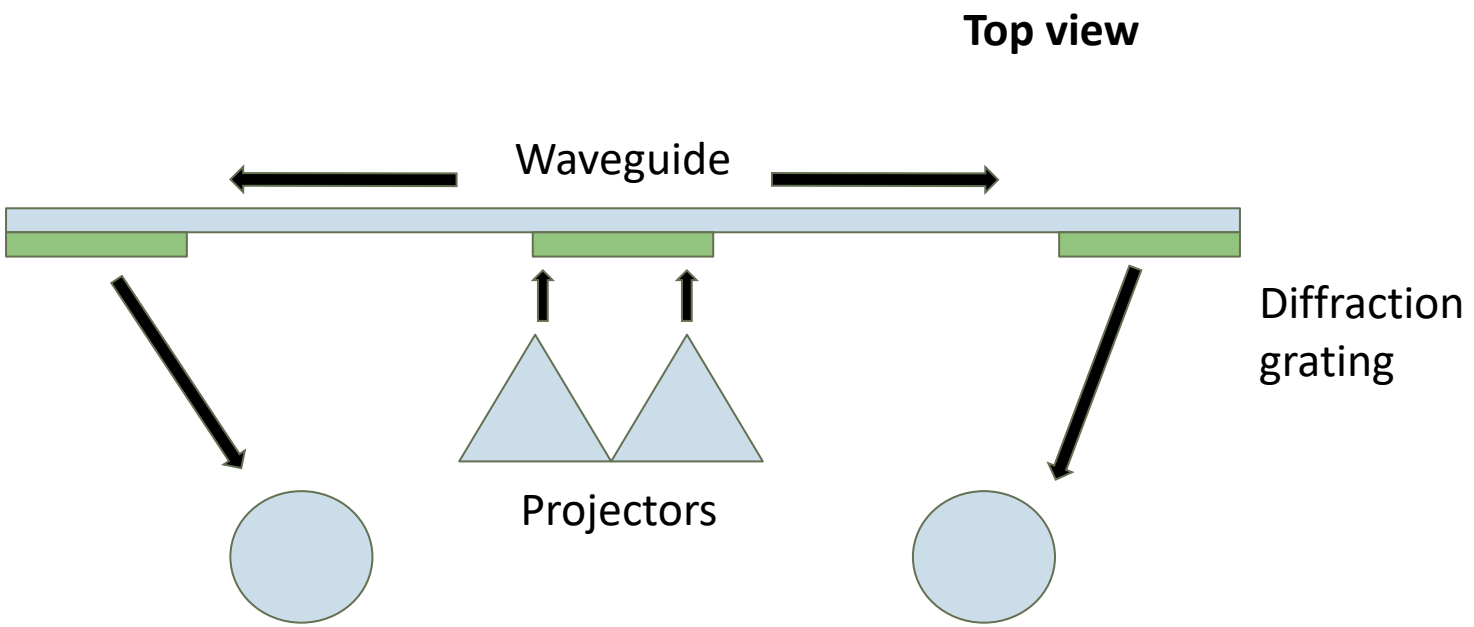
Types:

