Virtual Reality and Augmented Reality

Perception and Technology

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Perception and Technology

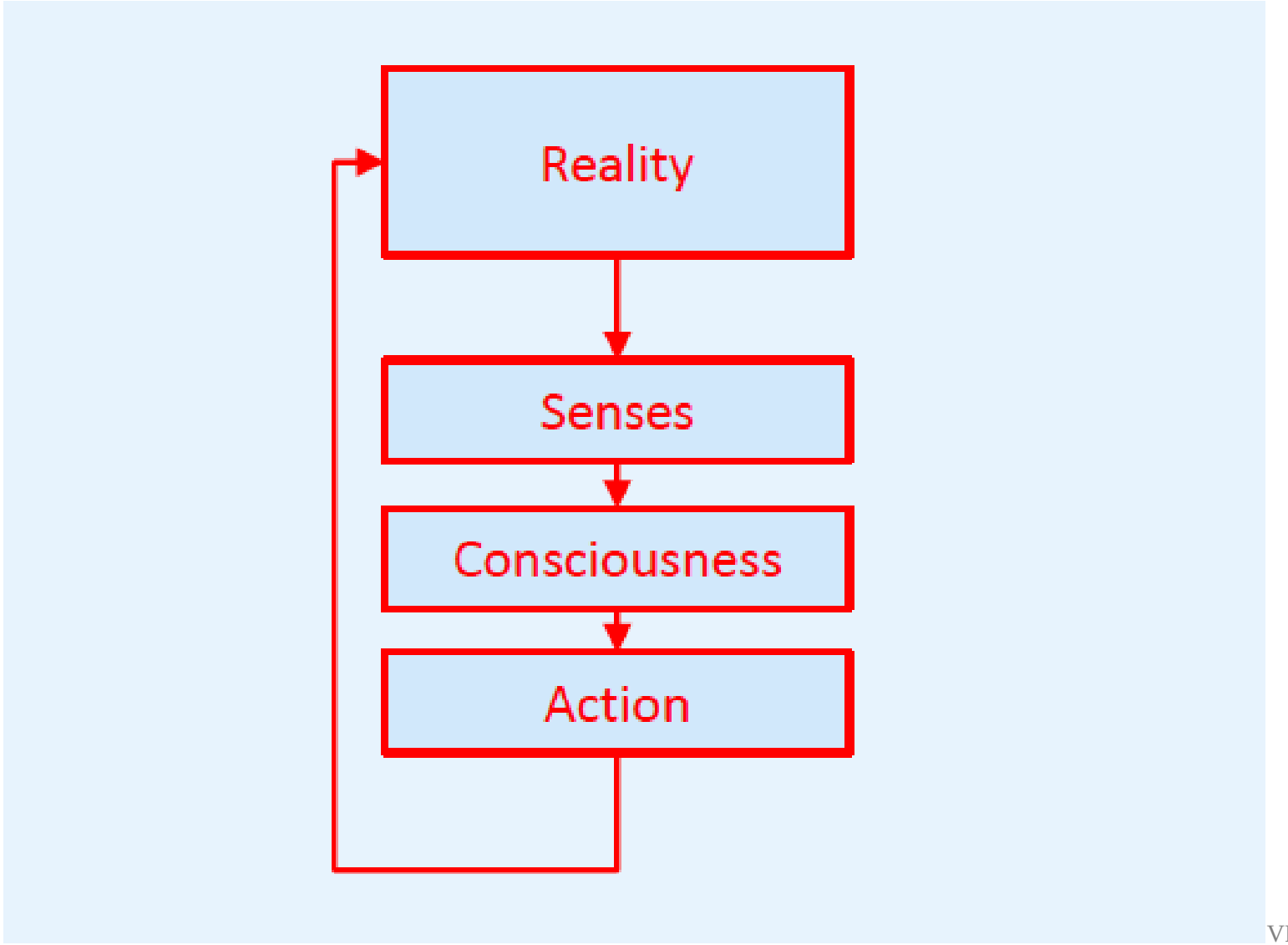
How do We Perceive Reality?

