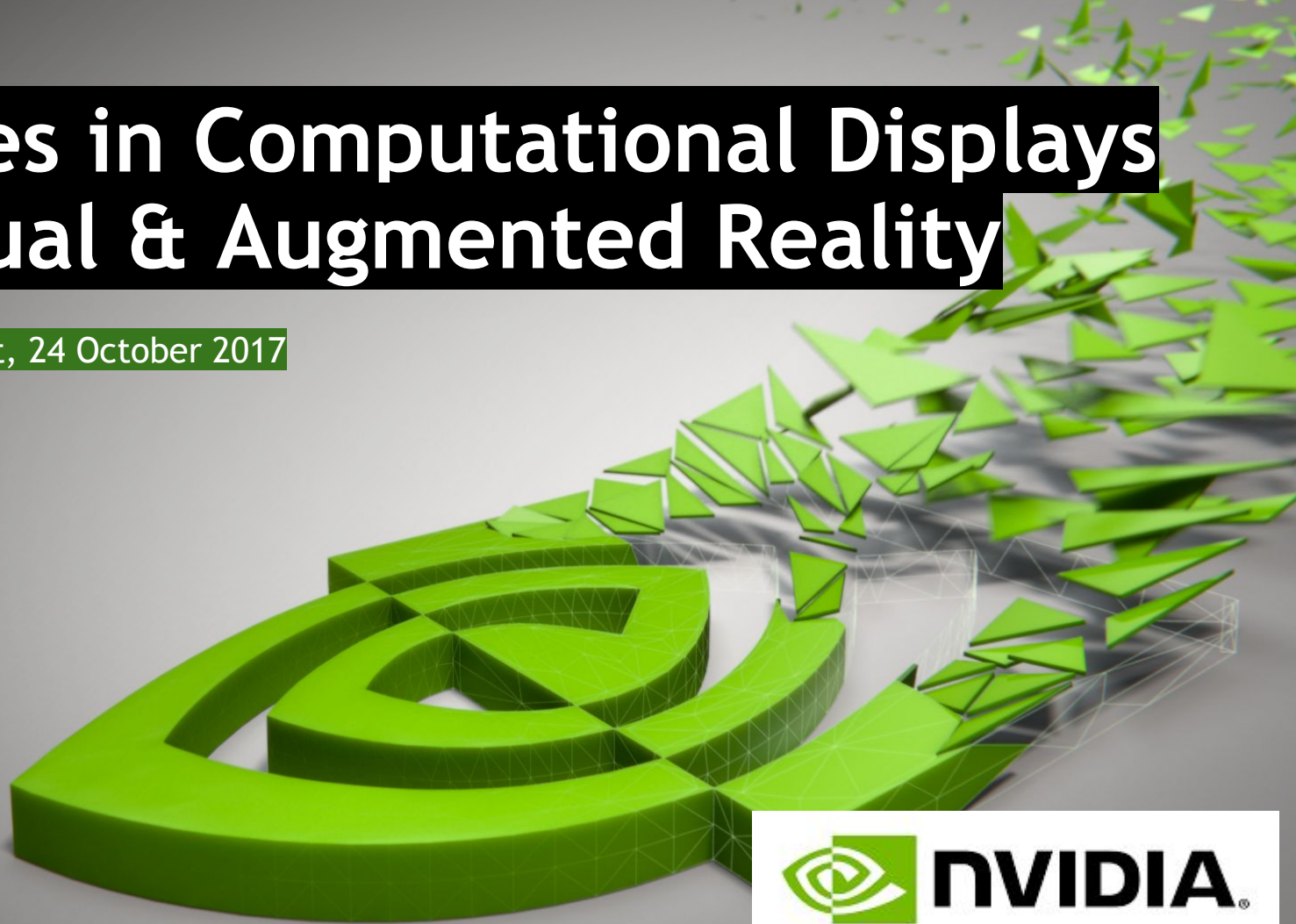


Advances in Computational Displays for Virtual & Augmented Reality

Presenter: Kaan Akşit, 24 October 2017

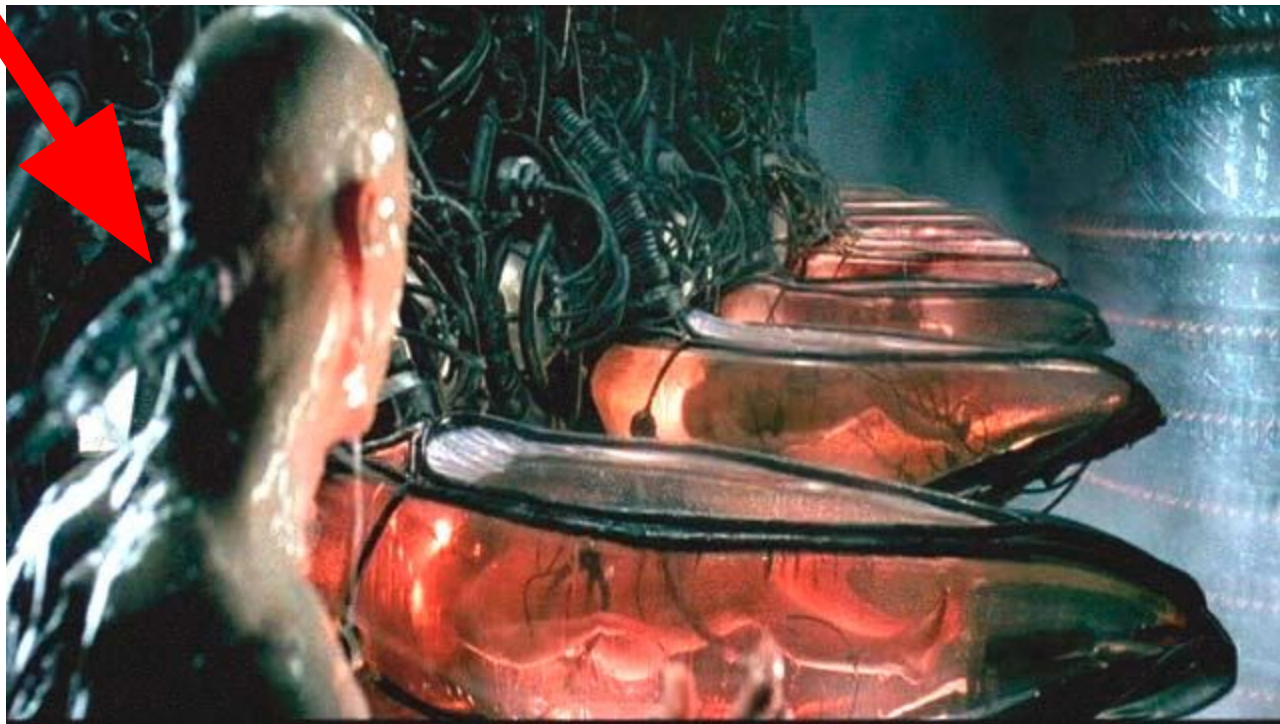


Kaan Akşit

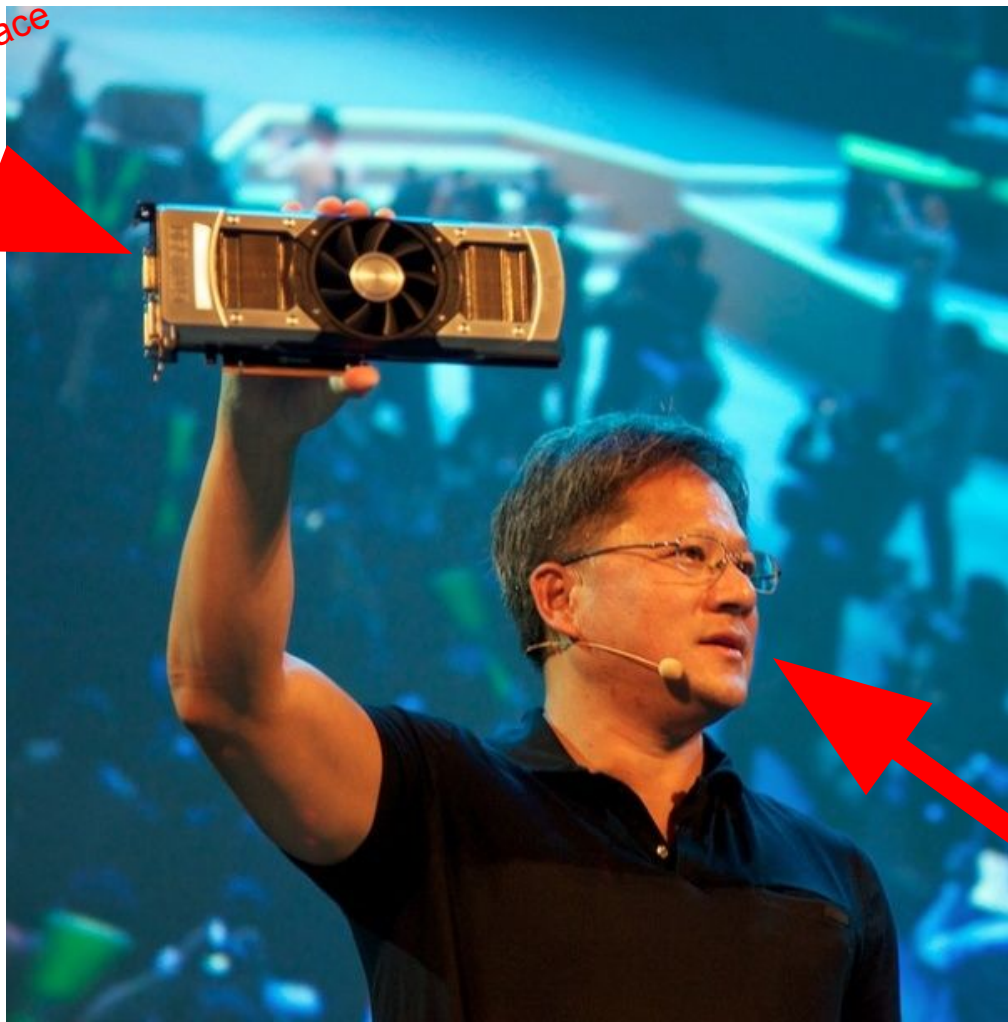


Basics

Machine-to-brain interface

