Fall 2019

CS6501: Topics in Human-Computer Interaction

http://seongkookheo.com/cs6501_fall2019

VR/AR Interfaces

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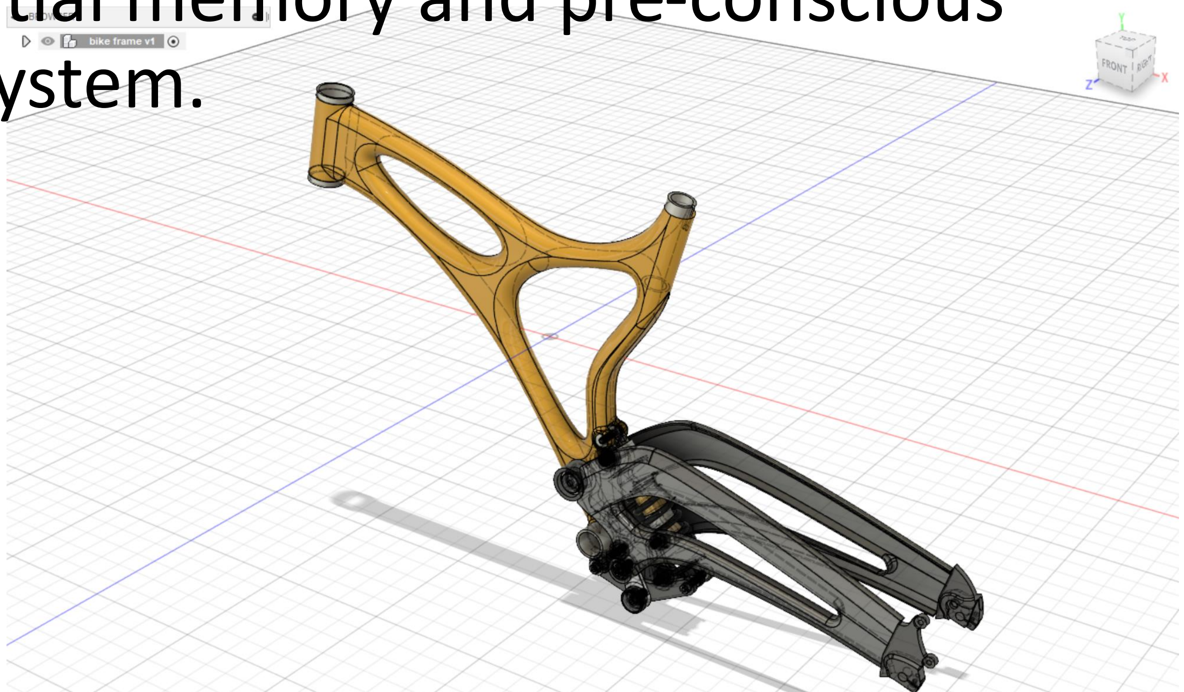
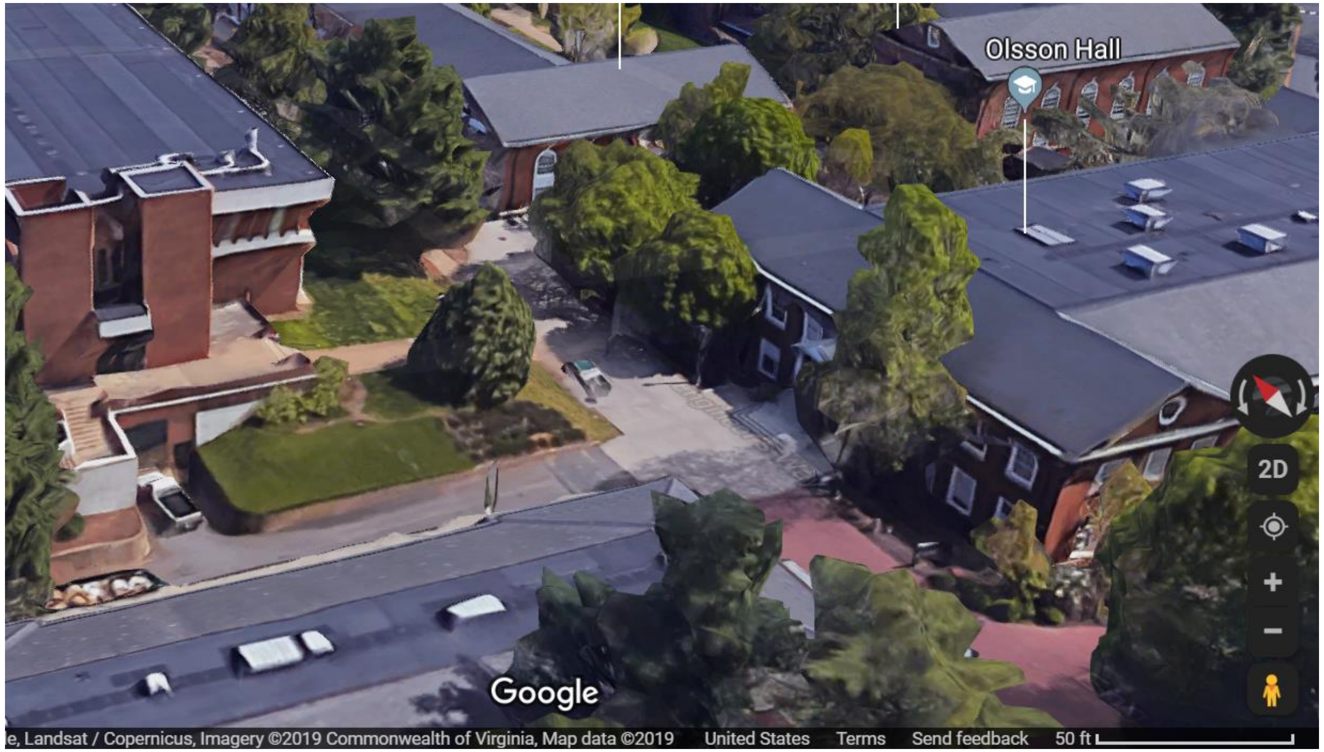
Why 3D?

