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

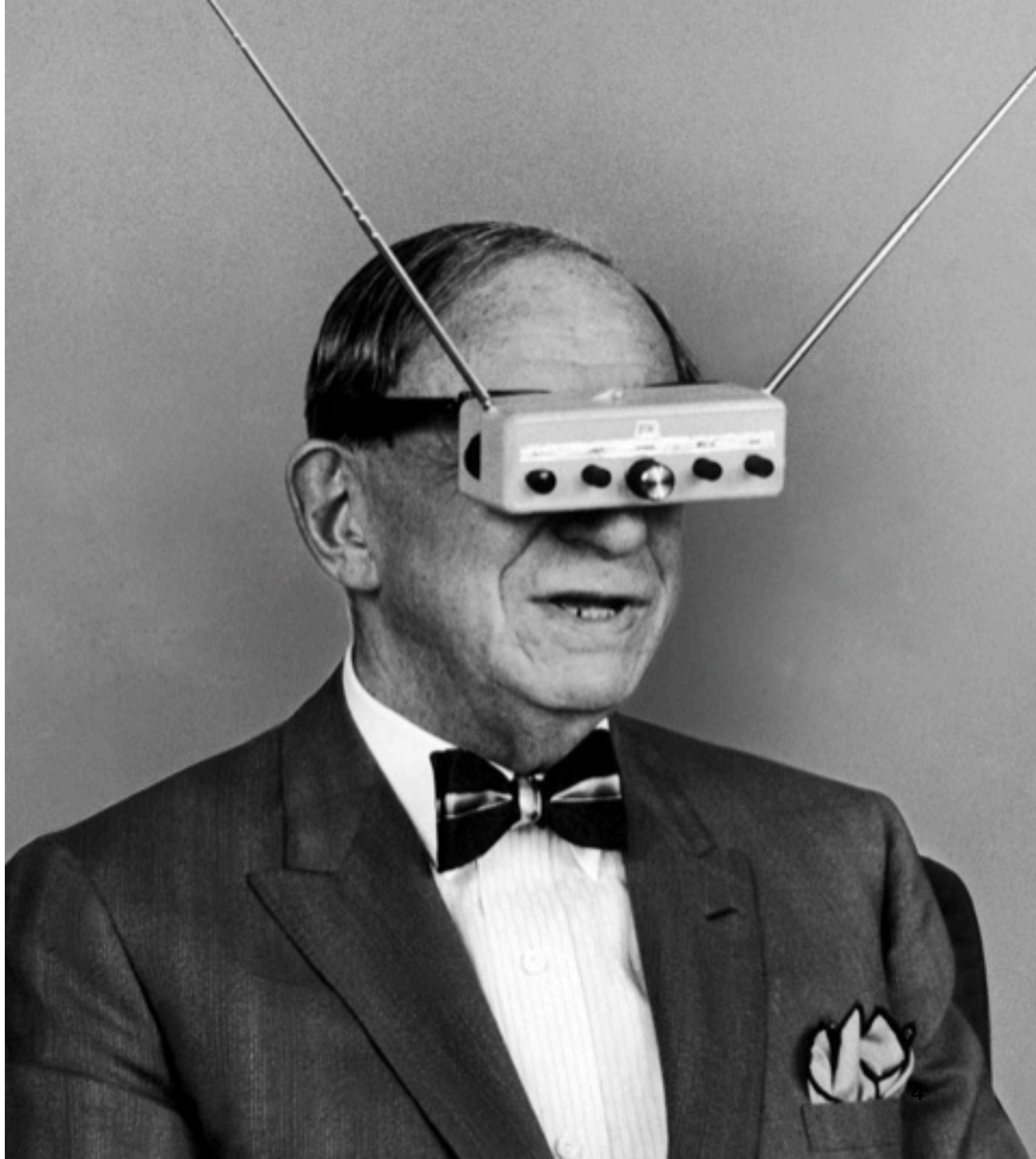
» Topic overview: *Augmented/Virtual (AR/VR) Reality*