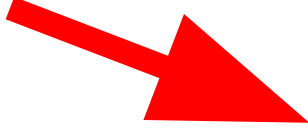


Machine-to-display interface

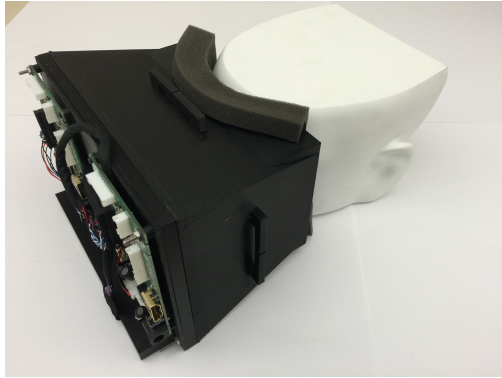


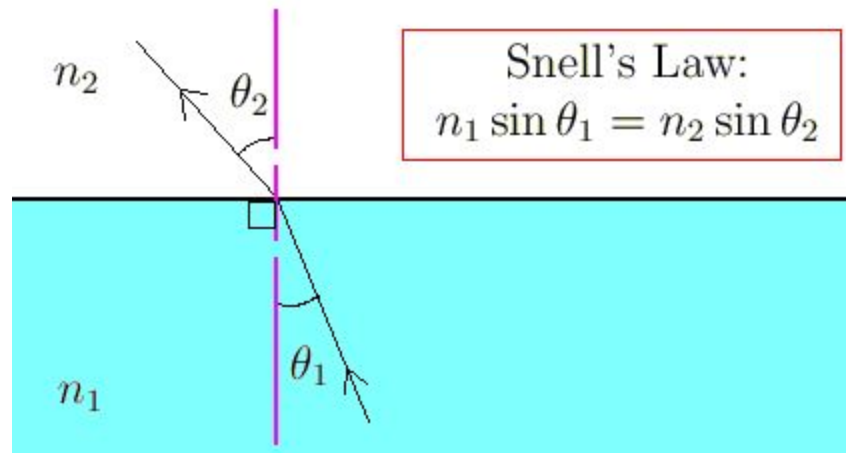
Our CEO
Jensen Huang

Nvidia's
Machine-to-eye interfaces

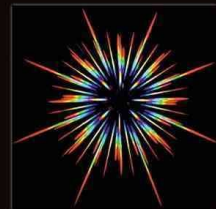


