

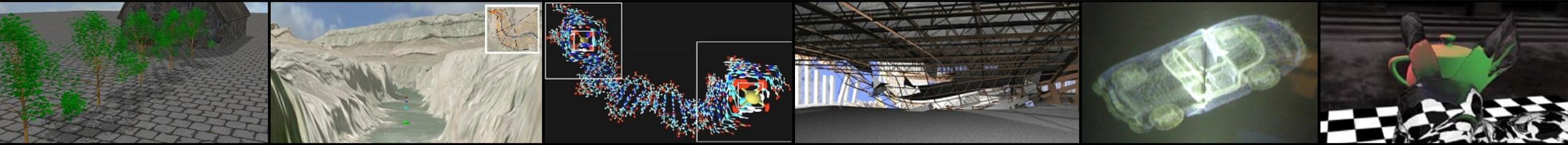
CIS 4930-001: INTRODUCTION TO AUGMENTED AND VIRTUAL REALITY



Introduction to Virtual Reality

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Some slides from: Anders Backman, Mark Billinghurst, Doug Bowman, David Johnson, Gun Lee,
Ivan Poupyrev, Bruce Thomas, Geb Thomas, Anna Yershova, Stefanie Zollman





2004

Problem Domain

Computer
Graphics



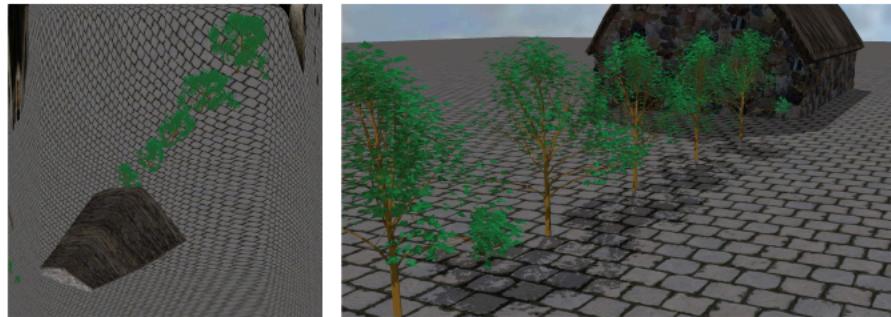


Figure 2 Single-image comprehensive visualization of real-world scenes. The graph camera image (left) seamlessly integrates 3 video feeds (right) and shows all 3 branches of the T corridor intersection.

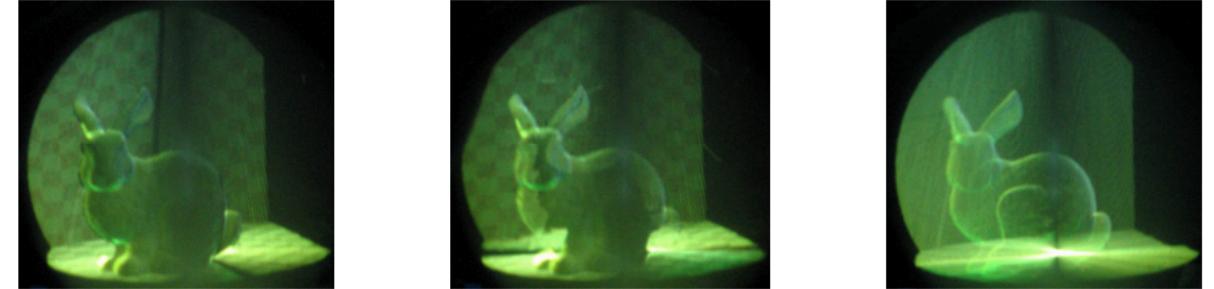


Figure 5 3D images rendered from DI (left), OCRI (middle), and original geometric model (right), all photographed from reference view.

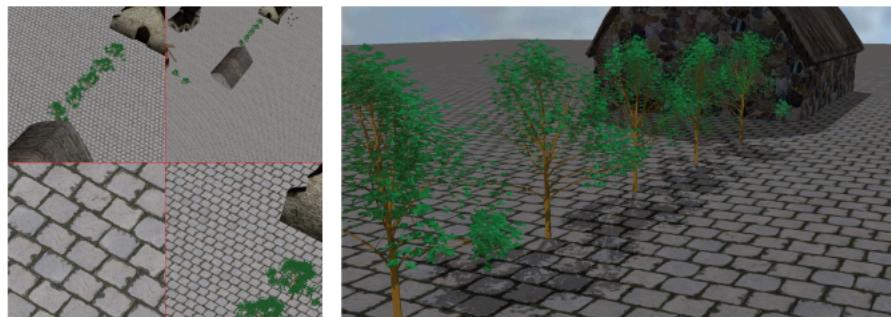


Figure 6 DI and OCRI 3D images from viewpoint translated 4" left.

