

Introduction to Virtual Reality

CS 6334 Virtual Reality

Professor Yapeng Tian

The University of Texas at Dallas

A lot of slides of course lectures borrowed from Professor Yu Xiang's VR class

Yapeng Tian

Assistant Professor in CS at UTD (joined Fall 2022)

Research area:

- Computer Vision
- Computer Audition
- Multimodal Learning

Ph.D., CS, University of Rochester, 2022

Master, EE, Tsinghua University, China, 2017

Bachelor, EE, Xidian University, China, 2013



yapeng.tian@utdallas.edu

<https://yapengtian.org/>

Introduce yourself

- Name
- Major program
- Which year in the program?
- Where are you from?



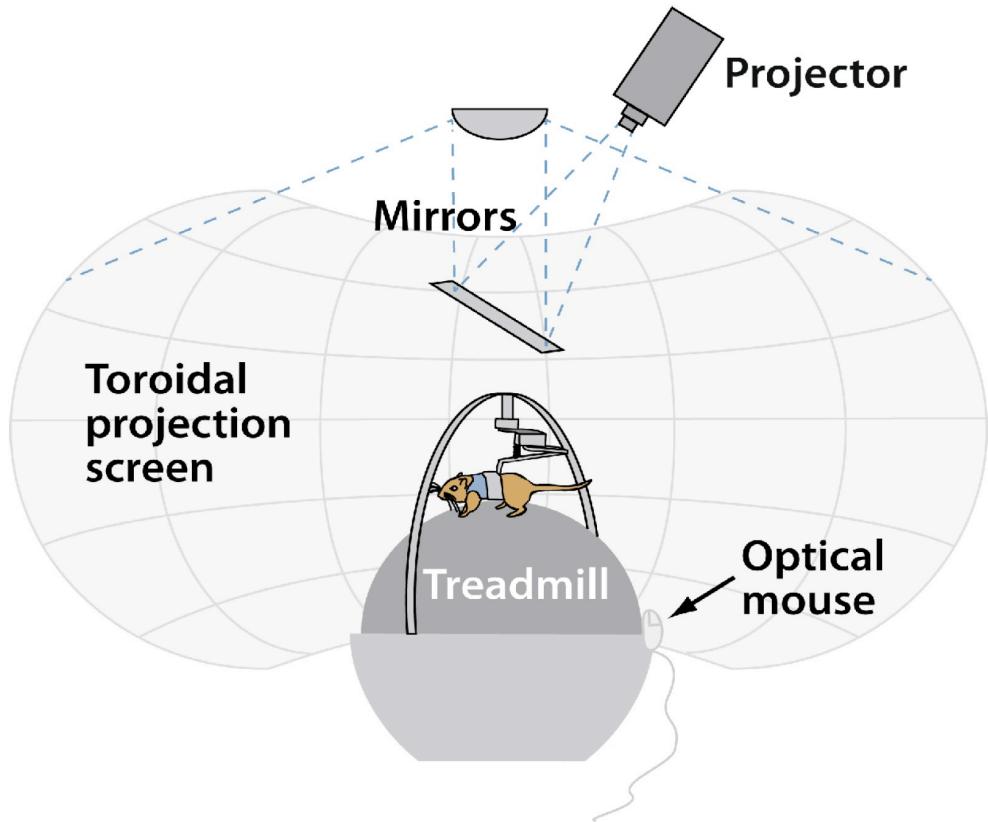
What is Virtual Reality?