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

For AR applications: use diffractive or holographic techniques



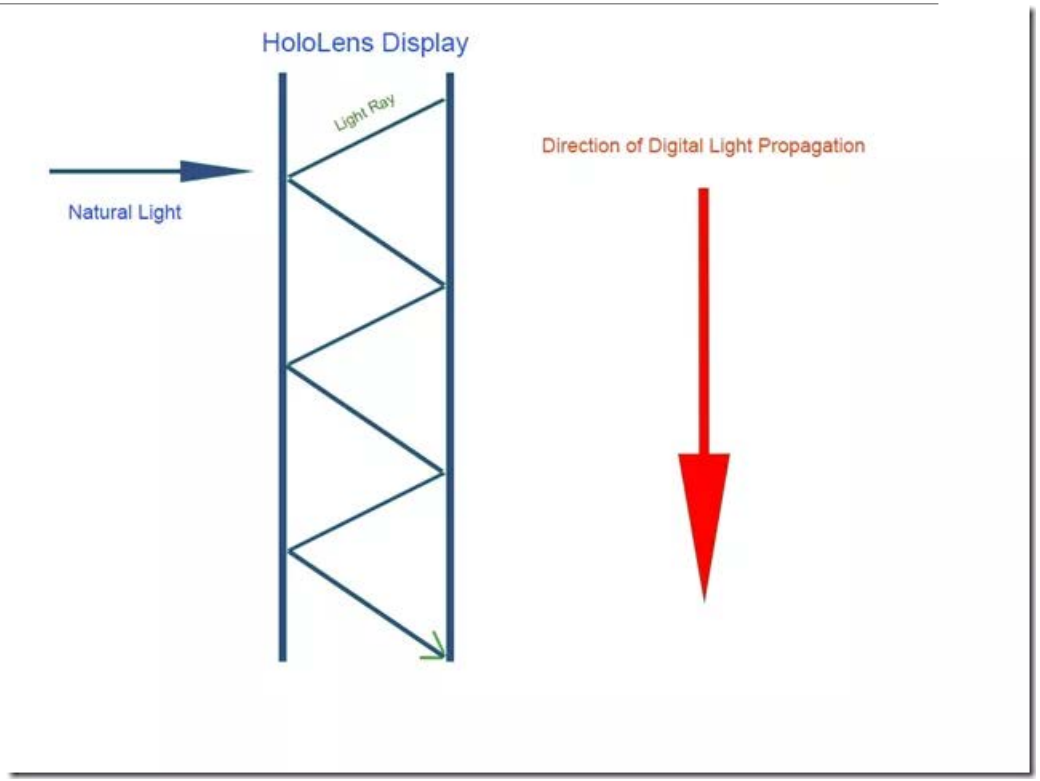
# Hololens



# 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

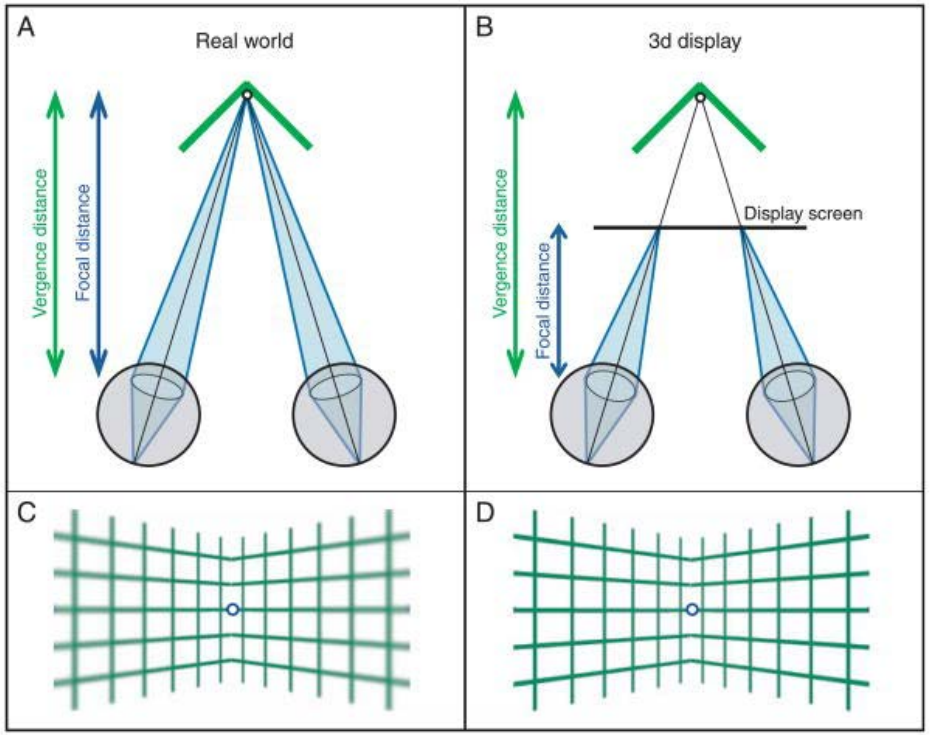
https://mspoweruser.com/secrets-of-hololens-optics-revealed/

# Hololens keeping every object in focus:

# Magic Leap Display Research

- 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

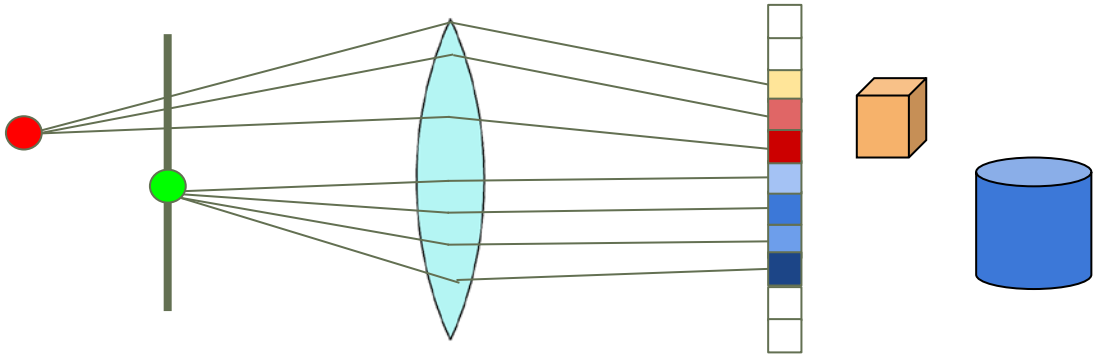
- Reviews & Interviews

  “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



# Required Hardware

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