

Introduction to Virtual Reality

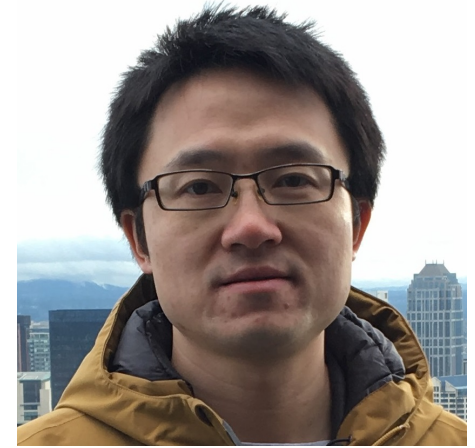
CS 6334 Virtual Reality

Professor Yu Xiang

The University of Texas at Dallas

Some slides of this lecture are based on the Virtual Reality textbook by Steven LaValle

Who am I?



- Assistant Professor in CS at UTD (joined Fall 2021)
 - Research area: robotics and computer vision
- Senior Research Scientist at NVIDIA (2018 – 2021) Robotics
- Postdoc Stanford, University of Washington (2016 – 2018)
- Ph.D., Electrical and Computer Engineering, University of Michigan, 2016
- Master, CS, Fudan University, China, 2010
- Bachelor, CS, Fudan University, China, 2007

Introduce yourself

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

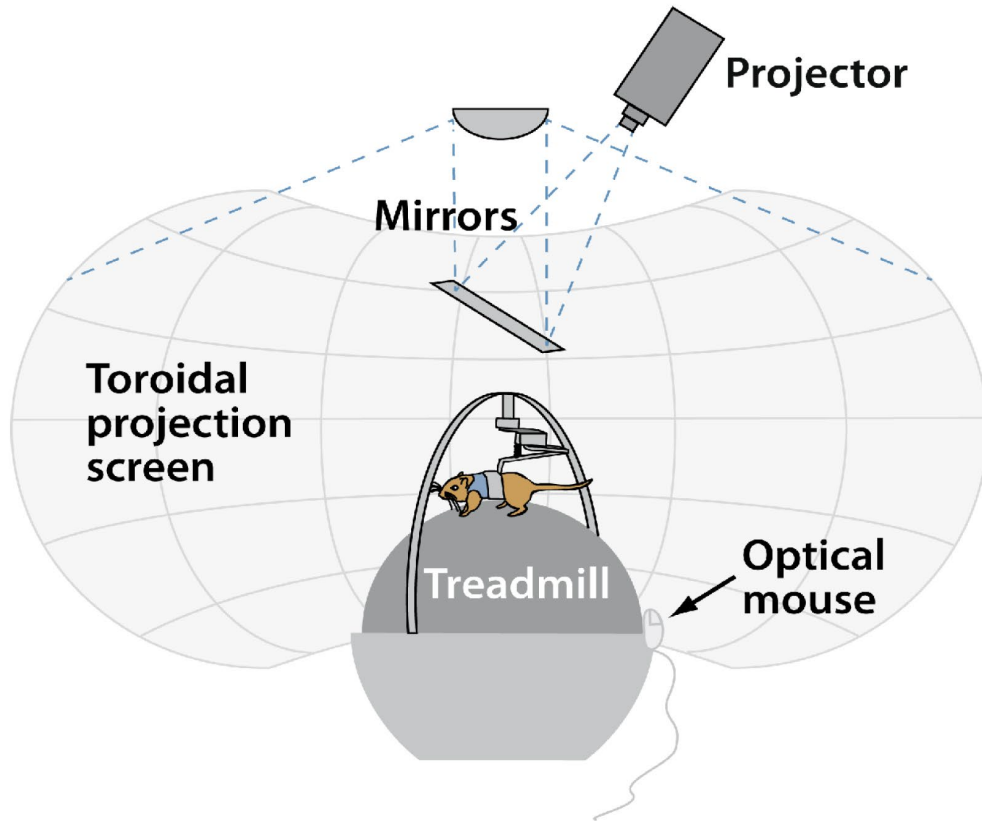


What is Virtual Reality?



