

CSE 190: Virtual Reality Technologies

LECTURE #12: LIGHTFIELD TECHNOLOGY

Announcements

Homework project 3

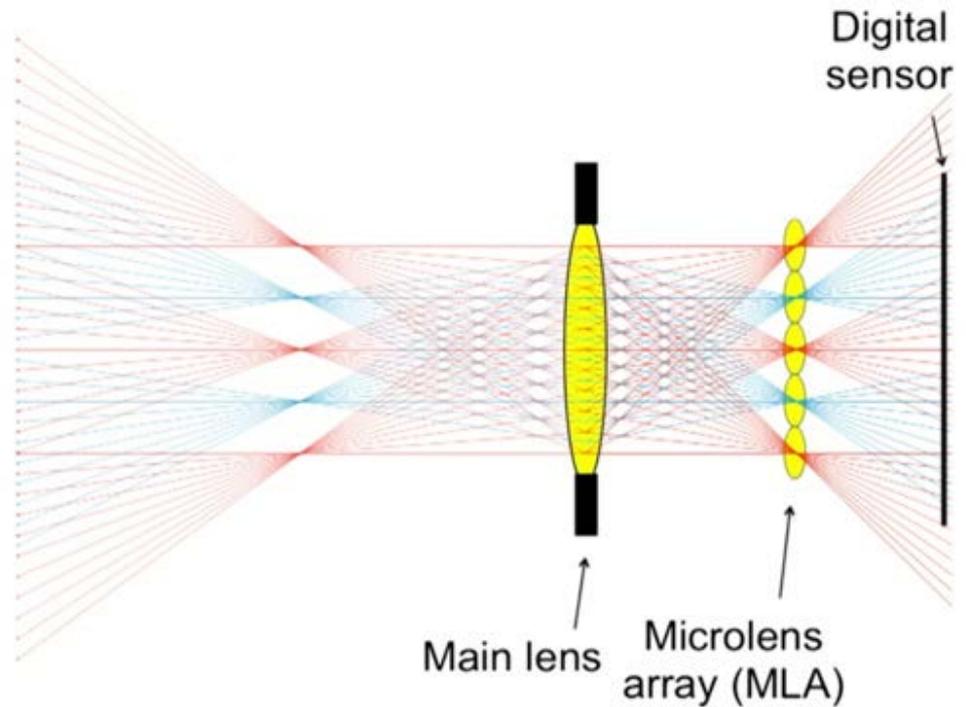
- Due Friday, May 17th at 2pm
 - To be demonstrated in VR lab B210
 - Upload code to TritonEd by 2pm

Midterm exam next Thursday, May 23rd

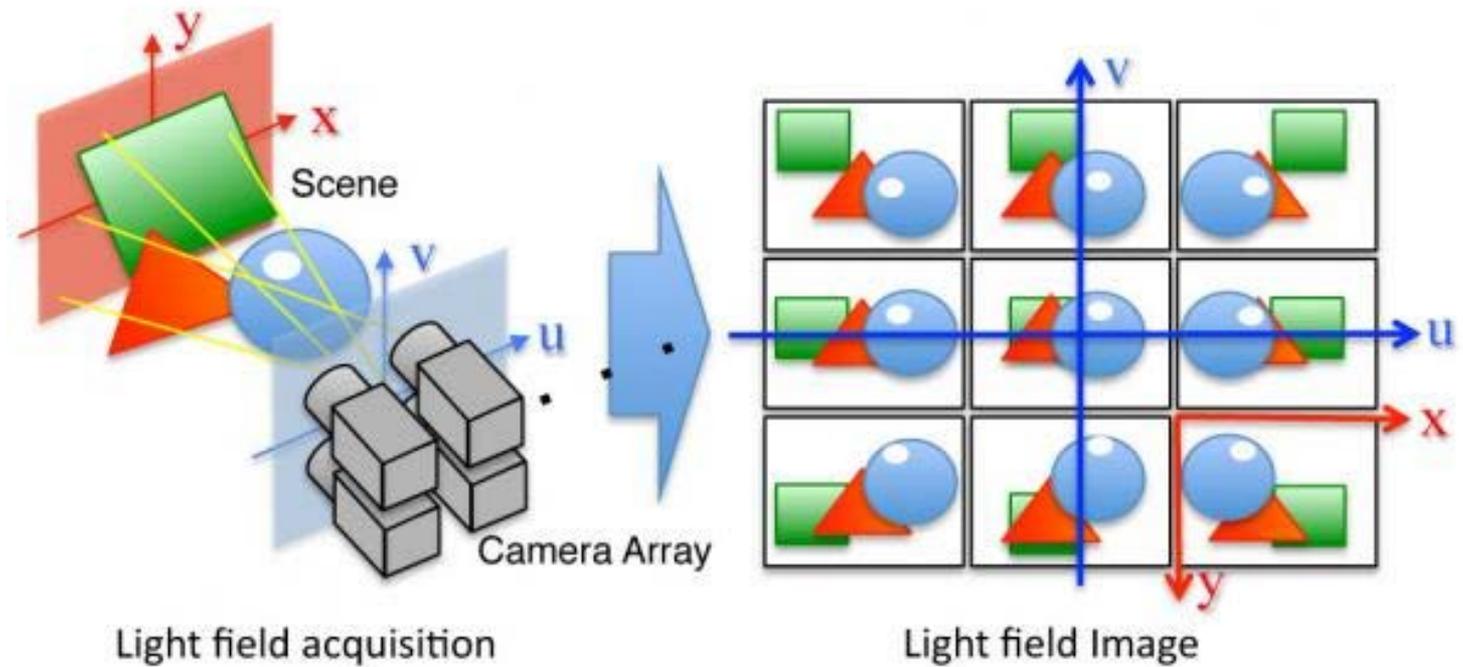
- In-class during lecture
- Closed-book
- Allowed: pen, pencil, eraser, ruler, scrap paper
- Follows the format of last two years' exams (can be found on course schedule)