Head-Mounted Near-Eye Light Field Display Prototype

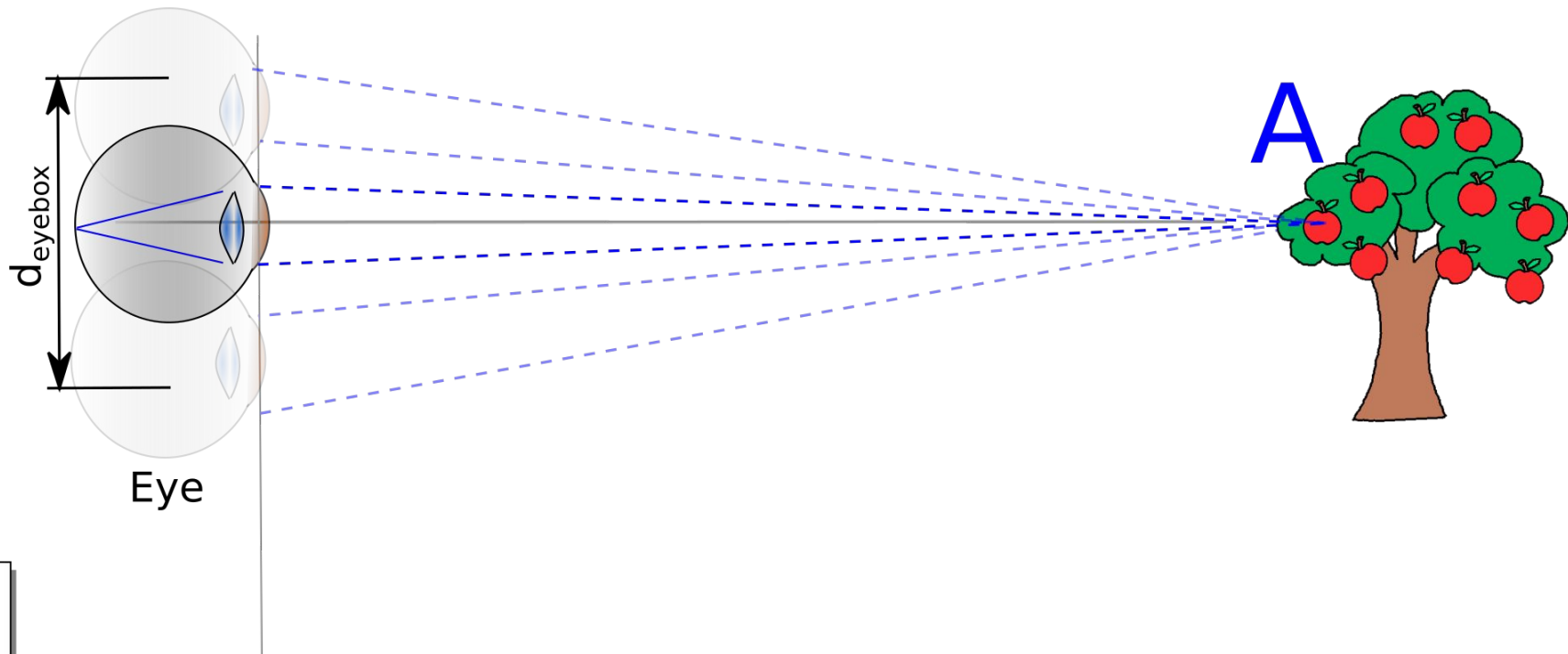


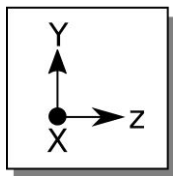
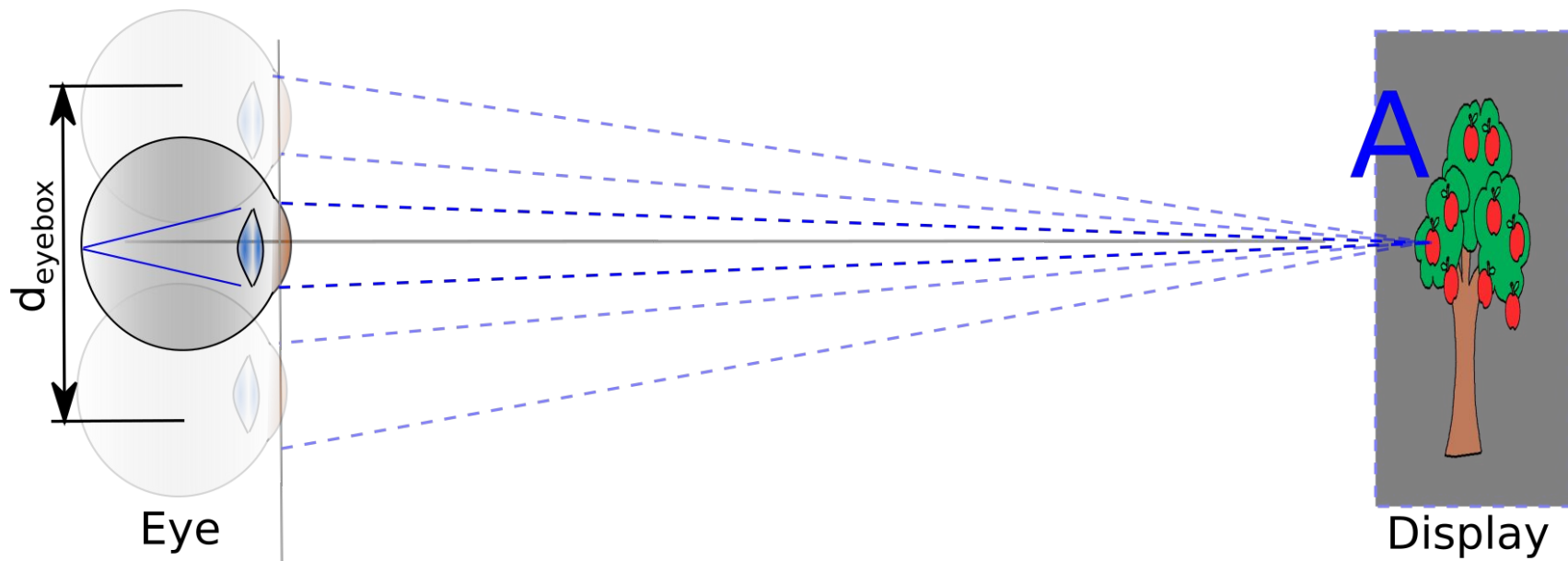


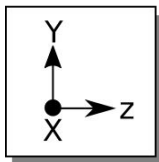
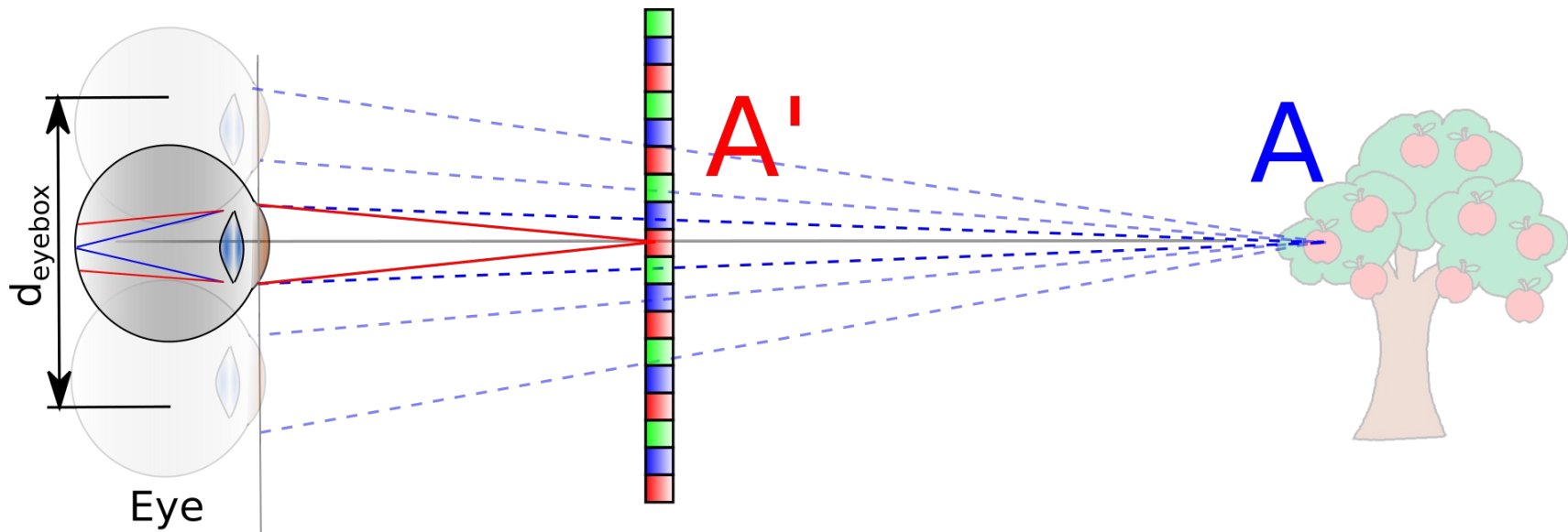
OPTICS
FIFTH EDITION

