

Human-Computer Interaction

**Augmented/Virtual
Reality**

Professor Bilge Mutlu

Questions

To ask questions during class:

- » Go to slido.com and use code #**2938904** or [direct link](#) or scan QR code
- » Anonymous
- » I will monitor during class



Today's Agenda

- » Topic overview: *Augmented/Virtual (AR/VR) Reality*
- » Group Discussion

History of AR/VR

Hugo Gernsback,¹ “Teleyeglasses” concept, 1936:

- » A stereo head-worn video display, but without interactive graphics or head tracking



¹[Life Magazine](#)

History of AR/VR

Ivan Sutherland,² Head-tracked AR/VR, 1968:

- » Stereo, see-through head-worn display
- » Synthesized imagery combined with view of real world



² [Atomic Digital, YouTube](#)

What is virtual reality (VR)?

- » Computer-generated world of virtual media³
 - » 3D
 - » Interactive
 - » Tracked relative to user



³[OculusRift VR](#)

What is Augmented Reality (AR)?

Definition: AR is a technology which (1) combines real and virtual imagery, (2) is interactive in real time, and (3) registers the virtual imagery with the real world.⁴ ⁵

Unlike VR, AR **supplement** rather than **replace** the real world



⁴ R.T. Azuma. A survey of augmented reality. *Presence: Teleoperators and Virtual Environments* 6:4, 355–385, 1997

⁵ [Image source](#)

Different types of AR⁶ ⁷

- » Mobile AR
- » See-through HMDs
 - » Video, optical
- » Projection-based AR
 - » Stationary
 - » Handheld/wearable

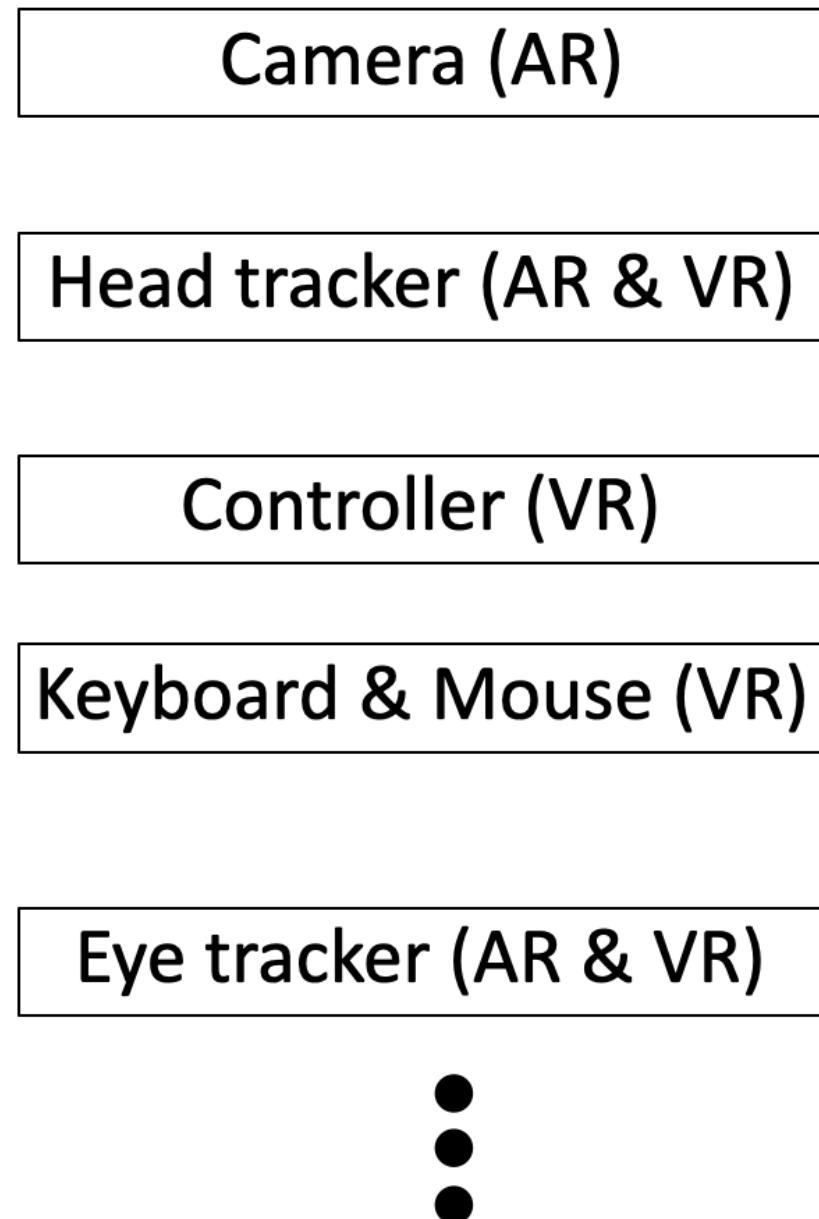


⁶Images: [left](#), [right](#)

⁷Next slide: [YouTube](#), Harrison et al. OmniTouch: wearable multitouch interaction everywhere. UIST 2011.



