CSE 190: Virtual Reality Technology

LECTURE #2: A BRIEF HISTORY OF VR

Announcements

First discussion with TA Andrew: Monday at 1pm on Zoom

Deadline for presentation date selection on wiki:
Monday April 13th at 11:59pm

Homework Project 1

Deadline: Sunday April 19th at 11:59pm

Potential issues:

- Windows PC with Iphone

Milestones for project will be added to project description

“I hear and I forget.
I see and I remember.
I do and I understand.”

Confucius?, 551-479 BC

Virtual Reality: Definition

Definition of **virtual reality** on Merriam-Webster:

An **artificial environment** which is experienced through **sensory stimuli** (such as sights and sounds) provided by a **computer** and in which one's **actions** partially determine what happens in the environment.

Related Terms

Virtual environment

Artificial reality

Computer generated environment

Computer simulated environment

Synthetic environment

Spatial immersion

Cyberspace

Virtual worlds

Virtual presence

VR History

The Beginnings

2012 Palmer Luckey invented VR

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2012 Palmer Luckey invented VR

Whirlwind: First CG System

1949: First computer graphics (CG) on Whirlwind Computer at MIT (Bouncing Ball)

Whirlwind development began in 1945

System was first demonstrated on April 20th, 1951

First digital computer capable of displaying real-time text and graphics on a video terminal (large oscilloscope screen)

1962: Sensorama

Morton Helig, 1950s: Designed and patented 'the experience theatre' - 180 degree horizontal and 155 degree vertical. 30 speakers, smell, wind, seats that moved.

Couldn't get funding, so in 1962 created the Sensorama: an arcade setup with a **vibrating motorcycle seat** and **handlebars** and two 35mm **projectors** for stereo and **wind** and **aromas** and **stereo sound** as the viewer moves through pre-recorded experiences.

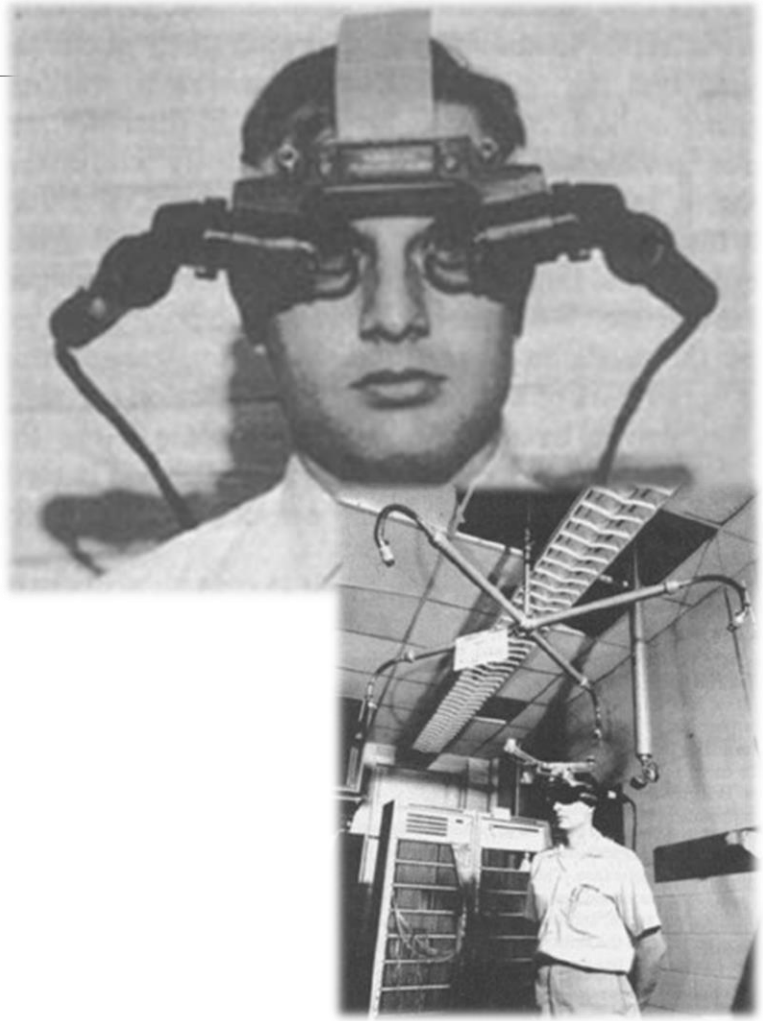
1965: Ivan Sutherland (University of Utah)

