

CSPE 51 – Augmented and Virtual Reality

B.Tech. (CSE) – III yr – A & B Sections

Class 1

- Course outline
- Course plan
- Course contents
- Books
- Introduction

Course Objectives

- To know basic concepts of virtual reality
- To understand visual computation in computer graphics
- To understand interaction between system and computer
- To know application of VR in Digital Entertainment
- To know basic concepts of augmented reality

Course Contents

- **UNIT I** Introduction of Virtual Reality: Fundamental Concept and Components of Virtual Reality - Primary Features and Present Development on Virtual Reality - Multiple Models of Input and Output Interface in Virtual Reality: Input - Tracker - Sensor - Digital Glove - Movement Capture - Video-based Input - 3D Menus & 3DScanner – Output - Visual /Auditory / Haptic Devices.
- **UNIT II** Visual Computation in Virtual Reality: Fundamentals of Computer Graphics - Software and Hardware Technology on Stereoscopic Display - Advanced Techniques in CG: Management of Large Scale Environments & Real Time Rendering.
- **UNIT III** Interactive Techniques in Virtual Reality: Body Track - Hand Gesture - 3D Manus - Object Grasp. Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR. X3D Standard; Vega - MultiGen - Virtools.

Course Contents – Contd...

- **UNIT IV** Application of VR in Digital Entertainment: VR Technology in Film & TV Production - VR Technology in Physical Exercises and Games - Demonstration of Digital Entertainment by VR.
- **UNIT V** Augmented and Mixed Reality: Taxonomy - technology and features of augmented reality - difference between AR and VR - Challenges with AR - AR systems and functionality - Augmented reality methods - visualization techniques for augmented reality - wireless displays in educational augmented reality applications - mobile projection interfaces - marker-less tracking for augmented reality - enhancing interactivity in AR environments - evaluating AR systems.

Course

OUTCOMES

- Upon completion of this course, the students will be able to:
- Provide opportunity to explore the research issues in Augmented Reality and Virtual Reality (AR & VR)
- Know the basic concept and framework of virtual reality
- Know the computer-human interaction

Books



Text Books

1. Burdea, G. C., P. Coffet., “Virtual Reality Technology”, Second Edition, Wiley-IEEE Press, 2003/2006
2. Alan B. Craig, “Understanding Augmented Reality, Concepts and Applications”, Morgan Kaufmann, 2013.

Reference Books

1. Alan Craig, William Sherman, Jeffrey Will, “Developing Virtual Reality Applications, Foundations of Effective Design”, Morgan Kaufmann, 2009.

Source

- Image and Video source - from the intranet and text books

Introduction



- Devices used
- What is AR, VR, MR, XR?
- Applications
- Reality Vs Virtual reality

Devices used in Reality Technology

| | VR | AR/MR |
|---|---|--|
|  PC |   |   |
|  Standalone |   |   |
|  Smartphone |   |   |

What is AR?



Augmented Reality (AR) is a live, direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data.

AR exists on top of our own world it provides as much freedom as you are given within your normal life. AR utilizes your existing reality and adds to it utilizing a device of some sort.

Mobile and tablets are the most popular mediums of AR now, through the camera, the apps put an overlay of digital content into the environment. Custom headsets are also being used.

Popular AR examples : Pokemon Go and Snapchat's new AR bitmojis.

Video : AR Examples

<https://www.youtube.com/watch?v=2sj2iQyBTQs>

What is VR?



- **Virtual Reality (VR)** is an immersive experience also called a computer-simulated reality.
- It refers to computer technologies using reality headsets to generate the realistic sounds, images and other sensations that replicate a real environment or create an imaginary world.
- VR is a way to immerse users in an entirely virtual world. A true VR environment will engage all five senses (taste, sight, smell, touch, sound), but it is important to say that this is not always possible.
- Gaming industry uses this technology into more practical applications.
- The market and the industry are still excited about this tech trend and further progress is expected in the near future.

Video : VR Example

https://www.youtube.com/watch?v=DfUUnp6Z_wc

Class 2

Recap: VR and AR

Today:

- Introduction to Reality
- Types
- Reality Vs Virtual Reality
- Photos and videos
- Introduction to VR

What is MR?



- **Mixed Reality (MR)**, sometimes referred to as hybrid reality, is the merging of real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real time.
- It means placing new imagery within a real space in such a way that the new imagery is able to interact, to an extent, with what is real in the physical world we know.
- The key characteristic of MR is that the synthetic content and the real-world content are able to react to each other in real time.

Video : MR Example

<https://virsabi.com/mixed-reality/>

What is XR?

