

Augmented Reality

Lecture 1

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Intro to the course

Intro to the course

Teachers

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Intro to the course

Lessons and exams

40 hours of lectures (and practical)

A project (1 CFU)

Exam: presentation of the project and oral exam on the course topics

Intro to the course

Slides and other

Attendance!

Aulaweb <https://2024.aulaweb.unige.it/course/view.php?id=2453>

Intro to the course

Topics

- Devices for AR visualizations and the human visual system
- 3D Geometry and the Visualization Pipeline
- Software for VR development (Unity 3D) and practical activities
- Image formation and visual features
- Devices' calibration, 3D reconstruction and tracking
- AR libraries (Vuforia and ARCore) and practical activities

Virtual, Augmented and Mixed Reality: an intro

Virtual and Augmented Reality (VR/AR)

- **Virtual Reality** (VR) places a user inside a completely computer-generated environment
- **Augmented Reality** (AR) aims to present information that is directly registered to the physical environment.
- AR goes beyond mobile computing in that it bridges the gap between virtual world and real world, both **spatially and cognitively**.
- With AR, the digital information appears to become part of the real world, at least in the **user's perception**.

Virtual and Augmented Reality (VR/AR)

The slide features a blue background with two circular icons. The top icon is yellow and contains a smartphone displaying a landscape scene with mountains, representing Augmented Reality. The bottom icon is dark blue and contains a VR headset, representing Virtual Reality. To the right of the icons, there are two columns of text. The top column, associated with the yellow icon, reads: "AUGMENTED REALITY IS COMPUTER GENERATED GRAPHICS ON TOP OF ACTUAL REALITY". The bottom column, associated with the dark blue icon, reads: "VIRTUAL REALITY IS COMPUTER GENERATED GRAPHICS TO CREATE AN ENTIRE VIRTUAL WORLD". A large, bold, white "VS." is centered between the two descriptions.

AUGMENTED REALITY IS
COMPUTER GENERATED
GRAPHICS ON TOP OF
ACTUAL REALITY

VIRTUAL REALITY IS
COMPUTER GENERATED
GRAPHICS TO CREATE AN
ENTIRE VIRTUAL WORLD

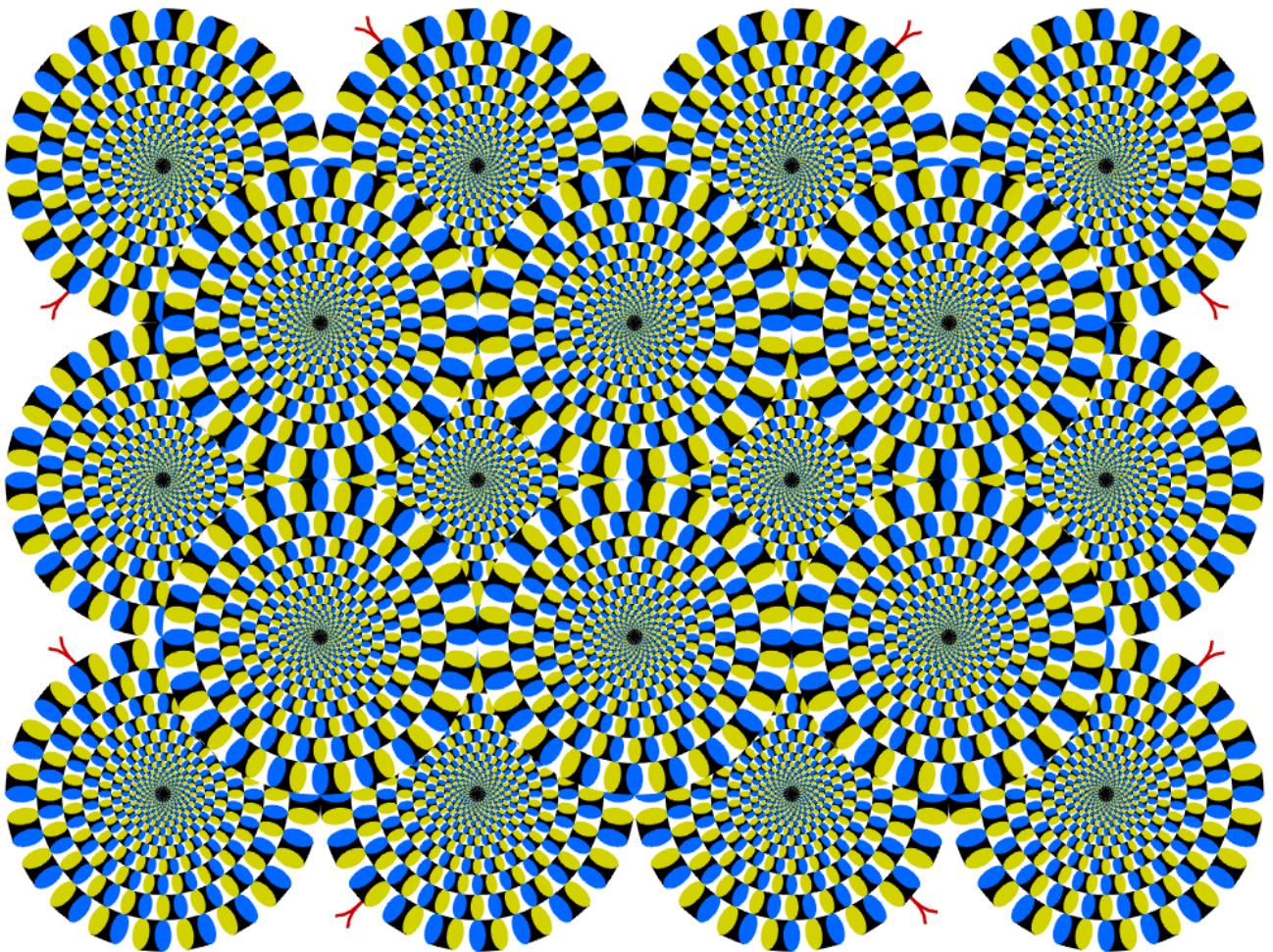
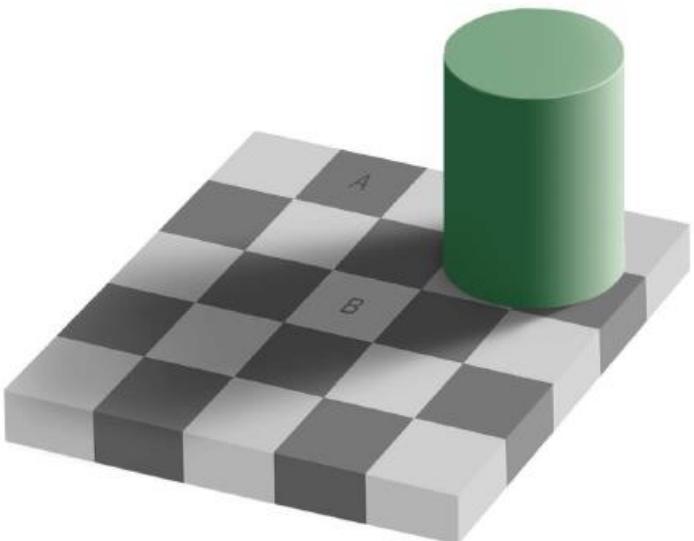
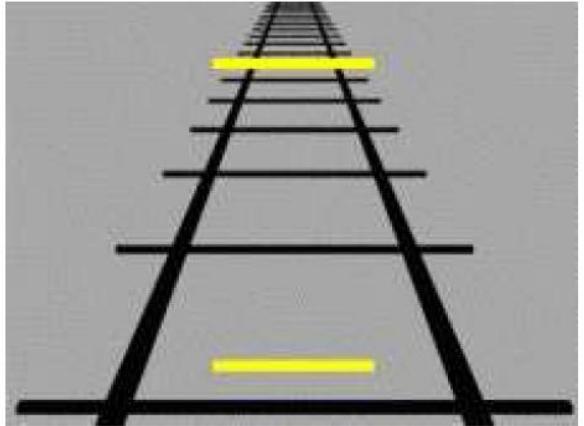
VS.