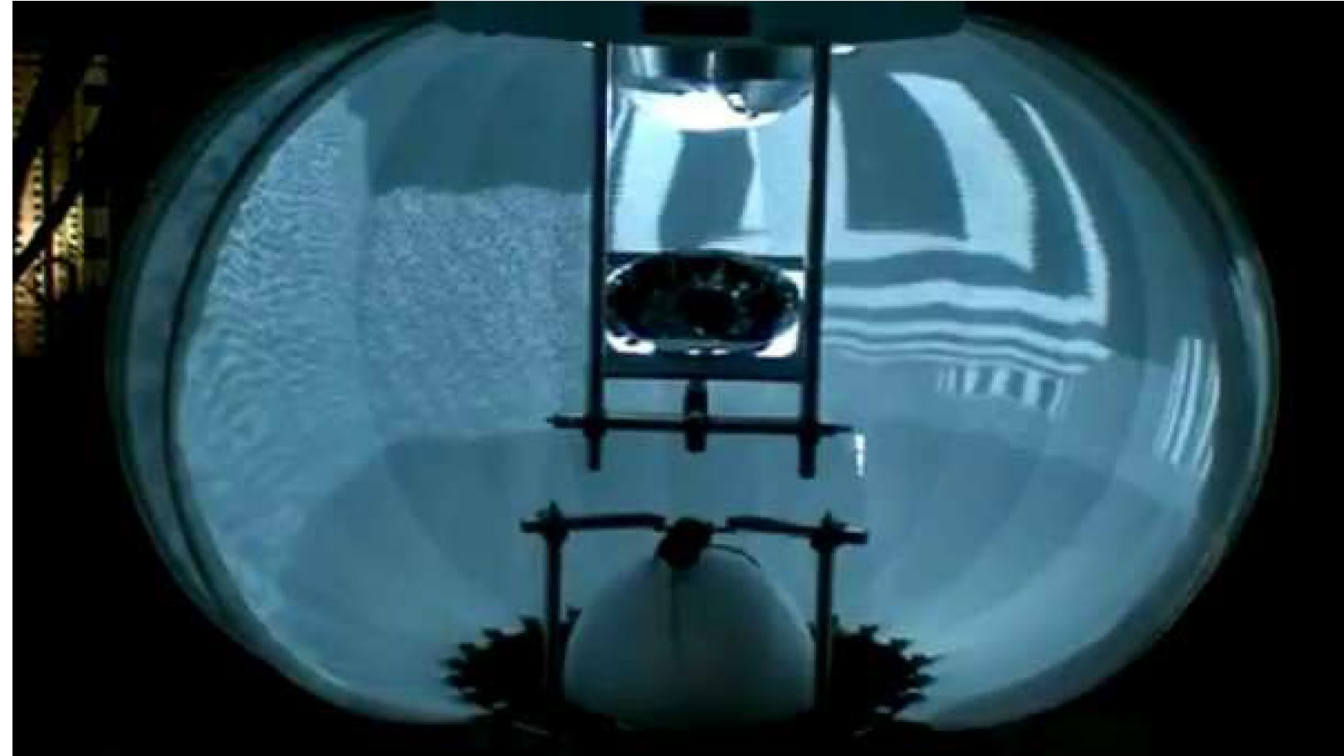
Birdly experience from the Zurich University of the Arts