Birdy experience from the Zurich University of the Arts

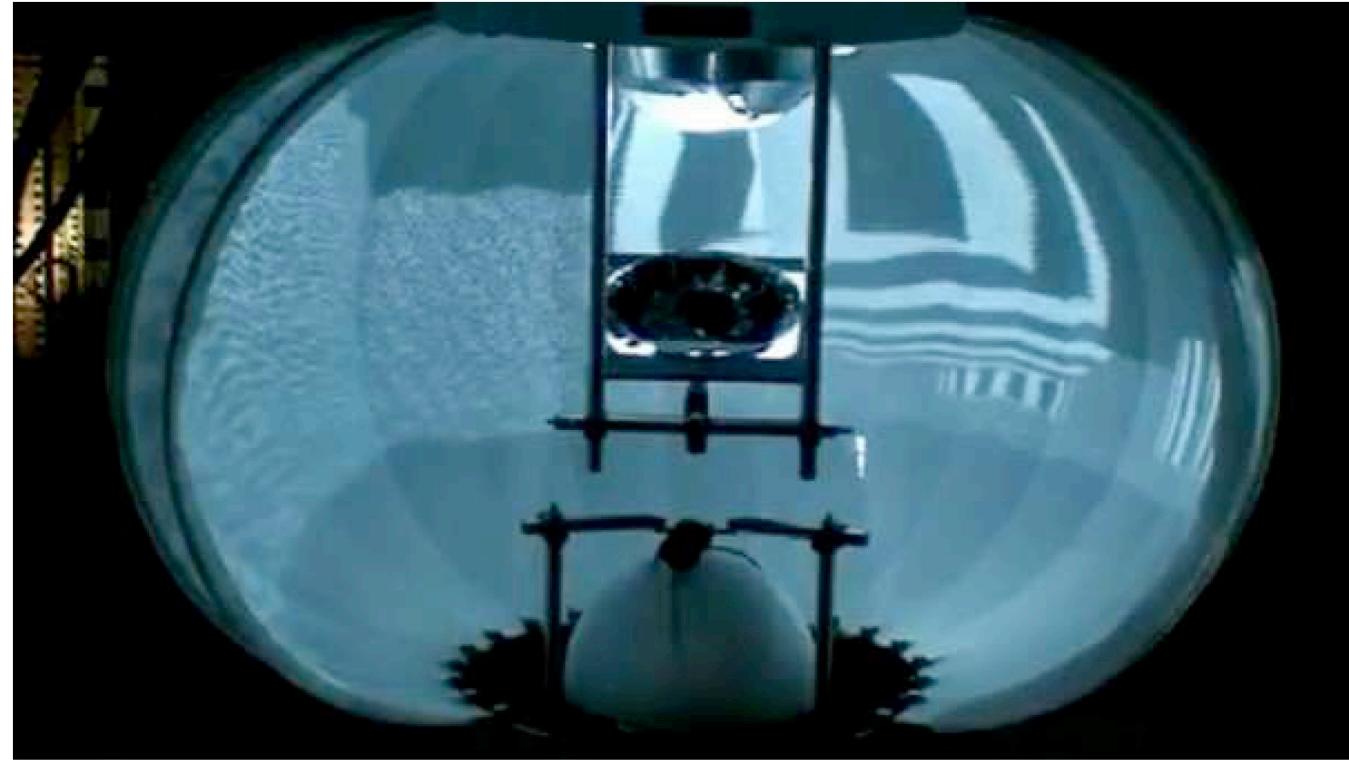


What is Virtual Reality?



(a) An experimental setup used by neurobiologists at LMU Munich to present visual stimuli to a gerbil while it runs on a spherical ball that acts as a treadmill.

Virtual Maze for a Gerbil



(b) A picture of a similar experiment, Princeton University

Definition of Virtual Reality

- “Inducing targeted behavior in an organism by using artificial sensory stimulation, while the organism has little or no awareness of the interface” – Steven LaValle
 - Targeted behavior: designed by the creator, flying, walking, exploring, gaming
 - Organism: humans, animals, fruit fly, fish, etc.
 - Artificial sensory stimulation: vision, audio, touch, etc.
 - Unawareness: unawareness of the interface, being “fooled” in a virtual world

What is Virtual Reality?



