
Virtual Reality Technology and Convergence

NBAY 6120

March 20, 2018

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Lecture 7

Virtual Reality

- A term used to describe a digitally-generated environment which can simulate the perception of PRESENCE.
- Note that within the context of this course, I refer to VR as containing 3D data as contrasted to just creating a digital copy of information obtained from a film or digital camera, such as a photograph or a texture.

Requirements for “PRESENCE”

- Understanding the Human Visual System
- Improving the Device Characteristics and System Performance
- Social Acceptance

Virtual Reality

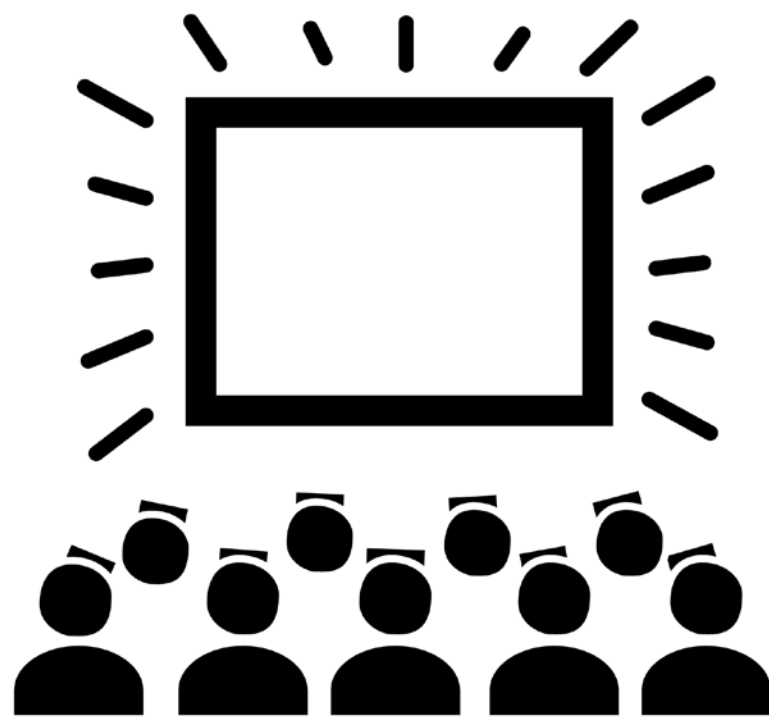
- A person immersed within this virtual world can manipulate objects, interact with the environment, and explore the virtual world in the same perceptual way as one interacts with the physical world.

Human in the Loop

- Abstract Interpretation
- Viewing a Picture on Television
- Cinema Viewing
- Presence









Social & Economic Requirements for Mass Acceptance of VR/AR

- Large enough investments for R & D & manufacture
- Cheap enough for mass market
- Social acceptance of 3G (Geeks, Games, and Goggles)

Facebook Buys Oculus Rift



Microsoft's Hololens



Microsoft's Hololens

3/30/16



Google

Why is Google (and Andreessen / Horwitz) investing
\$500+ million in Magic Leap?



Betting on New Worlds

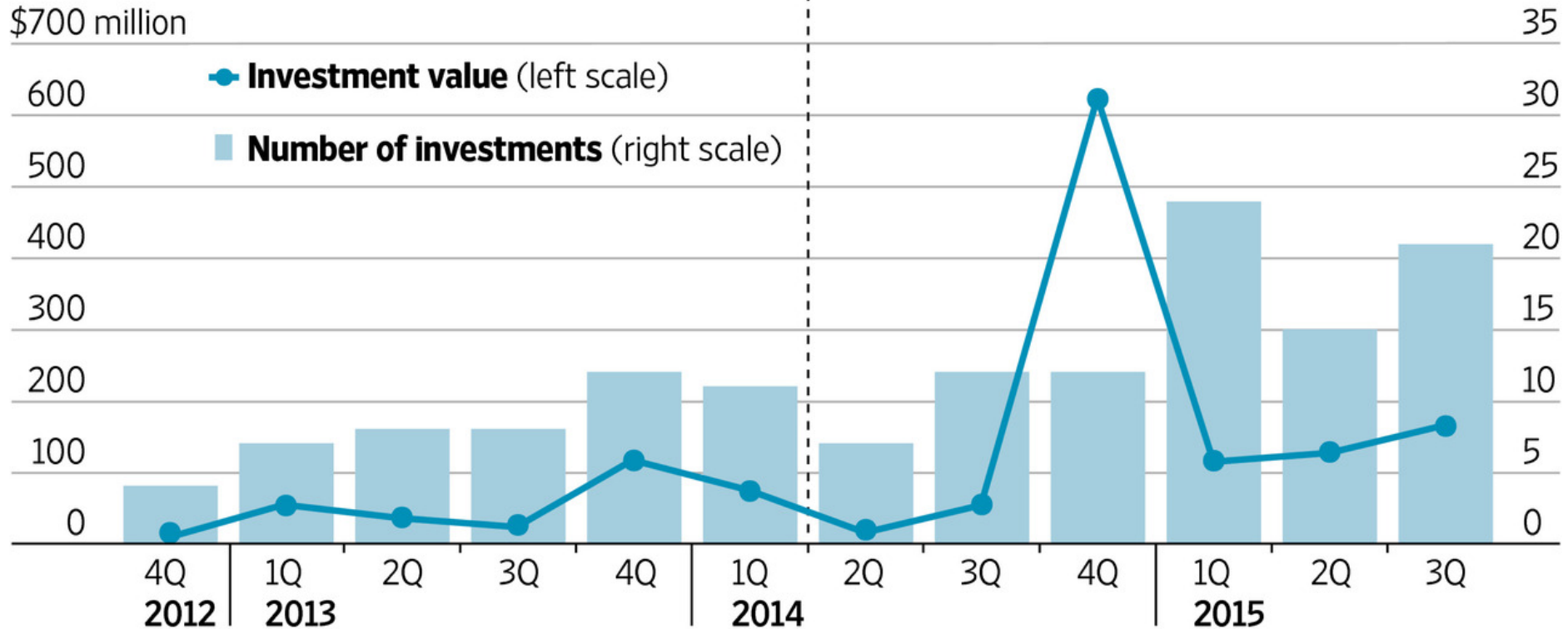
Venture funding for virtual reality and augmented reality (before and after Facebook's purchase of Oculus)

PRE-FACEBOOK TOTAL

Number of Investments: **50**
Investment value: **\$316 million**

POST-FACEBOOK TOTAL

Number of Investments: **91**
Investment value: **\$1.1 billion**



Source: CB Insights

THE WALL STREET JOURNAL.

Head-mounted Displays

1990s



Henry Fuchs,
University of
North Carolina

Oculus Rift DK2

2014

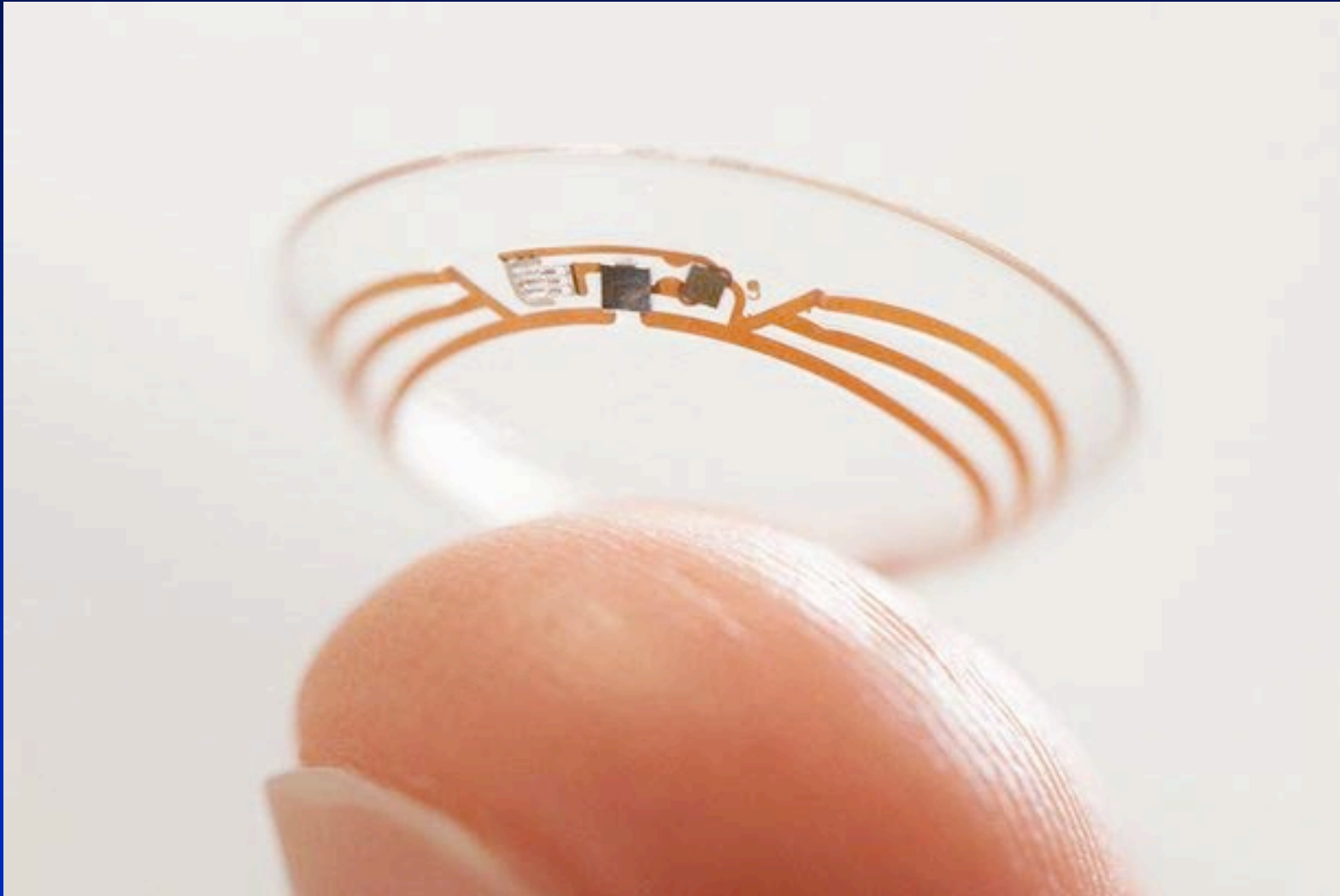


Oculus Rift

2016



Google Contact Lenses



Microsoft's Hololens



Magic Leap Displays

Rony Abovitz



2016

HTC and Valve's SteamVR Vive

2016



Google's Cardboard

2014

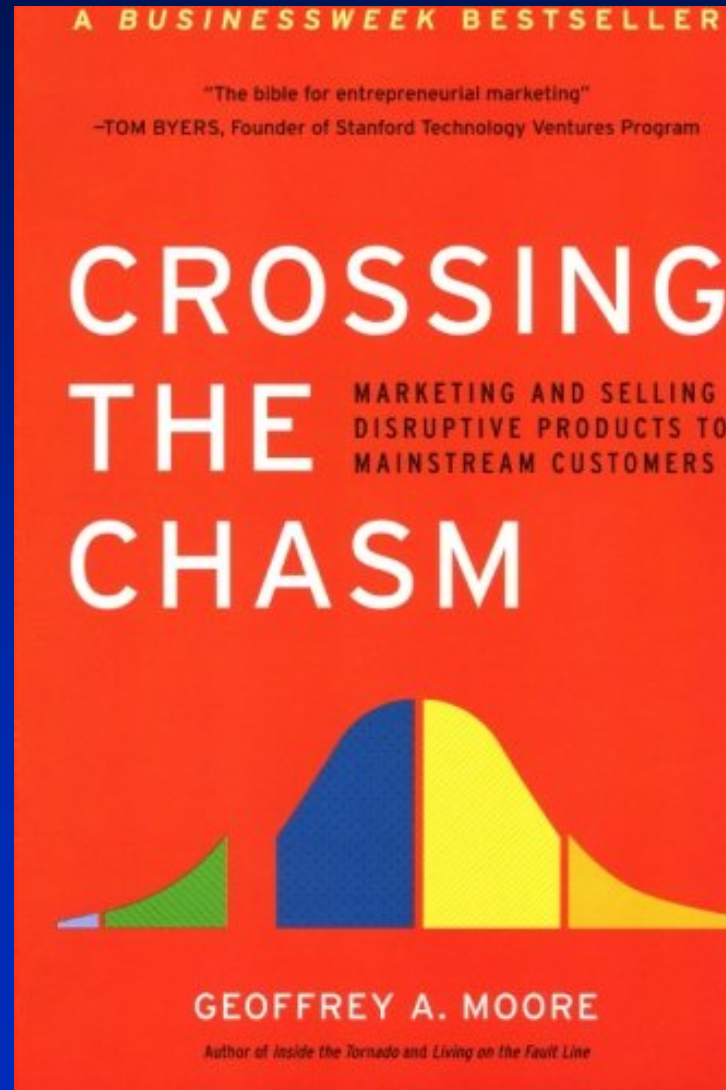


Pokemon Go

2016



“Crossing the Chasm”



Will Virtual Reality work this time?