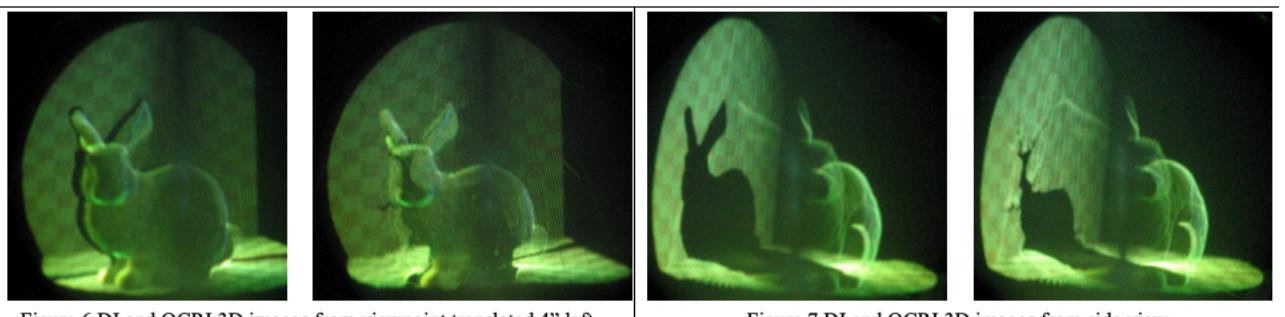
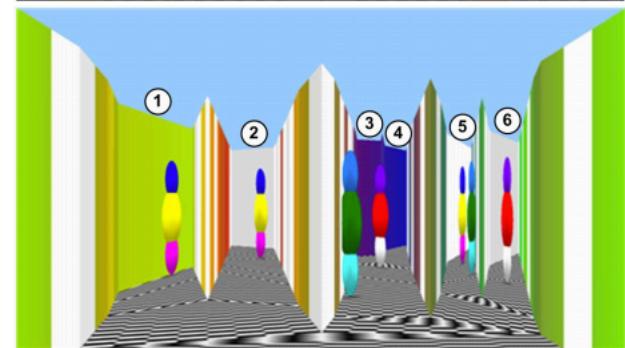
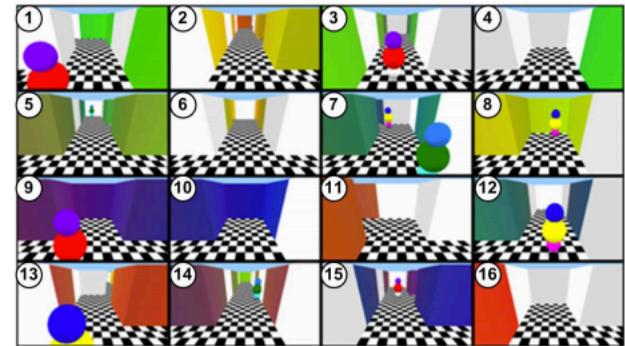
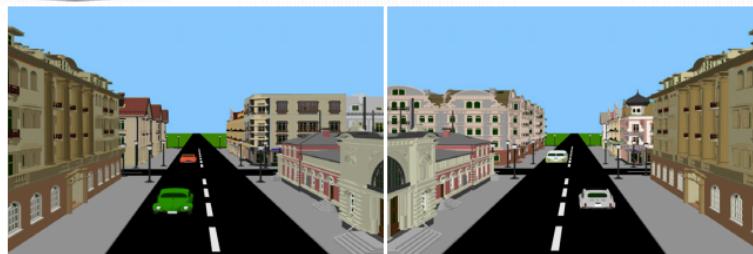


Figure 7 DI and OCRI 3D images from side view.



Figure 1 Enhanced virtual 3-D scene exploration. The graph camera image (top) samples longitudinally the current street segment as well as the 3 segments beyond the first intersections (bottom left). The 4 side streets are occluded in conventional images (bottom right).