» 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



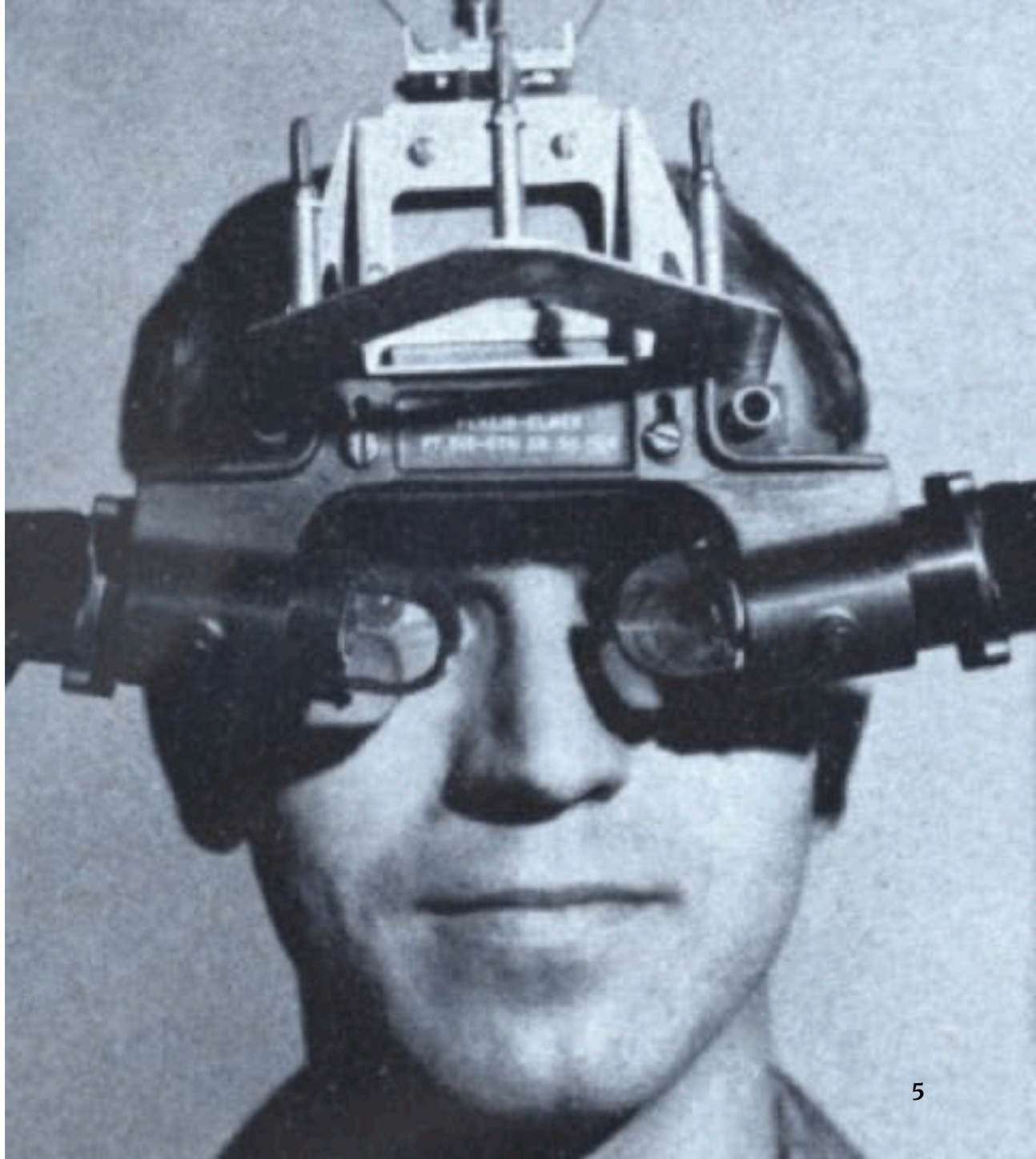
[1] Life Magazine

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

r Interaction | Professor Mutlu | Week 09: Seminar: ***Augmented/Virtual Reality***

What is virtual reality (VR)?