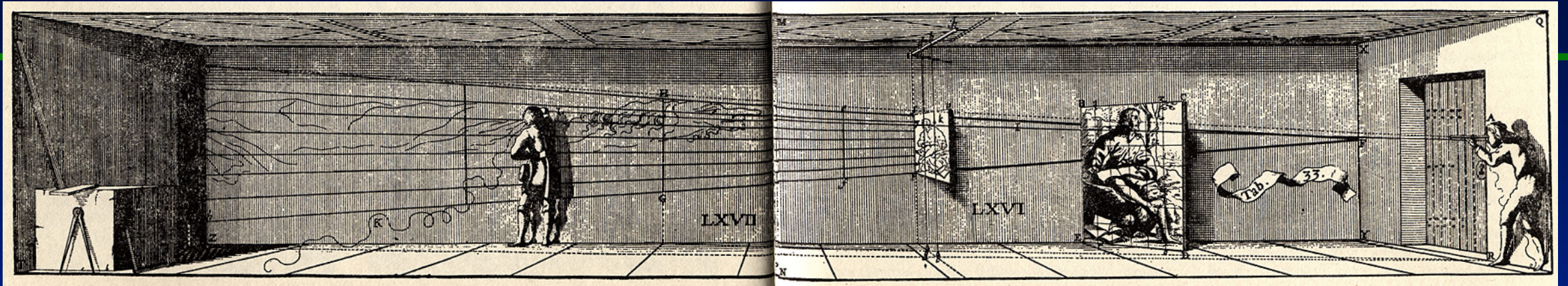
Virtual Reality

- Virtual Reality is not new
- The amount of financing which has been made available
- Costs have been sufficiently lowered to bring to the masses

Technical Requirements for VR/AR Satisfactory Delivery

- Display resolution similar to the human visual system
- Display quality similar to human visual system (illumination, color, etc.)
- Sufficient display rates for motion perception
- Rendering speeds to satisfy display rate requirements
- Sufficient wireless bandwidth for data

Distorted Images



Jean-Francois Niceron. *Thaumaturgus opticus*...(Rome, 1646), illus. 25.

The projection of a screen or grid in anamorphic perspective makes the transfer of a representation possible.



Erhard Schon. Picture puzzle: Out, You Old Fool c. 1535. Fred Leeman.
Hidden Images, 1975, Harry N. Abrams.