XR is the future



- **Extended Reality (XR)** refers to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables.
- Extended Reality includes all its descriptive forms like the Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR).
- In other words, XR can be defined as an umbrella, which brings all three Reality (AR, VR, MR) together under one term, leading to less public confusion. Extended reality provides a wide variety and vast number of levels in the Virtuality of partially sensor inputs to Immersive Virtuality.

Video : AR, VR, MR, XR Applications & Challenges

<https://www.youtube.com/watch?v=2ZMg0mfEw-k>

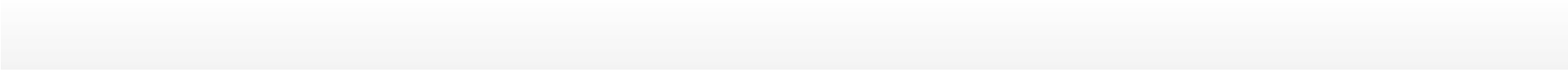


Applications

- Military
- Health care
- Education
- Visualization
- Entertainment



Challenges

- Device size and price
 - High computing requirement
 - Low latency
- 

Advantages and Disadvantages of VR

Advantages

- ▶ Virtual reality creates a realistic world.
- ▶ It enables user to explore places.
- ▶ Through Virtual Reality user can experiment with an artificial environment.
- ▶ Virtual Reality make the education more easily and comfort.

Disadvantages

- ▶ The equipments used in virtual reality are very expensive.
- ▶ It consists of complex technology.
- ▶ In virtual reality environment we cant move by our own like in the real world.