- We understand the world through our senses:
  - Sight, Hearing, Touch, Taste, Smell
- Two basic processes:

  Sensation: Gathering information

  Perception: Interpreting information

Simple Sensing/Perception Model



Simple Sensing/Perception Model

Cycle of perception and action:

- **Reality**: This represents the **external world**, which exists independently.
- **Senses**: Humans (or organisms) **perceive** reality through their senses (sight, hearing, touch, taste, and smell).
- **Consciousness:** The sensory information is **processed** by the brain, creating awareness and understanding.
- **Action:** Based on this consciousness, the individual takes **action**.
- **Feedback Loop:** The action then **influences** reality, and the cycle continues.

Goal of Virtual Reality

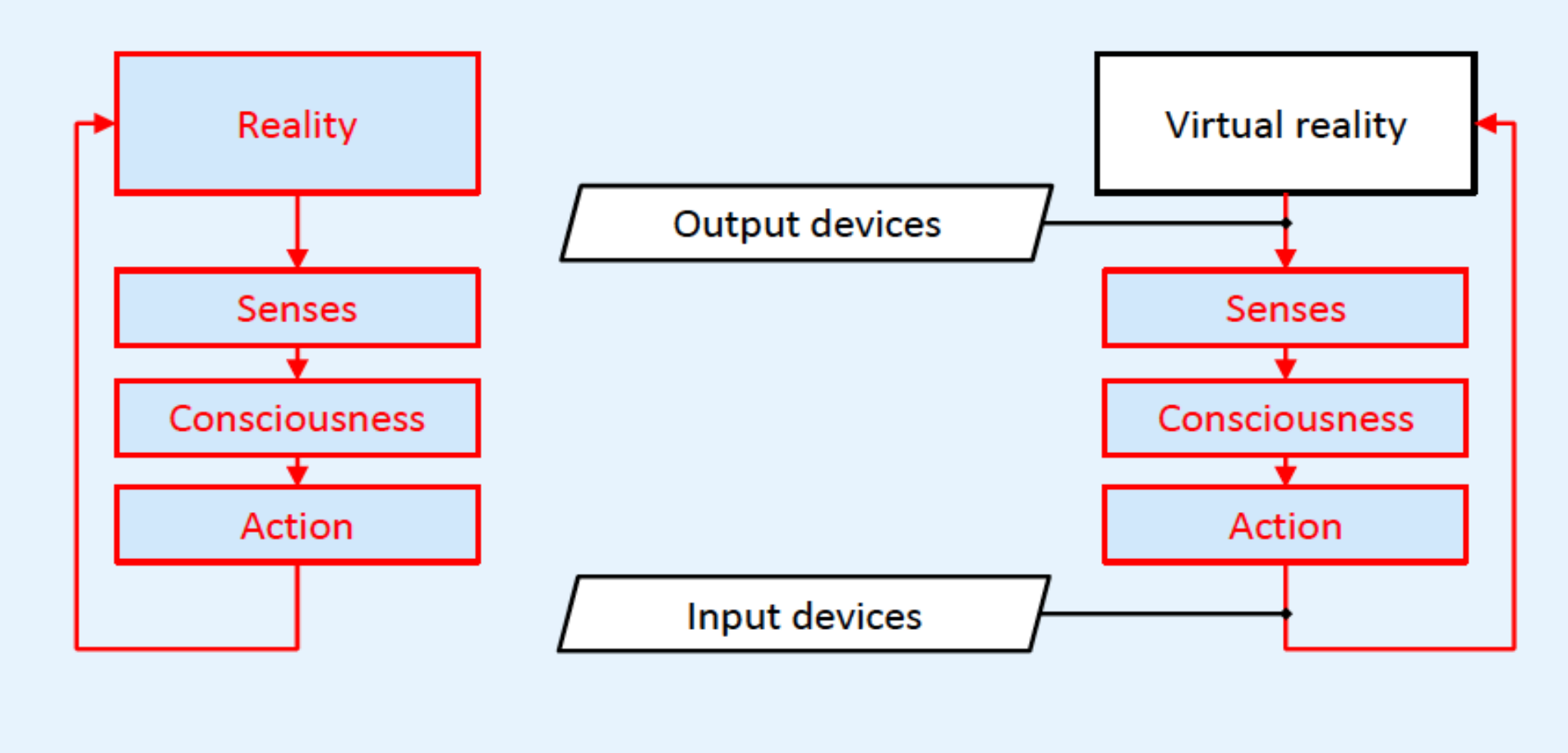
“.. to make it feel like you’re actually in a place that you are not.”