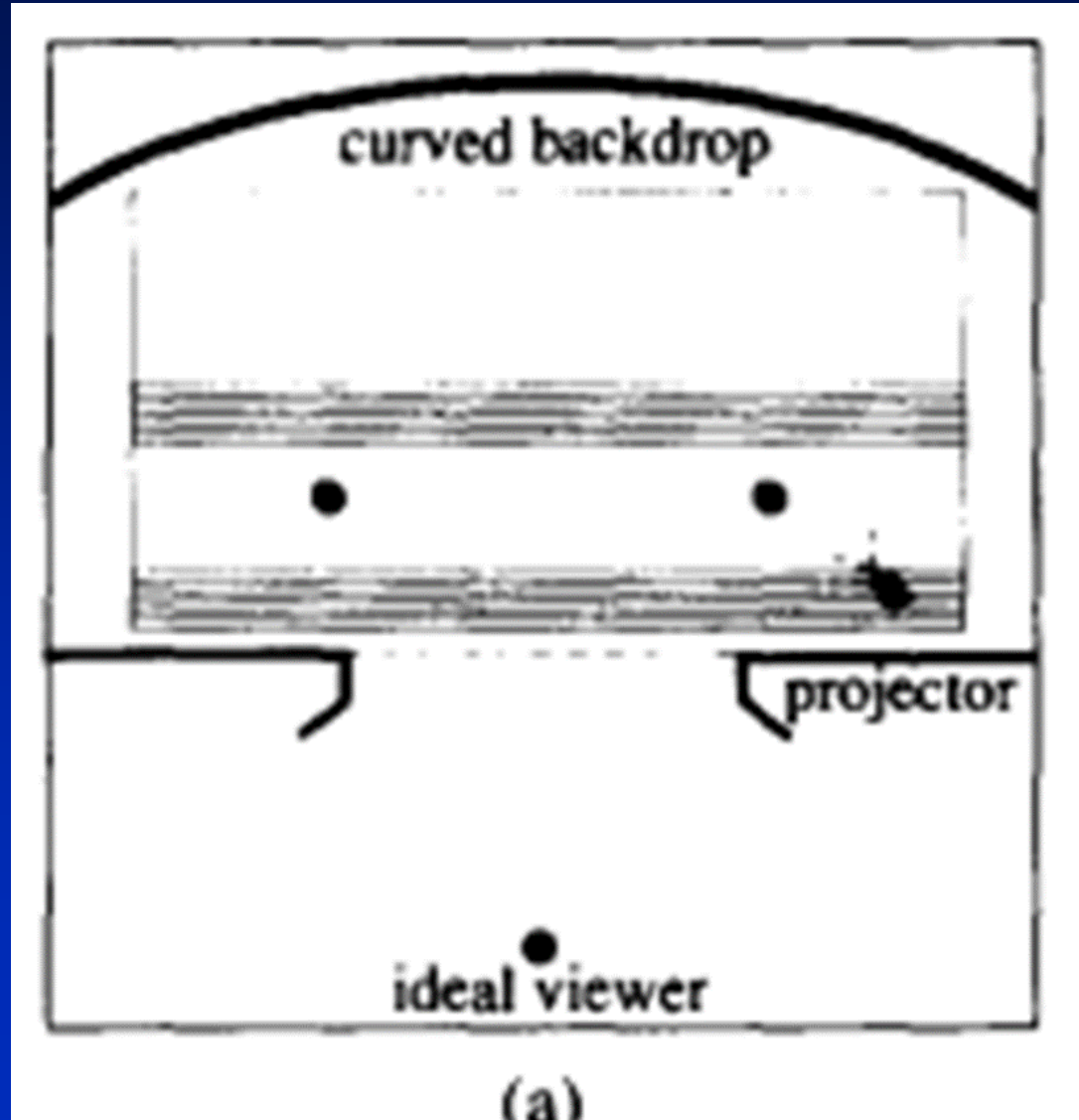
Hans Holbein

The Ambassadors



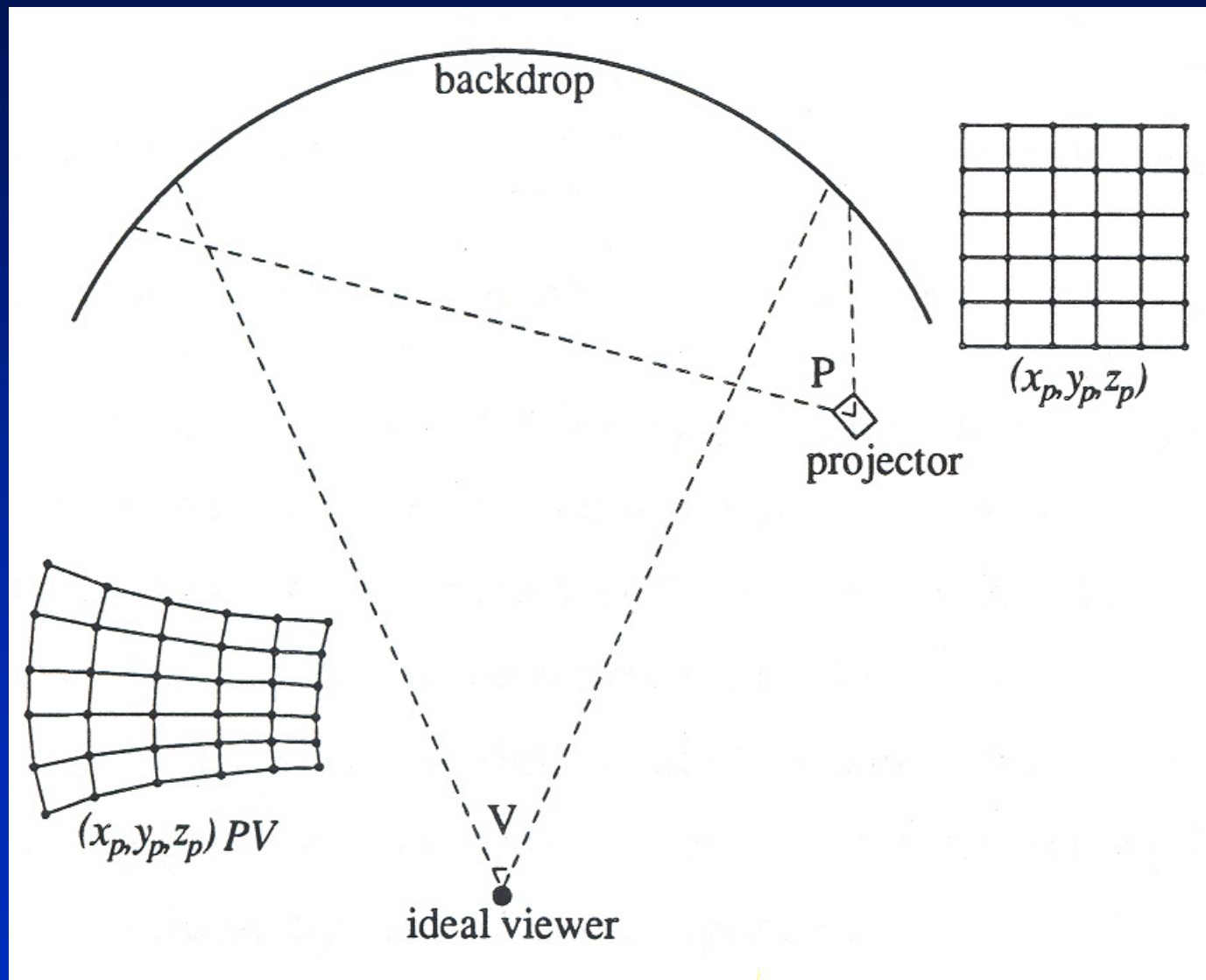
Opera Lighting

Siggraph 1991



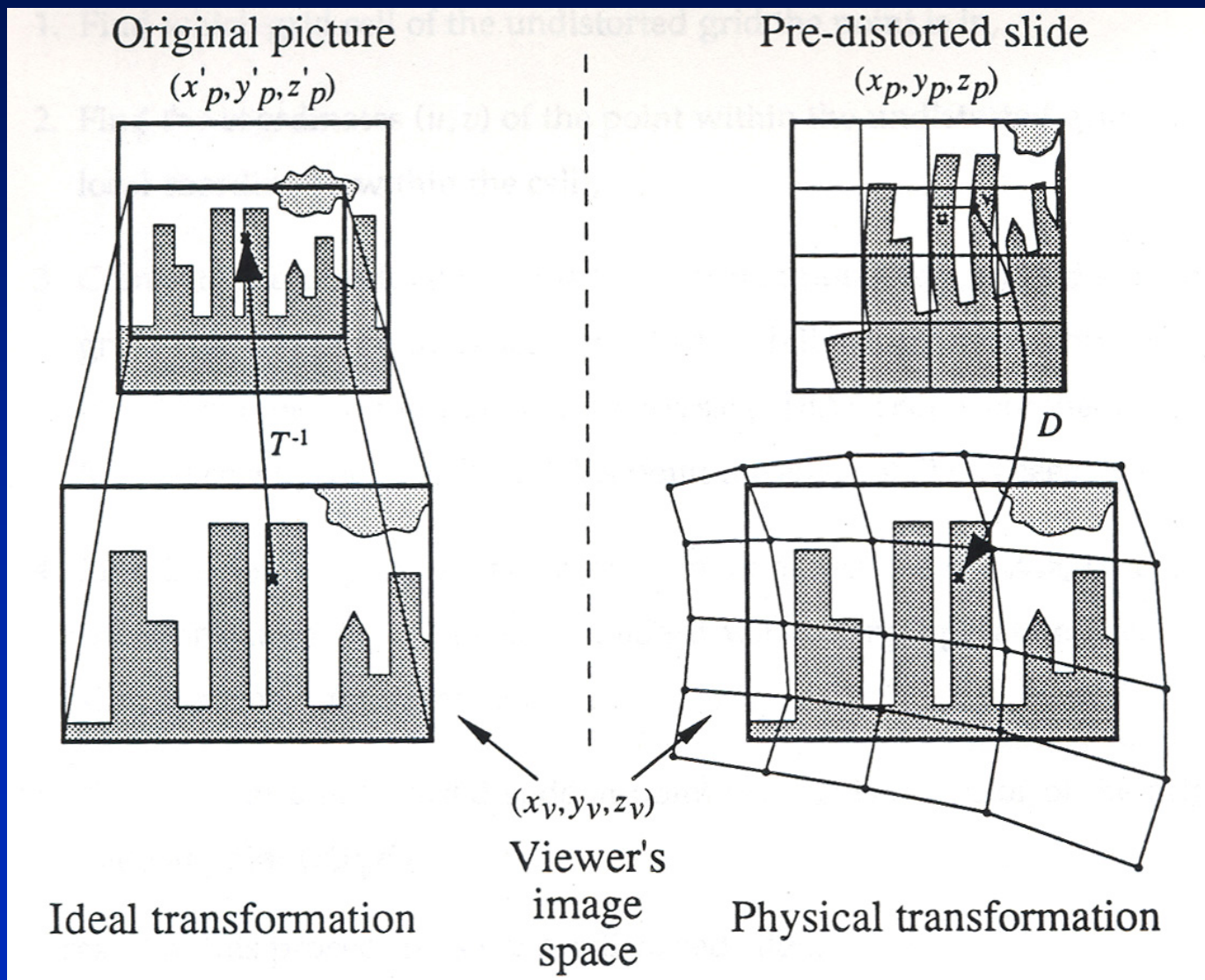
Opera Lighting

Siggraph 1991



Opera Lighting

Siggraph 1991



Opera Lighting

Siggraph 1991



Dorsey, Sillion and Greenberg

Opera Lighting

Siggraph 1991



Dorsey, Sillion and Greenberg

Truck Art

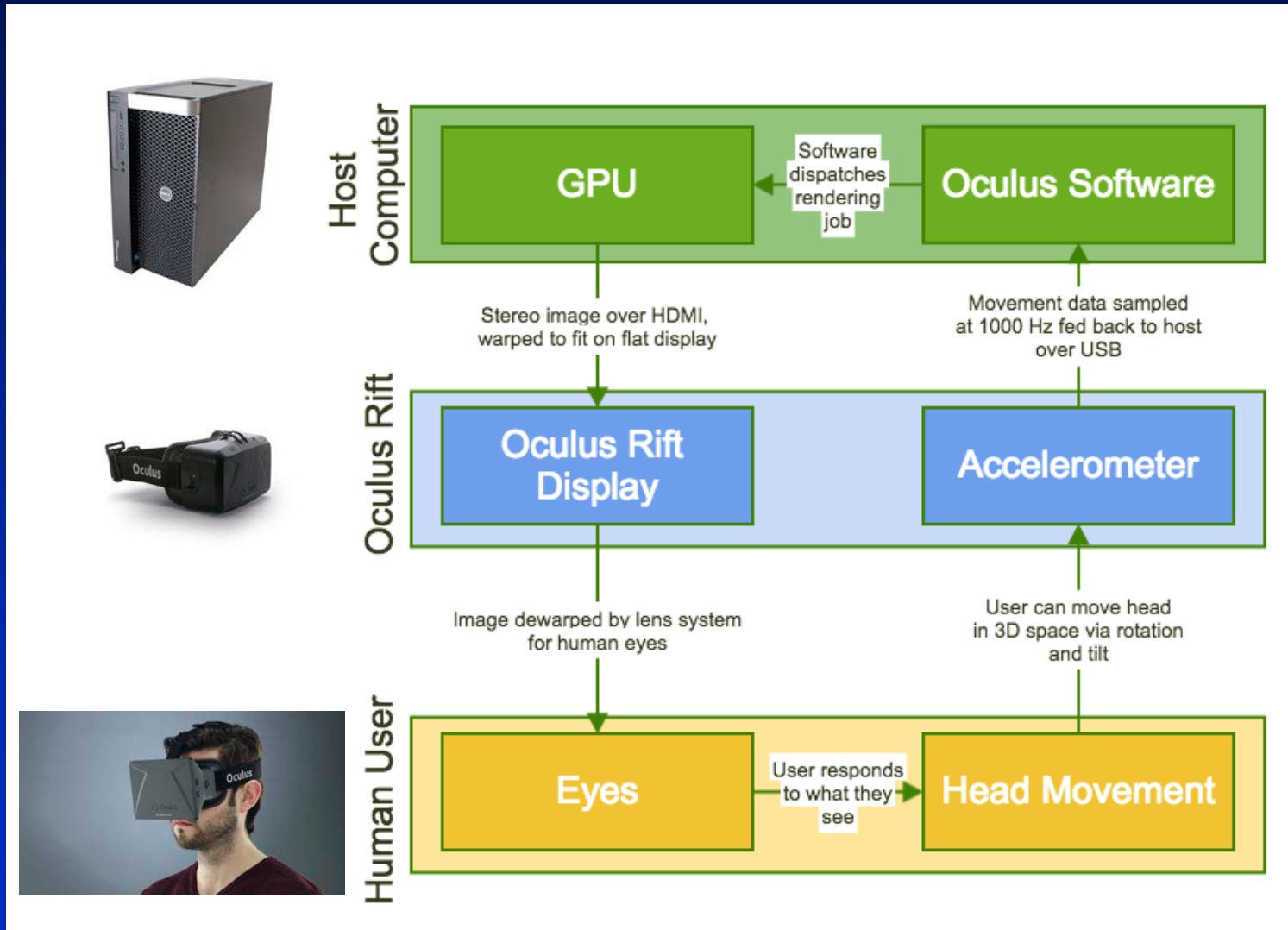


Julian Beever

Chalk Drawings



Oculus Rift DK2