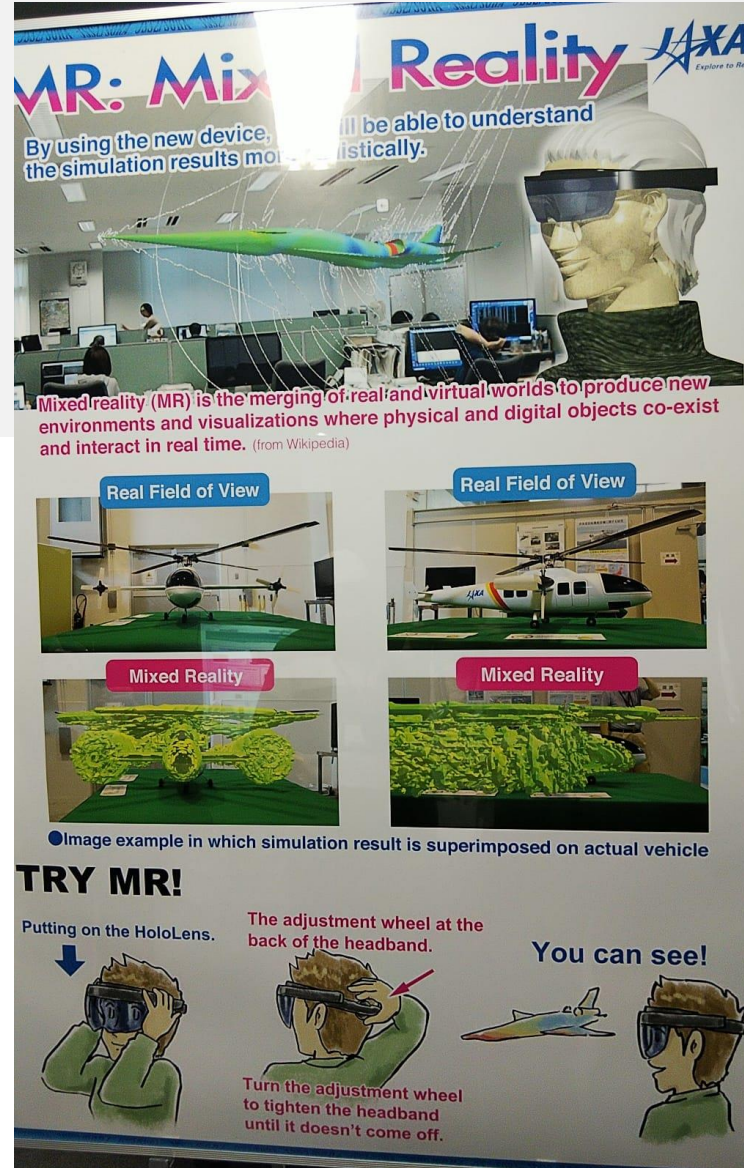
Tools

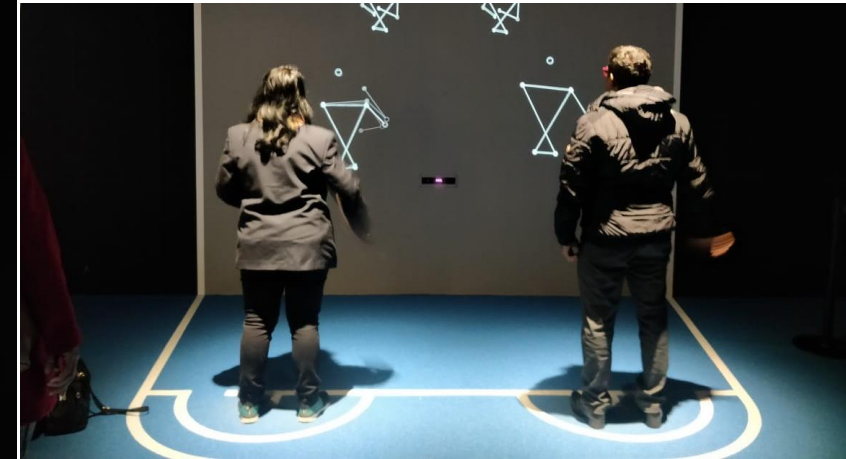
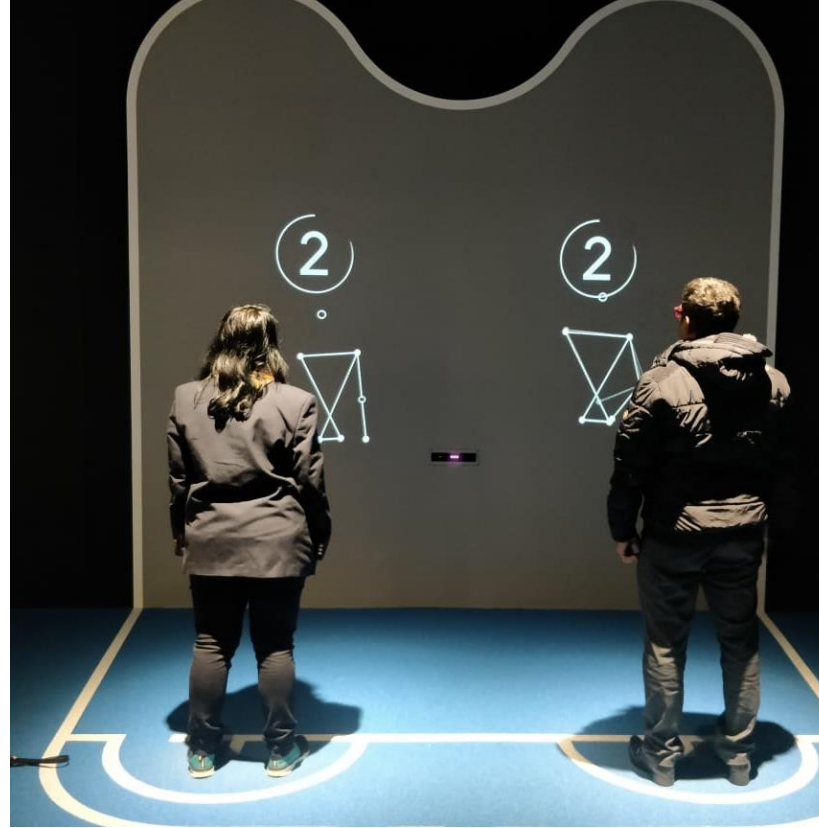
- Unity
- Unreal Engine 4
- Cryengine
- 3d Max
- Maya
- Many cloud-based tools available
- X3D
- Vega MultiGen
- Virtools



Japan - Photos

- JAXA Lab





Japan - Photos and Videos

Olympic Museum -
https://www.youtube.com/watch?v=-t6Kt2VB_Y

Unit – 1

Introduction of Virtual Reality: Fundamental Concept and Components of Virtual Reality - Primary Features and Present Development on Virtual Reality - Multiple Models of Input and Output Interface in Virtual Reality: Input - Tracker - Sensor - Digital Glove - Movement Capture - Video-based Input - 3D Menus & 3DScanner – Output - Visual /Auditory / Haptic Devices.

Introduction to VR

- **Virtual reality (VR)** - Computer simulation that creates an image of a world that appears to our senses in much the same way we perceive the real world, or “physical” reality.
- In order to convince the brain that the synthetic world is authentic, the computer simulation monitors the movements of the participant and adjusts the sensory display or displays in a manner that gives the feeling of being immersed or being present in the simulation.
- The term “virtual world” does not only refer specifically to virtual reality worlds. It can also be used to refer to the content of other media, such as novels, movies, and other communication conventions.