Target behavior: flying

Organism: the user

Artificial sensory stimulation: vision, wind, body motion

Unawareness: feels like in the air of San Francisco



Birdy experience from the Zurich University of the Arts

More VR Examples



Training



Gaming



Education



Control



Visualization



Socializing

Augmented Reality

- Visual stimuli are from both the virtual world and the real world
 - Combines real and virtual
 - Interactive in real time
 - Registered in 3D
 - Unawareness



Microsoft HoloLens

More AR Examples



Gaming



Shopping



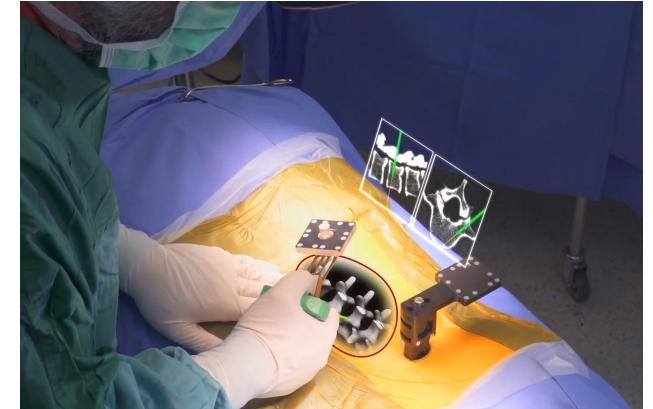
Assisting



Navigation



Training



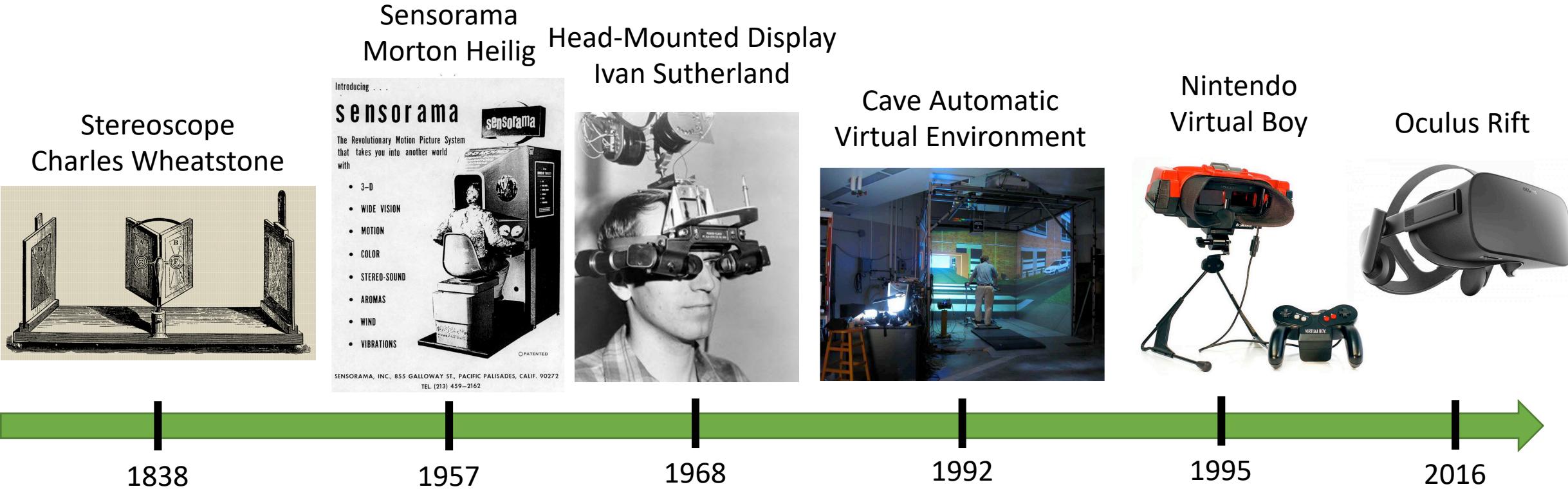
Surgery

National Academy of Engineering

- “Enhance Virtual Reality” is 1 of 14 NAE grand challenges for engineering in the 21st century