1963: Sketchpad: First **interactive** CG system with light pen

1965: Sutherland proposes the '**ultimate display**': "The ultimate display would, of course, be a room within which the computer can control the existence of matter. ... With appropriate programming such a display could literally be the Wonderland into which Alice walked"

1968: Sutherland created the first Virtual Reality and Augmented Reality (AR) Head Mounted Display (HMD) system: The **Sword of Damocles**

- **Real-time** computer generated display of wireframe cube with **head tracking** projected onto half-silvered mirrors so the cube floats in front of the user in the room.
- **Two heavy CRTs** mounted by the users head along with other hardware suspended from the ceiling by a **mechanical arm**.



VR Displays

1965: First commercial vector display (IBM, $100K)

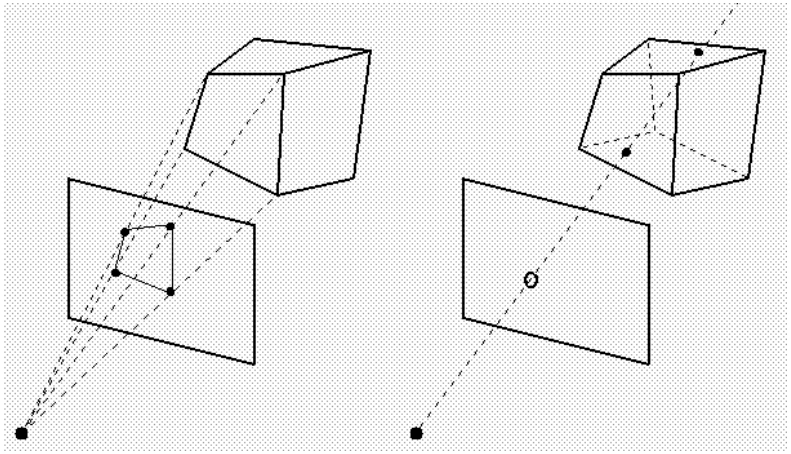
1967: First haptic display: Project GROPE (Fred Brooks, UNC)

“UNC uses a ceiling mounted ARM (Argonne Remote Manipulator) to test receptor sites for a **drug molecule**. The researcher, in virtual reality, grasps the drug molecule, and holds it up to potential receptor sites. Good receptor sites **attract** the drug, while poor ones **repel** it. Using a force feedback system, scientists can easily feel where the drug can and should go.”

Rendering Techniques

1968 **Ray casting** principle (Arthur Appel)

1971 **Scan conversion** Principle



Ray tracing iterates over **pixels**

Scan conversion iterates over **vertices**

1971 **Gouraud Shading** (Henri Gouraud; method based on Lambertian diffuse lighting model)

1974 **Texture Mapping** (Edwin Catmull, now President of Pixar)

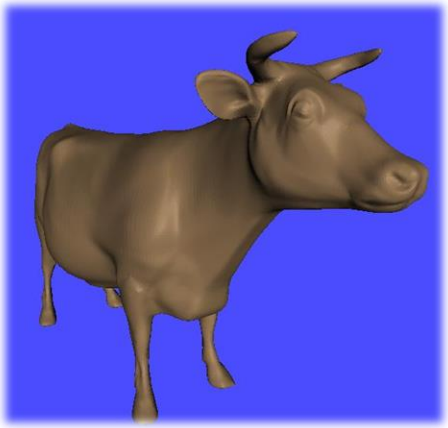
Rendering Techniques

1975 **Phong Shading** (shading model developed by Bui Tuong Phong; PhD from University of Utah, then professor at Stanford; *1942 +1975)
About improving the quality of synthesized images he wrote, "We do not expect to be able to display the object **exactly** as it would appear in reality, with texture, overcast shadows, etc. We hope only to display an image that **approximates** the real object closely enough to provide a certain degree of realism."