- **Creating the Illusion of Reality**
  - Fooling human perception by using technology to generate artificial sensations.
    - Computer generated sights, sounds, smell, etc

The **Oculus Rift CV1**, the first commercial VR headset

Palmer Luckey
Co-founder, Oculus

Reality vs. Virtual Reality



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

Reality vs. Virtual Reality

Virtual Reality: Instead of real-world stimuli, a VR system generates a digital environment.

Senses: VR output devices (e.g. headsets, speakers) simulate real-world sensory experiences.

Consciousness: The brain processes these virtual sensory inputs as if they were real.

Action: The user reacts within the VR environment (e.g., moving, interacting).

Feedback Loop: Actions are captured by input devices (e.g. controllers), which update the VR environment accordingly.

Example Birdly

Create illusion of flying like a bird

- Multisensory VR experience
  - Visual, audio, wind, haptic

https://www.youtube.com/watch?v=gHE6H62GHoM

Immersion vs. Presence

- **Immersion:** describes the extent to which technology is capable of delivering an illusion of reality to the senses of a human.
- **Presence:** a state of consciousness, the (psychological) sense of being in the virtual environment.
- ***So Immersion, defined in technical terms, is capable of producing a sensation of Presence.***

Goal of VR: Create a high degree of Presence

- Make people believe they are really in Virtual Environment

Richie’s Plank Experience

https://www.youtube.com/watch?v=4M92kfnpg-k

Four Illusions of Presence

- **Place Illusion:**
  - Feeling inside the virtual world *(the sensation that you are physically inside the virtual environment)*
- **Plausibility Illusion:**
  - Events are real *(depends on consistent interactions)*
- **Body Ownership:**
  - Seeing your body in VR
- **Social Presence:**
  - Other people are in VR *(feel that other virtual characters* ***(avatars)*** *represent real people with whom they can interact)*

Measuring Presence

- Presence is very subjective and the following summarizes how to measure it:

1. **Subjective Measures**
   - *Self report questionnaire*
     - ask users to reflect on their experiences and rate their immersion, realism, and interaction with the virtual world.
   - *Continuous measure*
     - Person moves slider bar in virtual environment depending on Presence felt.
2. **Objective Measures**
   - *Physiological measures*
     - Change in heart rate, skin conductance, skin temperature

AR Technology

AR Characteristics

- **Combines Real and Virtual Images**
  - Needs: Display technology
- **Interactive in real-time**
  - Needs: Input and interaction technology
  - *For example: Touch-Based Interaction, Gesture Recognition, Controller-Based Interaction*
- **Registered in 3D**
  - Needs: Viewpoint tracking technology
  - *For example: GPS Tracking, Marker-Based Tracking, SLAM (Simultaneous Localization and Mapping)*

Example: Magic Leap Display

- **Display**
  - Multi-layered Waveguide display
- **Tracking**
  - Inside out SLAM tracking *(is a computer vision technique in AR that uses device built-in cameras and sensors to map the environment and track the device's movement in real time.)*
- **Input**
  - 6DOF wand, gesture input

AR Display Technologies

Classification (Bimber/Raskar 2005)