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



Birdly 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



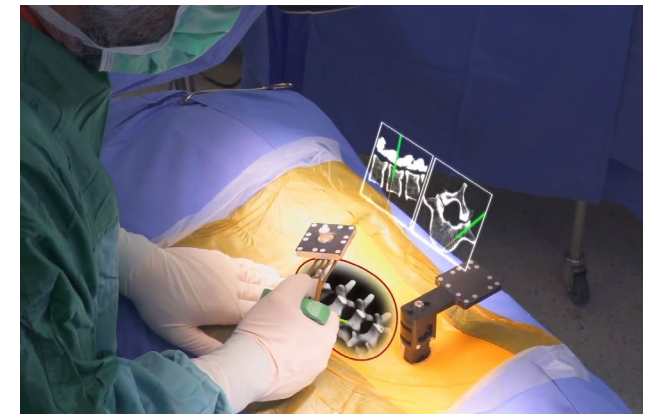
Assisting



Navigation



Training



Surgery

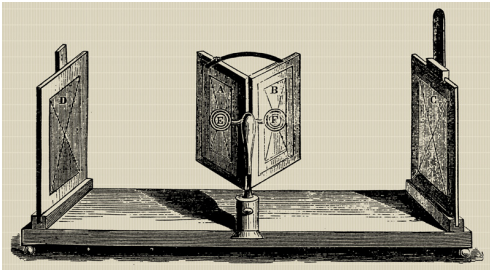
National Academy of Engineering

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



A Brief History of Virtual Reality

Stereoscope
Charles Wheatstone



Sensorama
Morton Heilig
Head-Mounted Display
Ivan Sutherland



Cave Automatic
Virtual Environment



Nintendo
Virtual Boy

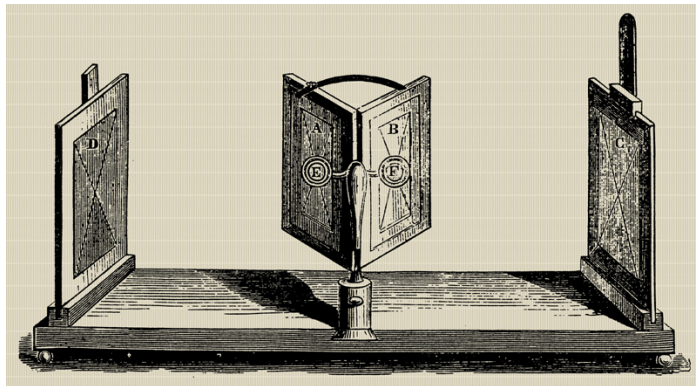
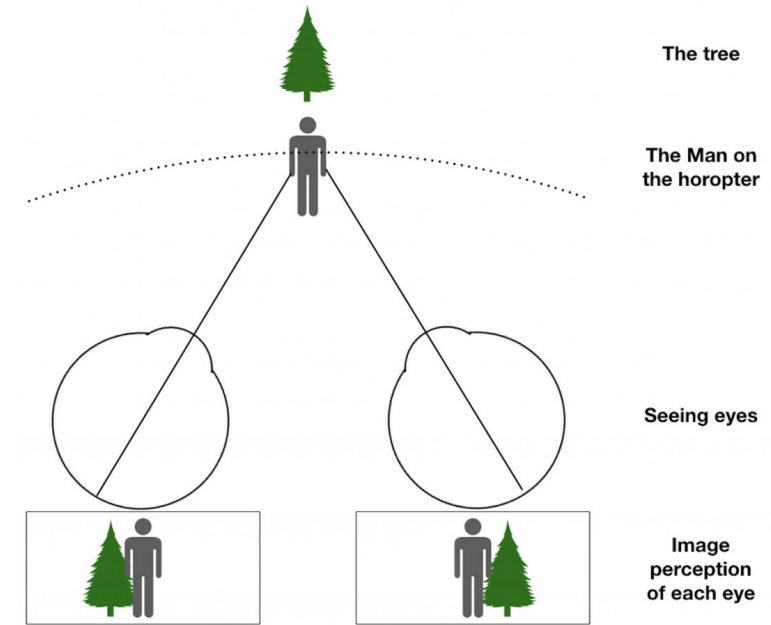