Class 3

Recap: Types of Reality – Definition of VR

Today:

- Types of VR
- Fundamental concepts of VR
- Components of VR
- Visual display – Stationary display

Types of VR

- Fully Immersive
- Non- Immersive
- Semi - Immersive





Fully-immersive

- Fully-immersive simulations give users the most realistic simulation experience, complete with sight and sound.
- To experience and interact with fully-immersive virtual reality, the user needs the proper VR glasses or a head mount display (HMD). VR headsets provide high-resolution content with a wide field of view. The display typically splits between the user's eyes, creating a stereoscopic 3D effect, and combines with input tracking to establish an immersive, believable experience.
- This type of VR has been commonly adapted for gaming and other entertainment purposes, but usage in other sectors, namely education, is increasing now as well. The possibilities for VR usage are endless.

Immersive Virtual Reality

Immersion into virtual reality is a perception of being physically present in a non-physical world.

Elements of virtual environments that increase the immersiveness of the experience:

1. Continuity of surroundings
2. Conformance to human vision
3. Freedom of movement
4. Physical interaction
5. Physical feedback





Non-immersive

- Non-immersive virtual experiences are often overlooked as a virtual reality category because it's already so commonly used in everyday life. This technology provides a computer-generated environment, but allows the user to stay aware of and keep control of their physical environment. Non-immersive virtual reality systems rely on a computer or video game console, display, and input devices like keyboards, mice, and controller.
- A video game is a great example of a non-immersive VR experience.

Non-Immersive Virtual Reality

- ▶ Large display, but doesn't surround the user.





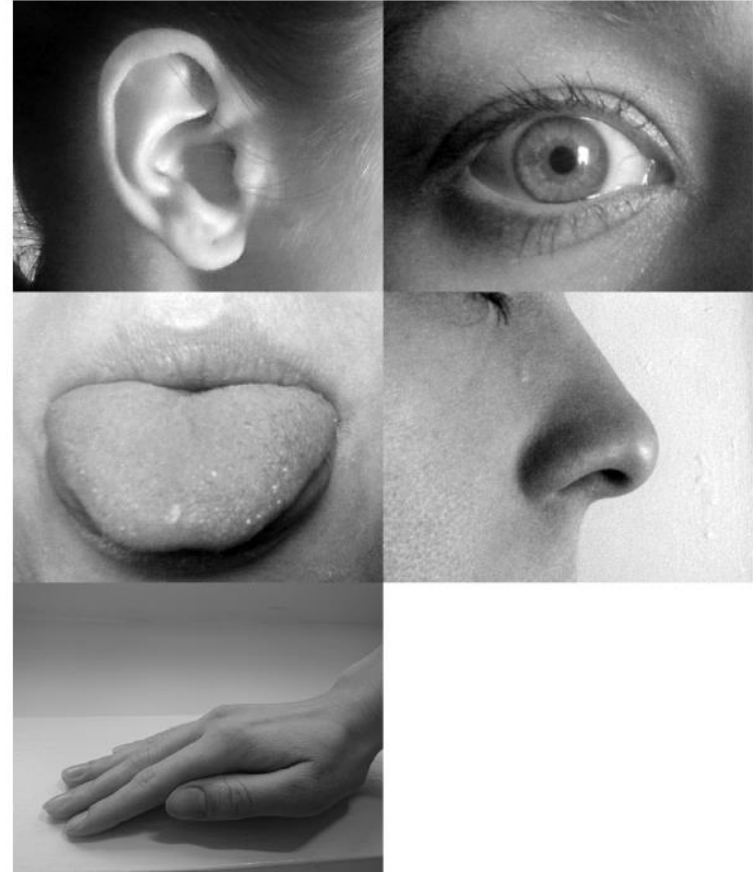
Semi-immersive

- Semi-immersive virtual experiences provide users with a partially virtual environment. It will still give users the perception of being in a different reality when they focus on the digital image, but also allows users to remain connected to their physical surroundings. Semi-immersive technology provides realism through 3D graphics, a term known as vertical reality depth. More detailed graphics result in a more immersive feeling.
- This category of VR is used often for educational or training purposes and relies on high-resolution displays, powerful computers, projectors or hard simulators that partially replicate design and functionality of functional real-world mechanisms.