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

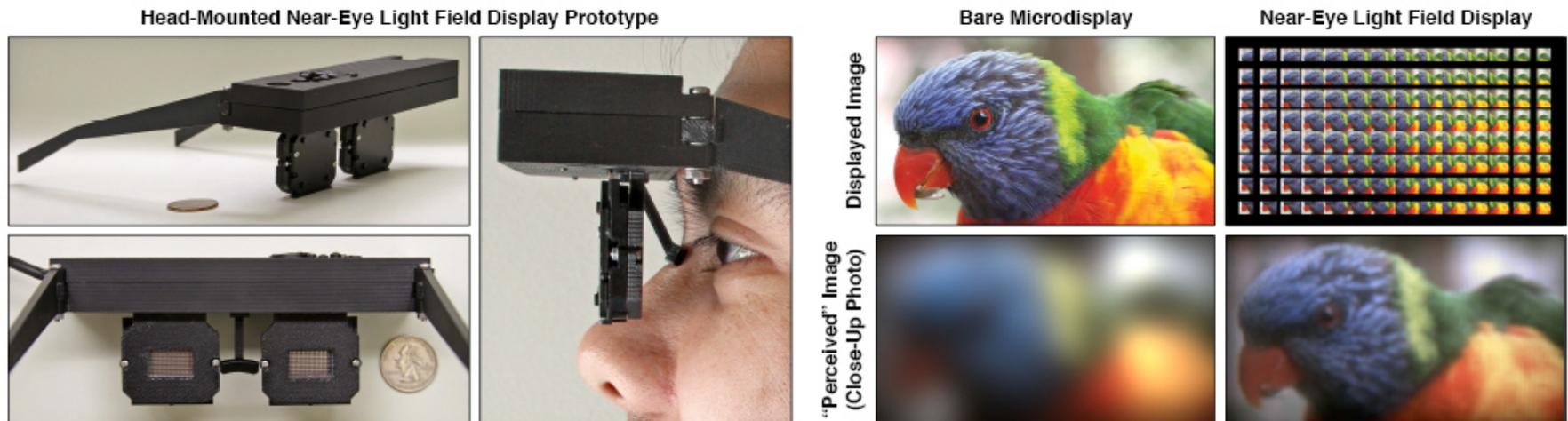


Figure 1: Enabling thin, lightweight near-eye displays using light field displays. (Left) Our binocular near-eye display prototype comprises a pair of OLED panels covered with microlens arrays. This design enables a thin head-mounted display, since the black box containing driver electronics could be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



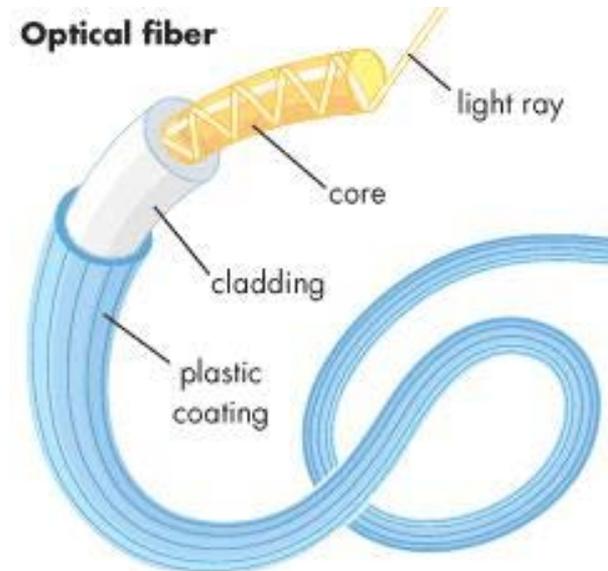
Waveguides

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

Types:

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

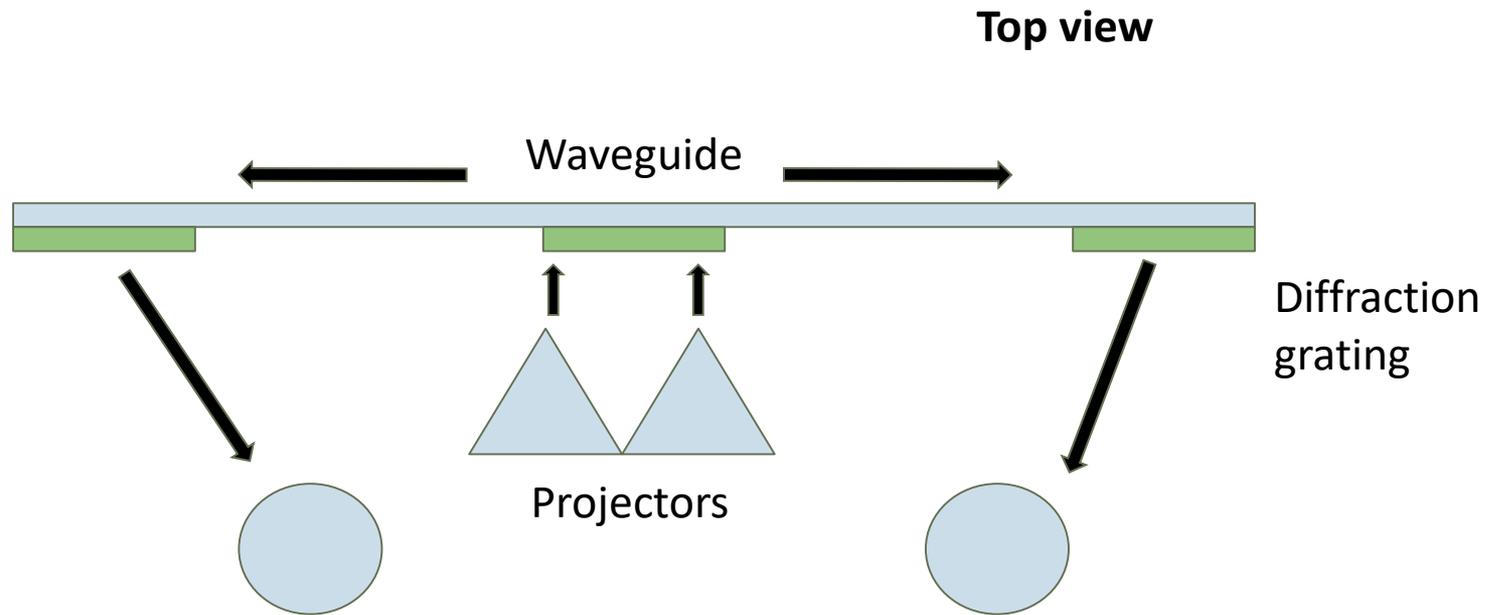
For AR applications: use diffraction or holographic techniques



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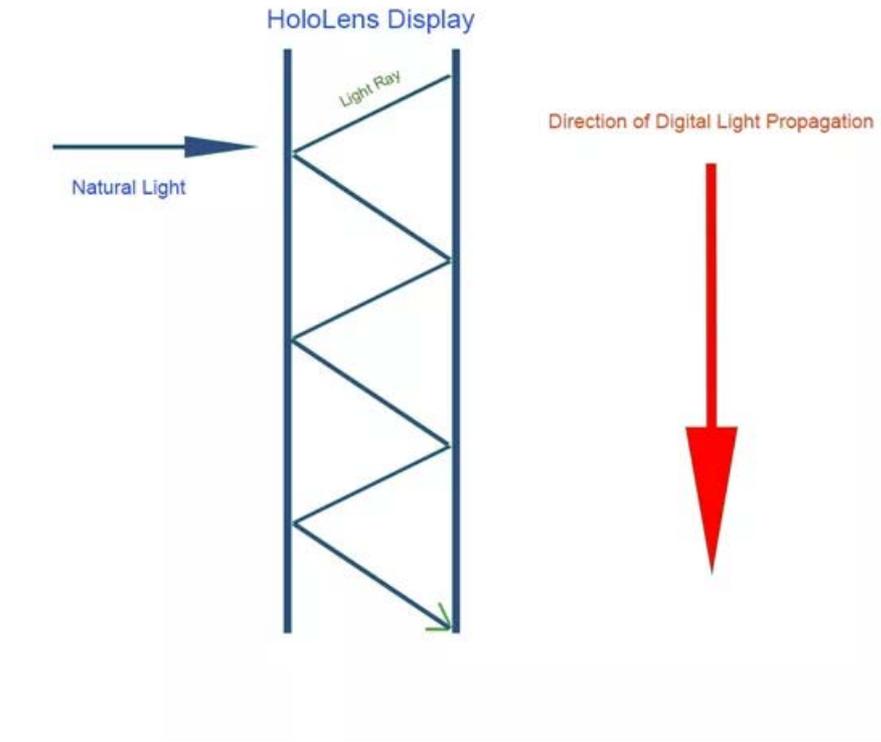