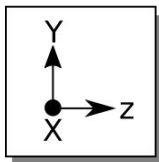
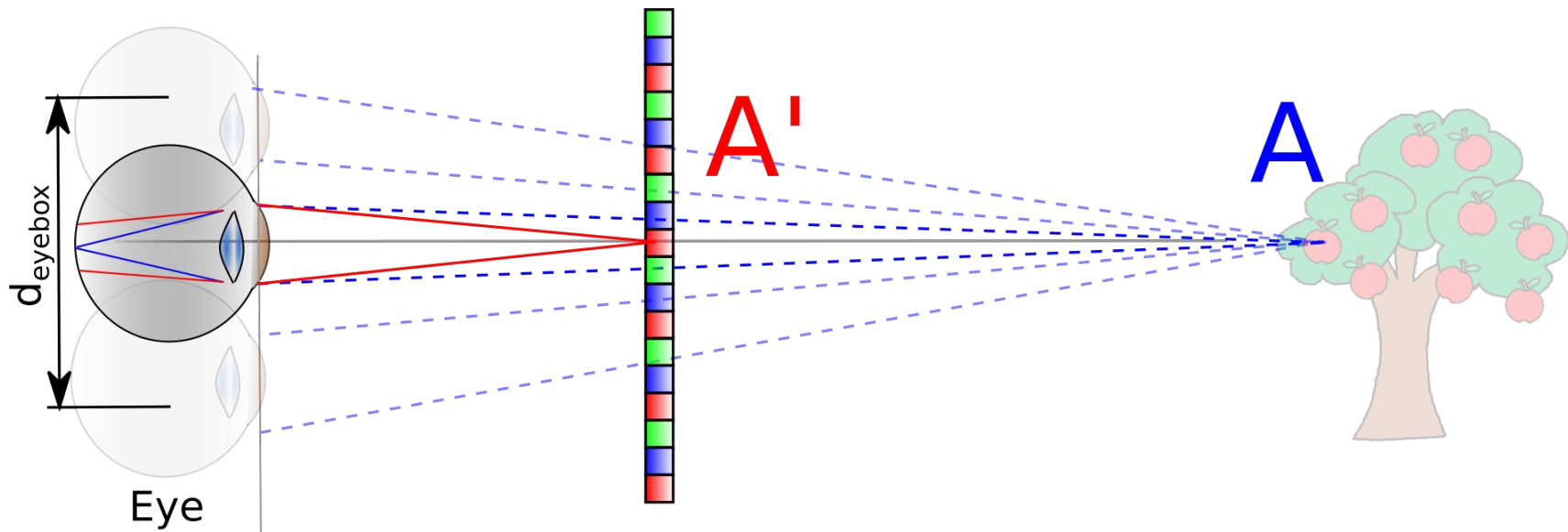


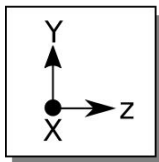
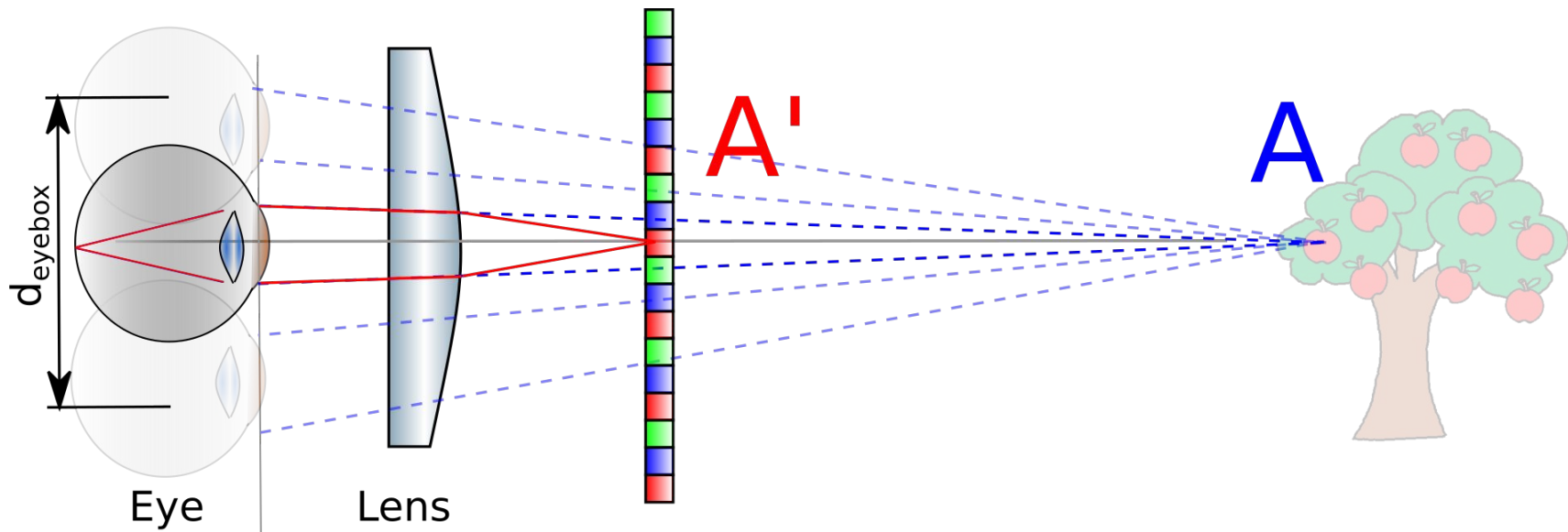
EUGENE HECHT