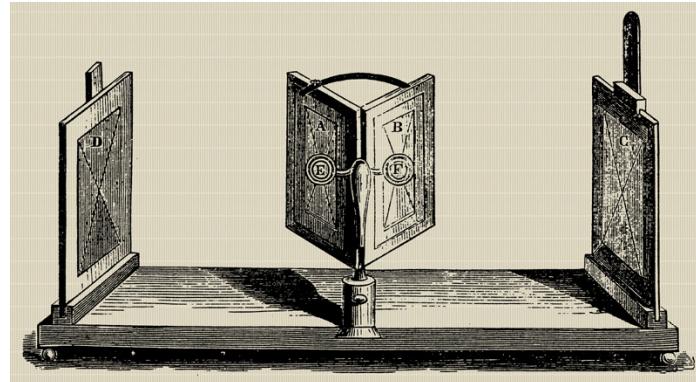


A Brief History of Virtual Reality



Stereoscopes since 1838

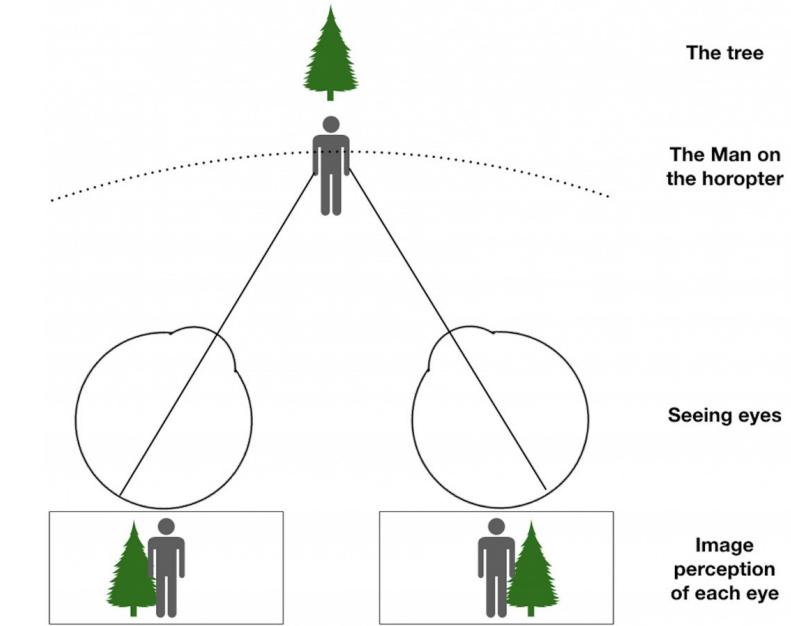
- Humans perceive depth and 3D from stereopsis
- A stereoscope displays images for left-eye and right eye



Charles Wheatstone, 1838



Holmes stereoscope, 1861



View-Master, 1930s

Sensorama by Morton Heilig (1957)

- 3D motion picture through stereoscopic display
- Pre-recorded video content
- Stereo sound
- Smell
- Wind
- Seat vibrations



Filmmaker

First Head-Tracked, Head-Mounted Display (1968)

- Ivan Sutherland developed the first head-tracked, head-mounted display
 - Tracked head movements
 - Perception of stationary

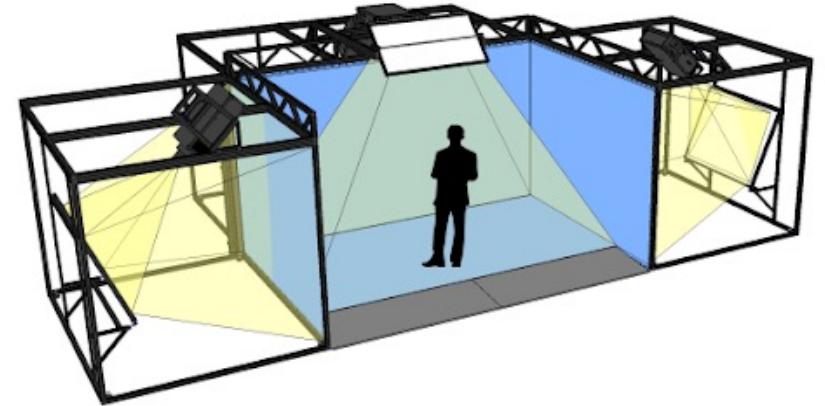


Computer scientist



Cave Automatic Virtual Environment (1992)