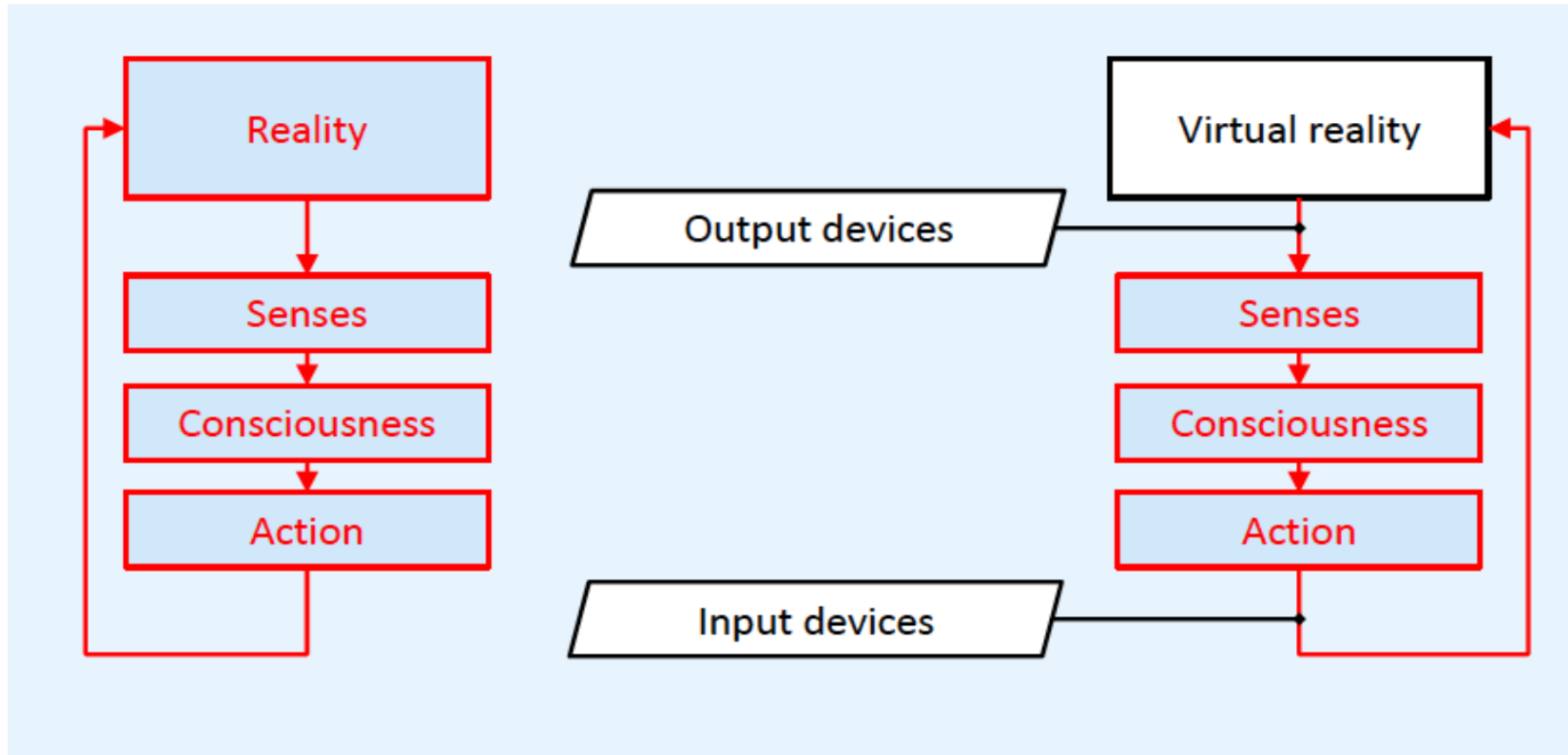
Fundamental Concepts of VR

How do We Perceive Reality?

- We understand the world through our senses:
 - Sight, Hearing, Touch, Taste, Smell (and others..)
- Two basic processes:
 - **Sensation** – Gathering information
 - **Perception** – Interpreting information