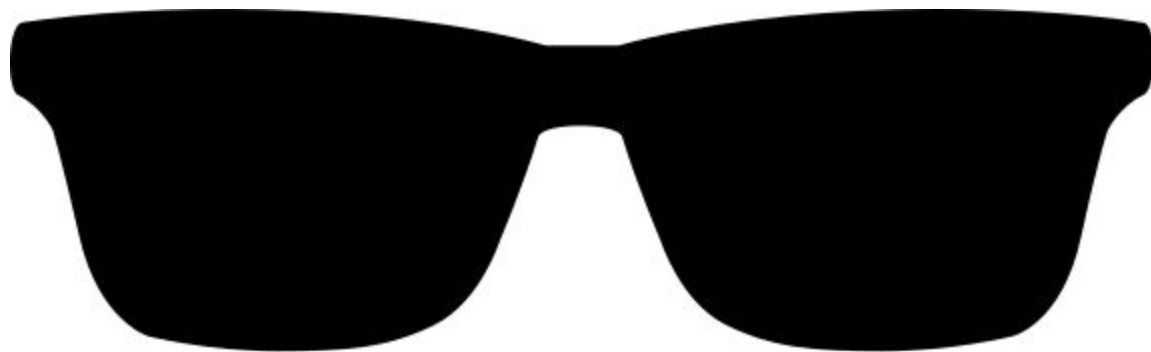




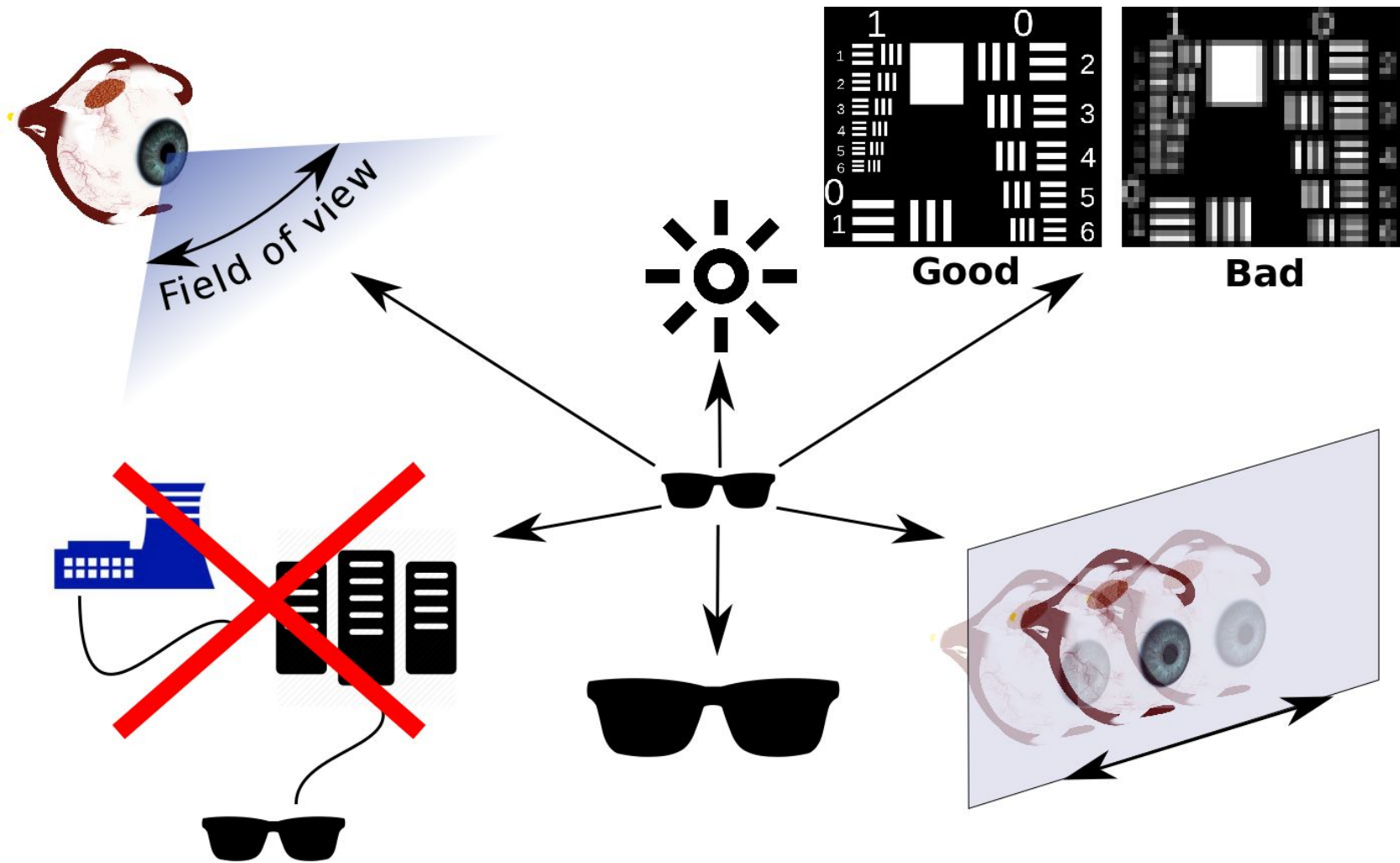
Today

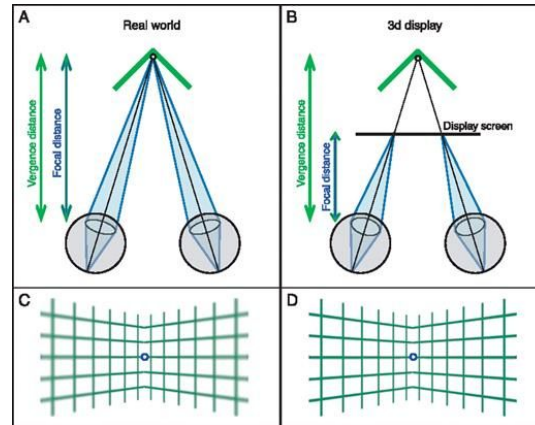
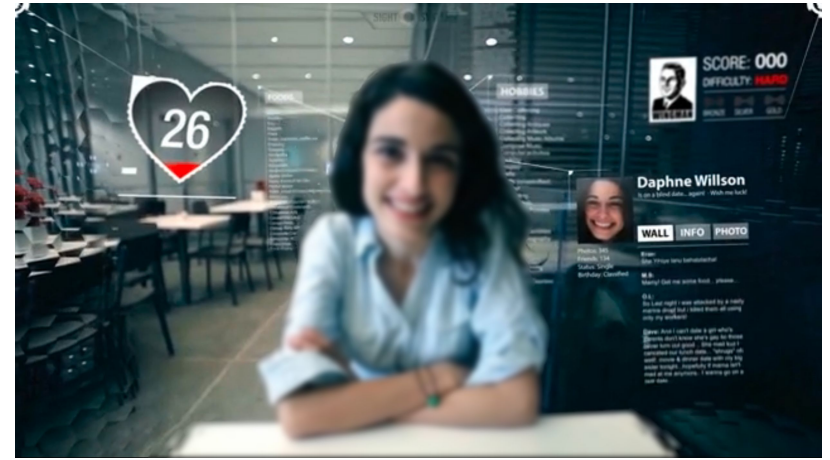


Challenges?



[Kramida et al. 2016, Hong Hua et al. 2017]

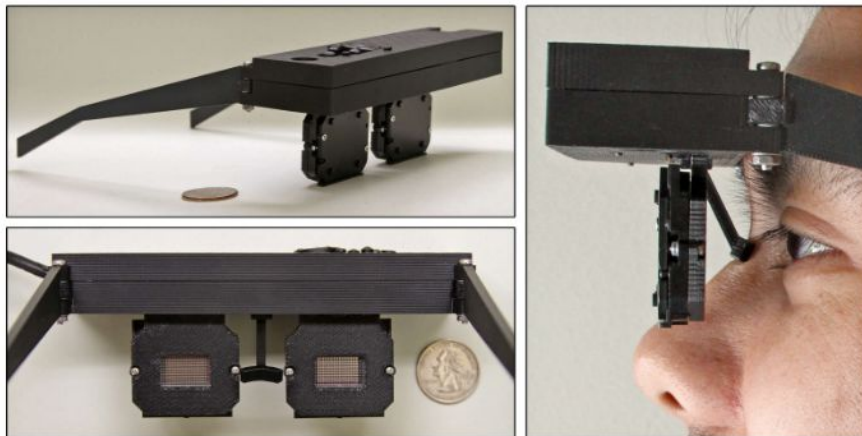




[Hoffman et al. 2008]

Nvidia's computational displays

Head-Mounted Near-Eye Light Field Display Prototype

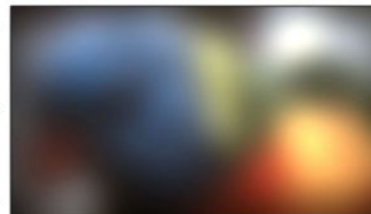


Bare Microdisplay

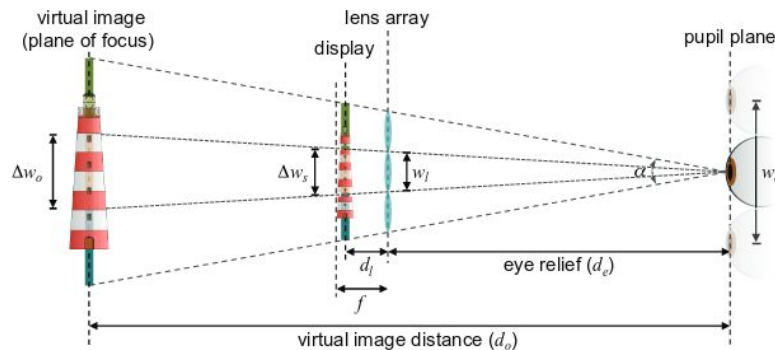
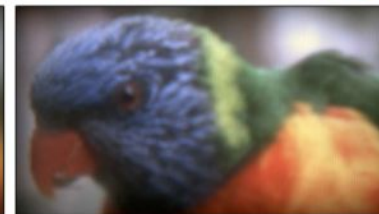
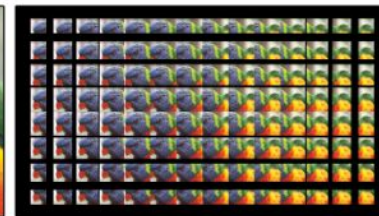


Displayed Image

"Perceived" Image
(Close-Up Photo)