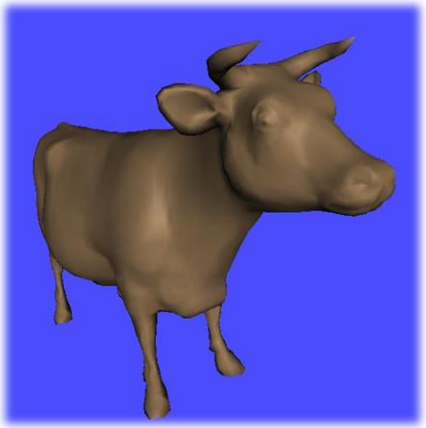
1979 **Ray Tracing** (Turner Whitted)

1984 **Radiosity** (Goral, Torrance, Greenberg, Battaile; Cornell University)

Flat shading



Gouraud shading



Phong shading

Tracking

Sayre Glove

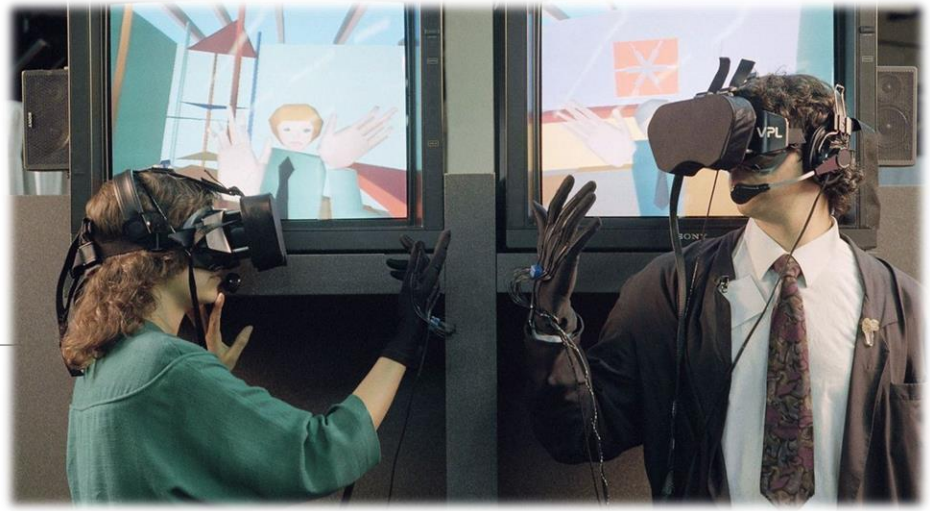
Polhemus Fastrak

1977: First instrumented glove "**Sayre Glove**" (Sandin, DeFanti & Sayre)
1979: **Polhemus** Tracking System (Raab et al.)
1985: **Jaron Lanier** & **VPL** research
- First company focused on VR products
- Popularized the term "virtual reality"
- Sold **DataGloves** in 1985 and **EyePhones** in 1988

1986: **Ascension Technologies** founded from former Polhemus employees

VPL EyePhone

Developer	VPL Research
Display	2.7", 2.75" or 3" B&W LCD with color filters (76,800 subpixels) From the Sony FLD-370 (1990) (3" 89,505 subpixels)
Resolution	~184.7x138.6 per eye (320x240 subpixels)
Optics	large expanse extra perspective (LEEP) optical system
Tracking	Polhemus tracker
FOV	90°x60° (80°x60° monoscopic)
Weight	2.4 kg
Release date	June 7, 1989
Price	$9,400