- The world around us is 3D.
- Understanding, designing, and analyzing in 3D is intuitive and efficient.
- Harnessing human abilities in spatial memory and pre-conscious processing by the human vision system.



Why not 3D?

- Complexity (added degrees of freedom).
- Most standard user interfaces are designed for 2D.



DOF	Control	Display
x	+	
y		
z	+	
θx		+
θy		-
θz		

Seeing in 3D (Depth Cues)

- We perceive things in 3D based on
  - Occlusion: Gives ordinal information
  - Perspective: Relative size, converging lines
  - Stereopsis: Accommodation, Convergence
  - Motion parallax
  - Contour, shading, specular highlights, reflections, shadows

Depth Cues can be misleading

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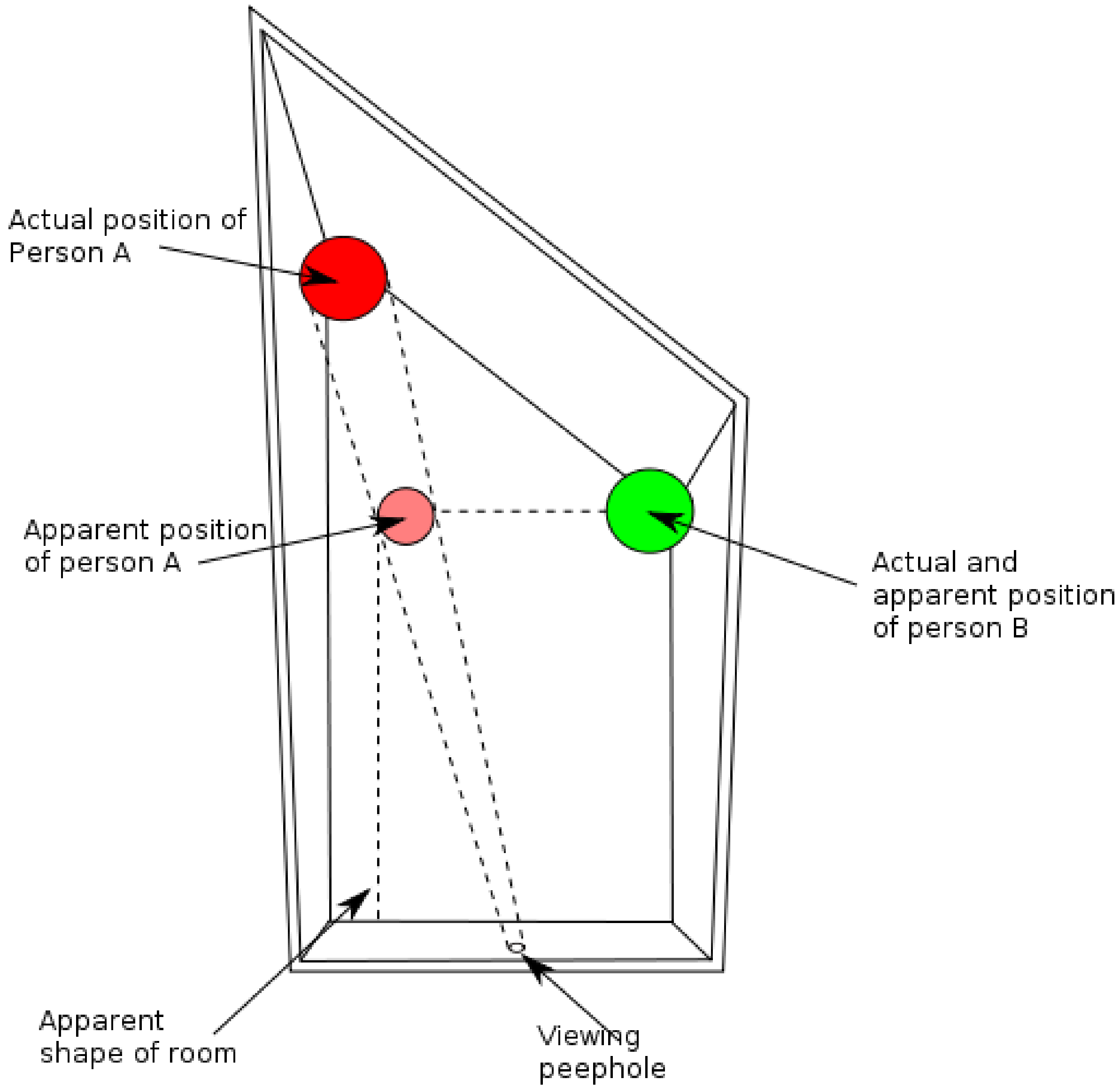
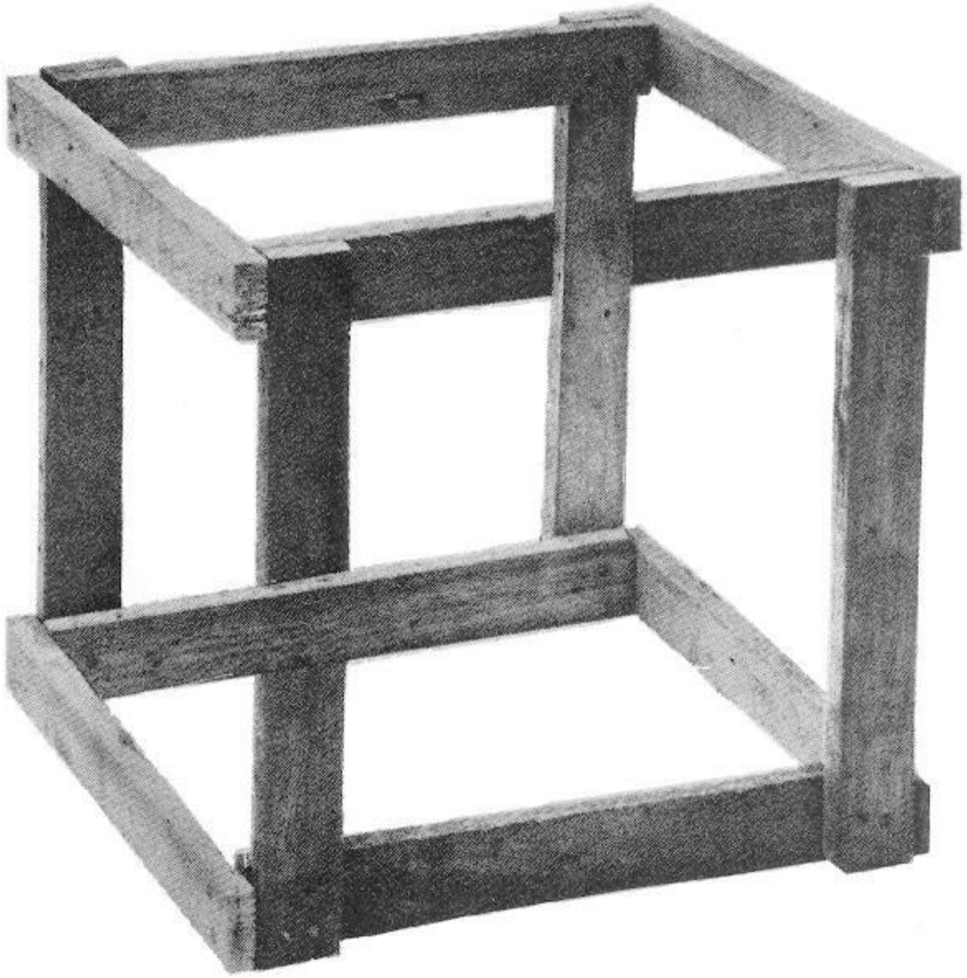
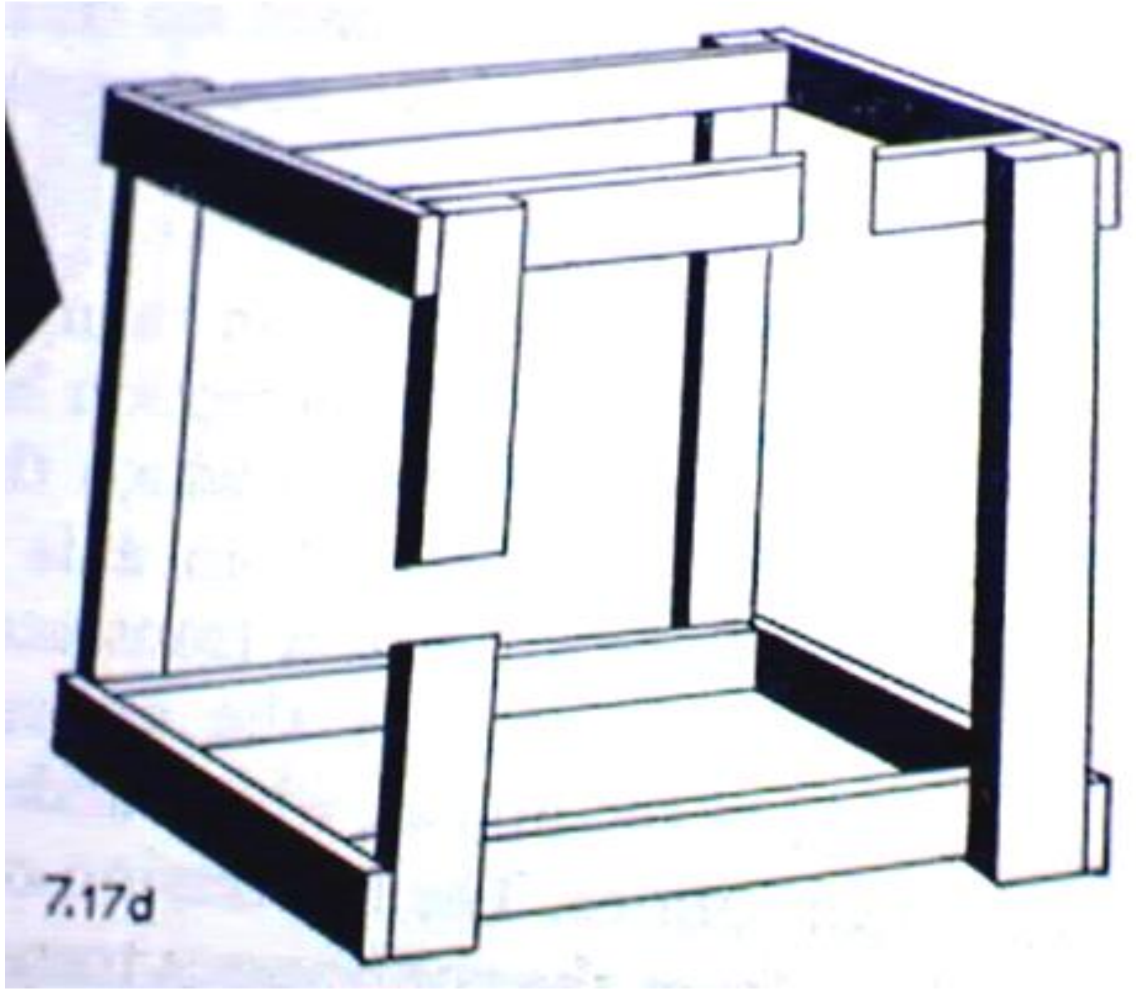