- **Head attached**
  - Head mounted display/projector

- **Body attached**
  - Handheld display/projector

- **Spatial**
  - Spatially aligned projector/monitor

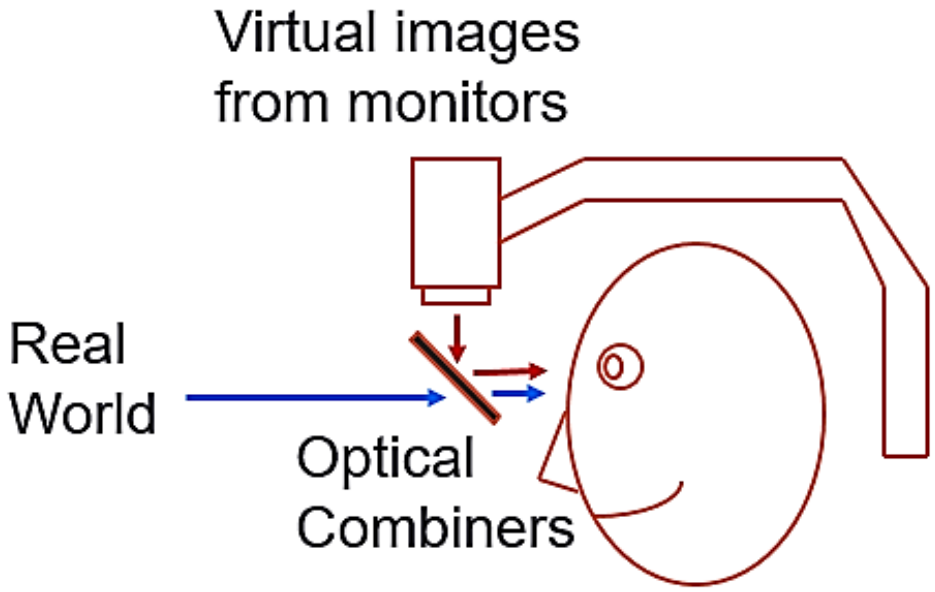
Head Mounted Display

Types of Head Mounted Displays

1. **Optical see-through HMD**

   - See the real world directly through **transparent lenses**.
   - **Micro displays** inside the headset generate virtual images, which are then reflected and guided to the user's eyes using optical combiners.
   - Better for **outdoor use**, **lower latency, more natural experience**, as users see the world with their own eyes.

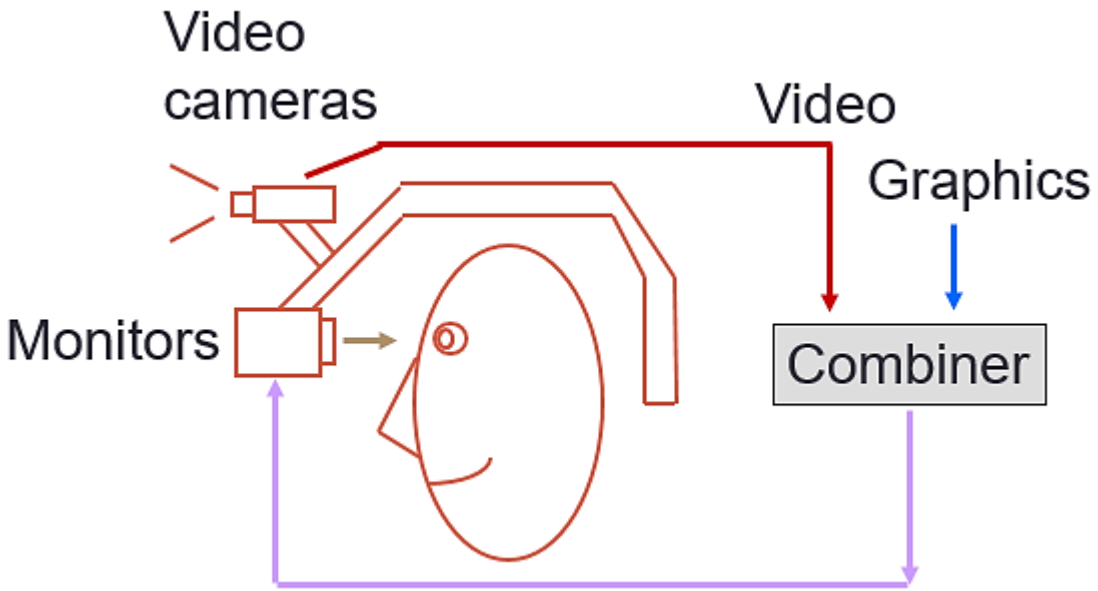
e.g. Microsoft HoloLens and Magic Leap



Types of Head Mounted Displays

2. Video see-through HMD

- The real world is captured by **cameras** and shown on internal screens inside the headset. **Do NOT** see the real world directly, only its **video feed.**
- Can achieve **full VR and AR, not ideal for outdoor use, higher latency.**



e.g. Meta Quest Pro

Handheld AR

Handheld AR

- Camera + display = handheld AR
- Mobile phone/Tablet display
- Video see-through AR

User-Perspective Hand-Held Display

User perspective	Device perspective
What the user actually sees on the screen.	**How** the AR system understands the real world using the camera and sensors.
The user moves the device to see the AR content	The device calculates where and how to place AR content
Happens **after** the device processes AR objects	Happens **before** the AR object appears

For Developers: Understanding device perspective helps you design better tracking & placement for AR objects.

Spatial AR

Spatial AR

- Project onto **irregular surfaces**
  - **Geometric Registration:** This ensures that virtual content is aligned accurately with the real-world surface.
  - **Projector blending:** When multiple projectors are used to cover a large area, It eliminates overlapping projections.

https://www.youtube.com/watch?v=AUJNxNkwEy0

THANK YOU