Virtual and Augmented Reality (VR/AR)



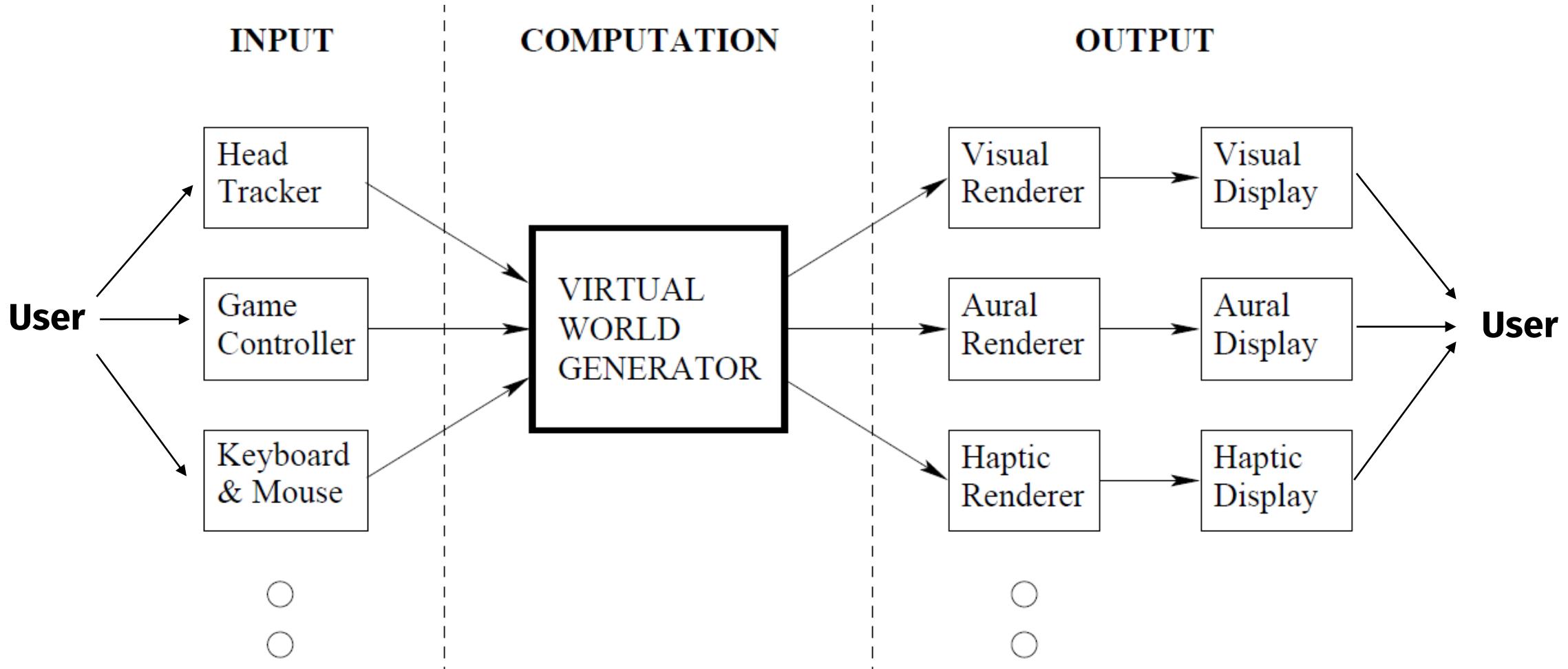
Virtual and Augmented Reality (VR/AR)