- A room with video projected on walls
- Stereoscopic viewing using polarized light and special glasses
- Head tracking for viewpoint-dependent video



Nintendo Virtual Boy (1995)

- 32-bit portable video game console with HMD
- Marketed as the first console capable of displaying stereoscopic 3D graphics
- Sales failed to meet targets, and Nintendo ceased distribution in 1996
 - Released 22 games for the system



Revival of VR (2016)

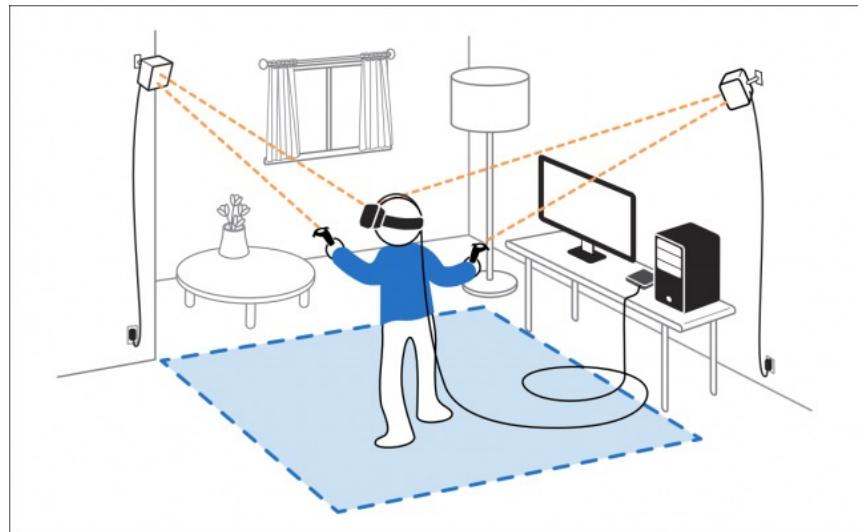
Oculus Rift



HTC Vive



Playstation VR



Tracking technologies

Today: Plenty of Opportunities

Meta

Amazon virtual reality in United States
86 results

Set alert

Machine Learning Engineer II, Visual Search & Augmented Reality
Amazon
Palo Alto, CA
 732 company alumni work here
15 hours ago

Senior Machine Learning Scientist, 2D/3D Computer Vision and Visual Effects, Prime Video
Prime Video & Amazon Studios
Sunnyvale, CA
 1 company alumnus works here
1 week ago · 2 applicants

SDE - Amazon Scout
Amazon
Seattle, WA
\$112K/yr - \$155K/yr (LinkedIn est.)
 23 connections work here
2 weeks ago

SDE - Amazon Scout
Amazon
Seattle, WA
\$112K/yr - \$155K/yr (LinkedIn est.)
 23 connections work here
2 weeks ago

Areas of Work
AR/VR
View 112 Open Positions



Reality Labs

We're building new, innovative hardware and software that radically redefine the way people work, play, and connect. From Meta Quest to Meta Portal and Meta Spark, our technologies make it easier for people to feel connected with each other and the world around them.