- Computer-generated world of virtual media[3]
  - 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

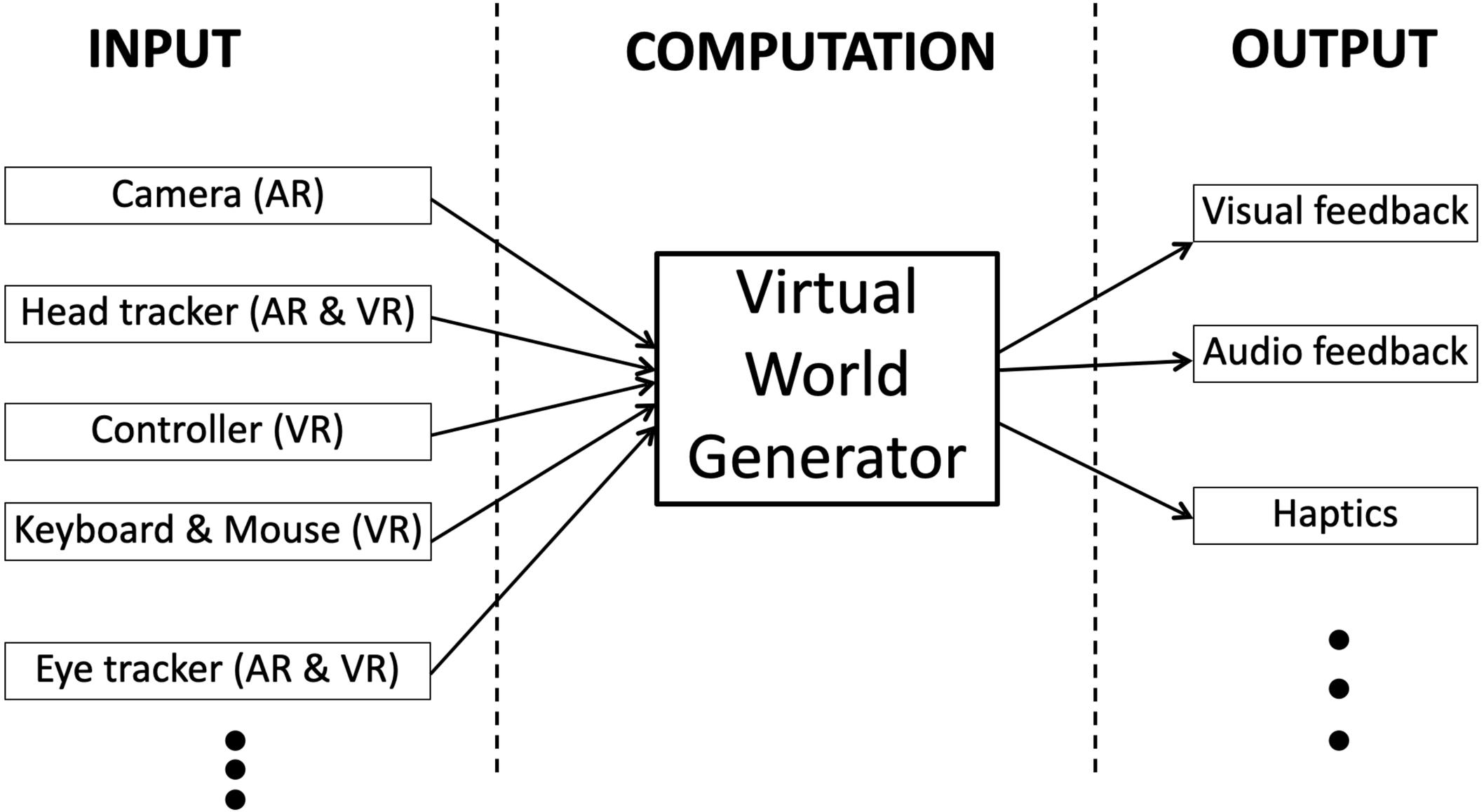
[4] R.T. Azuma. A survey of augmented reality. Presence: Teleoperators and Virtual Environments 6:4, 355-385, 1997
[^5]: Image source

Different types of AR[6] [7]