To deceive the senses

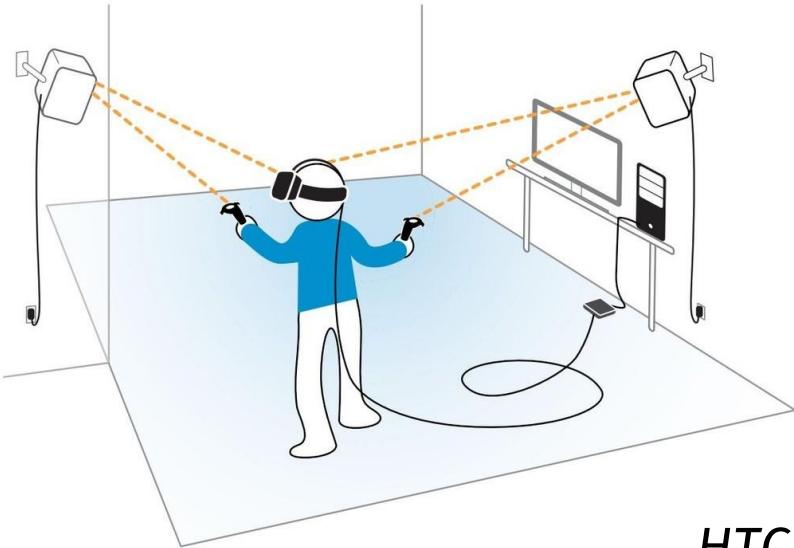


Virtual and Augmented Reality (VR/AR)

To deceive the senses



Virtual and Augmented Reality (VR/AR)



HTC Vive



Virtual and Augmented Reality (VR/AR)



HoloLens



Virtual and Augmented Reality (VR/AR)

Augmented Reality

Overlays digital images onto your view of the real world, often through a smartphone.

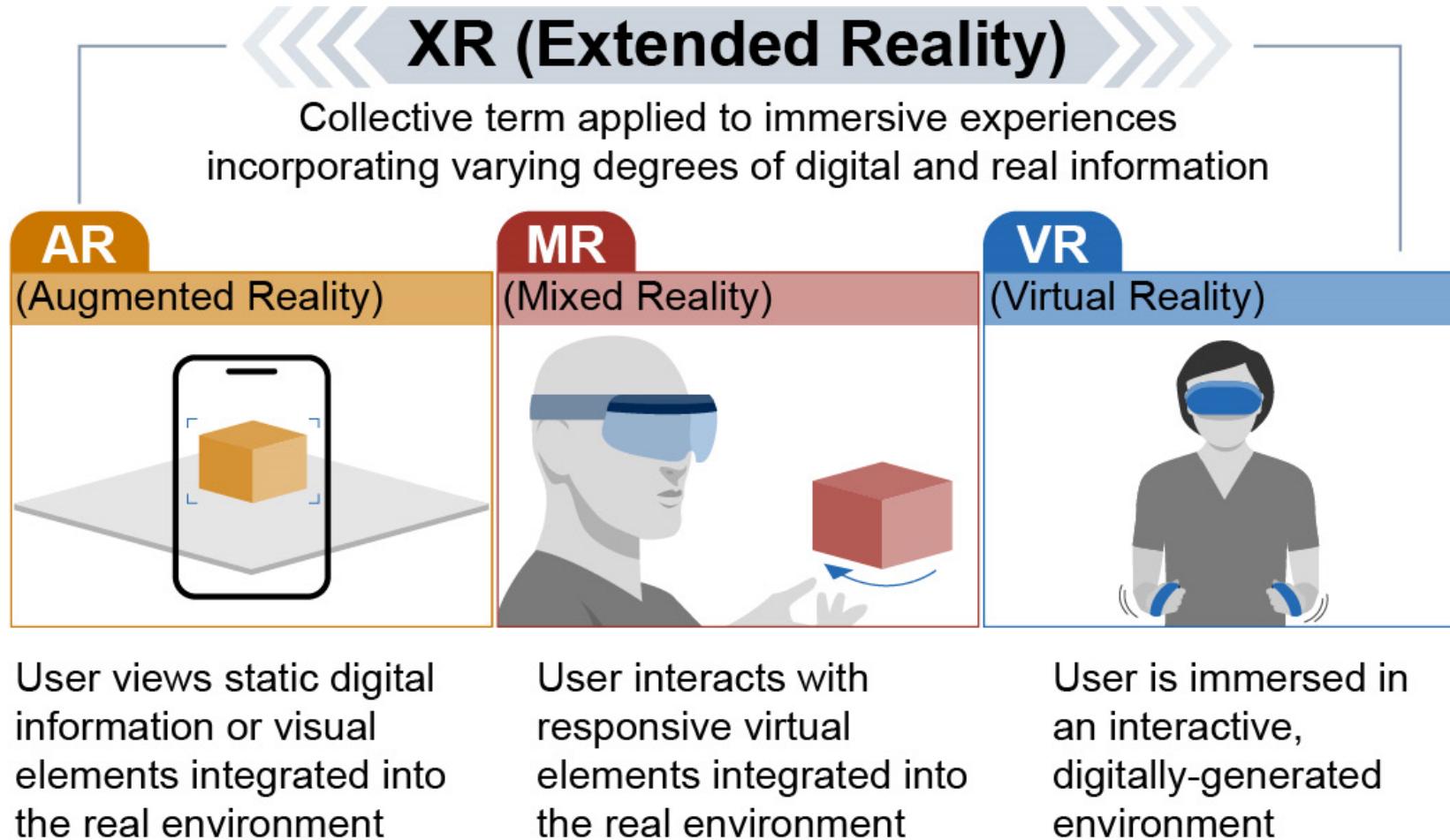


The illustration shows two stylized characters from the waist up. On the left, a character with purple hair and a teal shirt holds a smartphone horizontally, looking at it. On the right, another character with pink hair and a purple shirt wears a VR headset and extends their right arm forward, palm up, as if interacting with a virtual environment. They are set against a light orange background.

Virtual Reality

Primarily uses a headset to create an immersive 3D experience.