[Read the Blog](#)



Video
Empowering Immersive Connections at Reality Labs

Google virtual reality in United States
324 results

Set alert

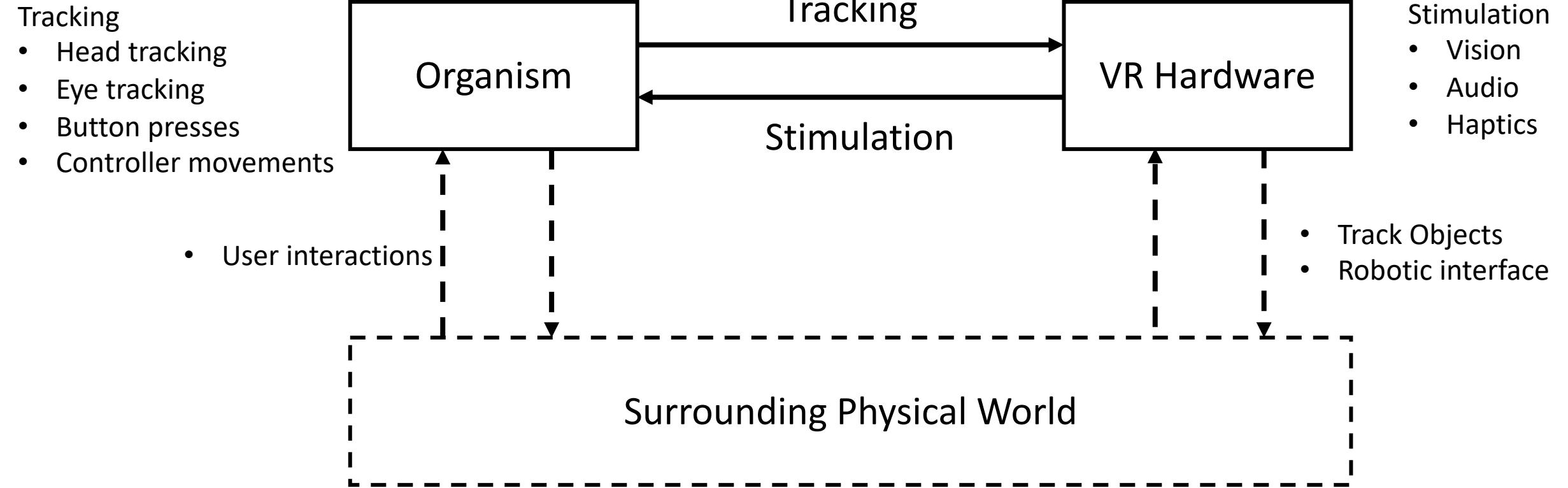
Software Engineer III, Display, Augmented Reality OS
Google
Seattle, WA
 18 connections work here
2 weeks ago · 7 applicants

Software Engineer III, Display, Augmented Reality OS
Google
Mountain View, CA
 18 connections work here
2 weeks ago · 1 applicant