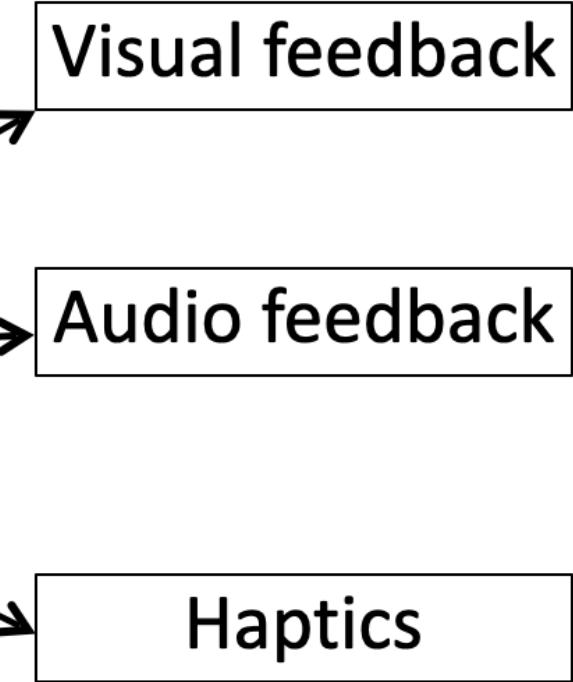
INPUT



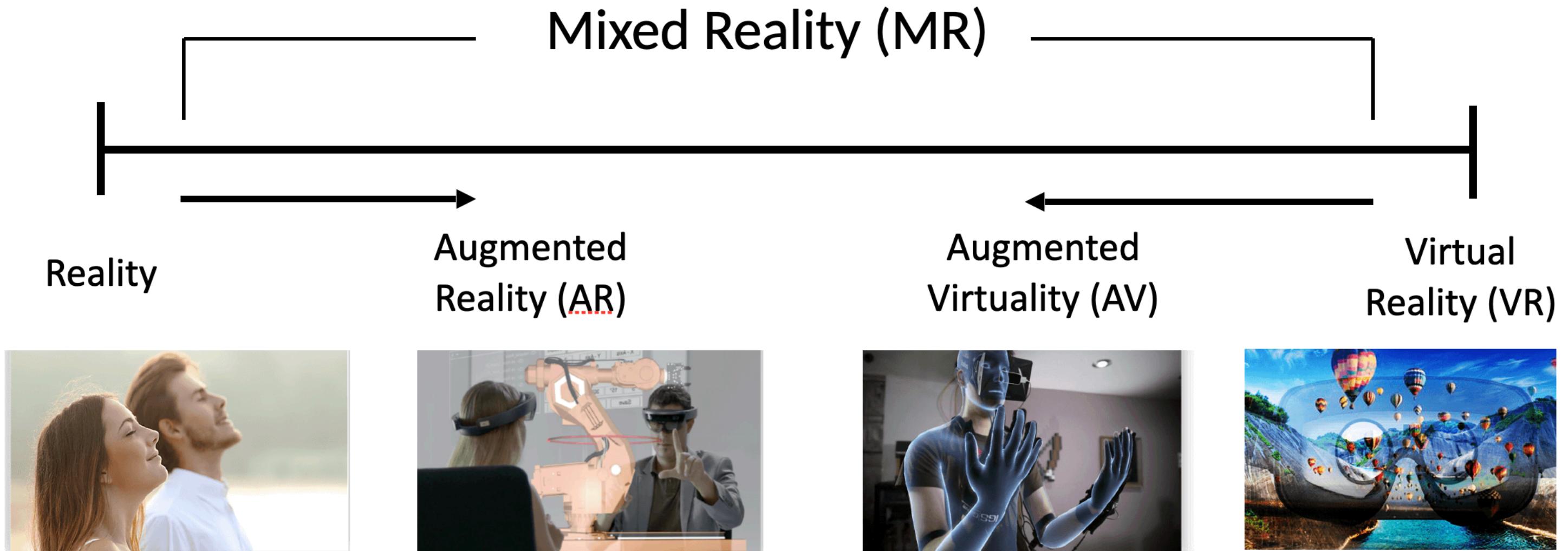
COMPUTATION

Virtual
World
Generator

OUTPUT



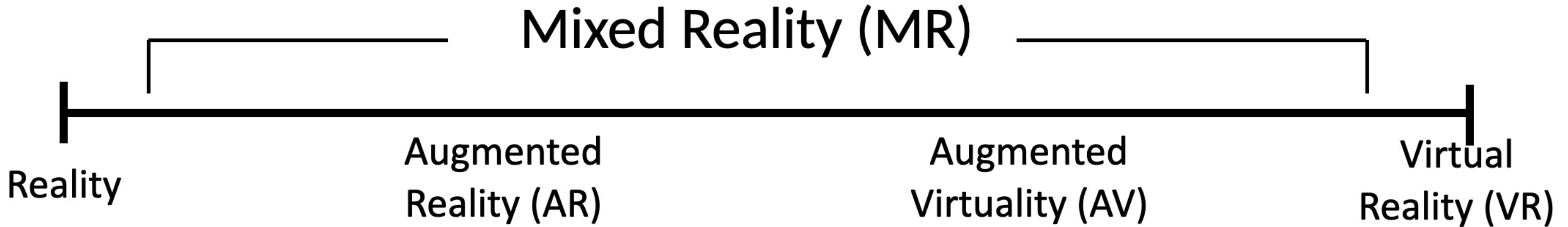
Reality-virtuality continuum⁸



⁸Milgram et al. Augmented reality: A class of displays on the reality–virtuality continuum. *Telemanipulator and telepresence technologies*, 1995.