Oculus Rift



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



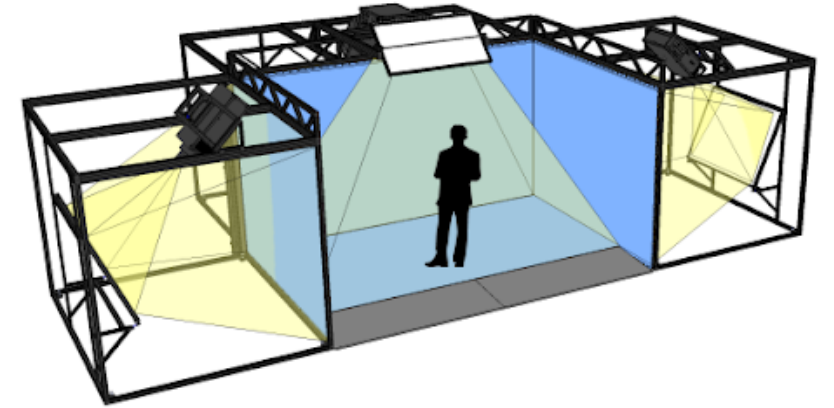
VPL Research (company) by Jaron Lanier (1984)

- The DataGlove
 - Wired to computer
 - Track hand movements and orientations
 - Allow people to manipulate and re-orient virtual objects
- The EyePhone
 - An HMD to immerse users into a computer simulation
 - Track head movement
- The DataSuit
 - A full-body outfit with sensors for measuring the movement of arms, legs and trunk



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 HDM
- 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)