INTRODUCE YOURSELF

Name

Background (department, year in school)

What are your interests in / exposure to in AR/VR?

A few things we will assume that you are all familiar with:

- Linear algebra
- OO programming (C#)
- You will teach each other practical aspects of AR/VR, such as using Unity3D, Blender, Maya, Photoshop, etc.



COURSE TOPICS

- What Augmented Reality/Virtual Reality is
- How to design good AR/VR experiences
- History of AR/VR & current status of the business
- Understand how VR works (engineering + psychology)
- Broad overview of the area of Computer Graphics & Real-time Rendering
- How to build your own AR/VR applications



SINGLE SEMESTER-LONG GROUP PROJECT (W/ MANY MILESTONES)

Week 1: Form project groups and develop project ideas

Week 2: Project pitch

Week 3: Formal project proposal

Week 8: Mid-Project Progress Report/Demos

Week 10: Peer demo & feedback

Week 13/14/15: Final project demos

Week 15: Project Due

In addition, each team will be responsible for presenting one (1) tool/technique lecture to the class (30 minutes)



WHAT IS IN THE LAB

Room: ENB 217

Hours: see syllabus

Workstations x2

* Note: This is an active research lab.
Please be respectful with noise, food,
etc. when working in the lab.



Oculus Go



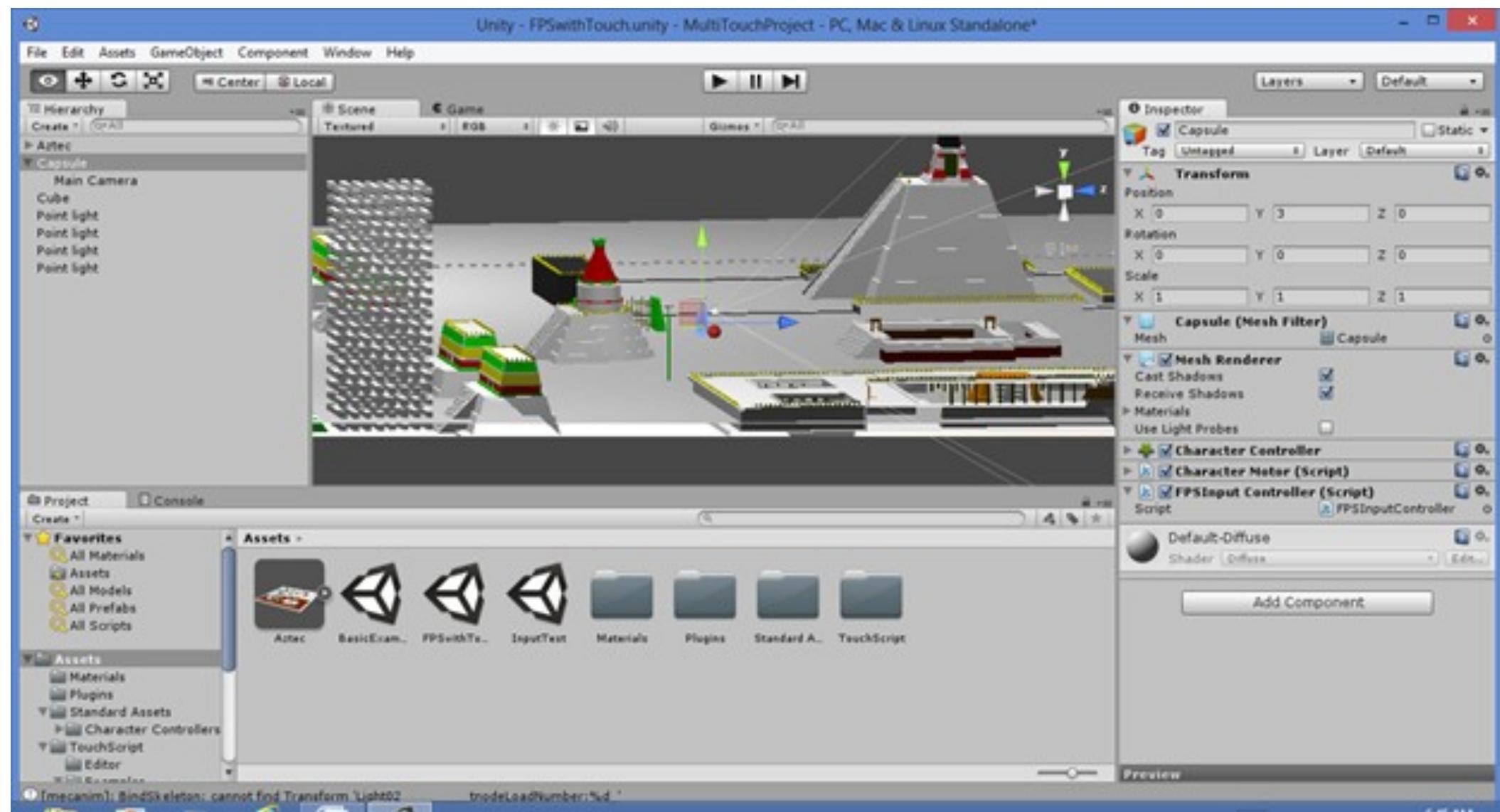
Vive Pro



Acer Chromebook
Tab 10 (ARCore)



UNITY3D



WHAT IS VIRTUAL REALITY



NASA Tech Briefs

Transferring Technology to
American Industry and Government

July/August 1988
Volume 12 Number 7



NASA's Virtual Workstation Shapes A VIVED Reality