Reality-virtuality continuum

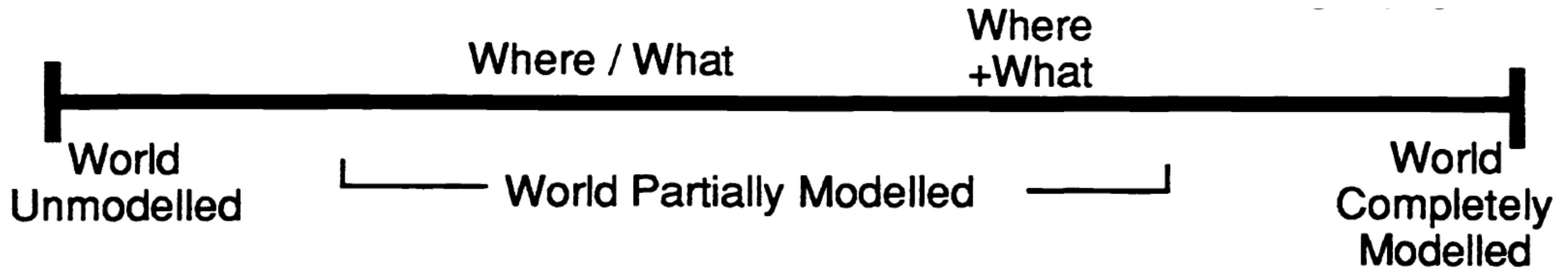
- » **VR:** completely synthetic world
- » **MR:** real world and virtual world presented (and experienced) together
- » **AR:** principally real environment with added computer-generated content
- » **AV:** principally virtual environment with added real content