Version 1

Version 2

Virtual Environments

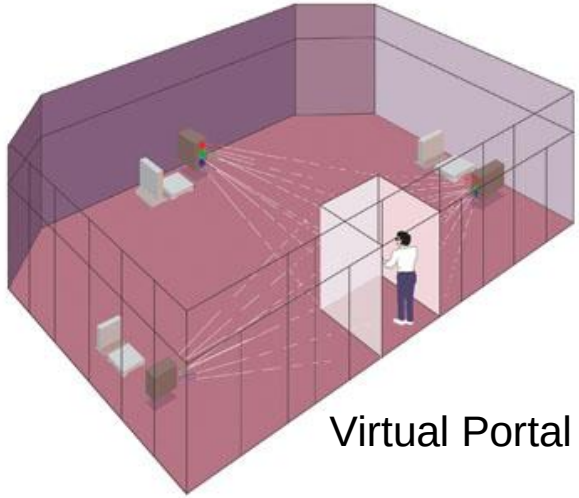
1987: British Aerospace **Virtual Cockpit**
1989: **NASA VIEW** System (Virtual Interface Environment Workstation)

- First complete VR system
- Project started in the early 80's
- General-purpose, multi-sensory, personal simulator and telepresence device
- Configuration included head and hand tracking, wide field-of-view stereo head-mounted displays, speech recognition, 3D audio output and a tracked and instrumented glove

1989: Fake Space Labs: Development of the **BOOM**
1992: **Virtual Portal** (M. Deering, Sun Microsystems)
1992: **CAVE**: Cave Automated Virtual Environment (Carolina Cruz Neira et. al., University of Chicago)

NASA VIEW

EVL CAVE



Virtual Portal

The 1990s

1993: Silicon Graphics **Reality Engine**:
- Hardware-supported Gouraud shading, texture mapping, Z-buffering, anti-aliasing, 200,000 polygons/sec (Comp. w/Nvidia GTX 2080: 20 billion polygons/sec)

1993: **OpenGL** standard created

1993: **PHANToM** Haptic Device (T. Massie, K. Salisbury)

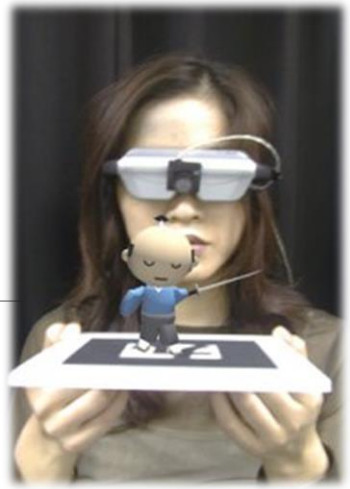
1995: Nintendo **Virtual Boy**
- 3D monochrome display, shipped 1.26M units, released 22 games

1996: Silicon Graphics **Infinite Reality** (5M polygons/sec)

1998: Silicon Graphics **Infinite Reality2** (13M polygons/sec)

1998: First **6-wall CAVE**
- Built by TAN at Royal Institute of Technology in Stockholm

1999: **ARToolKit** (Hirokazo Kato, HITLab, UW)



ARToolKit

Virtual Boy

Early 2000s

2002: **PC graphics** & PC clusters (NVIDIA FX4000: 130M polygons/sec)

2002: **DLP/LCD projectors**

- Time sequential (active) stereo possible with DLP technology

2002: **Optical tracking** for VR systems (e.g., Vicon, ART): predecessors of Oculus Rift tracking cameras

Optical Tracking System (Vicon)

This slide was not covered in lecture – it's here for context but won't be part of final exam

Sensics PiSight

First high-resolution, high FOV HMD

Released April 2006

2200x1200 color pixels per eye

150 degrees field of view

24 OLED microdisplays:
- 4x3 array for each eye
- 800x600 pixels

Full 6 degree of freedom tracking

Initially driven by PC cluster, later by single PC

~$200k

Modern Consumer VR/AR

June 29, 2007: Apple releases the first generation iPhone

August 1, 2012: Palmer Luckey revives VR with Oculus Kickstarter

March 25, 2014: Facebook buys Oculus VR for $2B

March 25, 2016: Oculus CV1 starts shipping

March 30, 2016: Microsoft HoloLens starts shipping

April 5, 2016: HTC Vive starts shipping

October 13, 2016: Sony releases Playstation VR

March 20, 2018: Oculus Go release date

April 5, 2018: HTC Vive Pro release date

August 2018: Magic Leap starts shipping

Feb 24, 2019: Microsoft HoloLens 2 announced

May 21, 2019: Oculus Quest release date

June 28, 2019: Valve Index release date

Where is VR used?