CIRCA 1985



virtual reality

noun

Simple Definition of VIRTUAL REALITY

Popularity: Bottom 40% of words

: an artificial world that consists of images and sounds created by a computer and that is affected by the actions of a person who is experiencing it

Source: Merriam-Webster's Learner's Dictionary



VIRTUAL REALITY GOAL

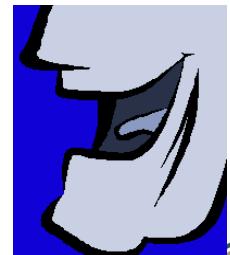
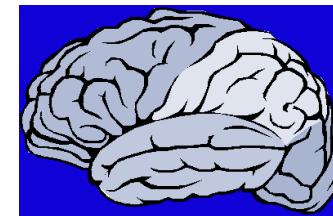
Take human senses (interfaces)

- Visual
- Audial
- Haptic/Tactile
- Scent
- Taste
- Neural

Replace with computer generated data

- Dynamics, visuals, AI, networking
 - Basically everything in science...!

Create sense of immersion



CATEGORIES OF VR

Desktop VR

- 3D world shown on monitor, mouse and keyboard input to interact
- Low cost, standard PC
- Games, Simulators



Augmented Reality

- A seamless mix between real world and Computer Graphics (CG) as well as sound. (e.g. Microsoft Hololense)



Telepresence

- The use of various technologies to produce the effect of placing the user in another location



Immersive VR

- Using other display technologies (helmets, walls, ...)
- User tracked in some sense



IMMERSIVE VR

Head mounted display, gloves

Separation from the real world



VR GOGGLES AND GLOVES



[HTTPS://YOUTU.BE/Ak-Bt7IM8Jc](https://youtu.be/Ak-Bt7IM8Jc)



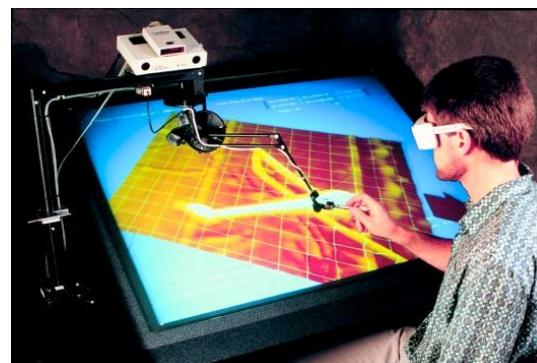
EXAMPLE VIVE APP – TILT BRUSH



[HTTPS://YOUTU.BE/IJUKZMVFX-0](https://youtu.be/IjukZMvfx-0)



TYPES OF VR



FLIGHT SIMULATOR (CAE)



[HTTPS://YOUTU.BE/YSixEkDOKOk](https://youtu.be/ySixEkDOKOk)