Depth Cues can be misleading



Freemish Crate
(Escher's Cube)

Depth Cues can be misleading

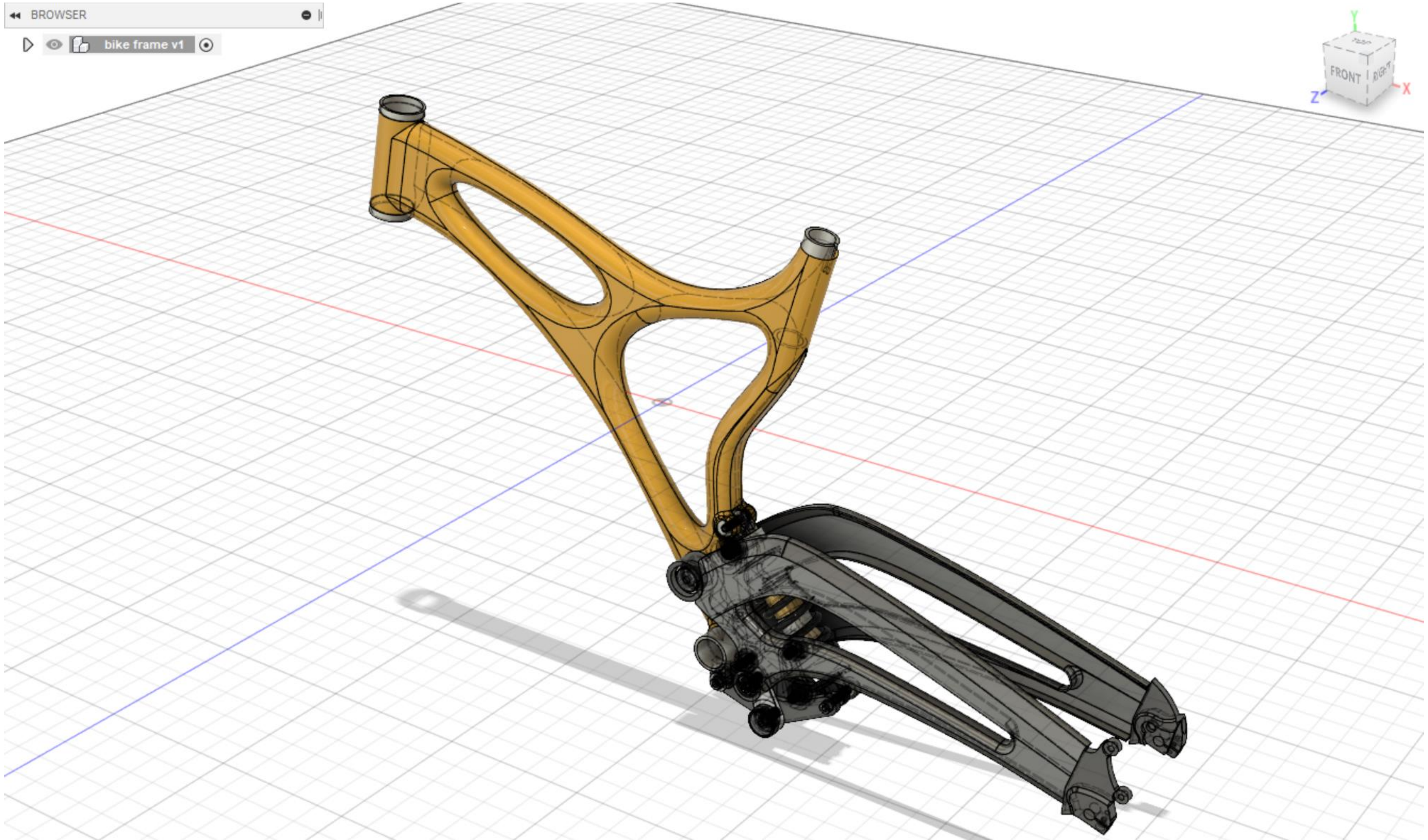


Depth Cues can be misleading

Julian Beever Drawings

3D Display Technologies

- 2D monitor with perspective projection



3D Display Technologies