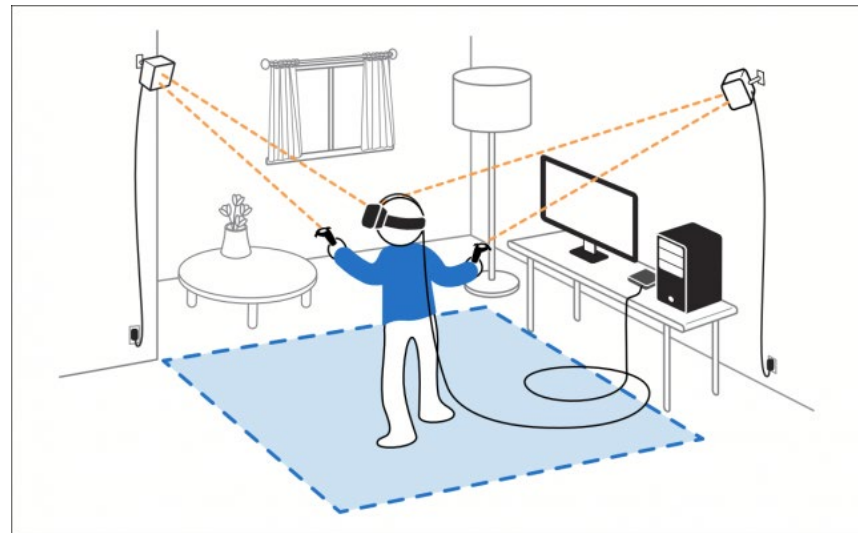
Oculus Rift



HTC Vive



Playstation VR

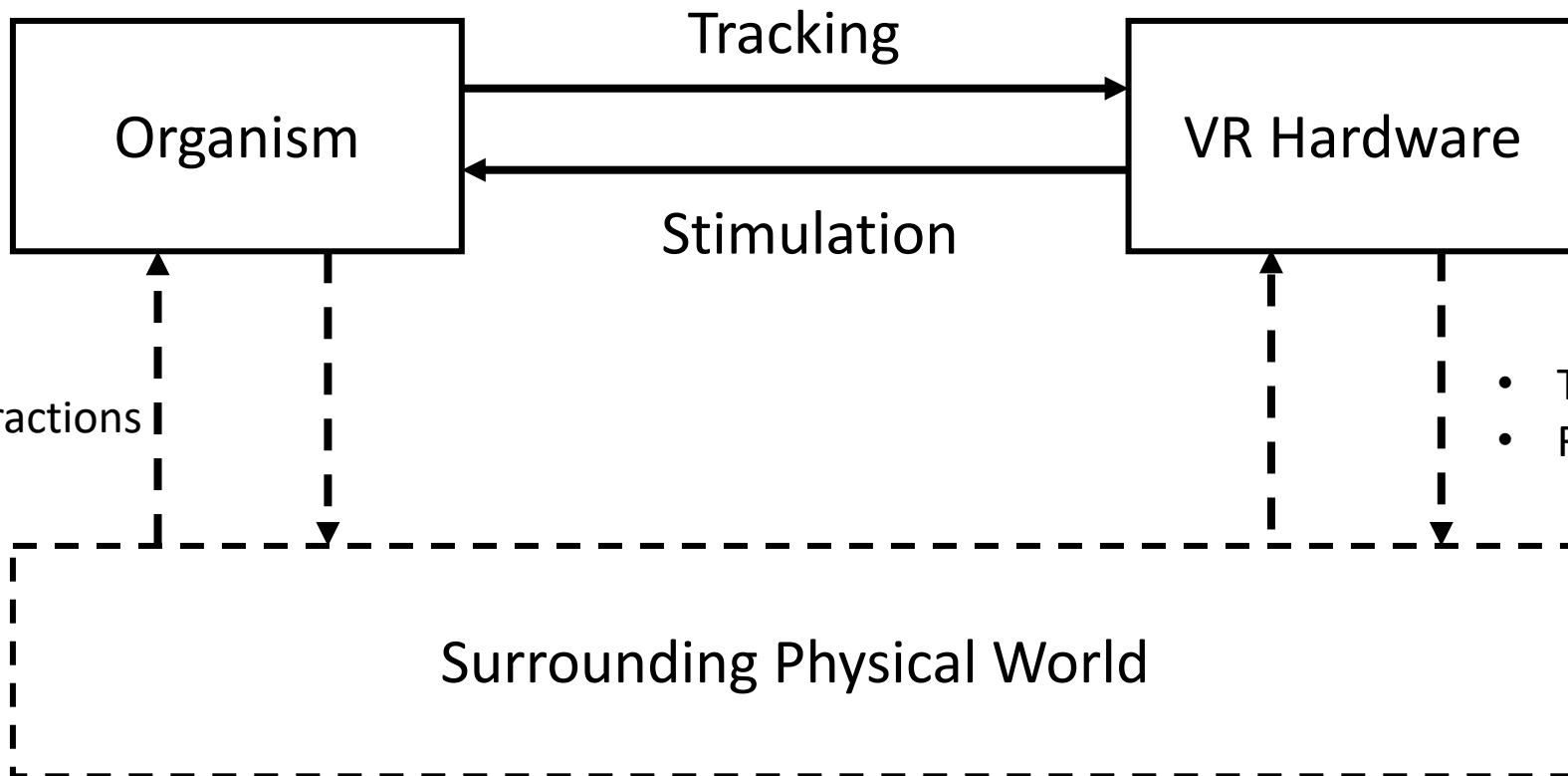


Tracking technologies

Overview of VR Systems

Tracking

- Head tracking
- Eye tracking
- Button presses
- Controller movements



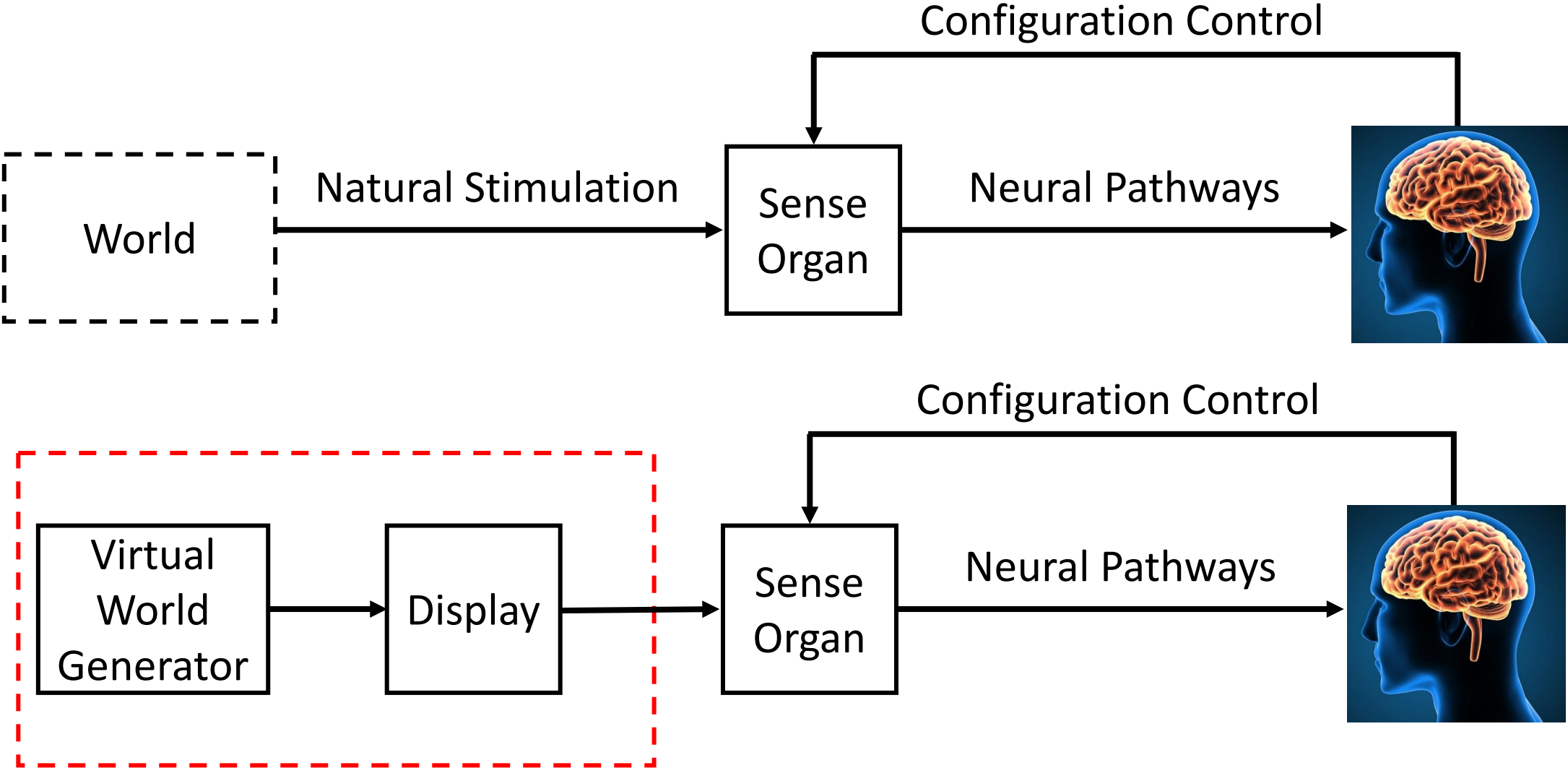
- User interactions

Stimulation

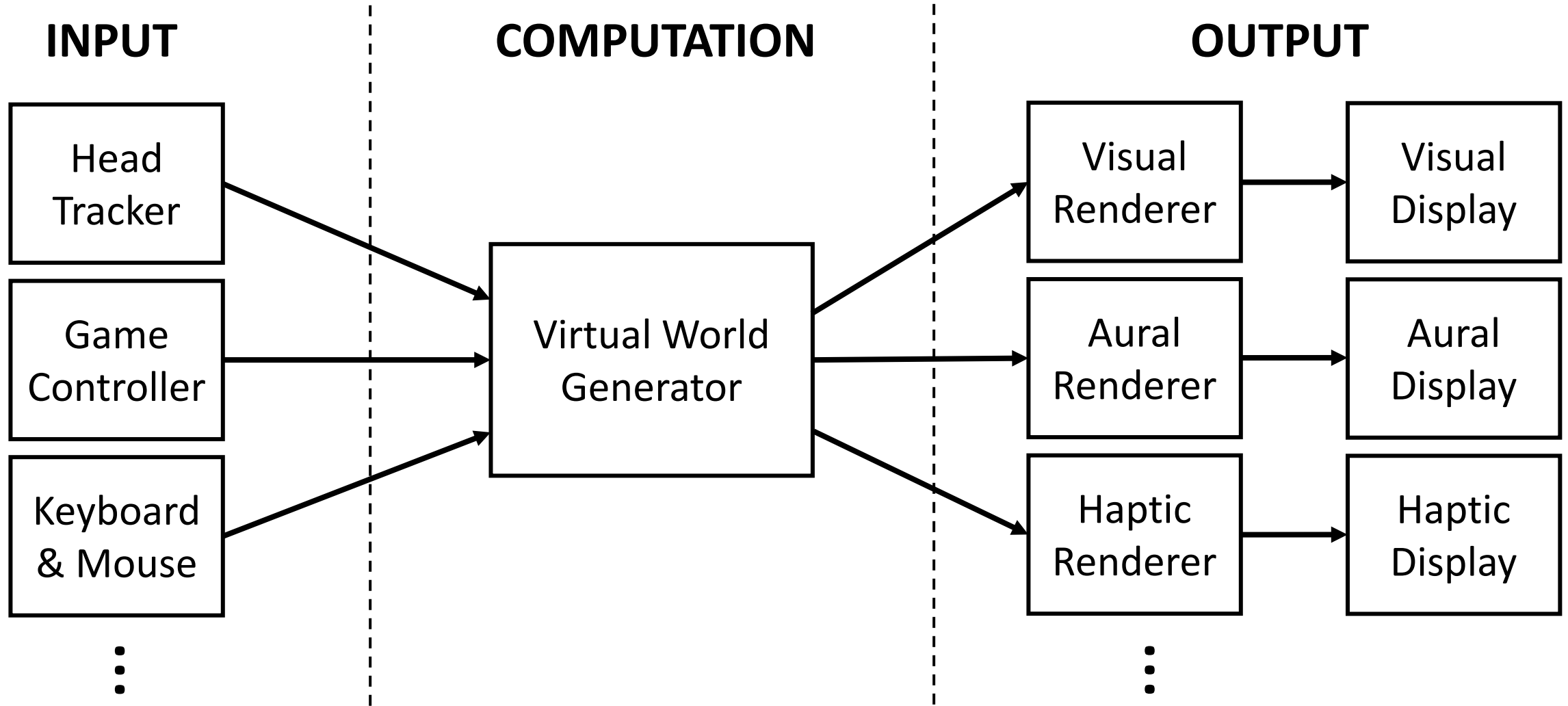
- Vision
- Audio
- Haptics

- Track Objects
- Robotic interface

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 develop robotic interfaces

Grading Policy

- Homework (40%)
 - 4 homework in total
 - Individual submission
- Team Project (55%): prototype of a VR system
 - 2 or 3 students for a project
 - Project proposal (5%)
 - Project mid-term report (10%)
 - Project presentation (15%)
 - Project final report (25%)
- In-class Activity (5%)
- No final exam!

Course Details

- Textbook

Steven M. LaValle. Virtual Reality. To be published by Cambridge University Press.
Available online: <http://lavalle.pl/vr/>

- My office hour

Monday & Wednesday 2:30PM – 3:30 PM
Email Appointment

- TA office hour: TBD

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