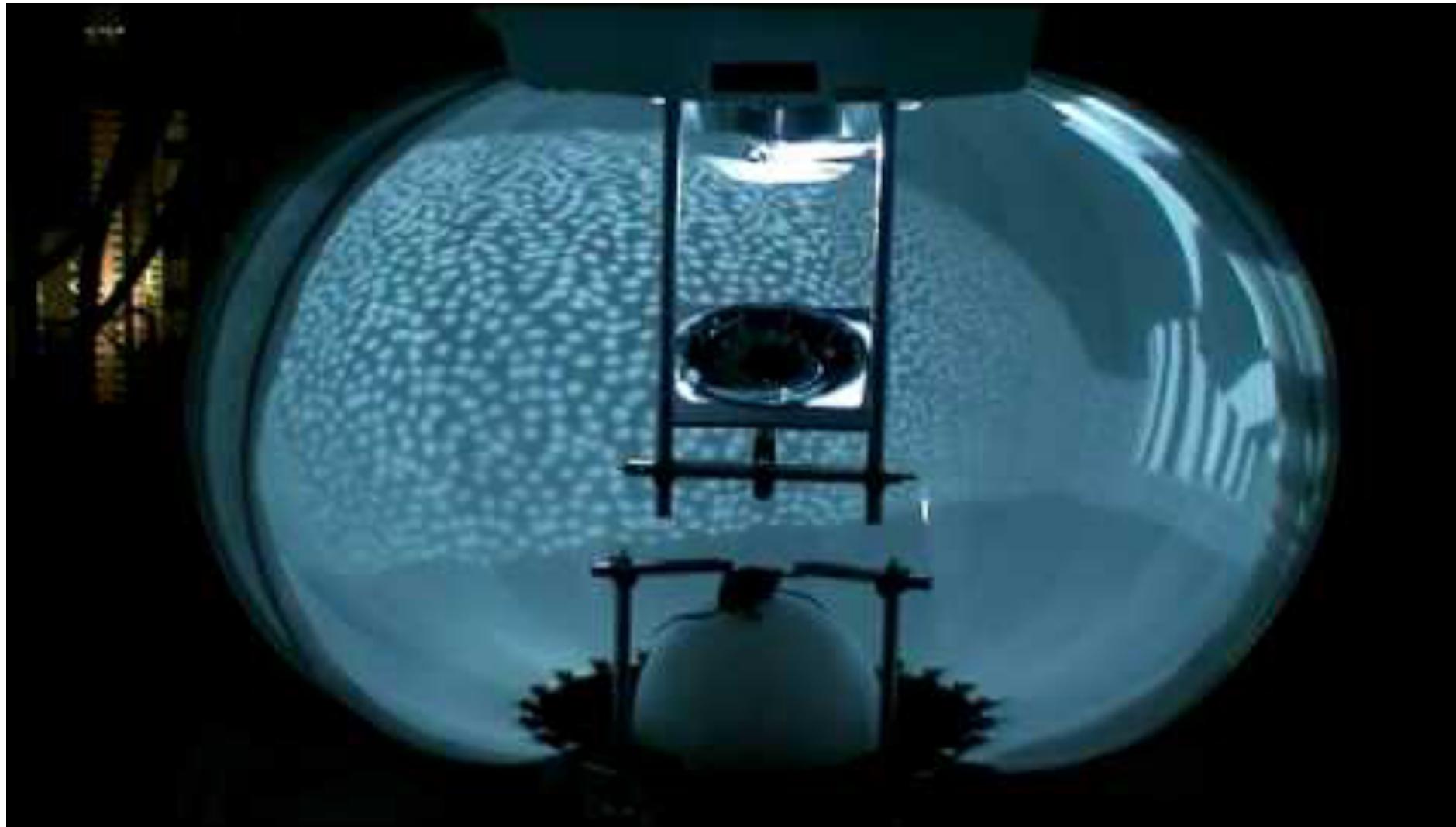
MIXED REALITY TABLETOP



[HTTPS://YOUTU.BE/DSSTUYCFJAG](https://youtu.be/DSSTUYCFJAG)



MOUSE IN VR MAZE



[HTTPS://YOUTU.BE/IDJOTEDBA2C](https://youtu.be/IDJOTEDBA2c)



OTHER DEFINITIONS

Virtual reality is...