Virtual and Augmented Reality (VR/AR/MR/XR)



(One) Definition of AR

The most widely accepted definition of AR was proposed by Azuma in his 1997 survey paper.

According to Azuma [1997], AR must have the following three characteristics:

- **Combines** real and virtual
- **Interactive** in real time
- **Registered** in 3D

This definition *does not require* a specific output device, such as a head-mounted-display (HMD), nor does it limit AR to visual media.

Audio, haptics, and even olfactory or gustatory AR are included in its scope, even though they may be difficult to realize.



(One) Definition of VR

Jonathan Steuer (Stanford University, 1992):

1. Produces a **virtual world**
2. **Interactive** in real time
3. Produces “**presence**”



Mixed Reality Continuum

- Milgram and Kishino [1994] proposed a **continuum** spanning from reality to virtual reality.

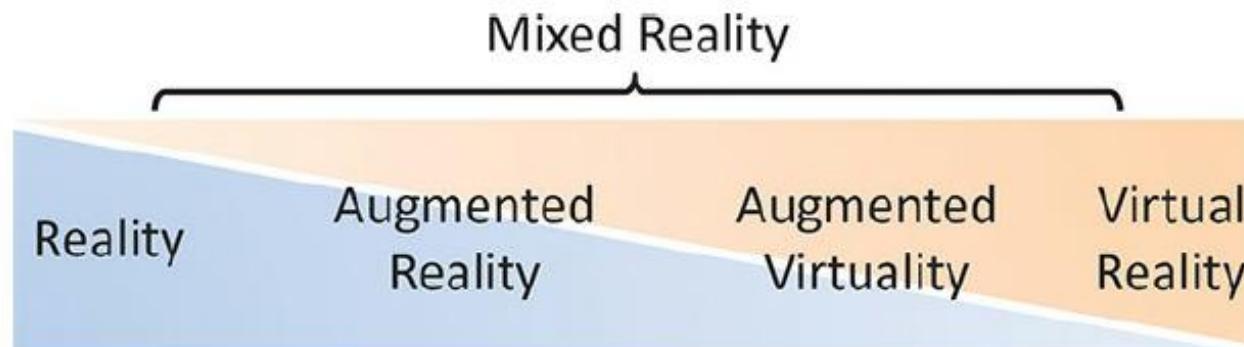
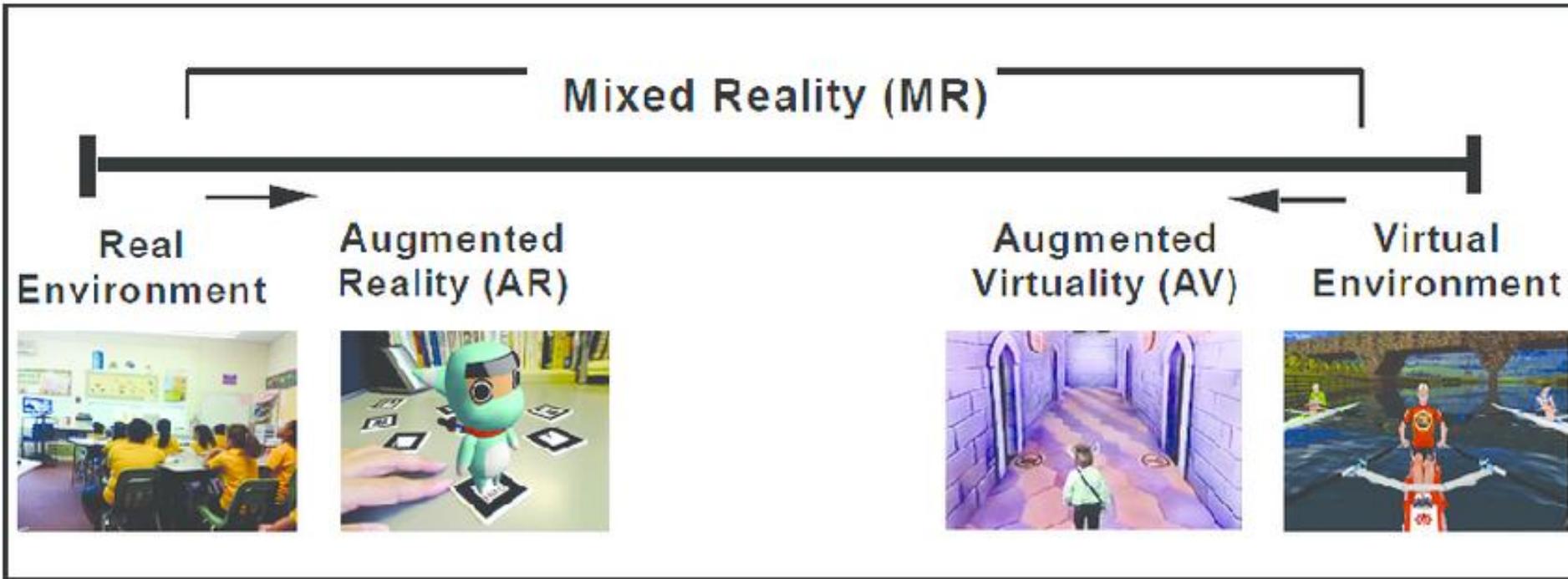