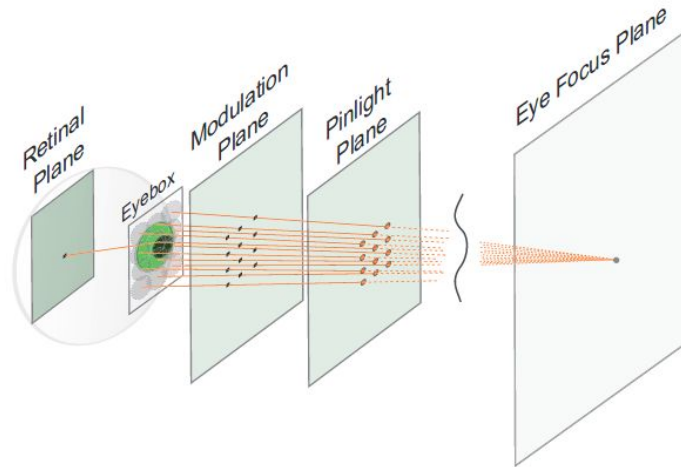
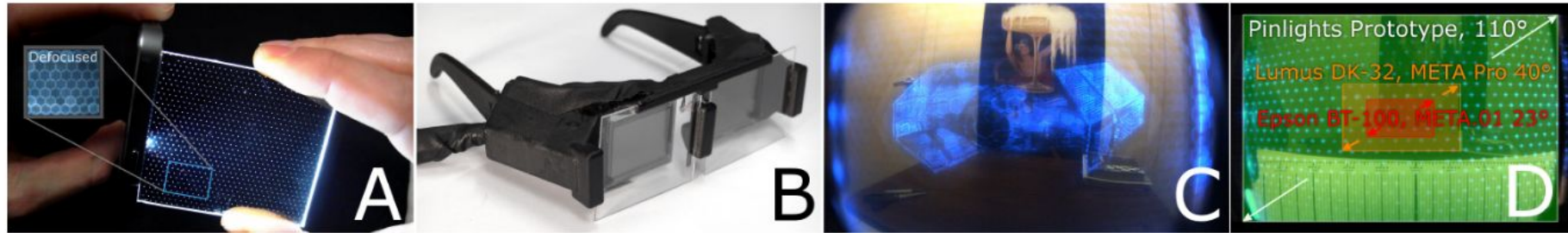


Near-Eye Light Field Display



SIGGRAPH 2014, SIGGRAPH 2014 (E-TECH)

Andrew Maimone, Douglas Lanman, Kishore Rathinavel, Kurtis Keller, David Luebke, and Henry Fuchs. "Pinlight displays: wide field of view augmented reality eyeglasses using defocused point light sources." In *ACM SIGGRAPH 2014 Emerging Technologies*, p. 20. ACM, 2014.



Lanman
and Luebke
2013

Maimone et
al. 2014

SIGGRAPH 2014, SIGGRAPH 2014 (E-TECH)

Felix Heide, Douglas Lanman, Dikpal Reddy, Jan Kautz, Kari Pulli, and David Luebke. "Cascaded displays: spatiotemporal superresolution using offset pixel layers." *ACM Transactions on Graphics (TOG)* 33, no. 4 (2014): 60.

Cascaded LCD Prototype



Conventional Display



Cascaded Display

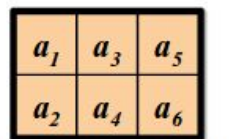


Factorizations

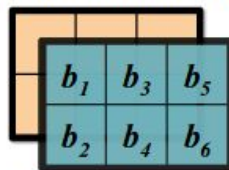
Layer 1



Layer 2



Conventional Display



Cascaded Display



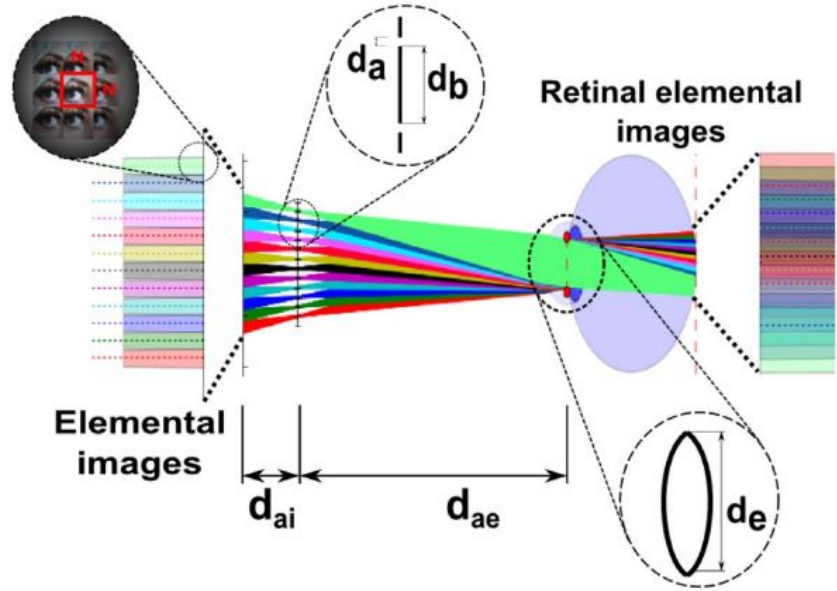
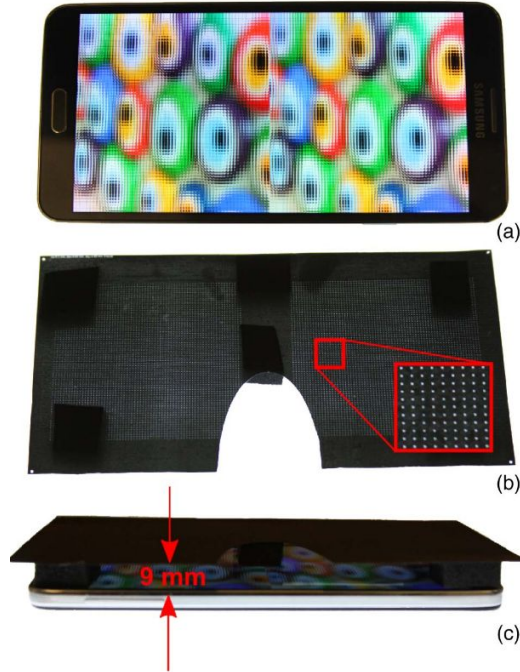
Subpixel Fragments

Lanman
and Luebke
2013

Maimone et
al. 2014

Heide et al.
2014

Kaan Akşit, Jan Kautz, and David Luebke. "Slim near-eye display using pinhole aperture arrays." *Applied optics* 54, no. 11 (2015): 3422-3427.



Lanman
and Luebke
2013

Maimone et
al. 2014

Heide et al.
2014

Akşit et al.
2015

SIGGRAPH ASIA 2016, SIGGRAPH 2016 (E-TECH)

Anjul Patney, Joohwan Kim, Marco Salvi, Anton Kaplanyan, Chris Wyman, Nir Benty, Aaron Lefohn, and David Luebke. "Perceptually-based foveated virtual reality." In *ACM SIGGRAPH 2016 Emerging Technologies*, p. 17. ACM, 2016.