- A computer technology that replicates an environment, real or imagined, and simulates a user's physical presence and environment to allow for user interaction. (Wikipedia)
- Electronic simulations of environments experienced via head mounted eye goggles and wired clothing enabling the end user to interact in realistic three-dimensional situations. (Coates, 1992)
- An alternate world filled with computer-generated images that respond to human movements. (Greenbaum, 1992)



MORE DEFINITIONS

- An interactive, immersive experience generated by a computer (Pimental, 1995)
- A Computer Generated world in which the user experiences himself to be, and act (Lars-Erik Janlert)
- a computer-synthesized, three-dimensional environment in which a plurality of human participants, appropriately interfaced, may engage and manipulate simulated physical elements in the environment and in some forms, may engage and interact with representations of other humans, past, present, or fictional, or with invented creatures. (Nugent, 1991)
- a way to visualize, manipulate, and interact with computers, and extremely complex data (Isdale, 1998)
- it's a cartoon world you can get into (Larijani, 1993)



VR IN THE MOVIES



Tron
1982



The
Lawnmower ...
1992



Johnny
Mnemonic
1995



The Matrix
1999



Gamer
2009



Ready Player
One
2018



THE DISCLOSURE (1992)



[HTTPS://YOUTU.BE/VFKYV7D5T8O](https://youtu.be/VFkyV7d5t8o)



VIRTUAL ENVIRONMENT (VE)

A computer generated and maintained world that a user can be placed "in"

- Surrounds the user (First person view, 3D/Stereo)
- Using 'all' modalities—vision, hearing, balance, touch, smell, taste (i.e., Presence)
- The world behaves as expected, or as needed by the application—in real-time with direct interaction (grabbing, pushing, pointing, ...)

VR == VE

- Used synonymously with virtual environment in most cases



BASIC VIRTUAL ENVIRONMENTS

3D graphics

Standard displays (desktop monitor)

Mouse, keyboard, game controller for input

User can view and navigate



BASIC VIRTUAL ENVIRONMENTS



LIMITATIONS OF BASIC VEs

Occlusion problems

Depth perception issues

Lack of precise spatial understanding

Difficult to control the viewpoint in 3D

Don't support "productive work"

VR helps to overcome these



KEY HARDWARE CHARACTERISTICS FOR VR

Virtual Reality has three key characteristics

- 3D stereoscopic display
- Wide field of view display
- Low latency tracking

When these three things are combined they provide a minimum for a compelling immersive experience



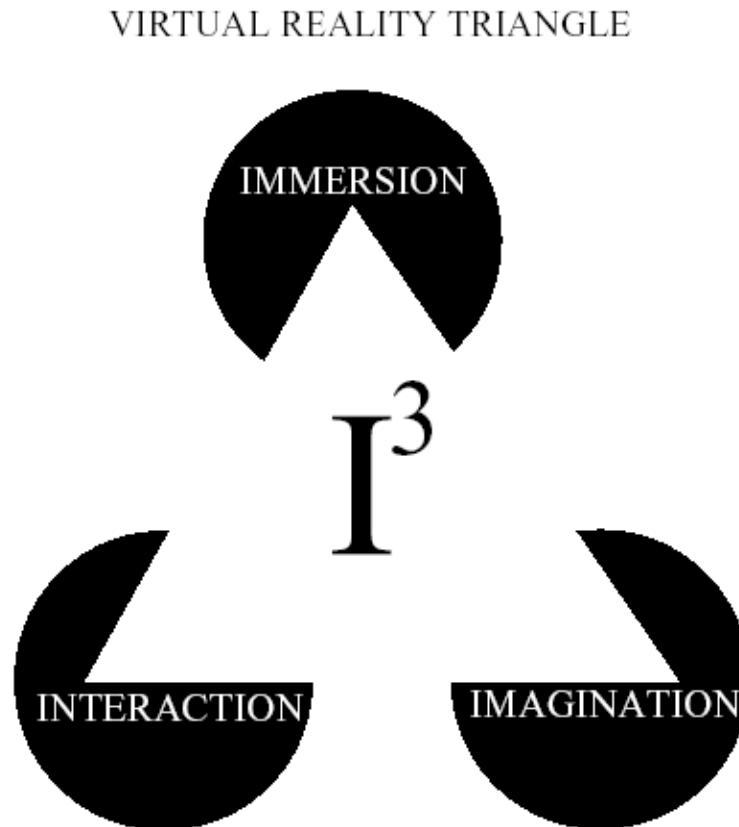
DEFINING CHARACTERISTICS



[HTTPS://YOUTU.BE/FPCBBjBGMK](https://youtu.be/FPCBBjBGMK)



KEY EXPERIENCE CHARACTERISTICS OF VIRTUAL REALITY



IMMERSION

“The extent to which the computer displays are capable of delivering an inclusive, extensive, surrounding and vivid illusion of reality to the senses of a human participant”
[Slater and Wilbur 1997]

Immersion measures quality of experience the system (hw/sw) is capable of delivering.