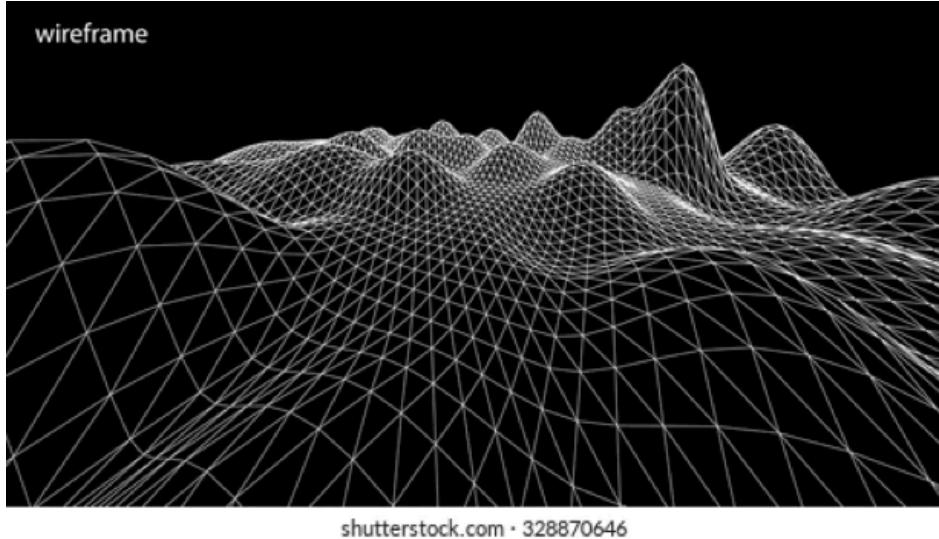
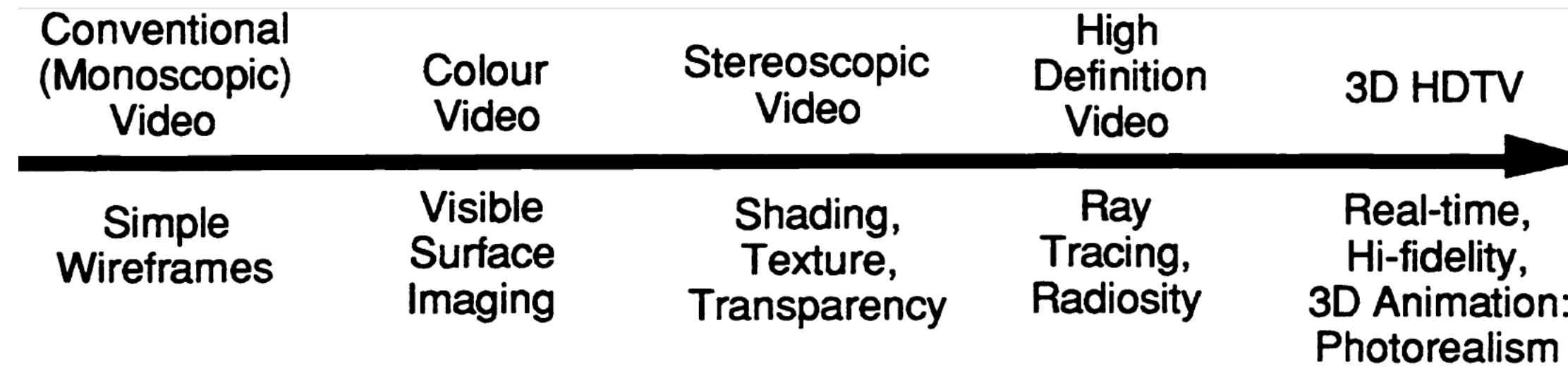
Characteristics of AR/VR systems

- » **Reality:** whether the environment is primarily virtual or primarily real; e.g., AR ↔ AV
- » **Immersion:** the extent to which the observer (or user) is immersed within the environment; e.g., Egocentric ↔ Exocentric
- » **Directness:** whether primary world objects are viewed directly or by means of some electronic synthesis process; Directly (e.g., optical see-through) ↔ Synthesized (e.g., video see-through)

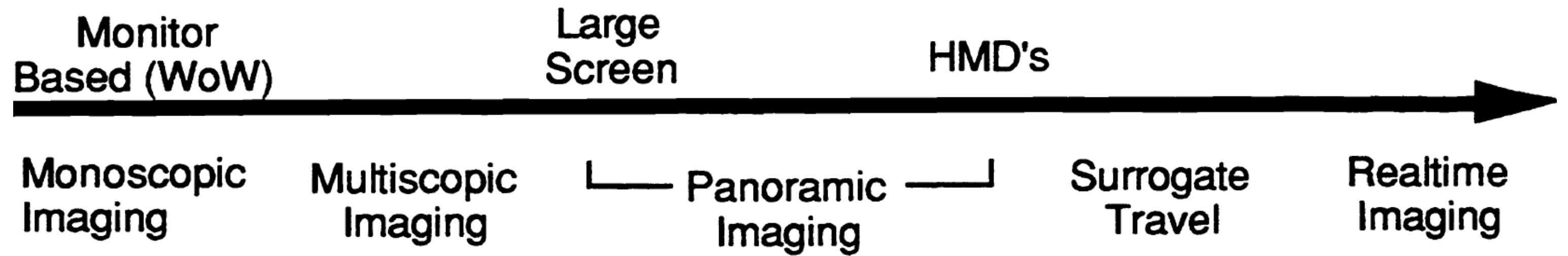
Taxonomy: Extend of World Knowledge



Taxonomy: Reproduction Fidelity (RF)