Gaming

Entertainment

Training

Architecture

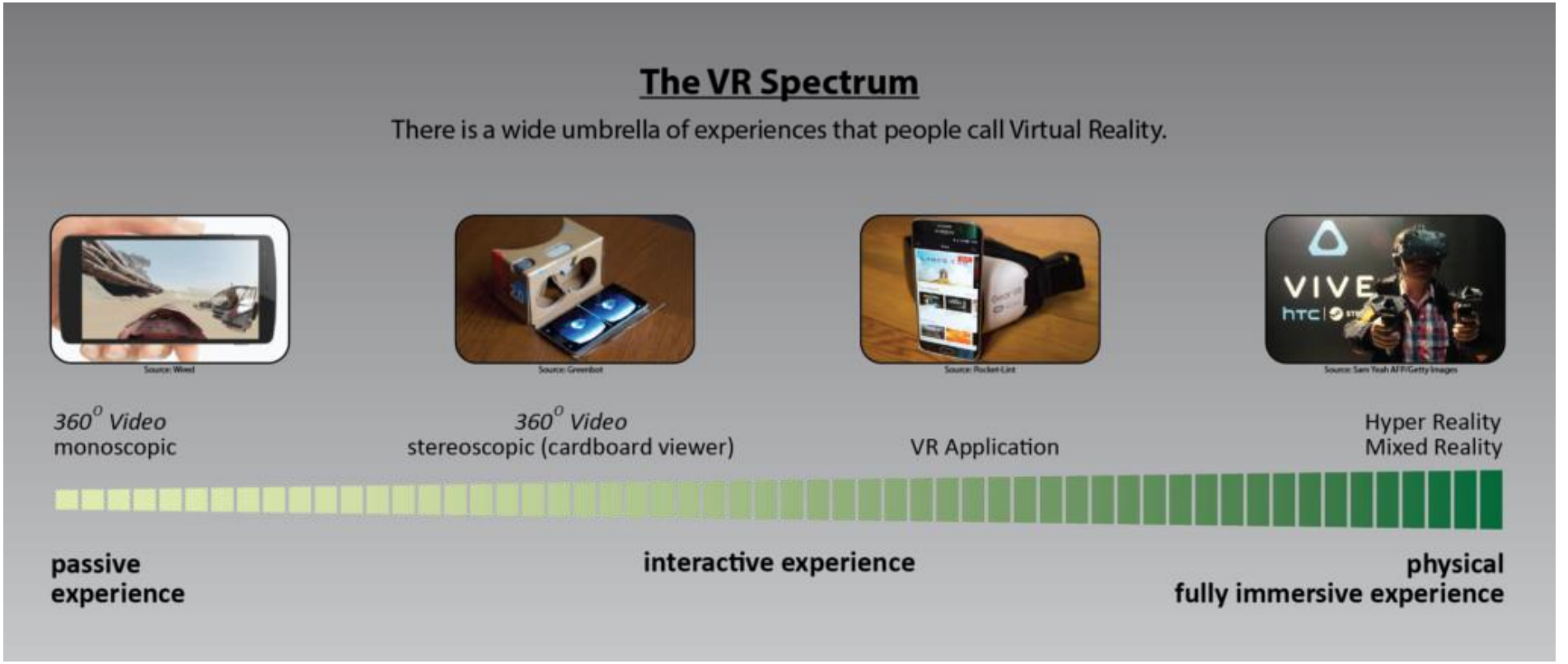
Medicine

Simulators

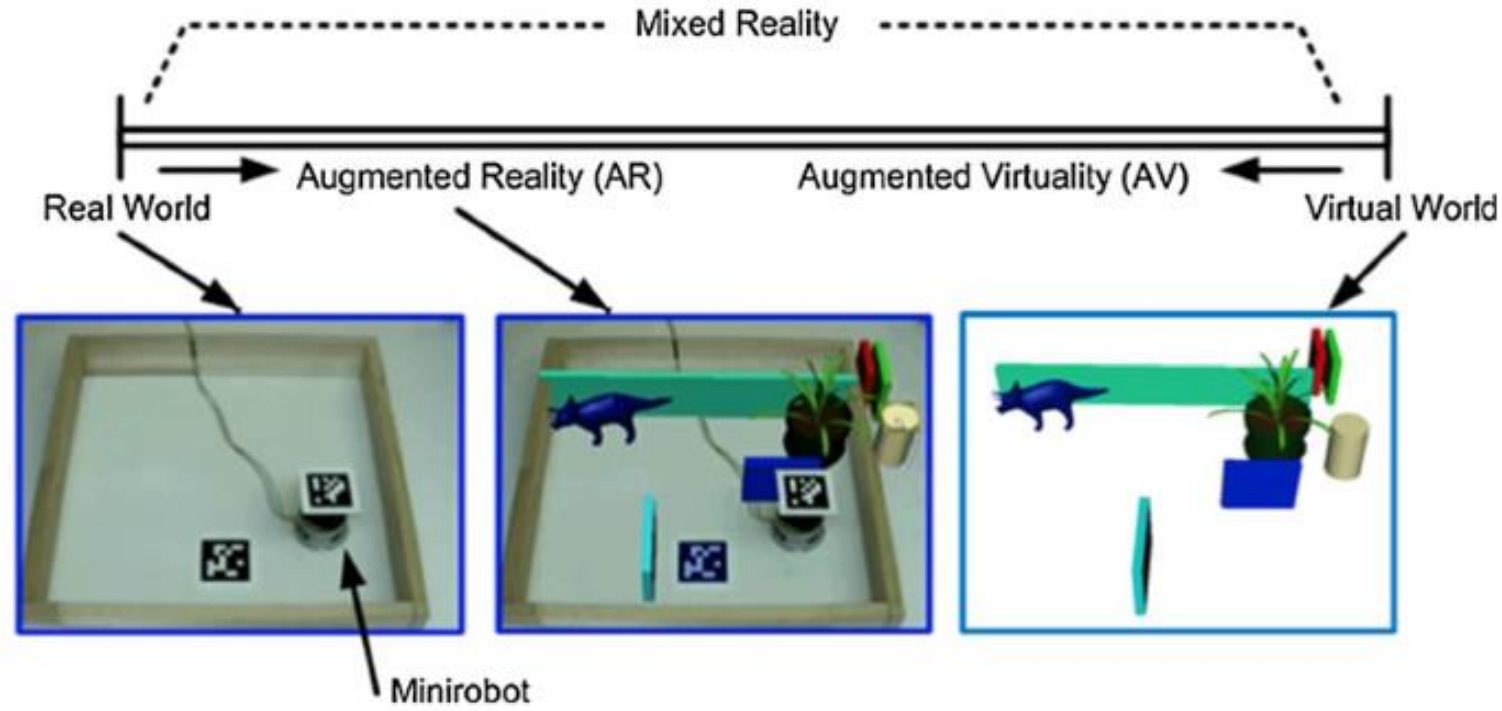
Scientific visualization

VR in Movies

The VR Spectrum



The Mixed Reality Spectrum



Related Technologies

Vehicle/Flight Simulators

CAD

Computer animation/special effects

Video Games

Augmented Reality – superset of VR

- Video AR: real world video with generated overlay
- See-Through AR: generated display is semi-transparent

Tele-Presence

- Teleconferencing
- Remote robotic control

Collaborative systems