- 2D monitor with perspective projection
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- 2D monitor with perspective projection
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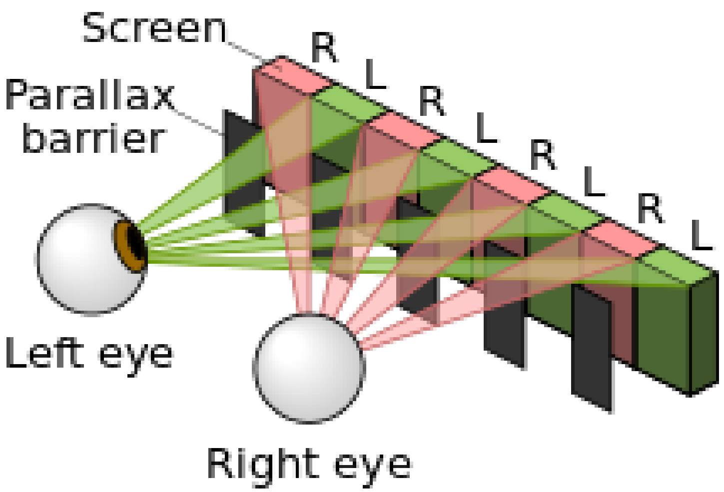
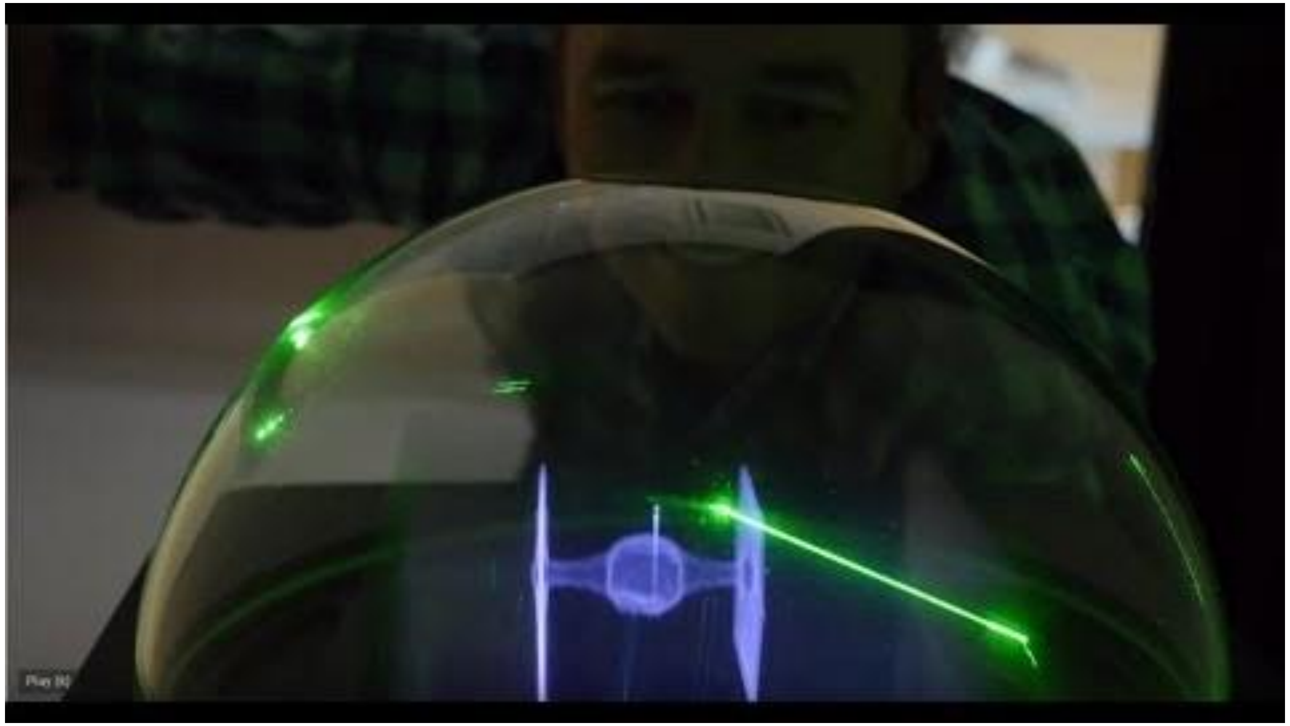
- Autostereoscopic displays