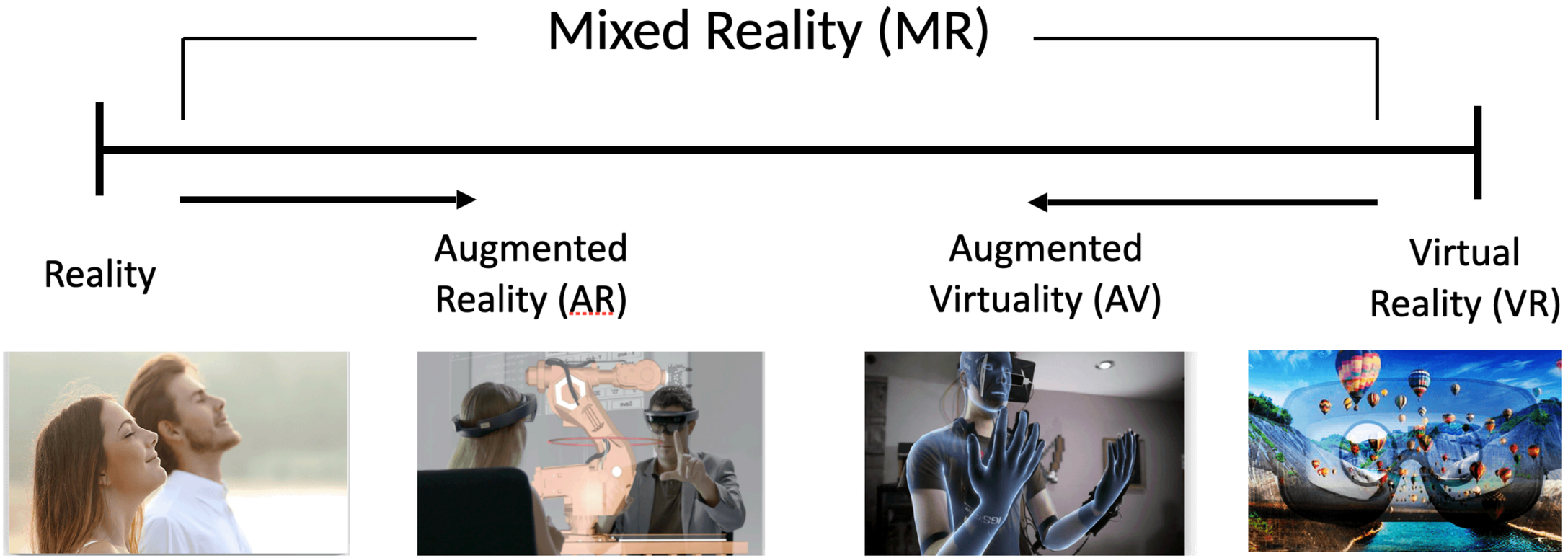
- Mobile AR
- See-through HMDs
  - Video, optical
- Projection-based AR
  - Stationary
  - Handheld/wearable

[6] Images: left, right

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


INPUT
COMPUTATION
OUTPUT
Camera (AR)
Head tracker (AR & VR)
Controller (VR)
Keyboard & Mouse (VR)
Eye tracker (AR & VR)
Virtual World Generator
Visual feedback
Audio feedback
Haptics

Reality-virtuality continuum[8]