Oculus Rift

Components

Accelerometers
and logic board

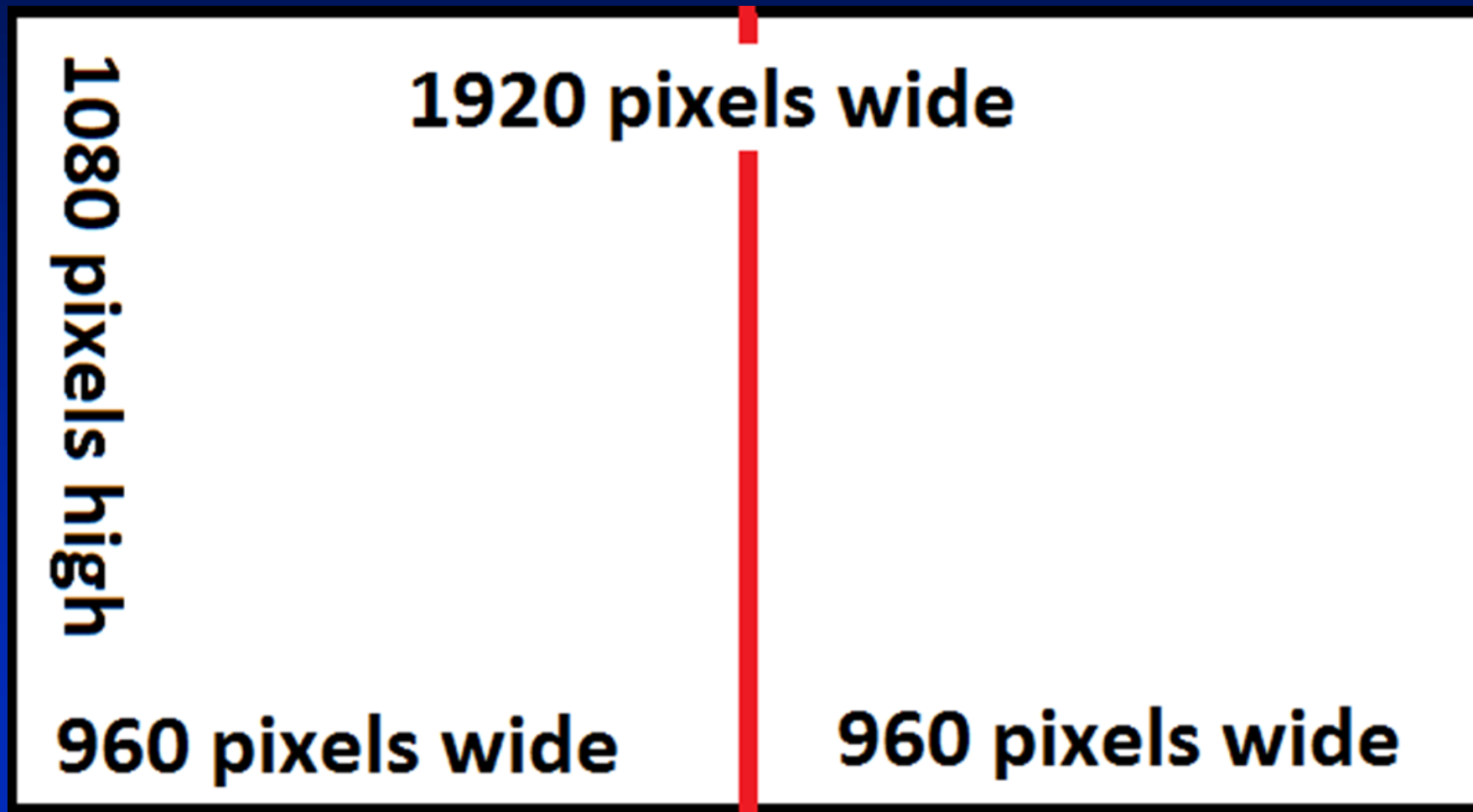
Flat 1080P
AMOLED
Display

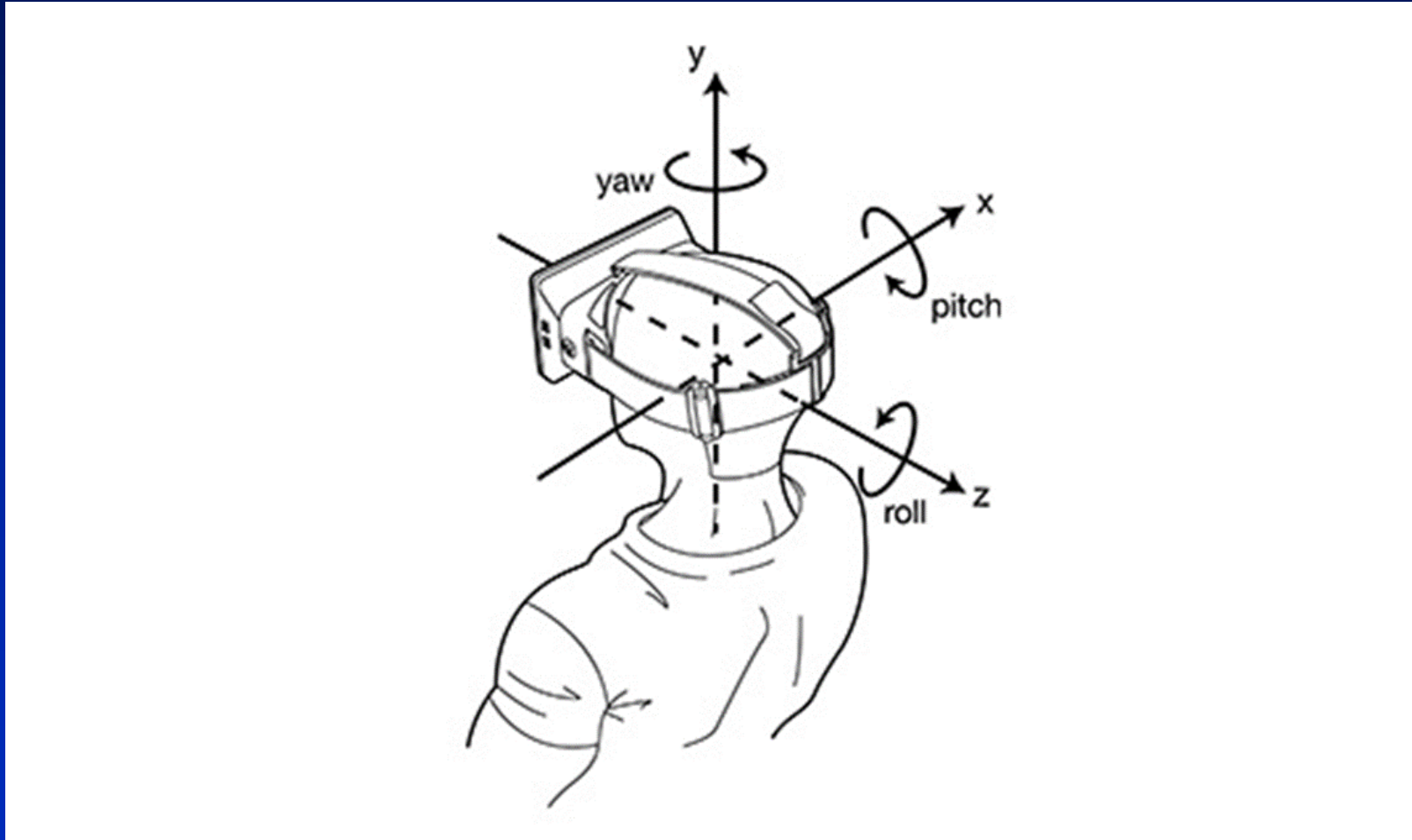


Lenses

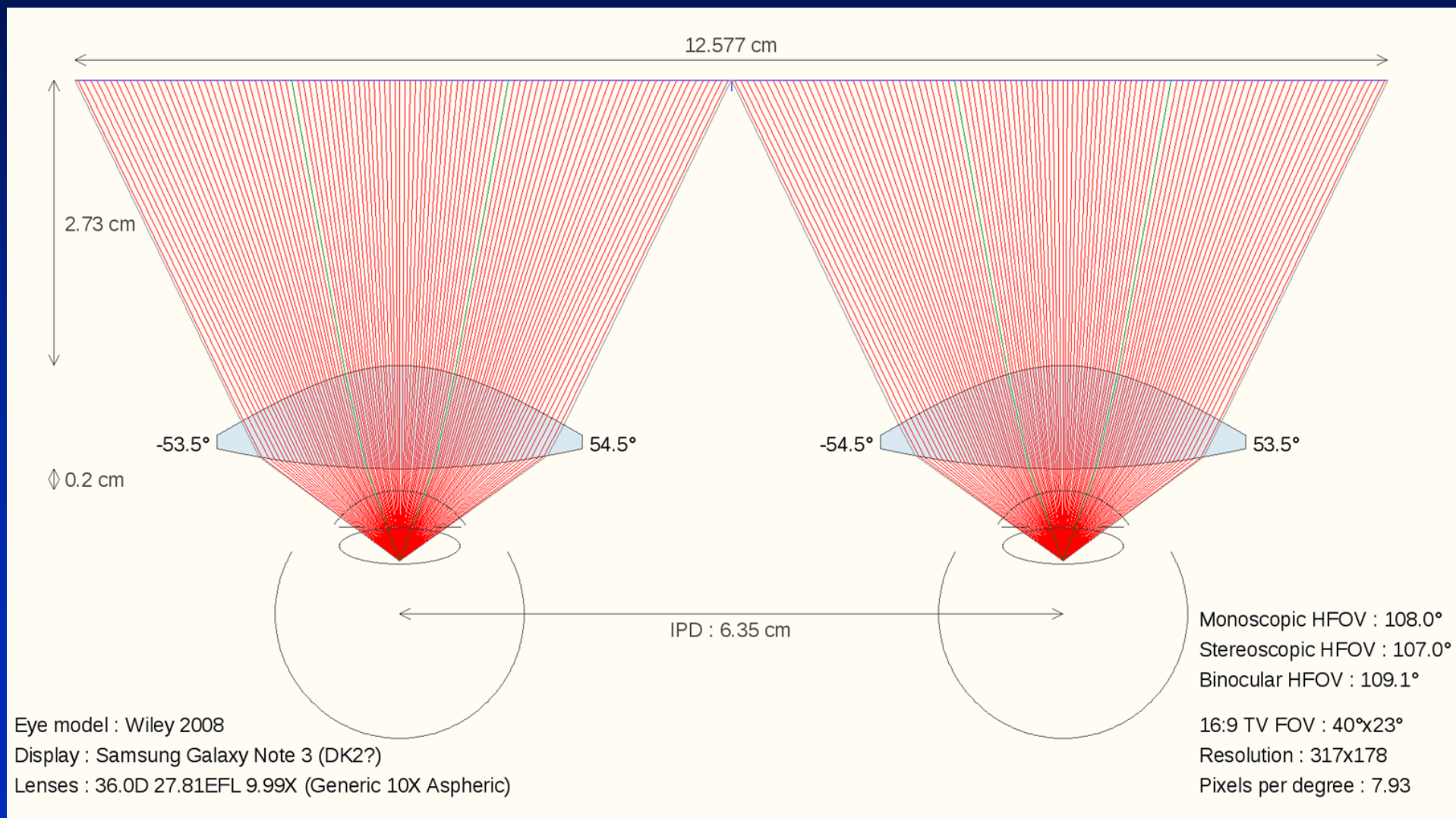


Oculus Rift DK2



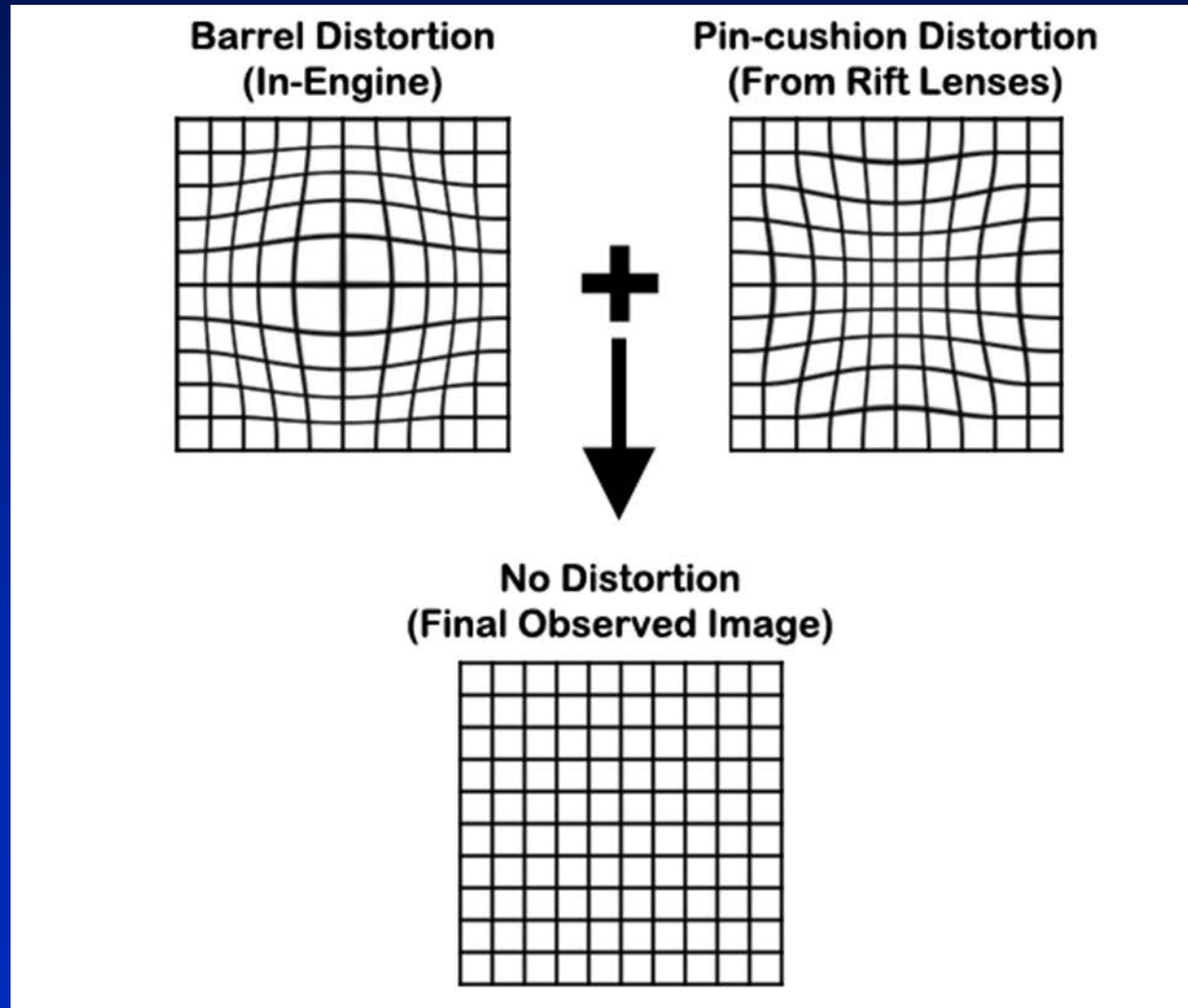


Distortion Strategy



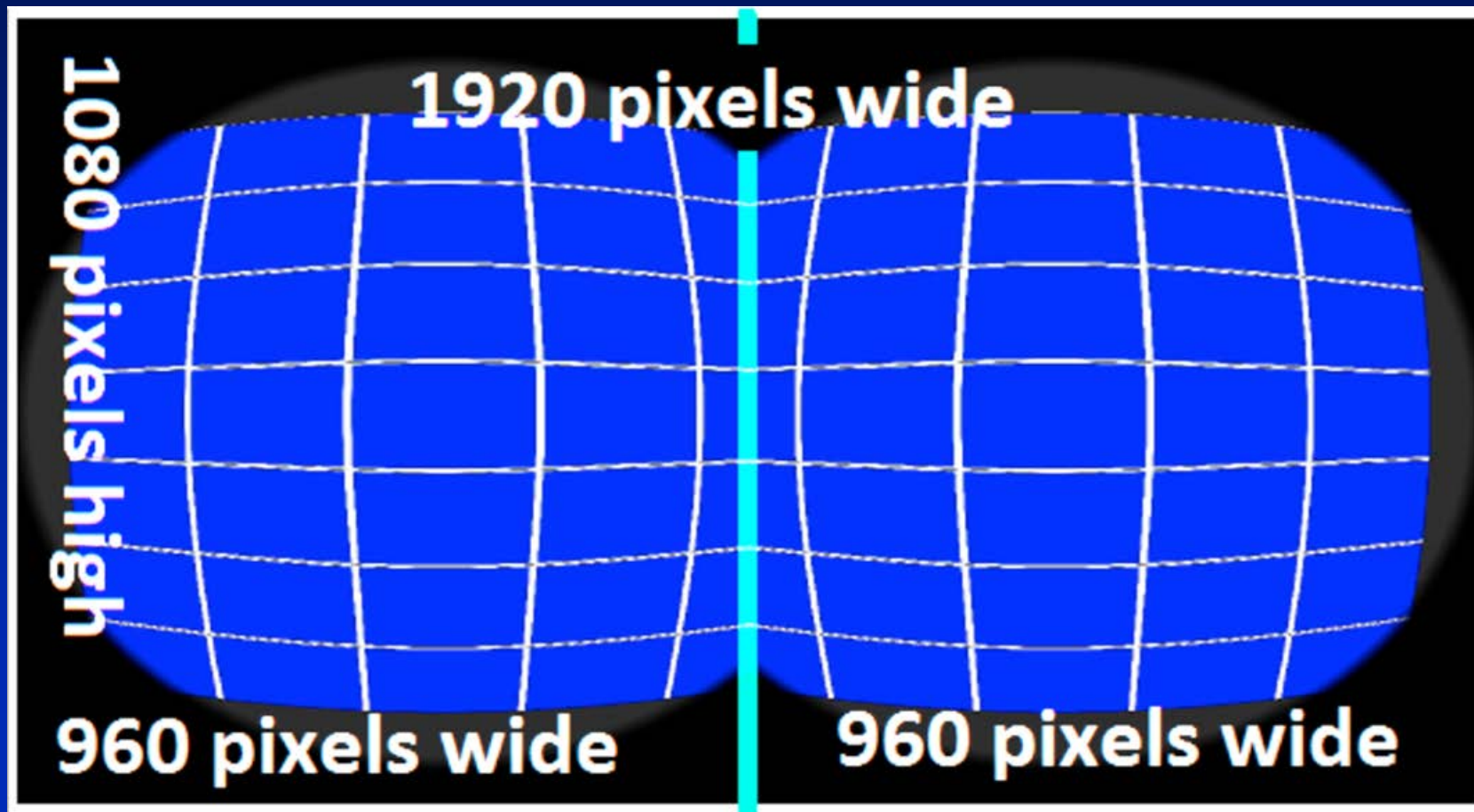
Oculus Rift DK2

Distortion Strategy



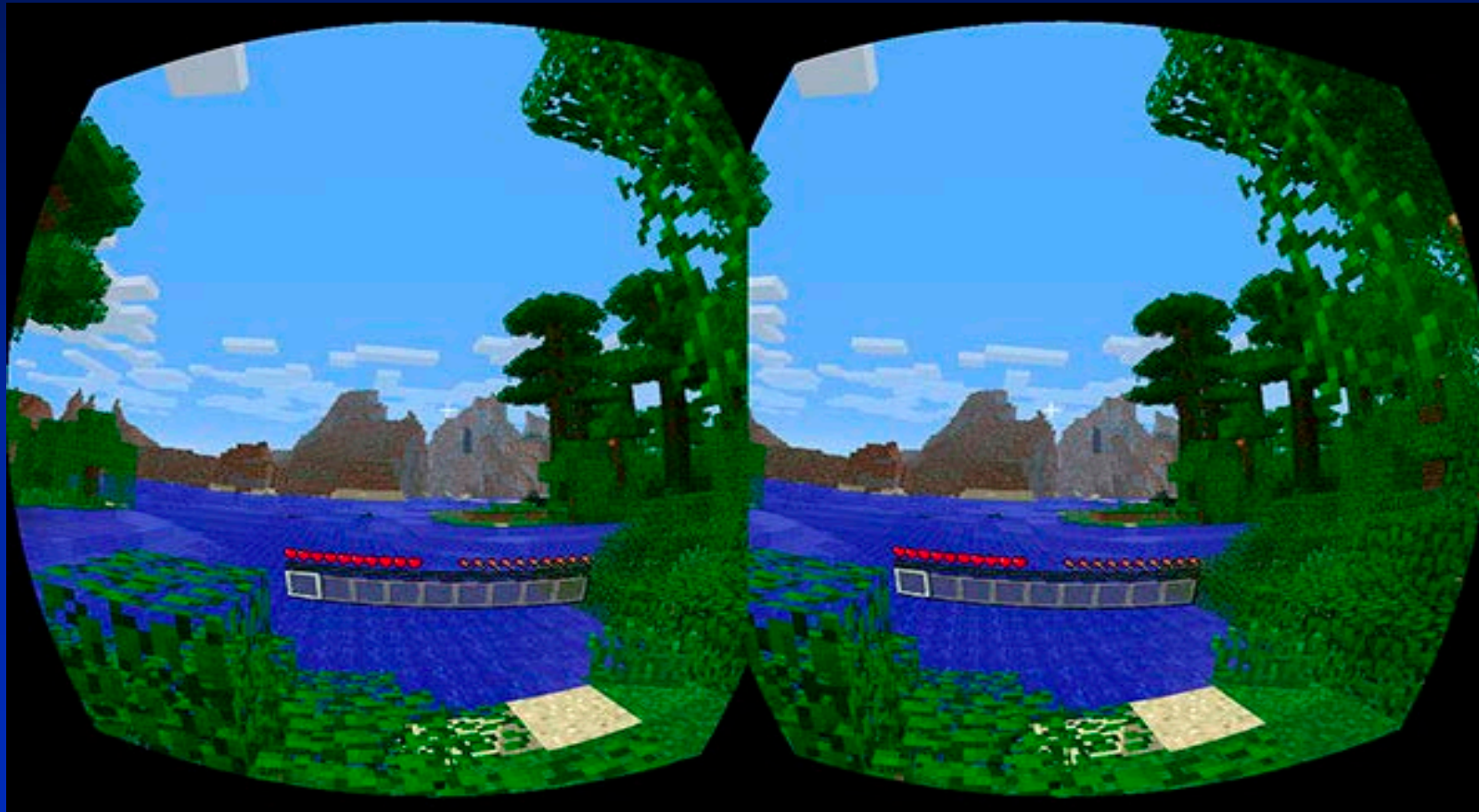
Oculus Rift DK2

Distorted Image



Oculus Rift DK2