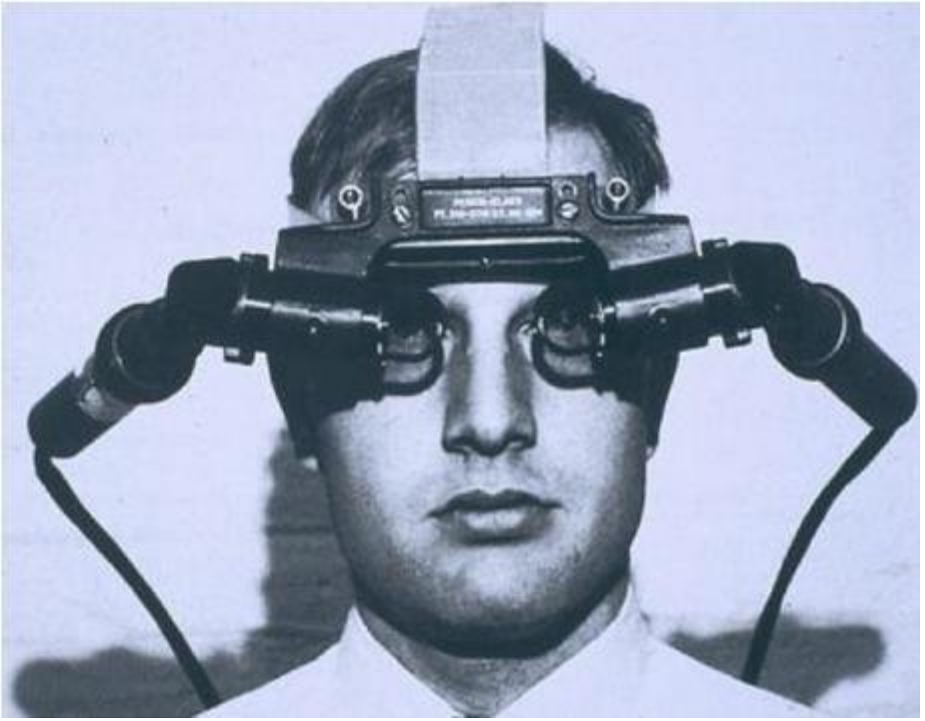
3D Display Technologies

- 2D monitor with perspective projection
- Stereoscopic displays
- Autostereoscopic displays
- Volumetric displays