<u>Example</u>	<u>VE?</u>	<u>Immersive?</u>
This PPT	No	No
3D Cinema	No	Yes
Desktop Video Game	Yes	Yes/No
HMD	Yes	Yes



IMMERSION

Produced by:

- Quality of graphics/sound
- Enveloping environment
- Natural interaction
- Realism

Responsiveness - Consequences

- Flight simulators, pilots grounded when crashing
- Police training with “bullet vest”



Walking Experiment at
UNC – Chapel Hill



PRESENCE – SUSPENSION OF DISBELIEF

Immersion – sensation of being in an environment

- mental immersion – suspension of disbelief
- physical immersion – bodily entering the medium



VR EXPERIENCE



[HTTPS://YOUTU.BE/PAC5SeNH8jw](https://youtu.be/PAC5SeNH8jw)



PRESENCE

Presence – The feeling of being present somewhere

Virtual Presence – the feeling of being present in a simulated environment

Virtual presence...

“Is experienced by a person when sensory information generated only by and within a computer compels a feeling of being present in an environment other than the one the person is actually in” (Sheridan, 1992, pg.6)

If immersion is connected to characteristics of the technology used, presence is a state of consciousness. (i.e., immersion + imagination)



PRESENCE

Presence – (mentally immersed) the participant's sensation of being in the virtual environment (Slater)

Why is it important?

- It is easier to understand and interact with a 3D world if you are there.

Sense of presence improves with realism

- Some aspects of realism weigh more heavily than others (e.g. motion vs. Gravity, texture vs. Shadows)

Amount of realism necessary is dependent on the application.

- Need to identify the necessary stimuli.



PRESENCE ...

“The subjective experience of being in one place or environment even when physically situated in another”



IMMERSION VS. PRESENCE

Immersion: the extent to which technology delivers a vivid illusion of reality to the senses of a human participant.

Presence: a state of consciousness, the (psychological) sense of being in the virtual environment.

So **Immersion** produces a sensation of **Presence**

Goal of VR: Create a high degree of Presence

- Make people believe they are really in Virtual Environment



HOW TO CREATE STRONG PRESENCE?

Use Multiple Dimensions of Presence

- Create rich multi-sensory VR experiences
- Include social actors/agents that interact with user
- Have environment respond to user

What Influences Presence

- Vividness – ability to provide rich experience (Steuer 1992)
- Using Virtual Body – user can see themselves (Slater 1993)
- Internal factors – individual user differences (Sadowski 2002)
- Interactivity – how much users can interact (Steuer 1992)
- Sensory, Realism factors (Witmer 1998)



EXAMPLE: UNC PIT ROOM

Key Features

- Training room and pit room
- Physical walking
- Fast, accurate, room scale tracking
- Haptic feedback – feel edge of pit, walls
- Strong visual and 3D audio cues

Task

- Carry object across pit (walk across or around)
- Dropping virtual balls at targets in pit



TYPICAL SUBJECT BEHAVIOR (FROM A DIFFERENT EXPERIMENT)



[HTTPS://YOUTU.BE/VVAO0DKOD-8](https://youtu.be/vVAO0DkoD-8)



BENEFITS OF HIGH PRESENCE



Leads to greater engagement, excitement and satisfaction

- Increased reaction to actions in VR

People more likely to behave like in the real world

- E.g. people scared of heights in real world will be scared in VR

More natural communication (Social Presence)

- Use same cues as face to face conversation

NOTE: THE RELATIONSHIP BETWEEN PRESENCE AND
PERFORMANCE IS UNCLEAR – STILL AN ACTIVE AREA OF RESEARCH



IMMERSIVE, TELEPRESENCE, VE, OR VR?

playing second life (first person video game)

watching a movie

video conferencing

listening to the music

playing a third person video game

talking on the phone

reading a book

looking at a painting

being under the influence of a hallucinogenic drug