Distorted Image



What is necessary to perceive depth?

Depth Perception from 2-D Images

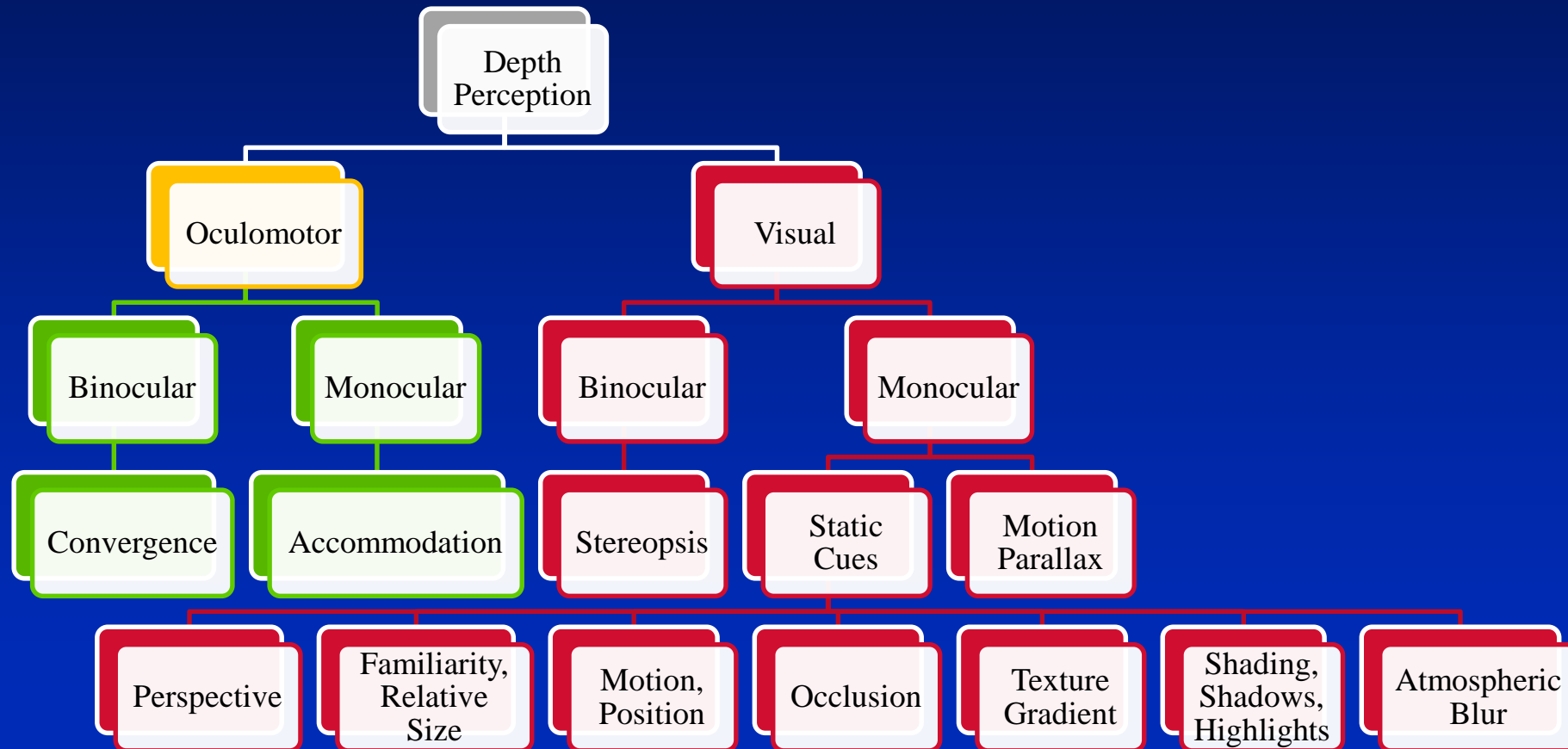
- Monoscopic
- Stereoscopic

Paris Street, Rainy Day 1877

Caillebotte

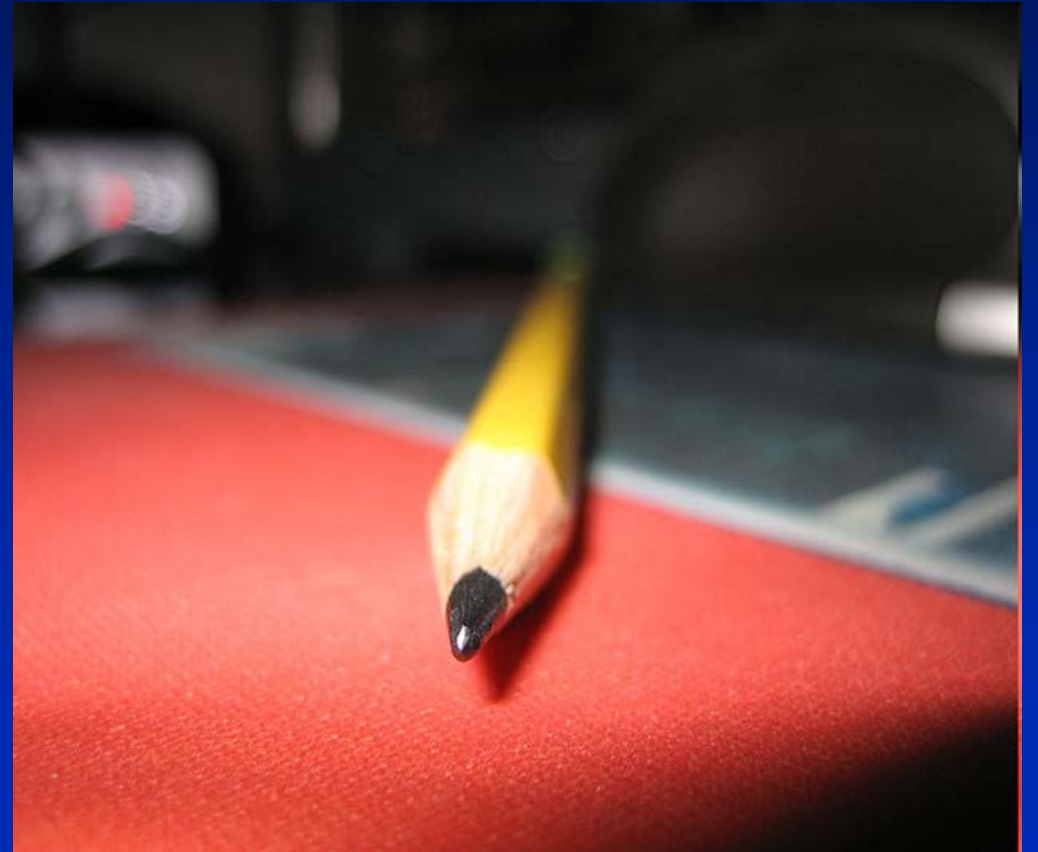


Human Depth Perception



Monoscopic Depth Cues

- Perspective
- Depth from Motion, Relative Size, Position, Familiarity
- Occlusion
- Texture Gradient
- Parallax from Motion
- Shading, Shadows and Specular Highlights
- Atmospheric Blur