[8] Milgram 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

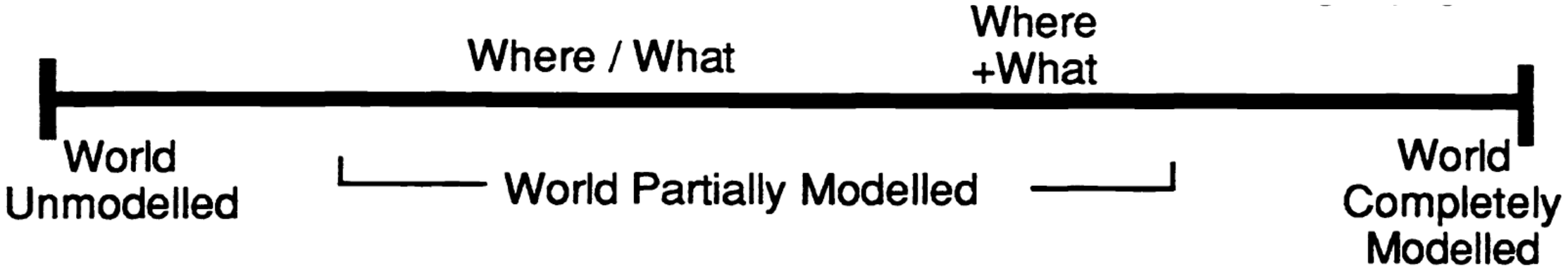
Characteristics of AR/VR systems

» **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

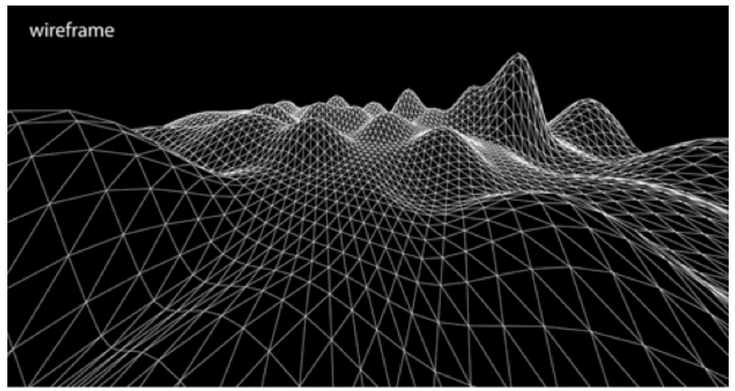
» **Directness**: whether primary world objects are viewed directly or by means of some electronic synthesis process; Directly (e.g., optical see-through) ↔ Synthesized (e.g., video see-through)

Taxonomy: Extend of World Knowledge

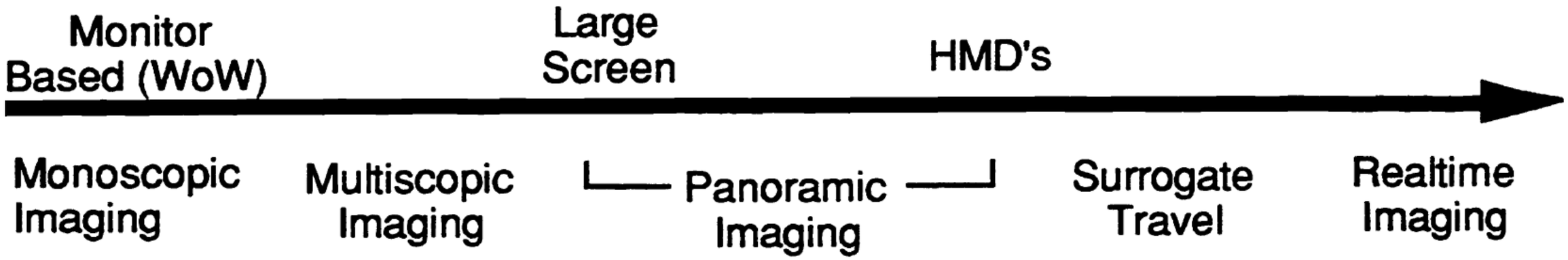


Taxonomy: Reproduction Fidelity (RF)

Conventional (Monoscopic) Video	Colour Video	Stereoscopic Video	High Definition Video	3D HDTV
Simple Wireframes	Visible Surface Imaging	Shading, Texture, Transparency	Ray Tracing, Radiosity	Real-time, Hi-fidelity, 3D Animation: Photorealism