Taxonomy: Extent of Presence Metaphor



3D UI Taxonomy

- » Objects
- » Space
- » Actions
- » Users
- » Tasks: locomotion; target acquisition, etc.
- » Collaboration: collocated/remote

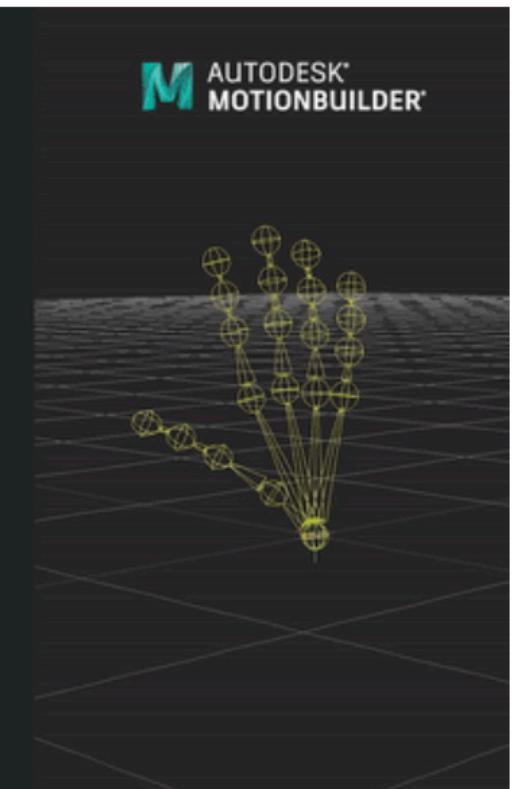
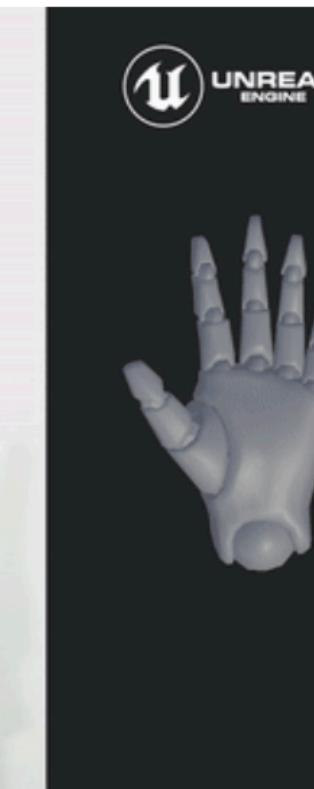
Barriers to 3D UI

- » 3D rendering (interactive, shaded graphics)
- » 3D interaction techniques: tradeoff between complexity and familiarity
- » Tracking & sensing: real-time, accuracy
- » Hardware
 - » Wide field of view; size/weight; appearance, cost
- » VR sickness

What is the state-of-the-art in research and industry?

Sensing & tracking techniques

Vision-based tracking | Controllers | Hand-worn devices⁹



⁹ Image sources: [MANUS](#), [Oculus](#), [Vive](#), [Sony PlayStation VR controller](#)



¹⁰[Vimeo](#), Sra et al. Breathvr: Leveraging breathing as a directly controlled interface for virtual reality games. *CHI* 2018.

WIREALITY

Enabling Complex Tangible Geometries in VR with Worn Multi-String Haptics



3D interaction techniques¹²

- » Object manipulation
- » Text entry
- » Navigation/locomotion: teleporting, redirected walking, avatar scaling, etc.
- » ...

¹² [YouTube](#), Fashimpaur et al. PinchType: Text Entry for Virtual and Augmented Reality Using Comfortable Thumb to Fingertip Pinches. *CHI EA'20*.



Mobile World
Congress 2019

HoloLens 2

DEMO





we play a beeping sound to indicate when the user has

Discussion Format

- » Group discussion ~15 minutes
 - » Separate to 9 groups randomly
 - » Discuss with your group members
 - » Take notes in the shared doc – pick your group number
- » Summary from each group & discussion ~10 minutes

Discussion Questions

- » What AR/VR/MR devices have you used? How's your experience?
- » What opportunities do AR/VR present? What fields can this technology be applied to?
- » What are the benefits and weaknesses of different AR/VR devices? Mobile vs. optical see-through vs. video see-through vs. projection-based? How do you select devices in your research?
- » What challenges do AR/VR pose? How should we overcome these challenges?