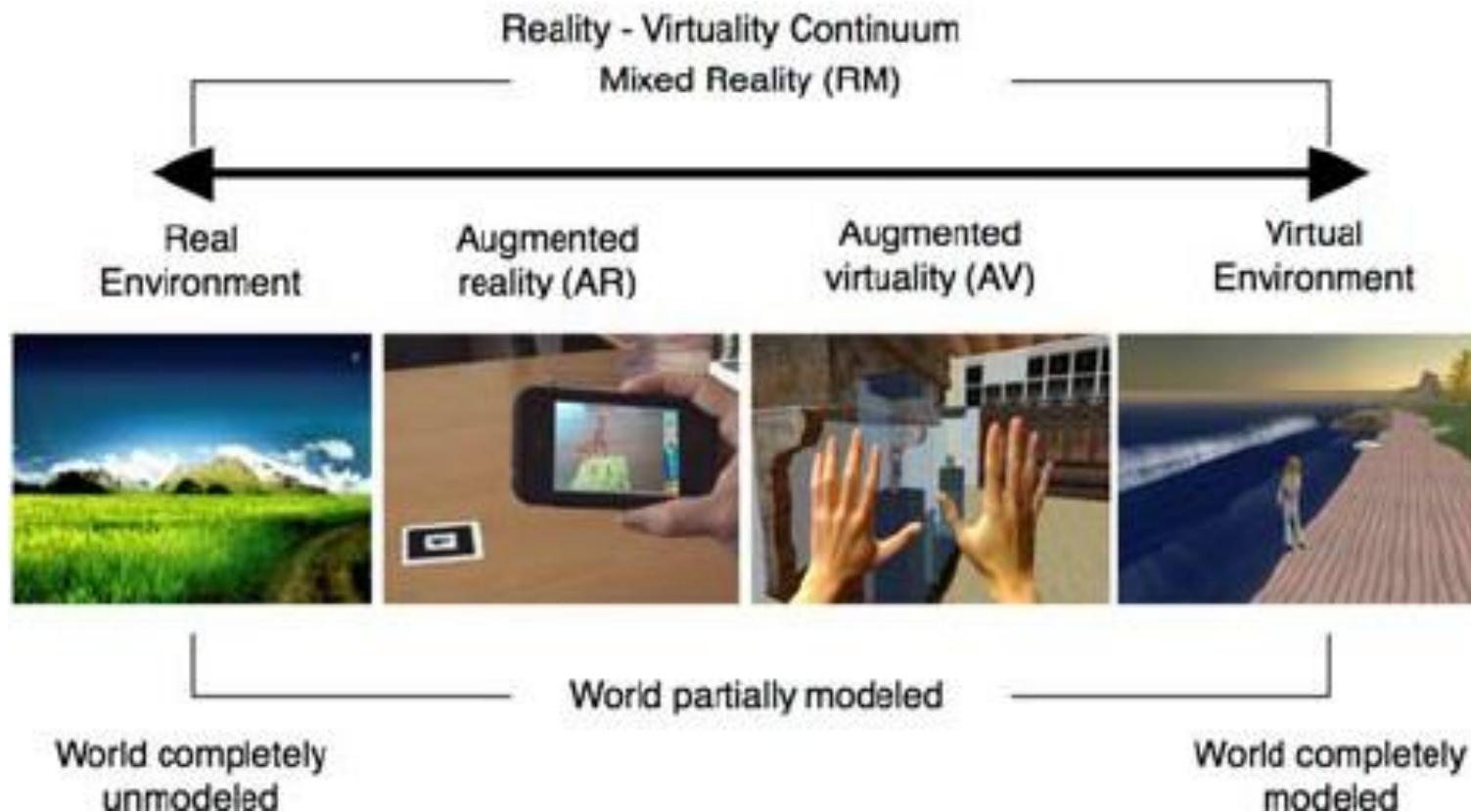
Figure 1.30 The mixed reality continuum captures all possible combinations of the real and virtual worlds.

- **MR** involves the **merging of real and virtual worlds** somewhere along the “virtuality continuum” which connects completely real environments to completely virtual ones.