Taxonomy: Extent of Presence Metaphor



3D UI Taxonomy

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

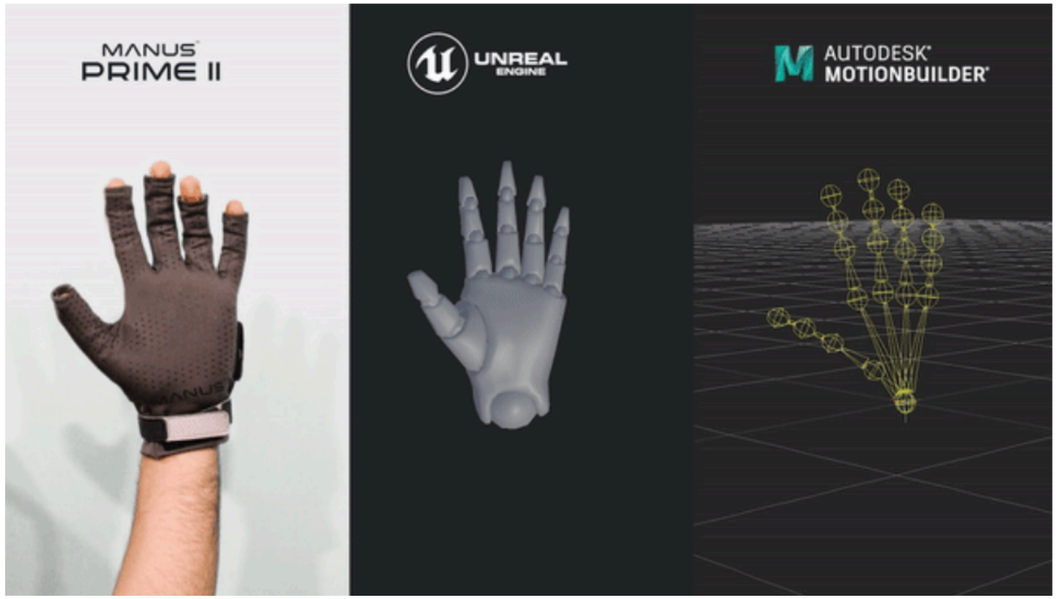
Barriers to 3D UI

- 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 devices[9]



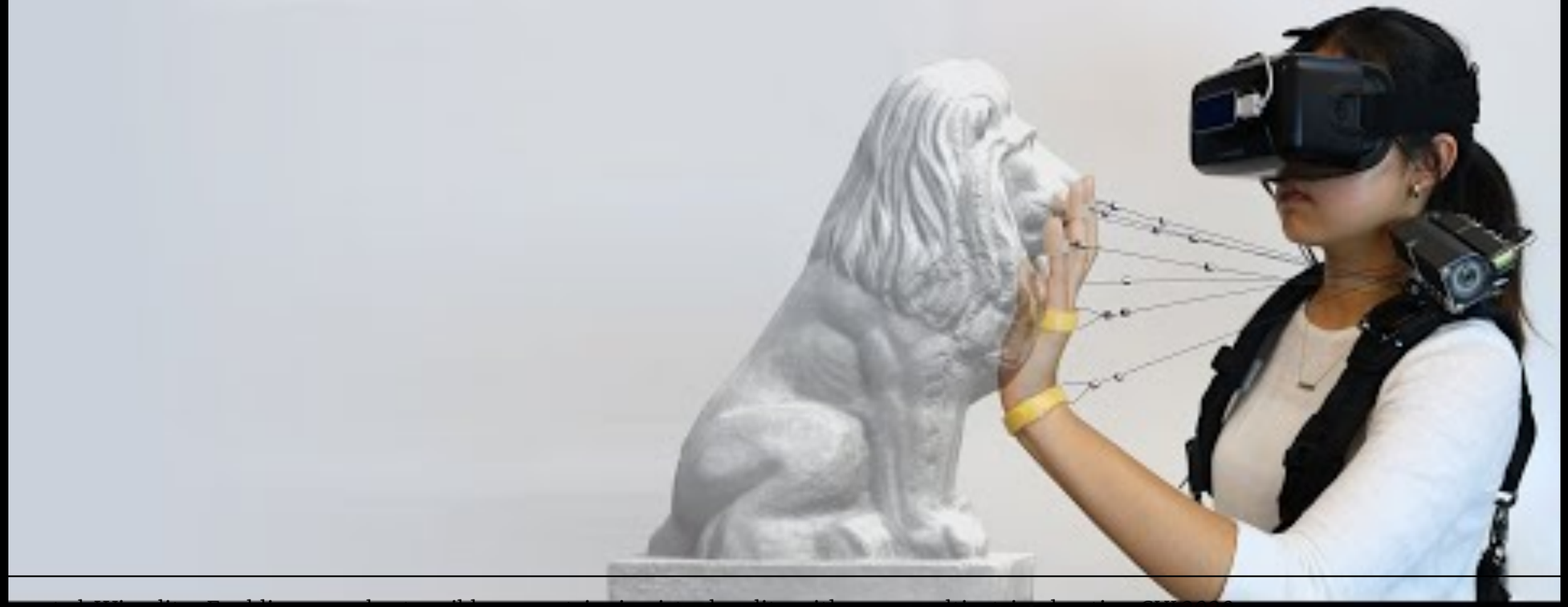
[9] Image sources: MANUS, Oculus, Vive, Sony PlayStation VR controller

10

[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 techniques[12]

» 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*.


Microsoft
Mobile World Congress 2019
HoloLens 2
DEMO


That's what we s
W
X
S
Q W E R T
Y U I O P
A S D F G
H J K L
Z X C V B
N M


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?