Hololens



Hololens — waveguide

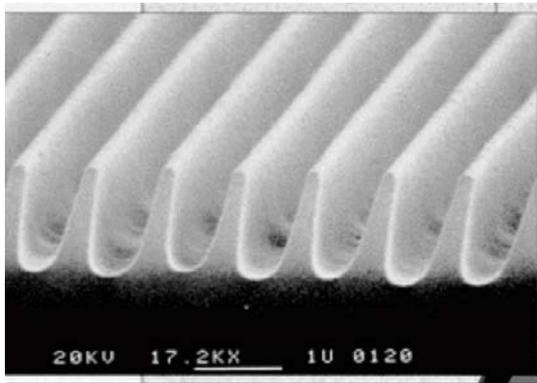
Lens = planar
(holographic/diffractive)
waveguide
Total internal reflection



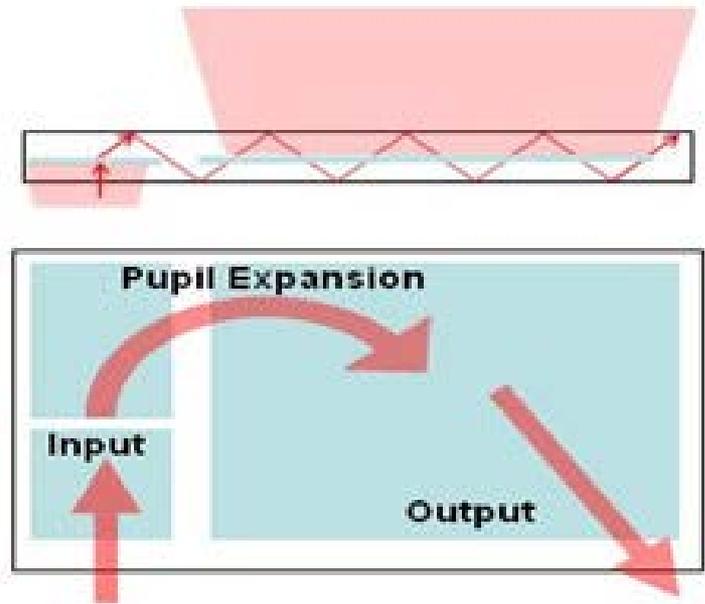
Hololens — diffractive extraction

Diffractive grating redirects light onto eye

Field of view



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



<http://www.displaydaily.com/articles/446-sponsored-articles/14132-waveguide-based-displays-maturing-for-augmented-reality-applications>