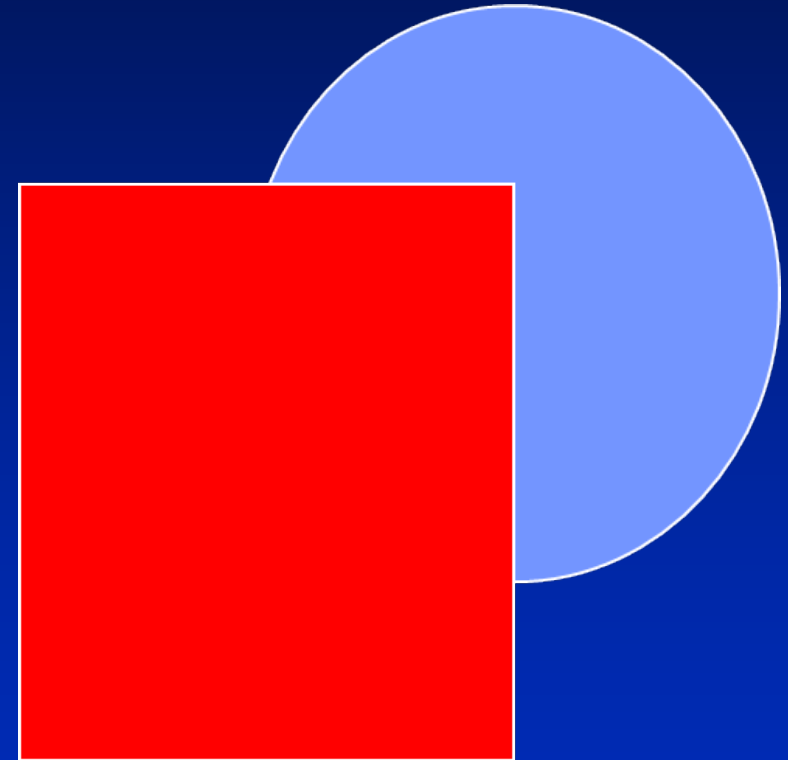
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Monoscopic Depth Cues

- Perspective
- Depth from Motion, Relative Size, Position, Familiarity
- **Occlusion**
- Texture Gradient
- Parallax from Motion
- Shading, Shadows and Specular Highlights
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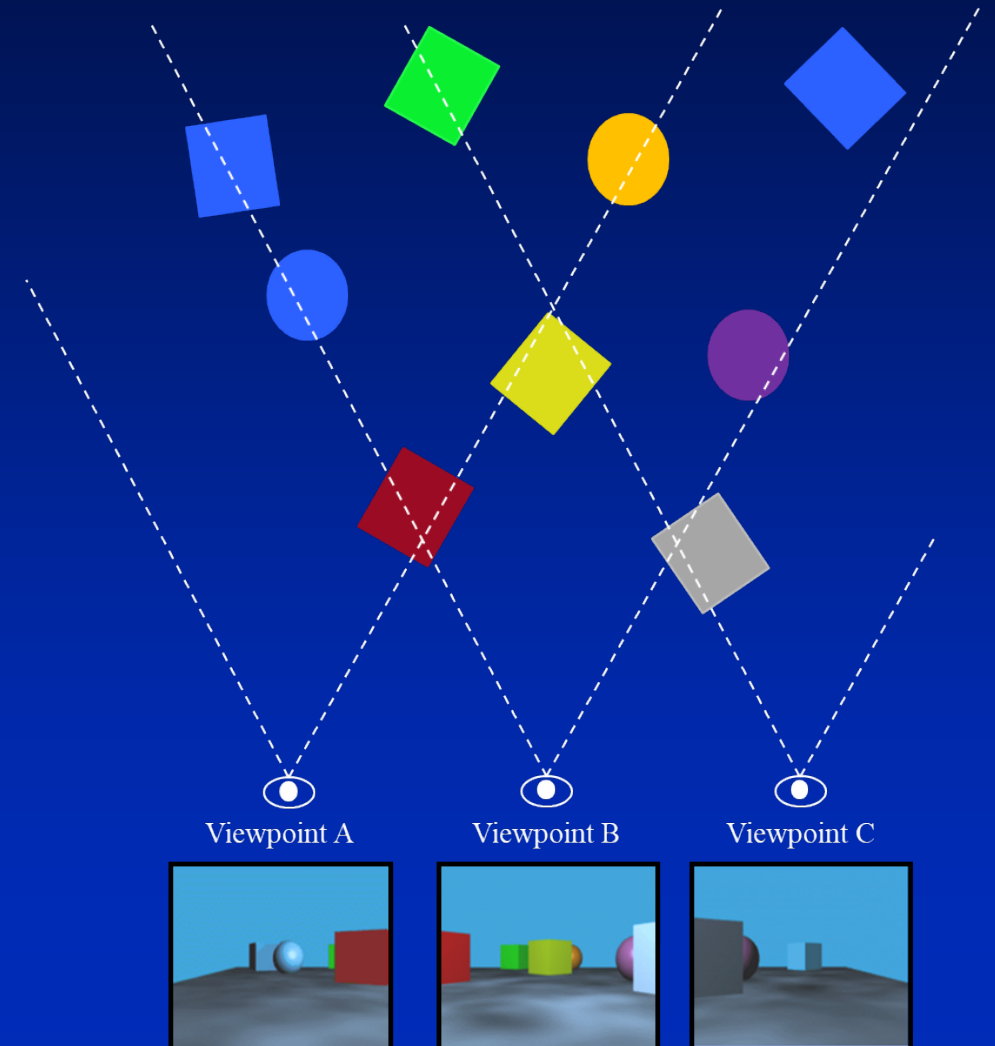
Monoscopic Depth Cues

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- **Texture Gradient**
- Parallax from Motion
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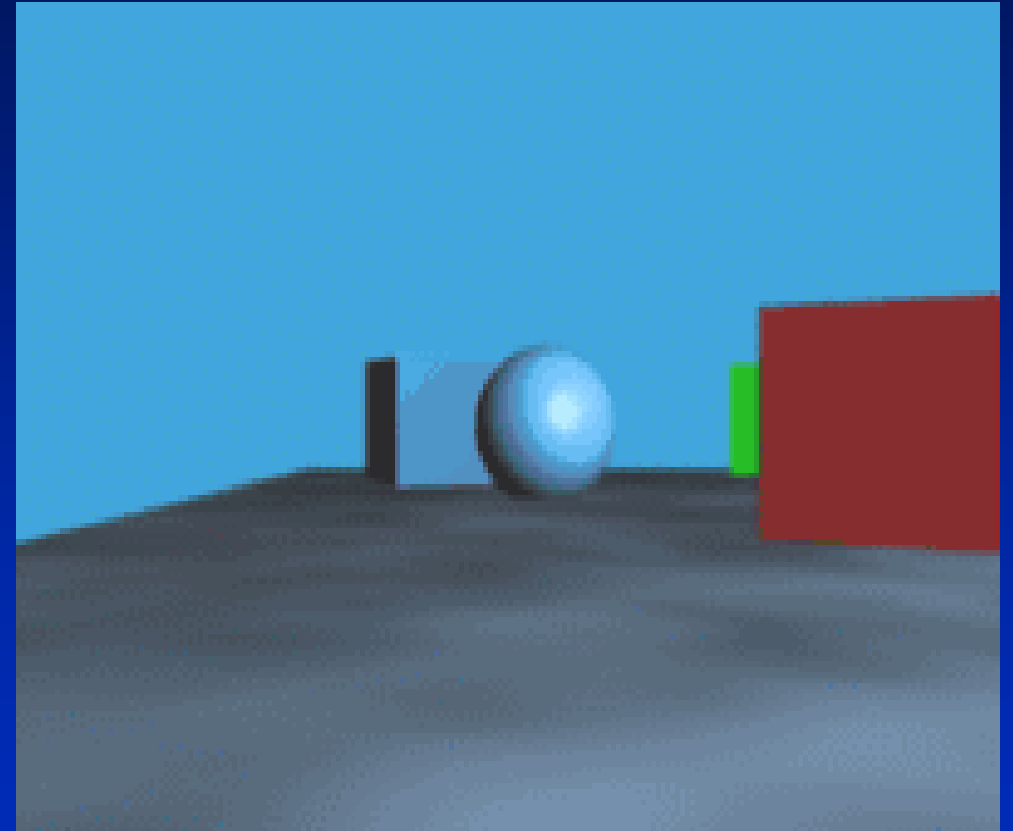
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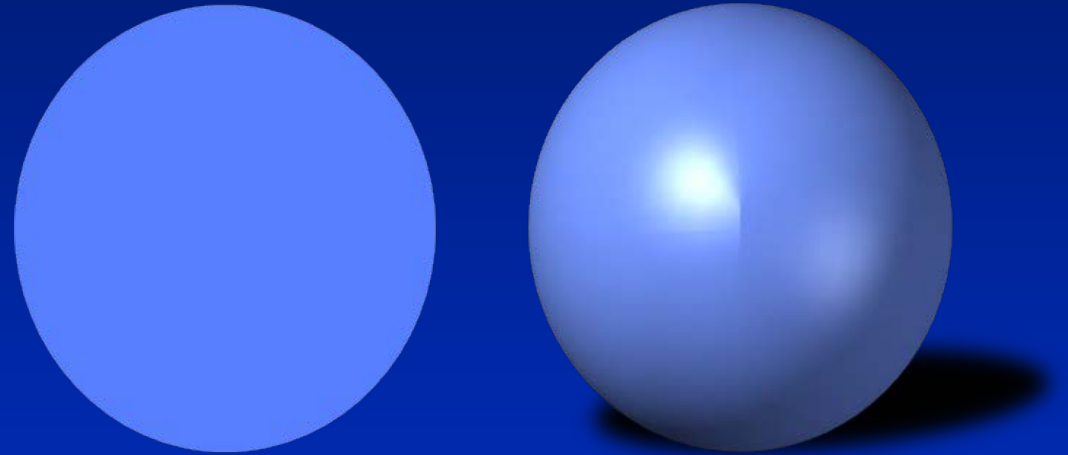
Monoscopic Depth Cues