Lanman
and Luebke
2013

Maimone et
al. 2014

Heide et al.
2014

Akşit et al.
2015

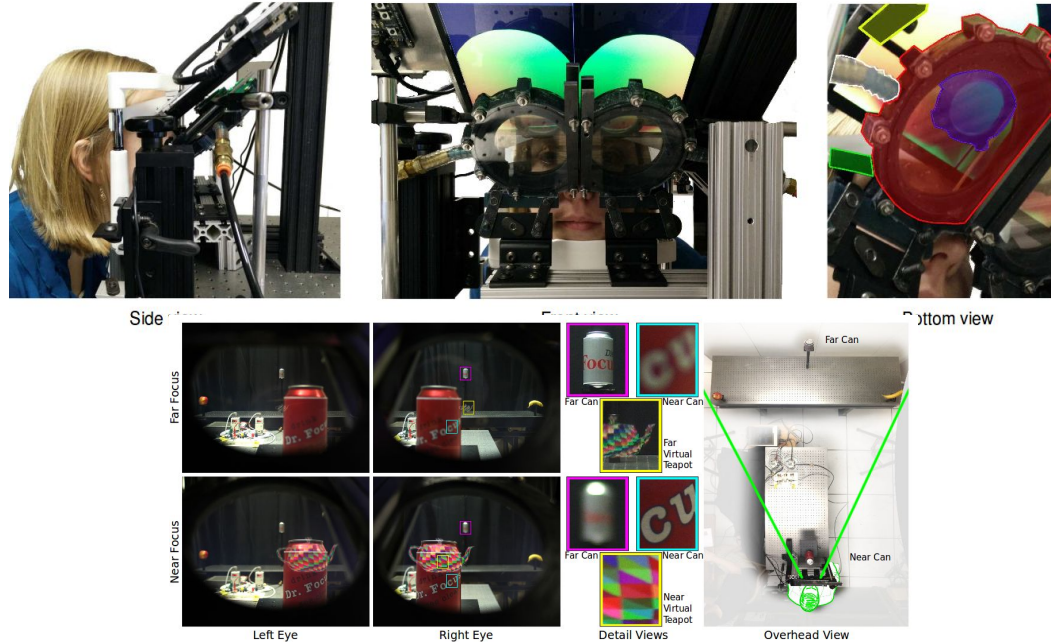
Patney et al.
2016

Varifocal displays

IEEEVR 2017 **Best paper Award!!**, SIGGRAPH 2017 (E-TECH)

Wide Field Of View Varifocal Near-Eye Display Using See-Through Deformable Membrane Mirrors

David Dunn, Cary Tippetts, Kent Torell, Petr Kellnhofer, [Kaan Akşit](#), Piotr Didyk, Karol Myszkowski, David Luebke, Henry Fuchs



Lanman
and Luebke
2013

Maimone et
al. 2014

Heide et al.
2014

Akşit et al.
2015

Patney et al.
2016

Dunn et al.
2017



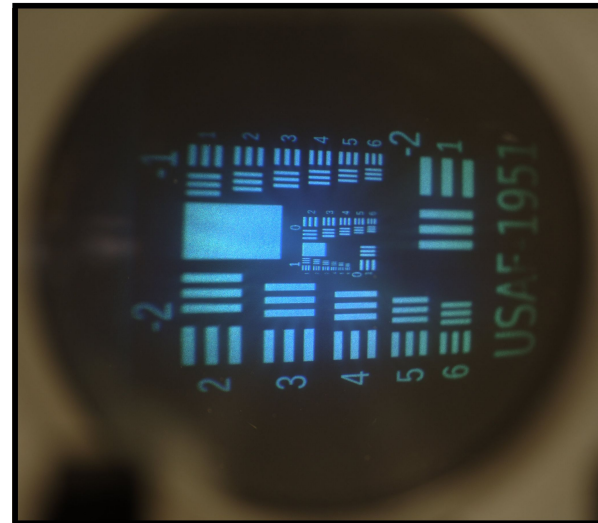
	Focus mechanism	FoV	resolution	eyebow	form factor	compute overhead
Pinlight displays [Maimone et al. 2014]	always in focus	wide	low	moderate	thin	high
Free-form optics [Hua and Javidi 2014]	light fields	narrow	high	moderate	moderate	high
HOE [Kim et al. 2015]	holographic	wide	high	small	bulky	N/A
HOE [Maimone et al. 2017]	holographic	wide	high	small	N/A	high
Focus tunable light engine [Liu et al. 2008]	varifocal	narrow	high	small	bulky	moderate
Multi-focal plane display [Hu and Hua 2014]	varifocal	narrow	high	moderate	bulky	high
Membrane [Dunn et al. 2017]	varifocal	wide	high	large	bulky	low
This work	varifocal	wide	high	large	moderate	low

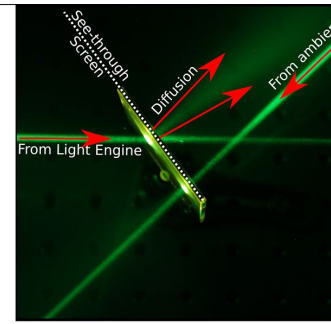
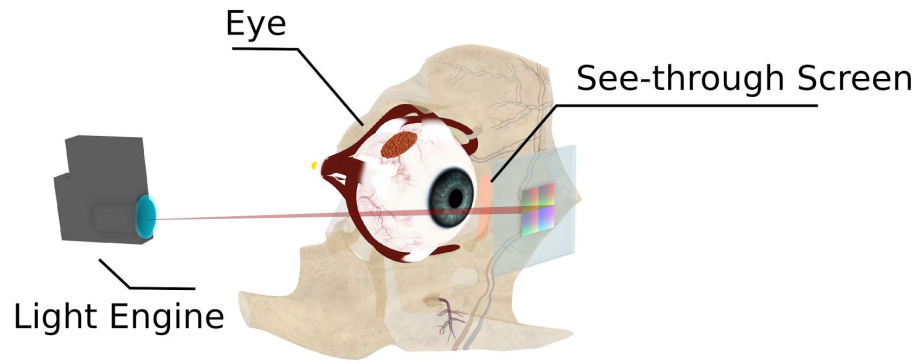


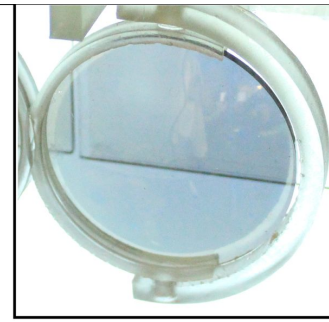
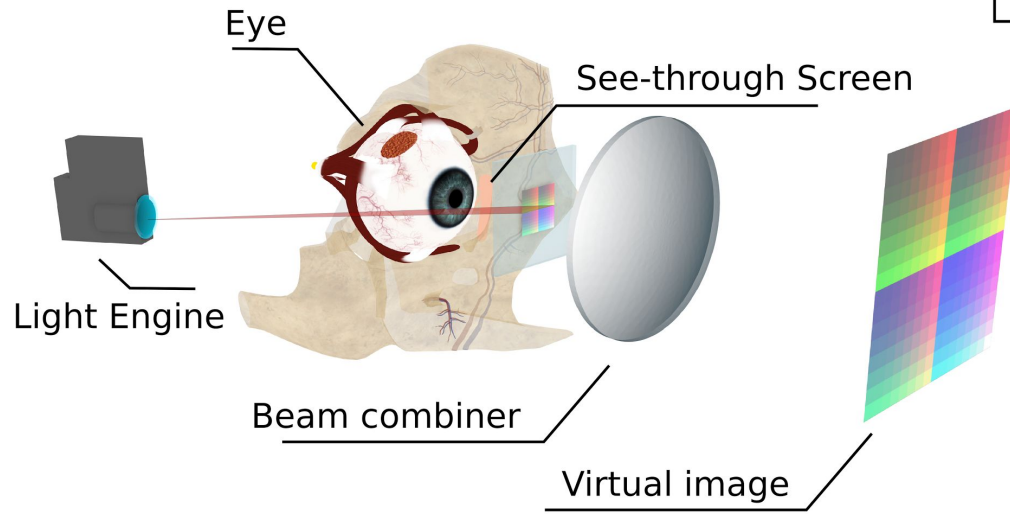
	Focus mechanism	FoV	resolution	eyebow	form factor	compute overhead
Pinlight displays [Maimone et al. 2014]	always in focus	wide	low	moderate	thin	high
Free-form optics [Hua and Javidi 2014]	light fields	narrow	high	moderate	moderate	high
HOE [Kim et al. 2015]	holographic	wide	high	small	bulky	N/A
HOE [Maimone et al. 2017]	holographic	wide	high	small	N/A	high
Focus tunable light engine [Liu et al. 2008]	varifocal	narrow	high	small	bulky	moderate
Multi-focal plane display [Hu and Hua 2014]	varifocal	narrow	high	moderate	bulky	high
Membrane [Dunn et al. 2017]	varifocal	wide	high	large	bulky	low
This work	varifocal	wide	high	large	moderate	low