Hololens — diffractive extraction

Three diffractive elements
for RGB

- Maybe fourth for luminance





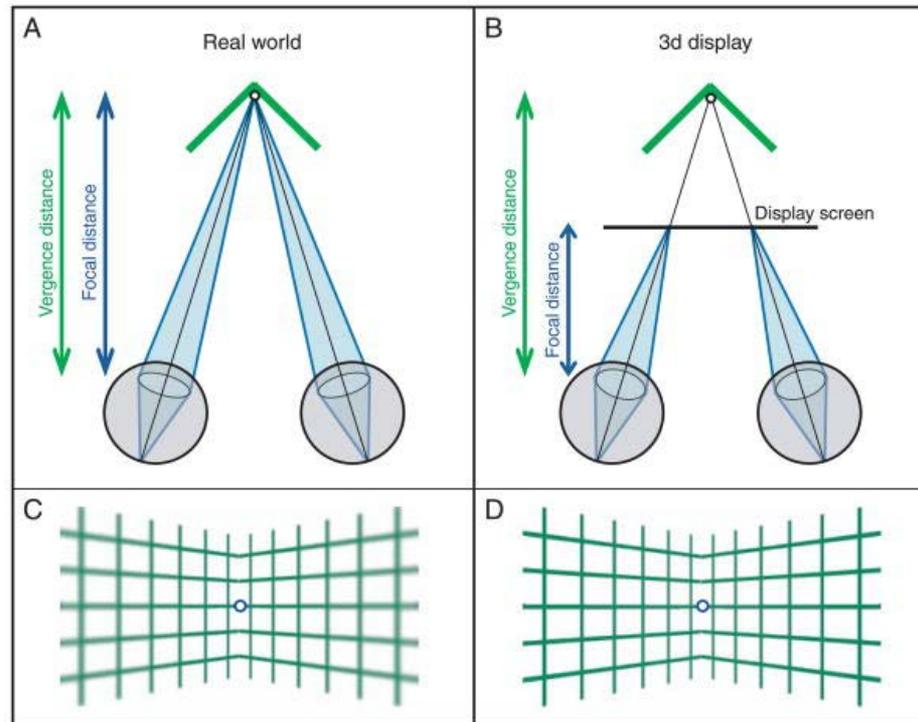
Hololens keeping every object in focus:



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

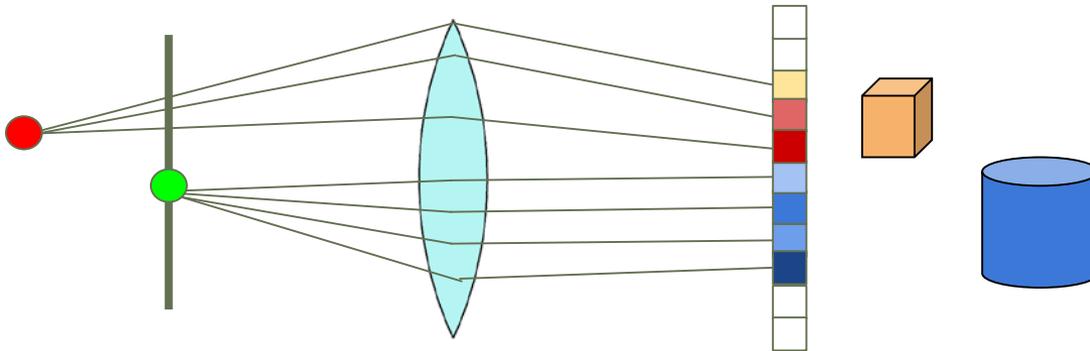
- Reviews & Interviews

“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



How Would it Work?

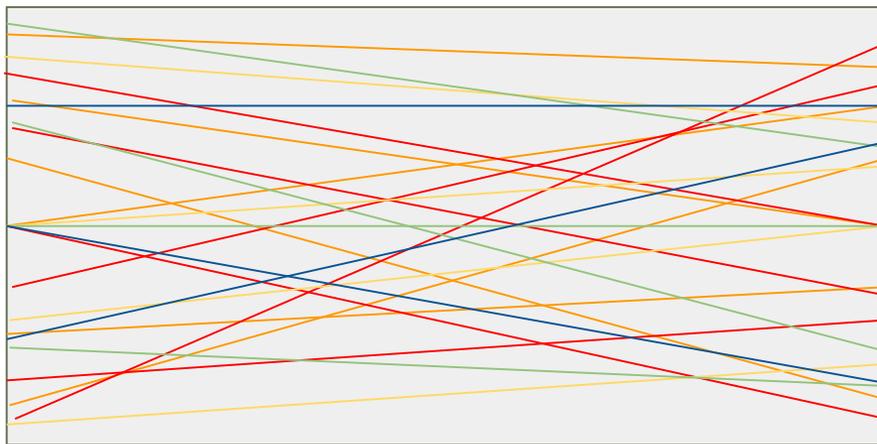
“Your brain is like a graphics processor. We basically tried to clone what that signal is, we made a digital version of that, and we talk to the GPU of the brain.”

- *Magic Leap CEO Rony Abovitz*

Kelly, K. (2016, April). The Untold Story of Magic Leap, the World's Most Secretive Startup. *Wired*.

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)



What is a Light Field?

“A light field encompasses all the light rays at every point in space travelling in every direction.”

- *Magic Leap Patent Application (2015)*

The Hardware?

- Diffraction Optical Elements

“Inclusion of one or more DOEs... may advantageously allow steering of beams emanating from the face of the planar waveguide and control over focus or focal depth.”

- *US patent application no. 20,150,016,777*

The Hardware?

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