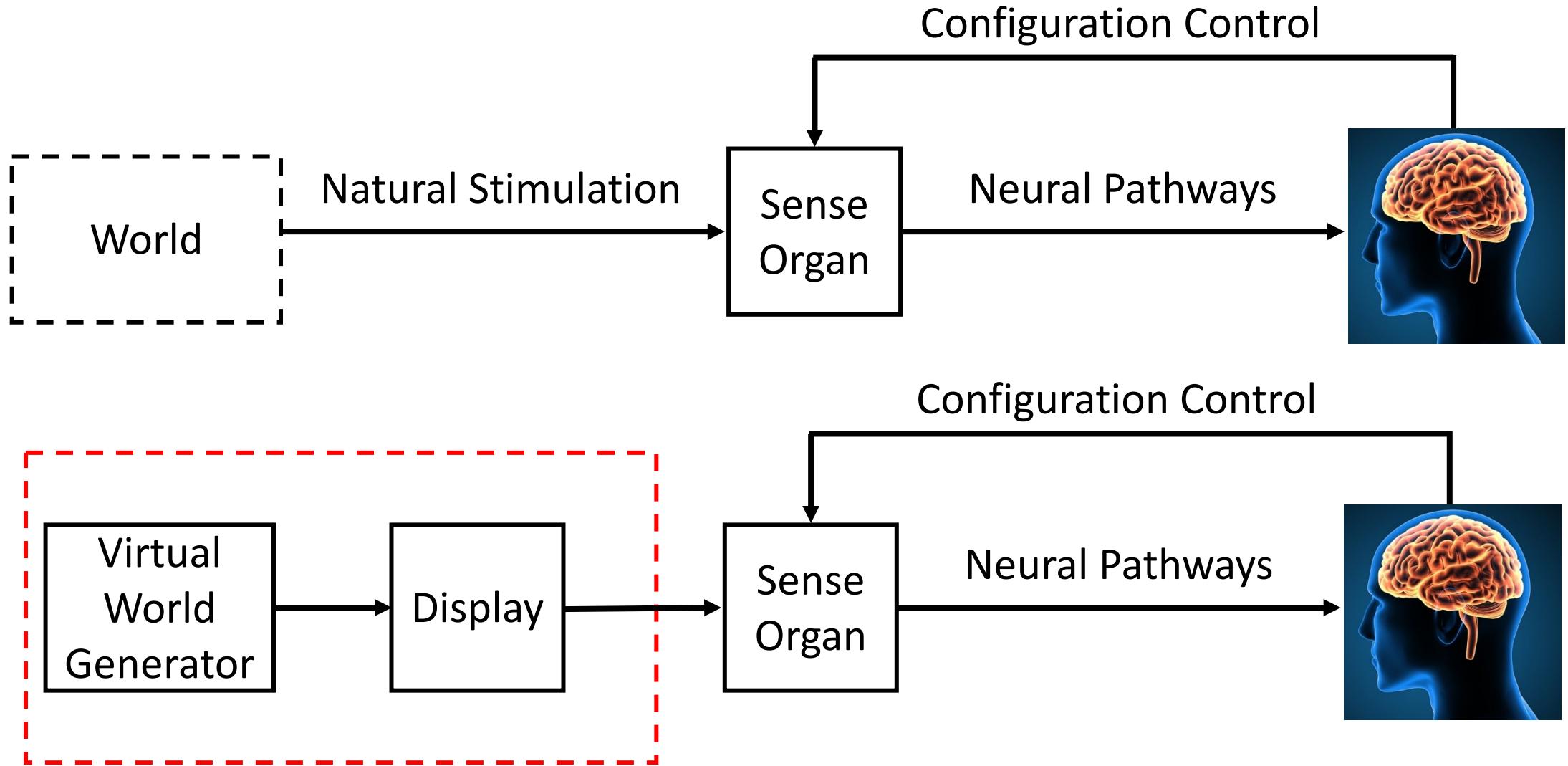
Software Engineer III, Augmented Reality
Google
Seattle, WA
 18 connections work here
1 day ago · 18 applicants

Software Engineer III, Augmented Reality
Google
Mountain View, CA
 154 company alumni work here
16 hours ago