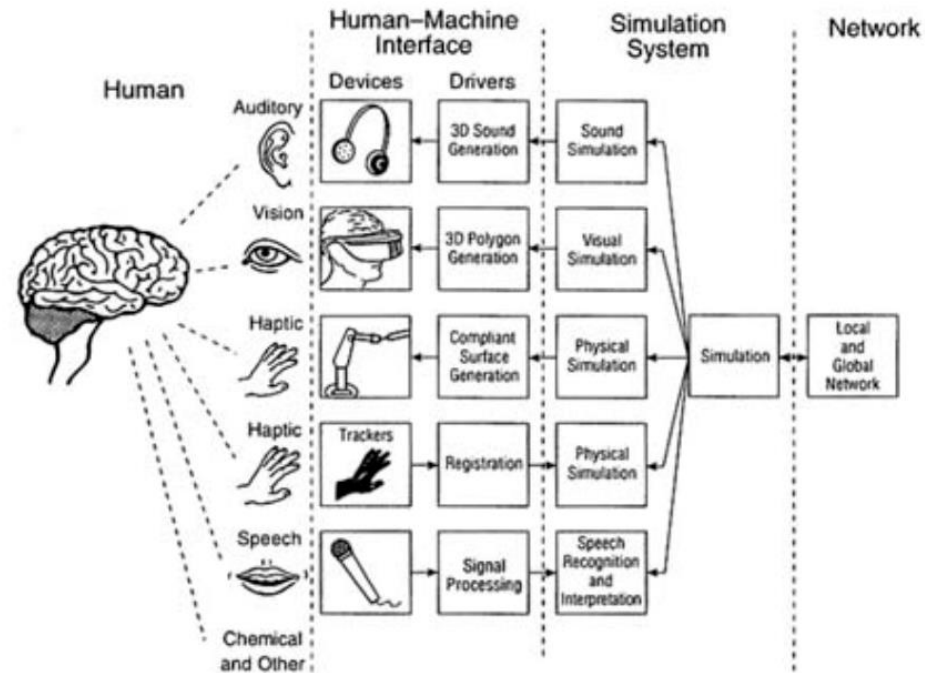
Reality vs. Virtual Reality



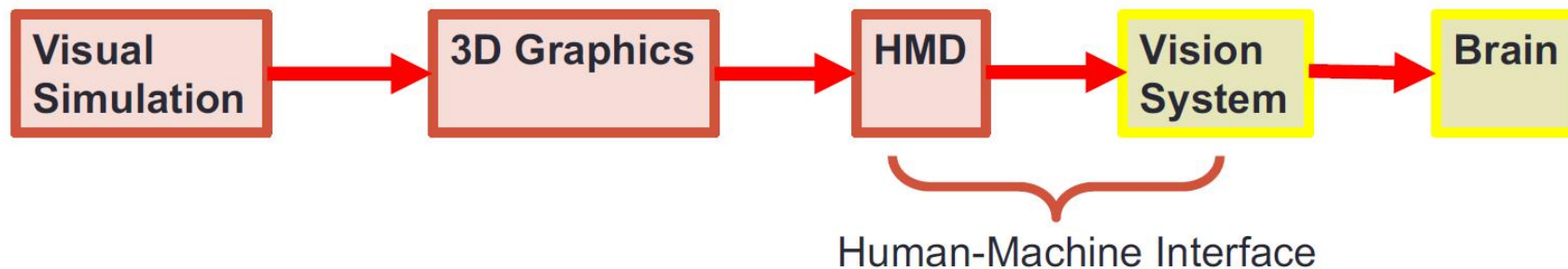
- In a VR system there are input and output devices between human perception and action

Using Technology to Stimulate Senses

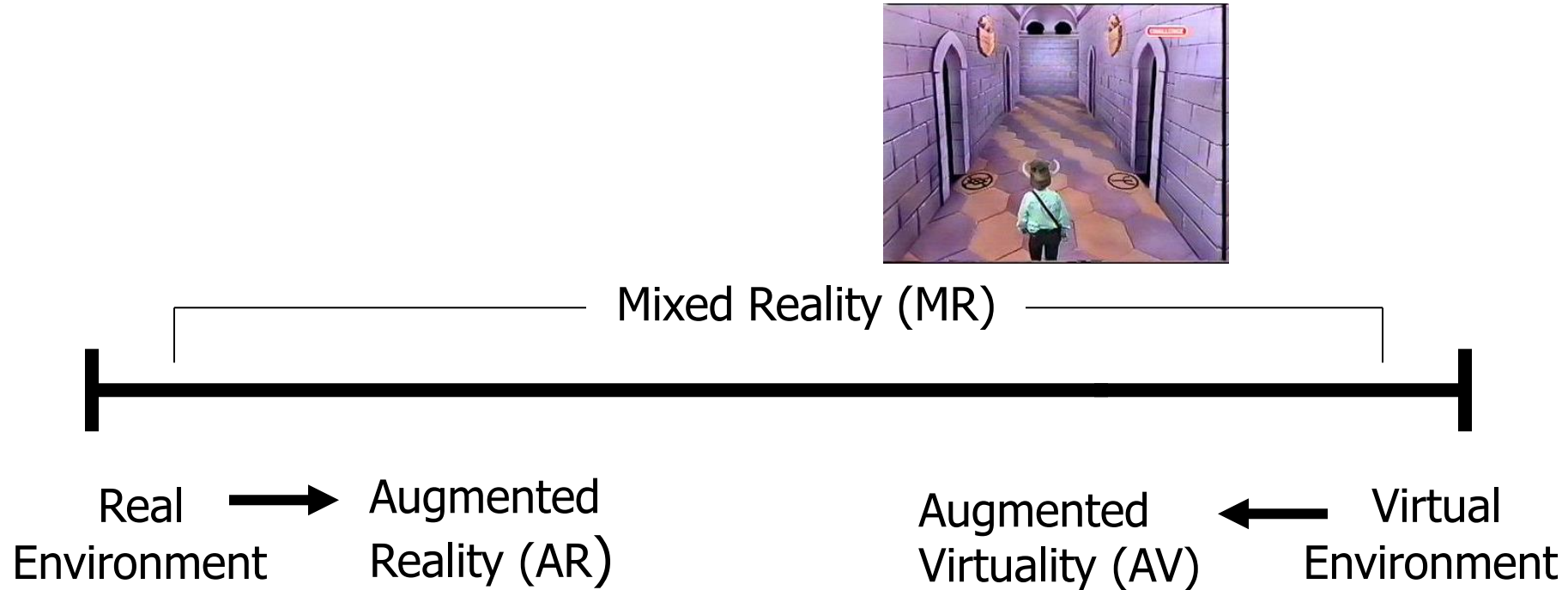
- **Simulate output**
 - E.g. simulate real scene
- **Map output to devices**
 - Graphics to HMD
- **Use devices to stimulate the senses**
 - HMD stimulates eyes