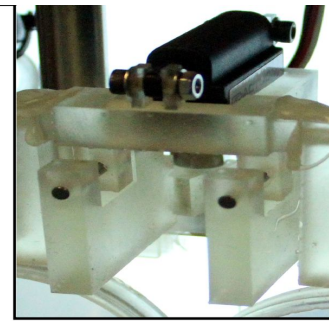
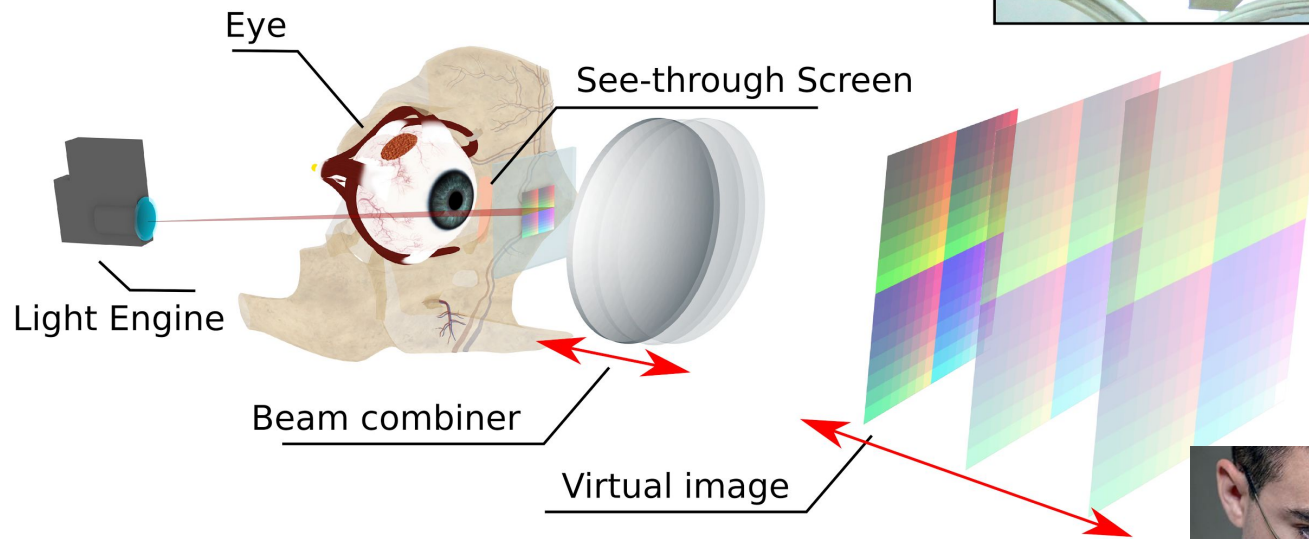


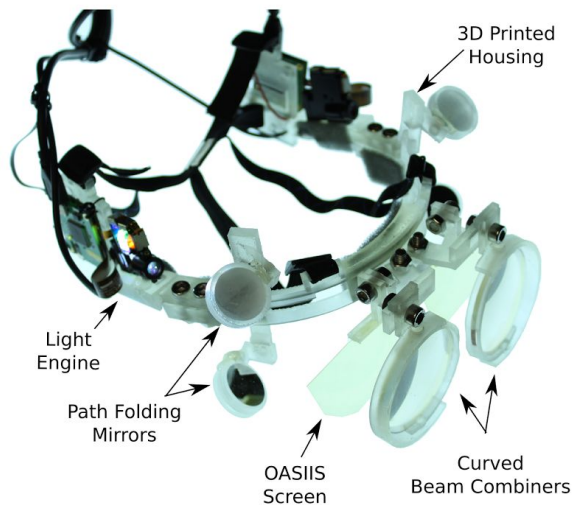
Holographic Optical Element



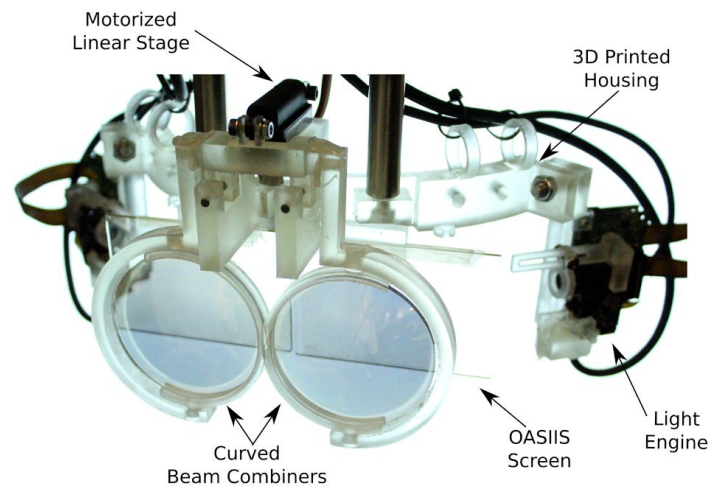








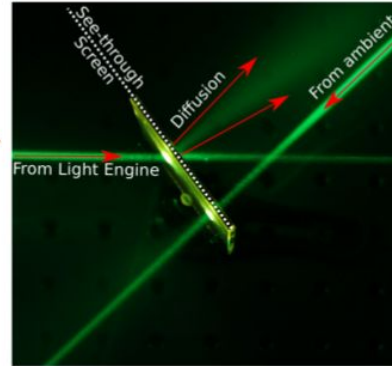
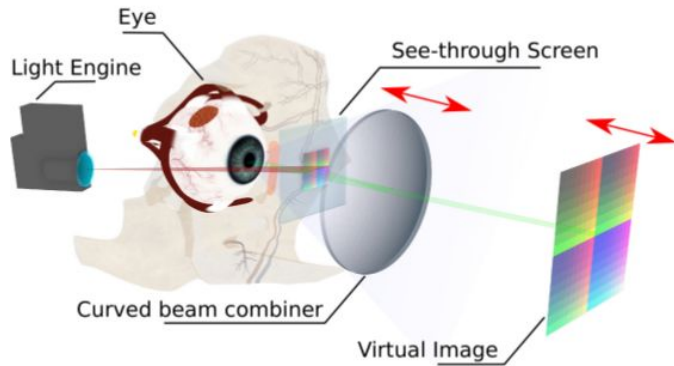
Wearable Fixed Focus Prototype

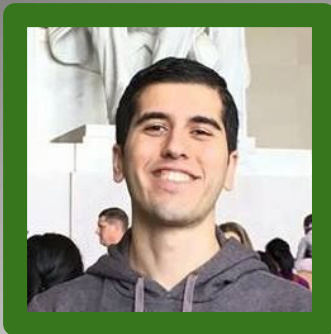


Wearable Varifocal Prototype

SIGGRAPH ASIA 2017, SIGGRAPH 2017 (ETECH)
Near-Eye Varifocal Augmented Reality Display using See-Through Screens

Kaan Akşit, Ward Lopes, Jonghyun Kim, Josef Spjut, Peter Shirley, David Luebke





Kaan Akşit, kaksit@nvidia.com
<https://kaanaksit.com>



Nvidia Research
<http://research.nvidia.com>