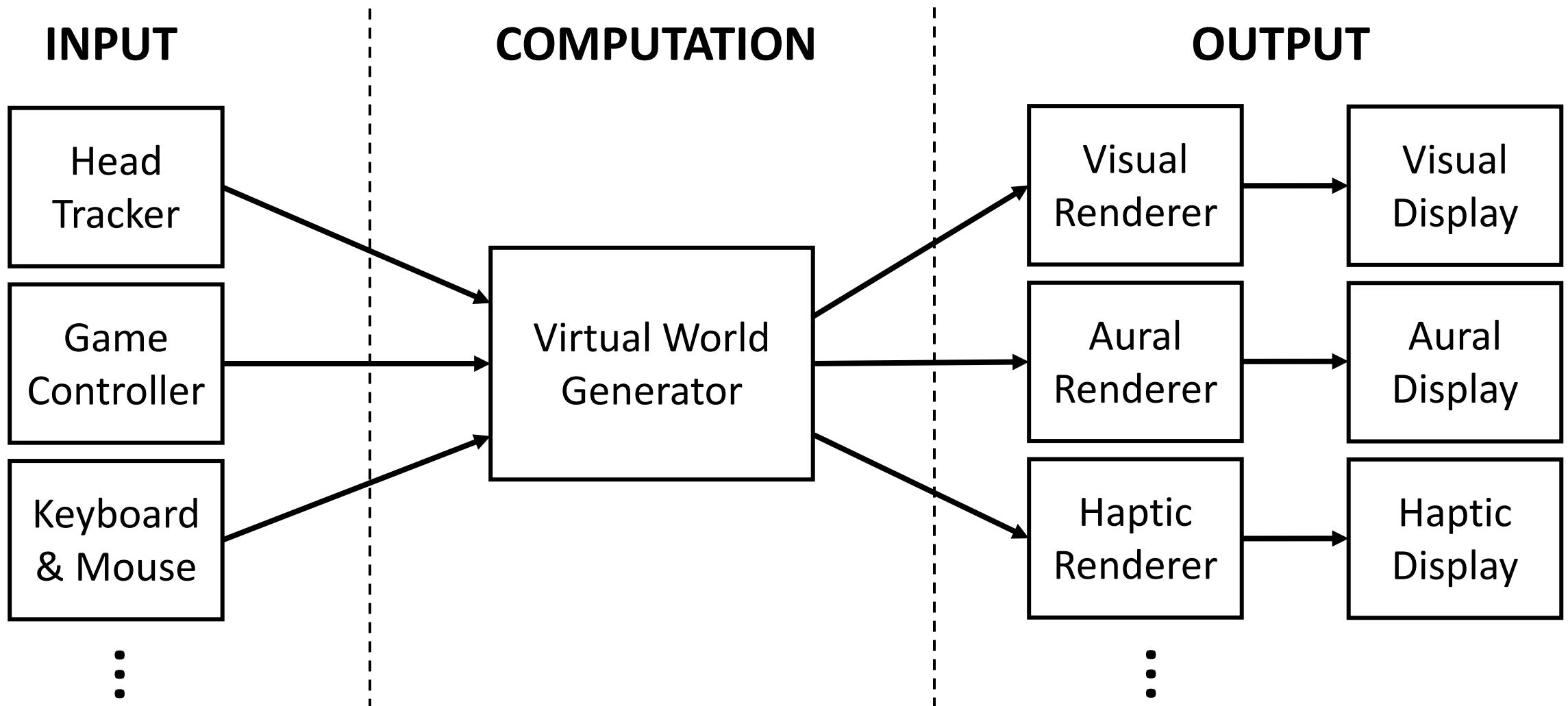
Overview of VR Systems



Natural V.S. Virtual



VR Systems



What will you learn in this course?

- Ability to develop 3D virtual environments
- Ability to render 3D virtual worlds into images
- Ability to understand human visual system and visual perception
- Ability to understand audio and haptics
- Ability to develop head tracking, eye tracking and pose tracking techniques
- Ability to develop locomotion, 3D selection and manipulation techniques
- Ability to understand advanced telepresence systems

Grading Policy

- Homework (40%)
 - 4 homework in total
 - Submit all homework assignments on time. Collaboration is allowed so long as final work is done independently, and all collaborators are acknowledged.
 - Individual submission
- Team Project (50%):
 - Develop prototype of a VR system OR solve an VR-related research problem
 - 2-4 students for a project
 - Project proposal (5%)
 - Project mid-term report (10%)
 - Project presentation (15%)
 - Project final report (20%)
- In-class Activity (10%)
 - Participate in class, online discussion
- Late Policy
 - For the assignments (not including reports for your final project), students will be allowed a total of five late days per semester; each additional late day will incur a 20% penalty.
- No final exam!

Course Details

- **Textbook**

Steven M. LaValle. Virtual Reality. To be published by Cambridge University Press.

Available online: <http://lavalle.pl/vr/>

LaViola, J., Kruijff, E., McMahan, R., Bowman, D., and Poupyrev, I. 3D User Interfaces: Theory and Practice, 2nd Edition. Addison-Wesley Professional, 2017. (Optional)

- **My office hour**

Monday & Wednesday 2:30PM – 3:30 PM

- **TA office hour: TBD**

- **Course website:** <https://yapengtian.org/t/6334F22/>

- **Course access and navigation:** [eLearning](#)