Mixed Reality Continuum



Mixed Reality Continuum

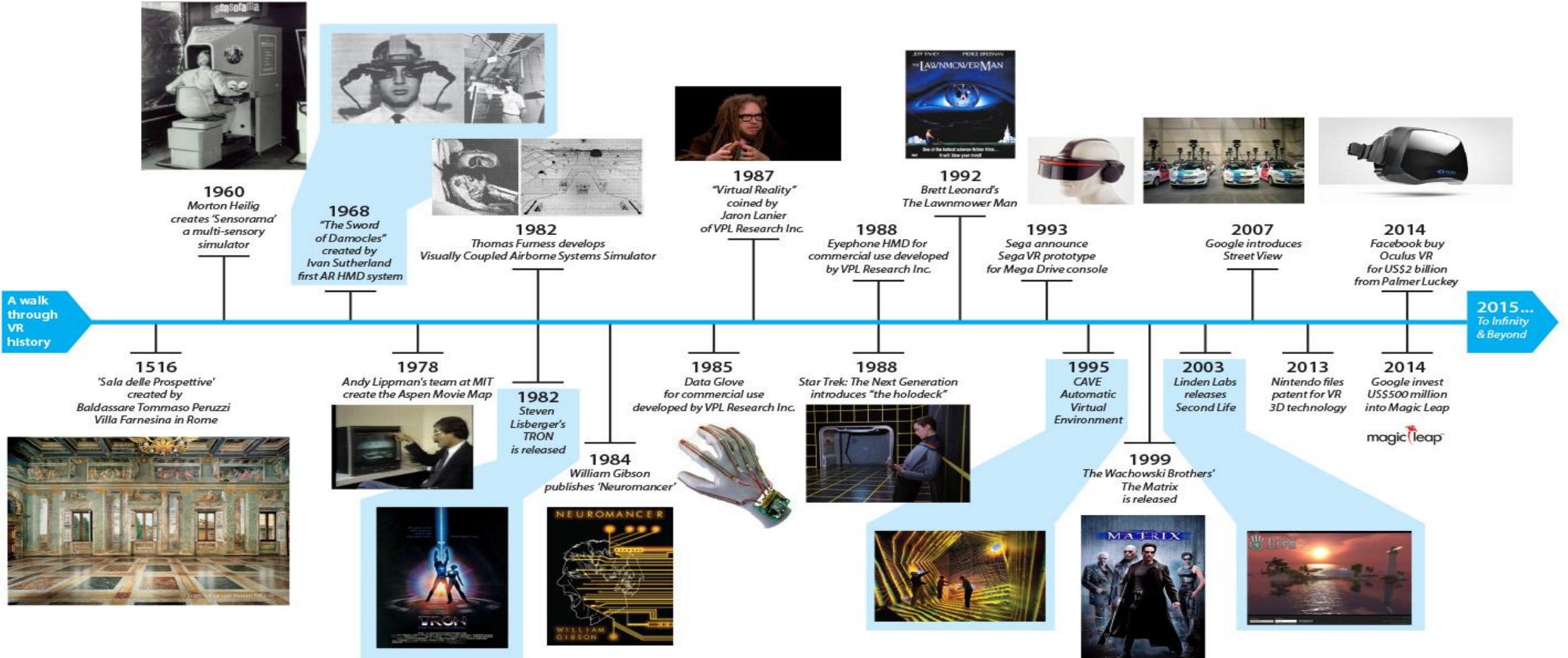




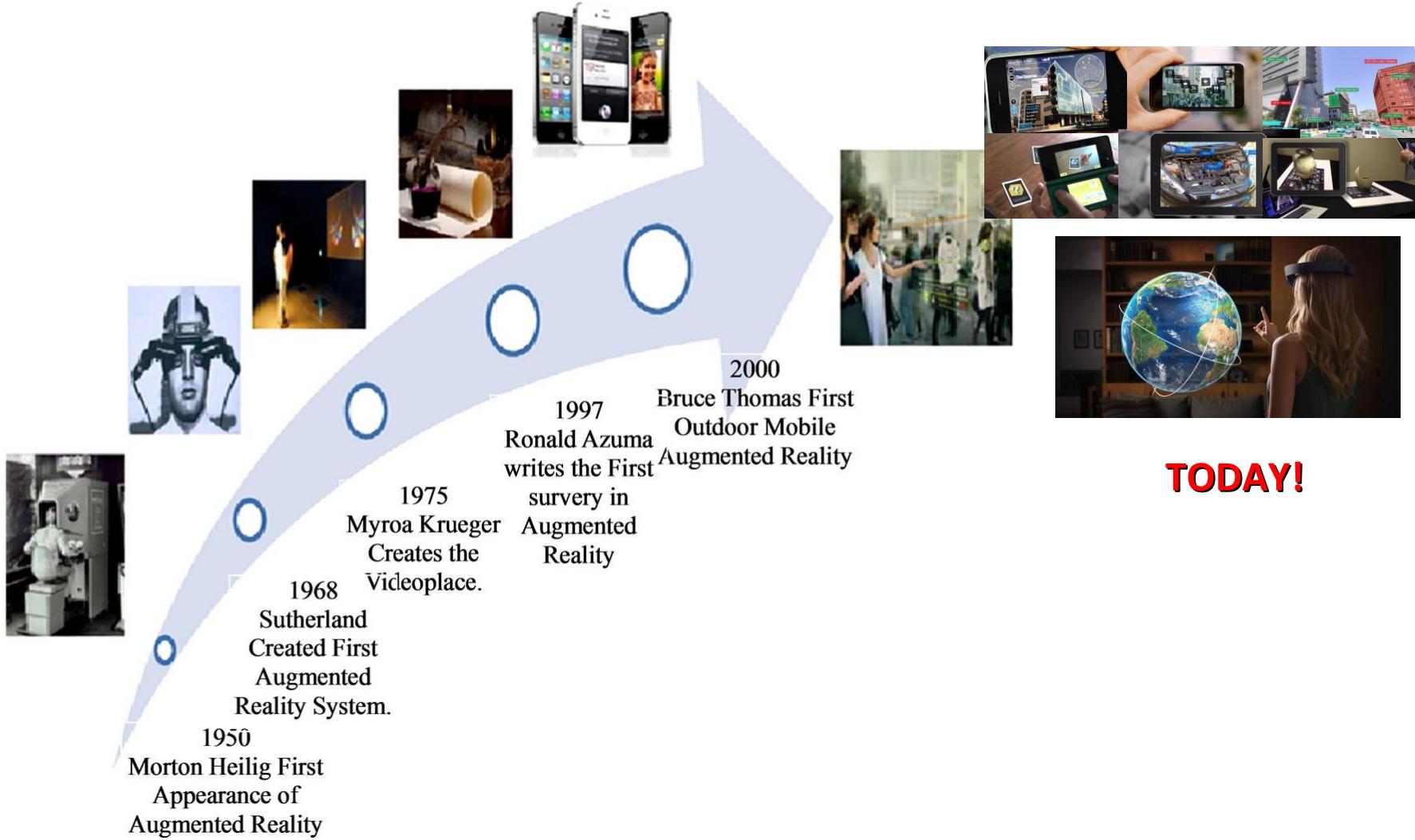
History

History

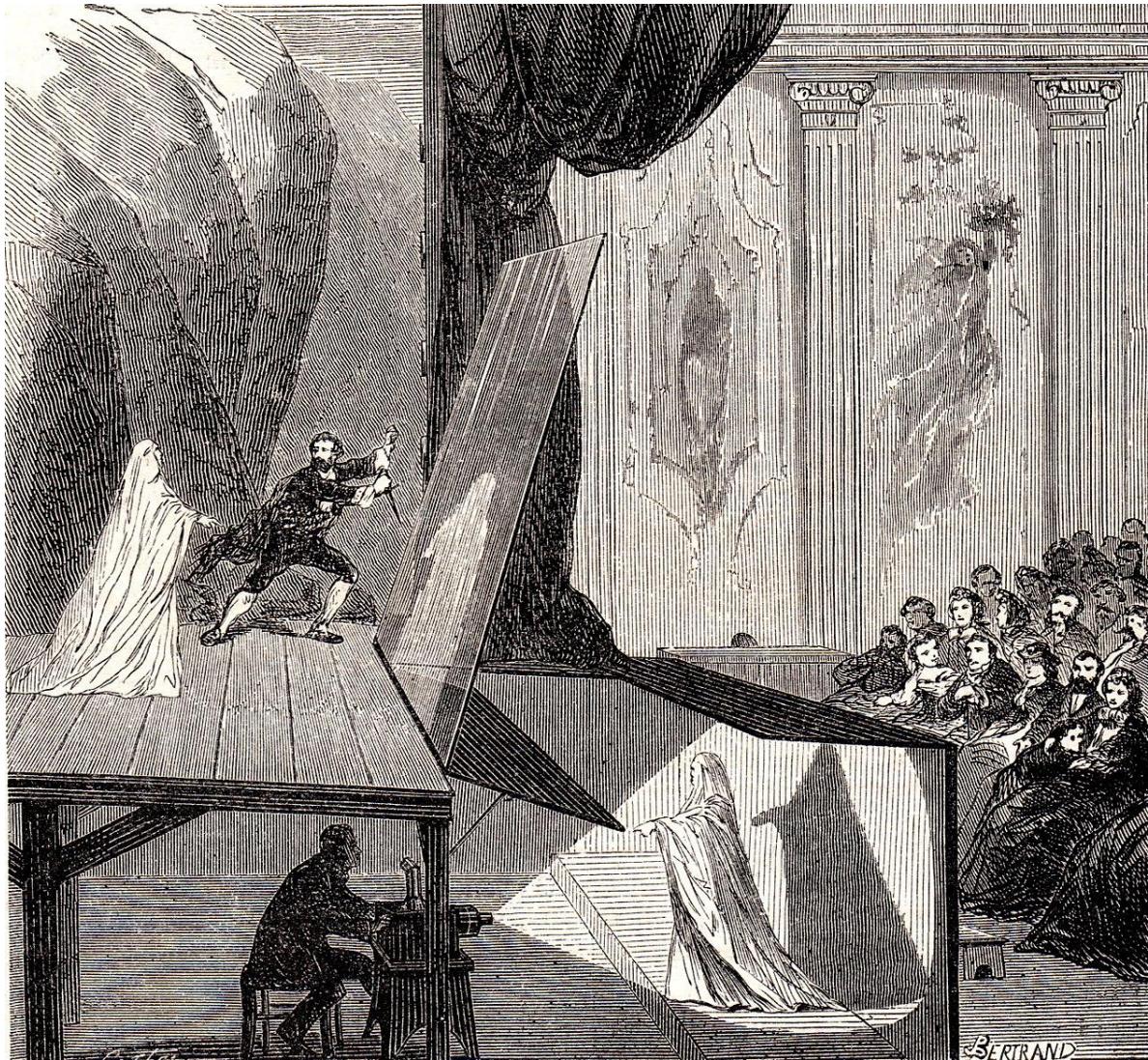
From Mark Billinghursts, Bruce Thomas, University of South Australia



History