Example: Visual Simulation



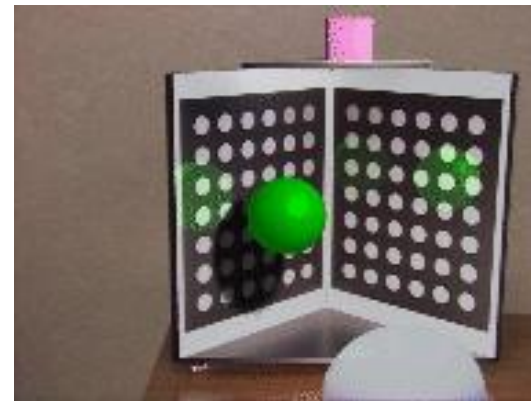
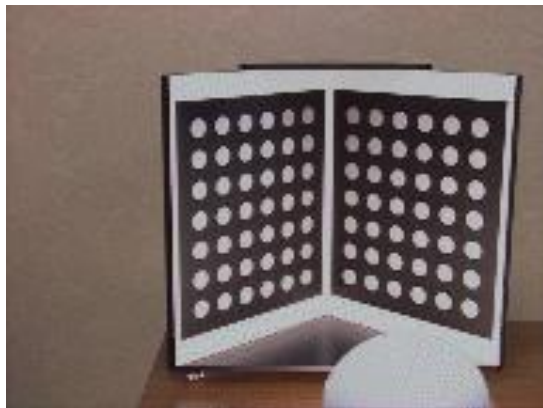
Milgram's Reality-Virtuality Continuum



Milgram coined the term "Augmented Virtuality" to identify systems which are mostly synthetic with some real world imagery added such as texture mapping video onto virtual objects.

Combining the Real and Virtual Worlds

- Precise models
- Locations and optical properties of the viewer (or camera) and the display
- Calibration of all devices
- To combine all local coordinate systems centered on the devices and the objects in the scene in a global coordinate system
- Register models of all 3D objects of interest with their counterparts in the scene
- Track the objects over time when the user moves and interacts with the scene



Realistic Merging

Requires:

- Objects to behave in physically plausible manners when manipulated
- Occlusion
- Collision detection
- Shadows

Types of reality:

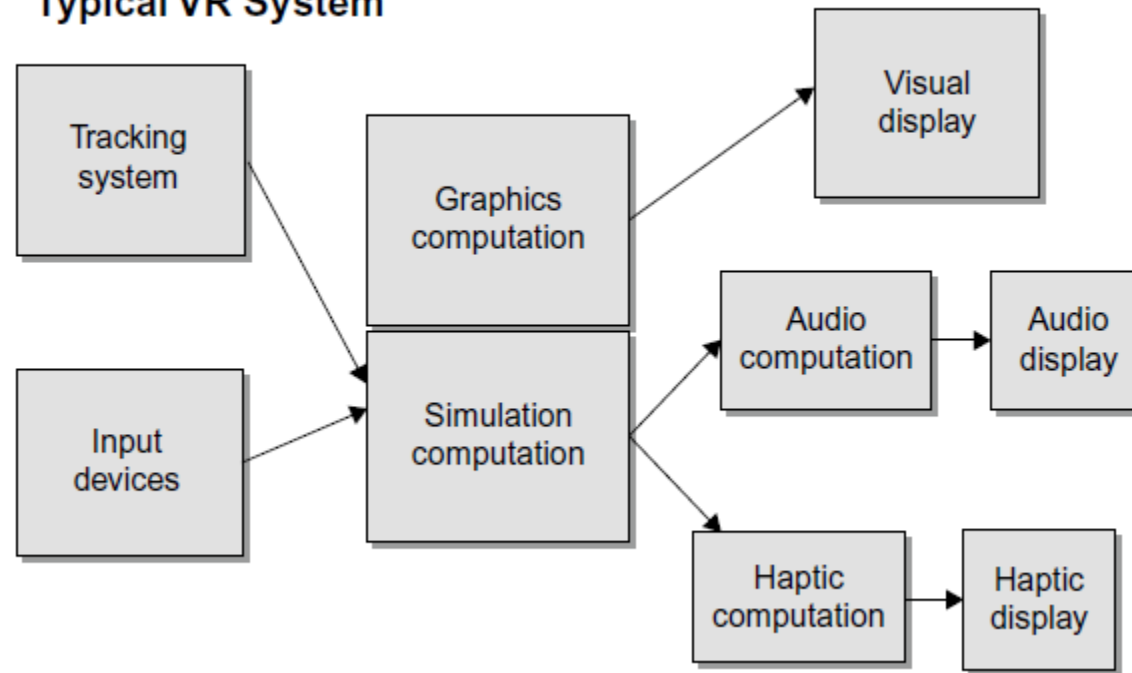
- AR, VR, MR, XR

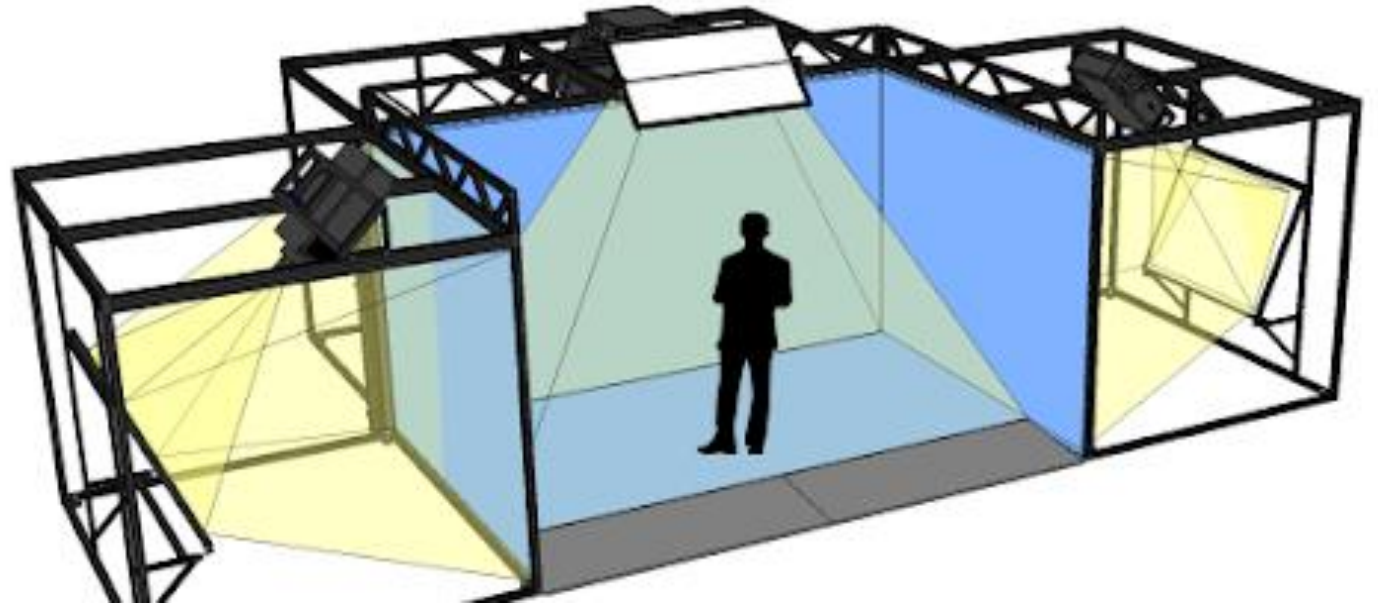
Elements of VR



Components of Virtual Reality

Typical VR System





Stationary display



Stationary display – Desktop Display & CAVE

Reference

- Burdea, G. C., P. Coffet., “Virtual Reality Technology”, Second Edition, Wiley-IEEE Press, 2003/2006
- Alan Craig, William Sherman, Jeffrey Will, “Developing Virtual Reality Applications, Foundations of Effective Design”, Morgan Kaufmann, 2009.
- Images and videos used in tis presentation are referred from the Internet source