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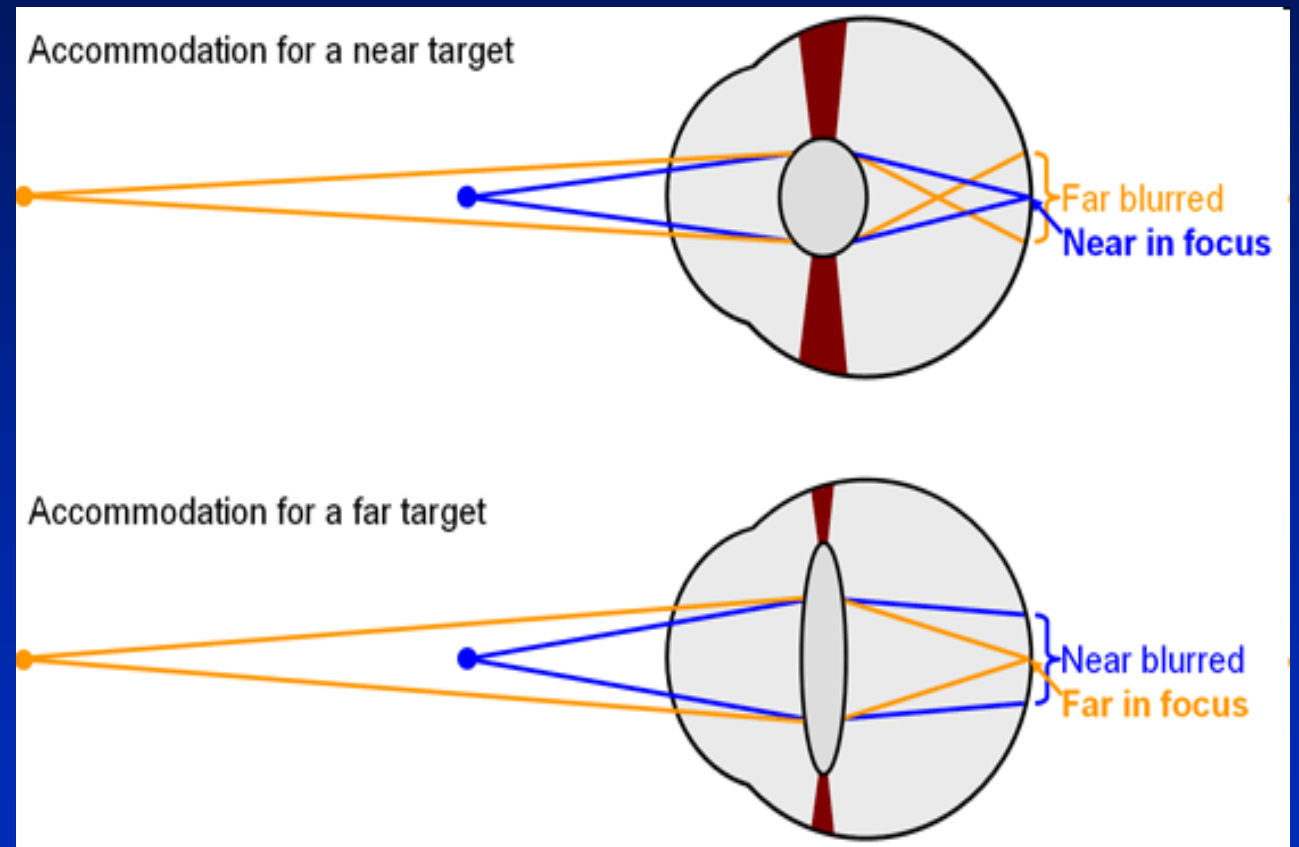
Monoscopic Depth Cues

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Monoscopic Depth Cues

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- Atmospheric Blur
- **Accommodation**

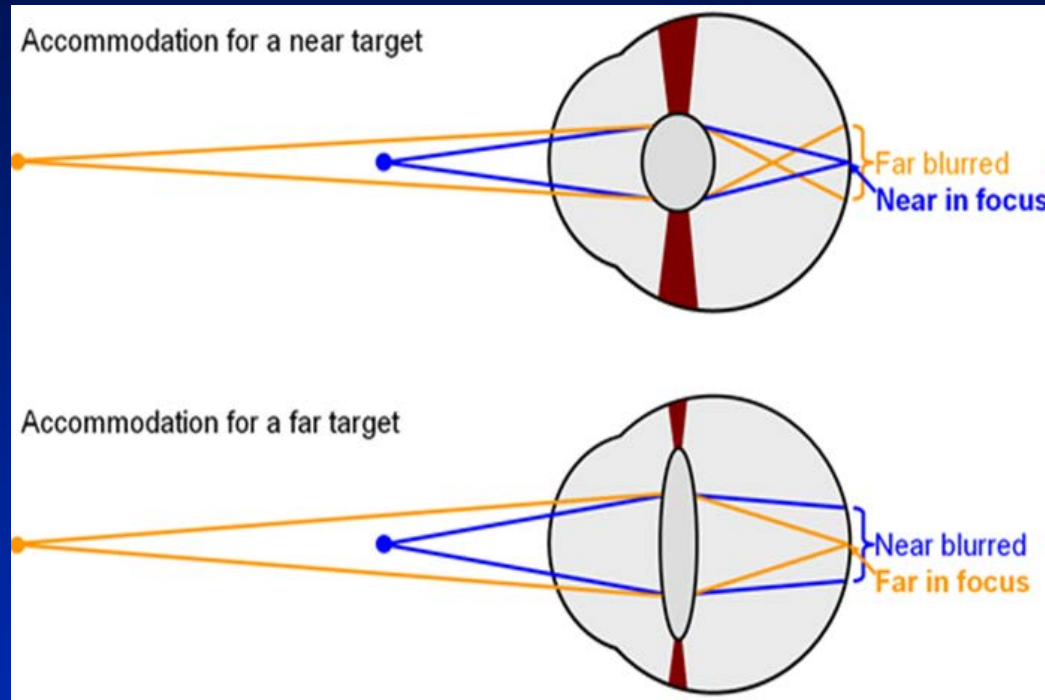


Note change in lens shape

Accommodation

- This is the process by which the vertebrate eye changes optical power to maintain a clear image or focus on an object as its distance varies.

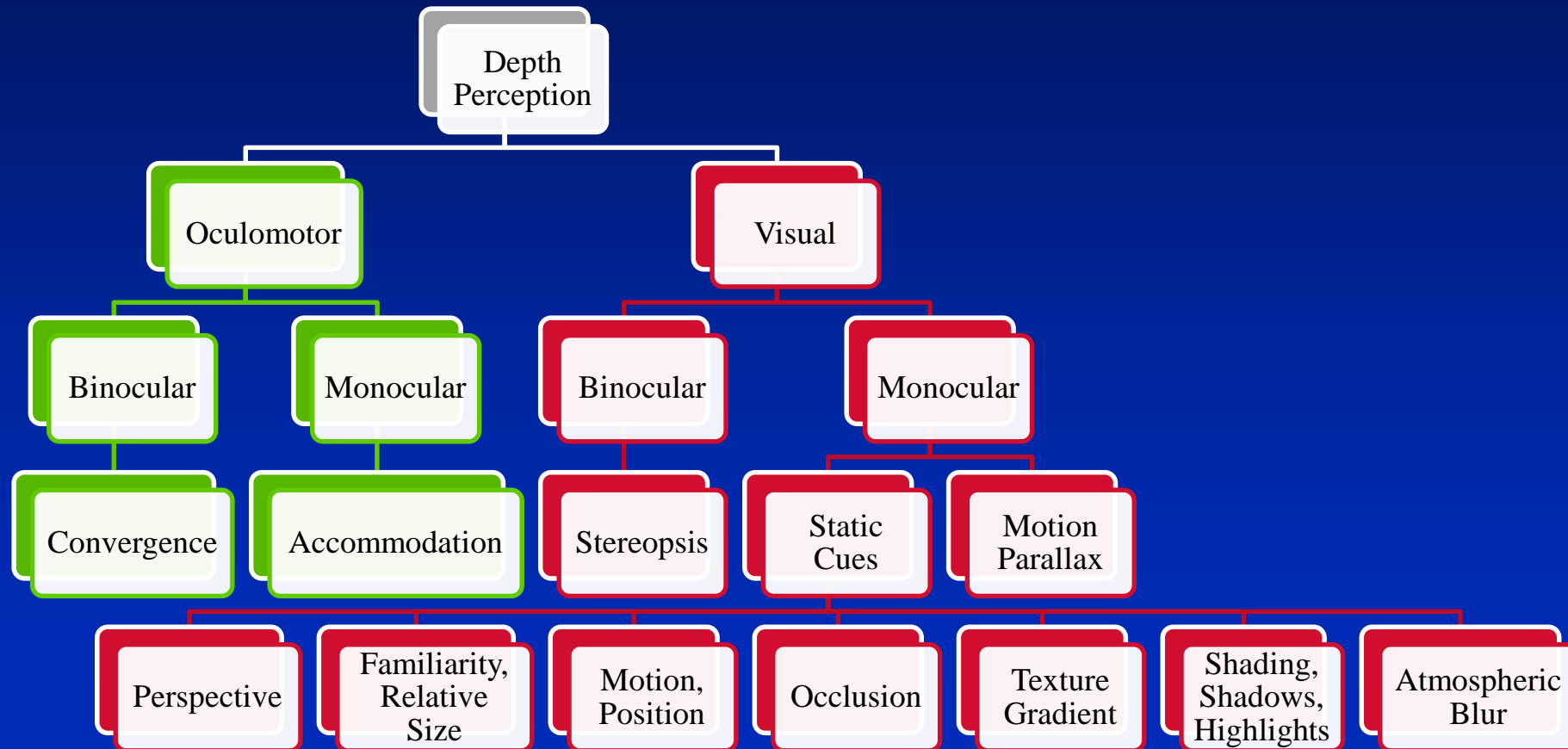
Accommodation



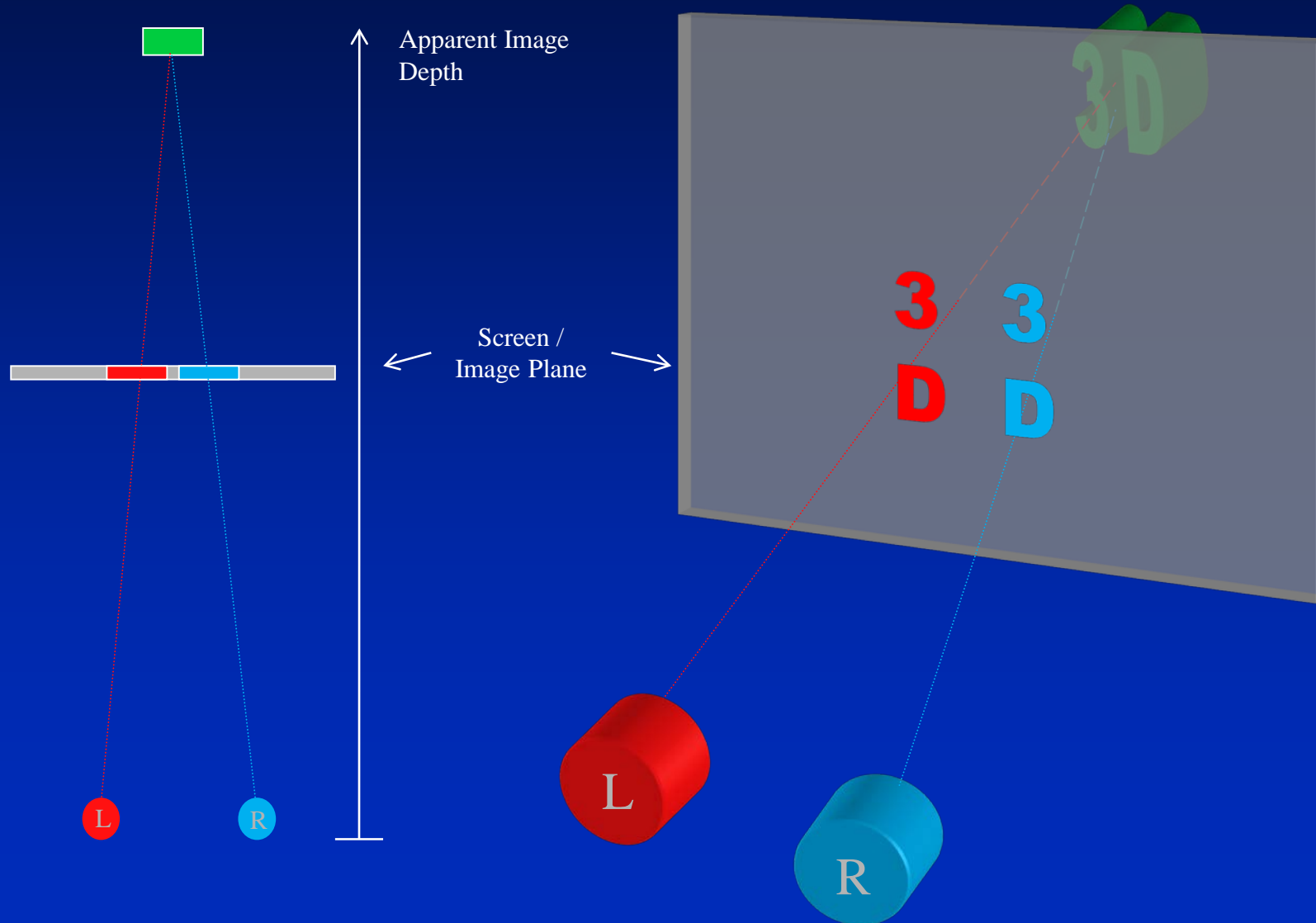
The reflex can be controlled but cannot be ‘felt’
Accommodation amplitude declines with age