History...VR and AR

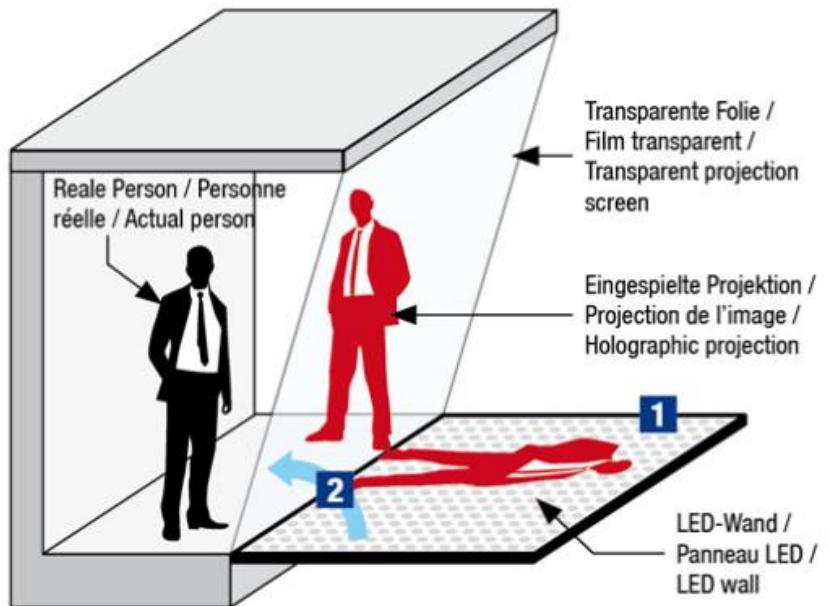


Pepper's Ghost 1862

History...VR and AR



The same technique



History...VR and AR

Stereoscopes

Wheatstone, Brewster, ...



1838

VR, AR,
Ivan Sutherland



1968

VR explosion

Oculus, Sony, Valve, MS, ...