Virtual Reality

- Has a very long history



The Ultimate Display, Ivan Sutherland, 1965

The Ultimate Display, Ivan Sutherland, 1965

Virtual Reality

- Has a very long history
- Finally became something an individual can buy
- With 6-DOF tracking of head and hands
  - 3 DOF for position (*x*, *y*, *z*)
  - 3 DOF for orientation (θx, θy, θz)

Virtual Reality

- Many benefits coming from 6-DOF input and output
  - Spatial congruence in 3D
  - 1:1 Rendering of the virtual object
  - Stereoscopic display supporting views from various viewpoints
  - High information bandwidth coming from 6-DOF head + 2 x 6-DOF hands

DOF	Control	Display
x	+	+
y	+	+
z	+	+
θ_x	+	+
θ_y	+	+
θ_z	+	+

Virtual Reality

- But also many problems
  - Still bulky and cumbersome to wear
  - Low display resolution
  - No proper haptic feedback
  - Motion Sickness
  - Fatigue and low input accuracy from in-air interaction
  - Lack of awareness on physical world

Augmented Reality

- Overlaying digital content on top of the physical world

Augmented Reality

- Overlaying digital content on top of the physical world
- Available in various form factors, handheld, projected, and head-mounted
- Devices with see-through displays exist, but viewing angle is narrow

Augmented Reality

- Has many benefits coming from having digital content and the physical world together.

- But still has many technical difficulties
  - Accurate sensing of the environment
  - Limited field of view
  - Matching physical and virtual world

Plane, Ray, and Point: Enabling Precise Spatial Manipulations with Shape Constraints

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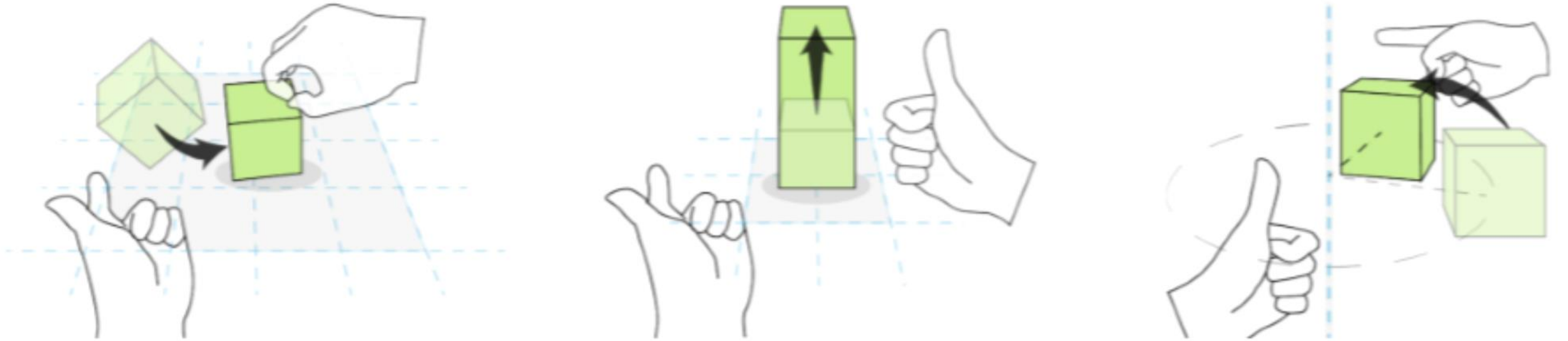

Figure 1. A user can create shape constraints such as Plane (left) or Ray (right) through gestures with their non-dominant hand. The same gestures can be used by the dominant hand to control the manipulation degrees of freedom (middle, right).

ABSTRACT

We present *Plane, Ray, and Point*, a set of interaction techniques that utilizes shape constraints to enable quick and precise object alignment and manipulation in virtual reality. Users create the three types of shape constraints,

INTRODUCTION

Commercial implementations of Virtual Reality (VR) systems typically provide rich and immersive visual experiences in 3D environments controlled with 6 degrees of freedom (DOF) (3 position and 3 orientation) input

Thank you!