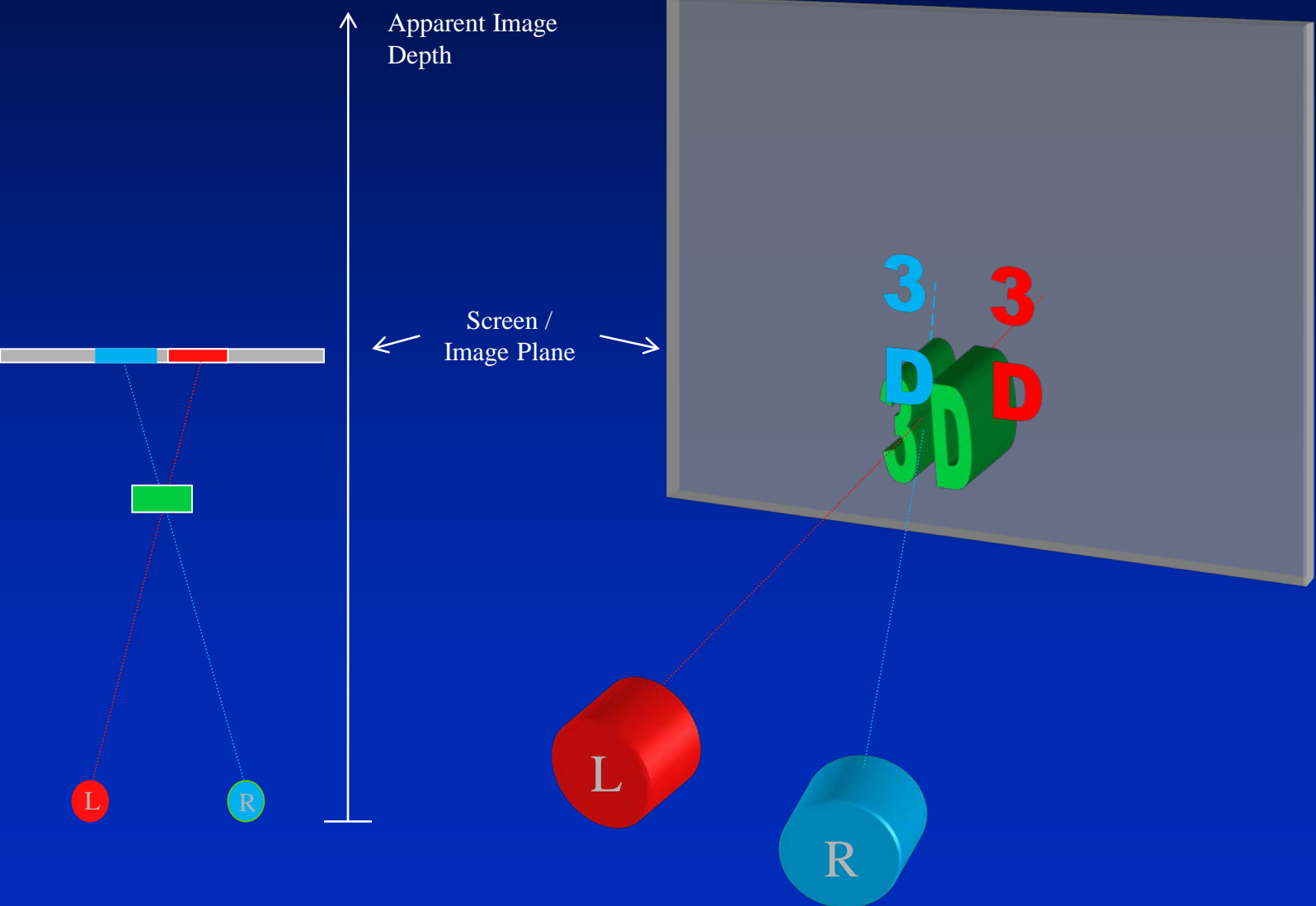
Human Depth Perception



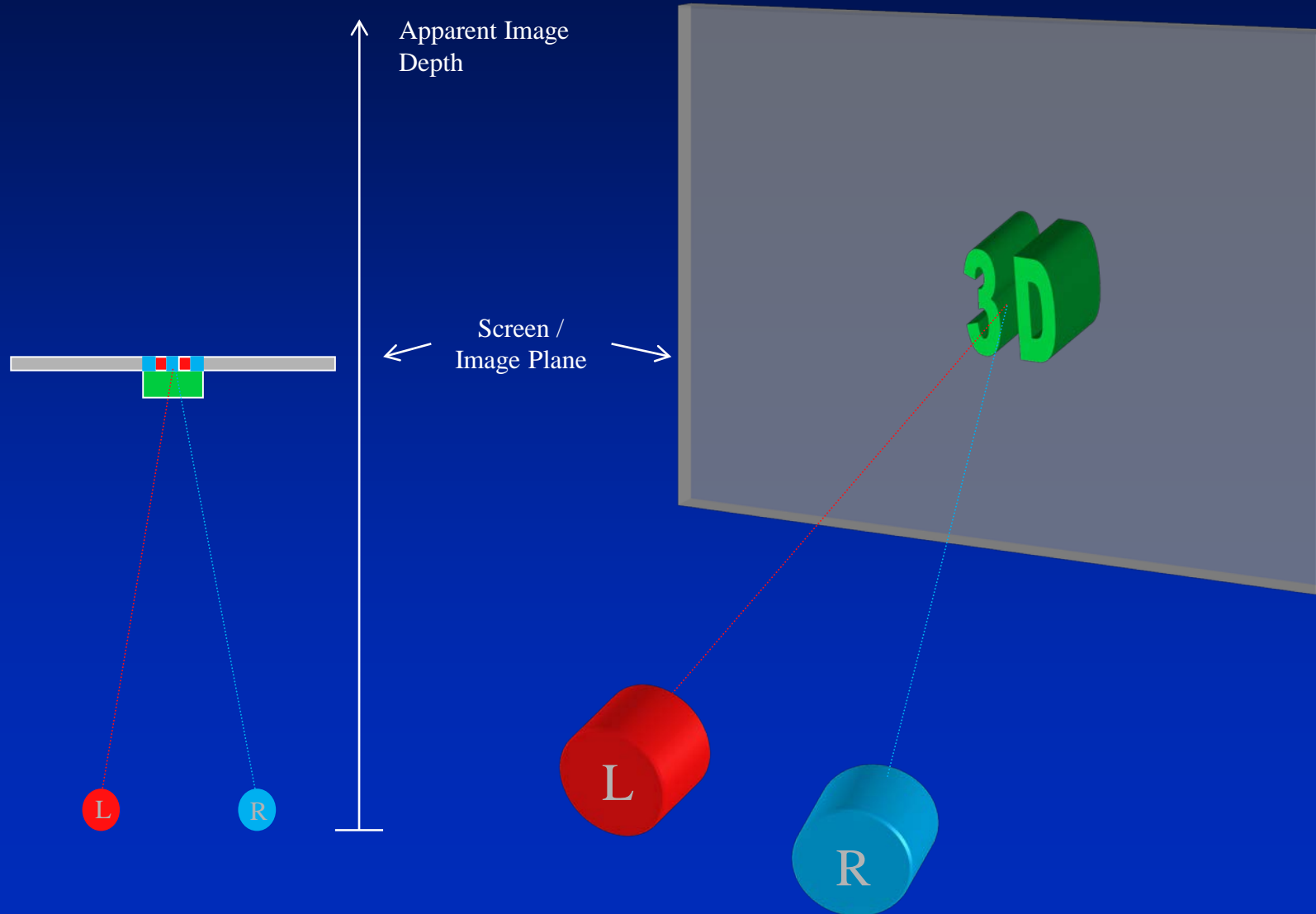
Stereoscopic Vision: Behind The Screen (Concave)



Stereoscopic Vision: In Front Of The Screen (Convex)



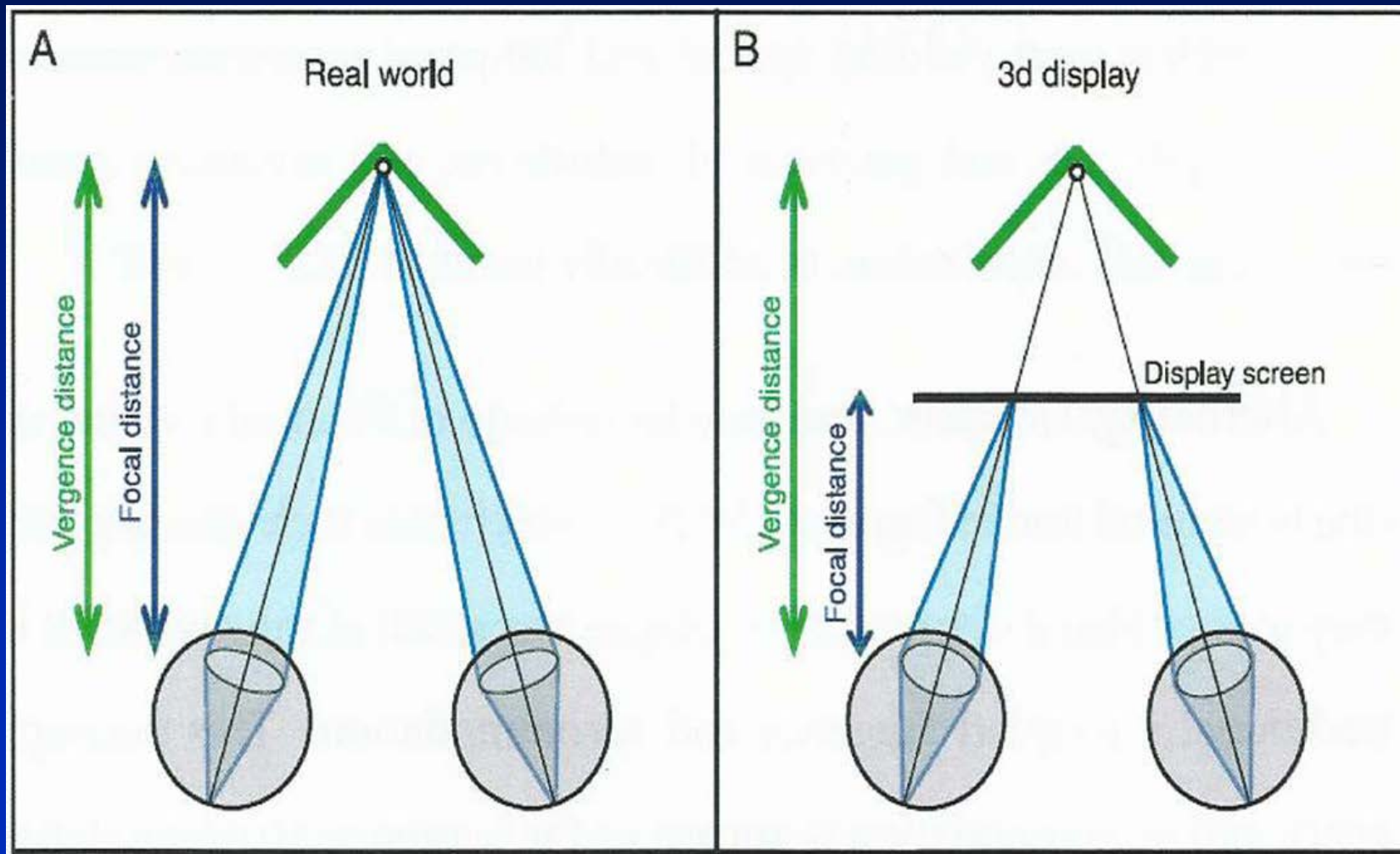
Stereoscopic Vision: At The Screen



Vergence

- The simultaneous movement of the pupils of the eyes toward or away from one another during focusing.
- This measure of the convergence or divergence of a pair of light rays is defined as vergence.

Diagram of Vergence



Vergence Accommodation Conflict

- Computer and projection displays present images on a single surface but have a focal distance (blur on the retina) which may be in front of or behind the screen
- The inability to fuse the binocular stimuli causes discomfort and fatigue to the viewer
- Viewers can be trained, and the discomfort can diminish with practice

End