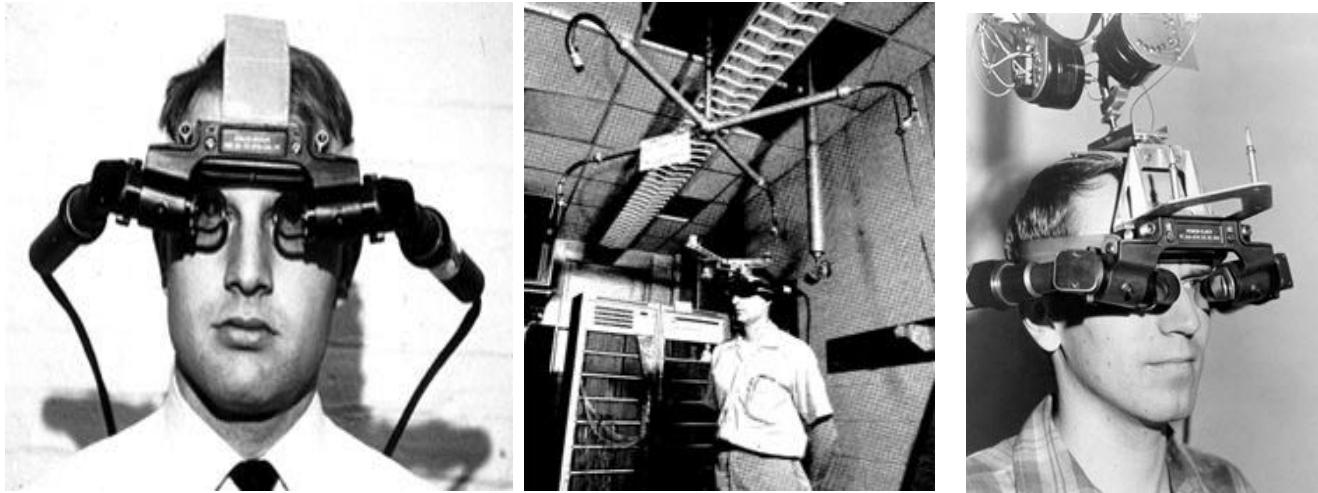


2012-2016

AR Displays

History...VR and AR

Sword of Damocles (1968)

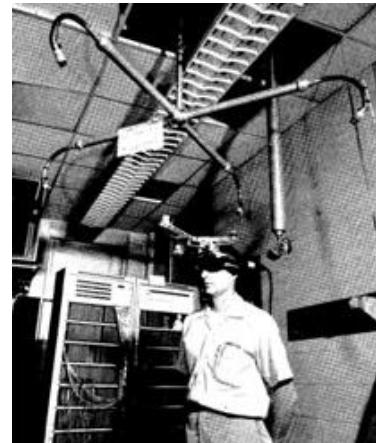


Ivan Sutherland (University of Utah)

History...VR and AR

Sword of Damocles (1968)

*Do not think of that thing
as a screen,
think of it as a **window**, a
window through
which to look in a virtual
world*

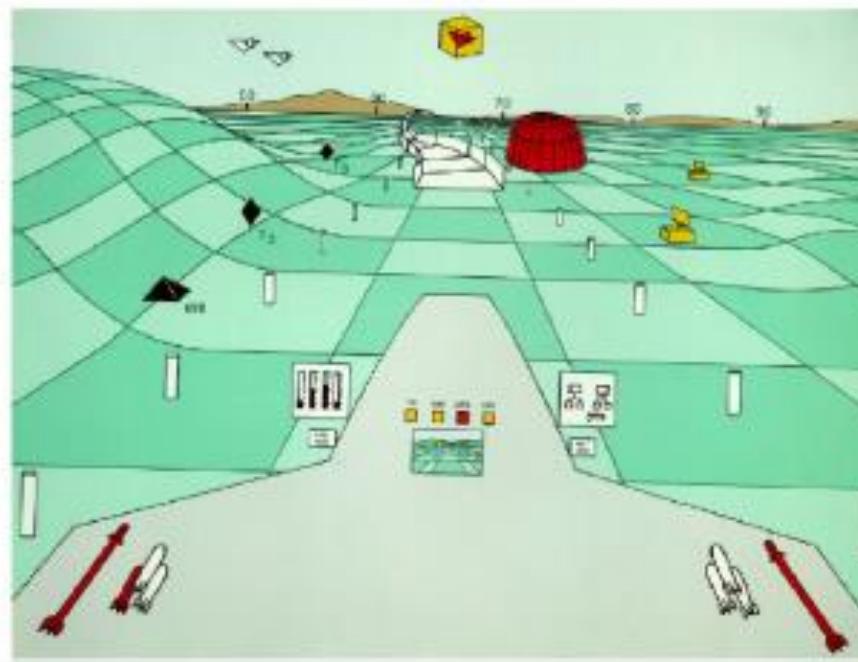


Ivan Sutherland
(University of Utah)

*With an appropriate
programming such a
system could literally
be the wonderland
where Alice walked!*

History...VR and AR

The US Air Force Super Cockpit system '86



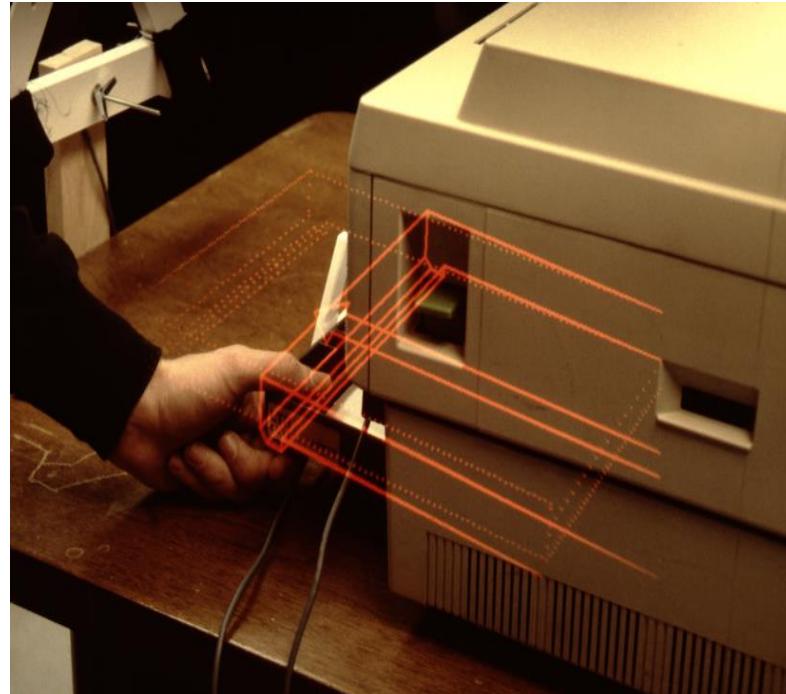
History...VR and AR

Boeing (1992) AR for
maintainance



History...VR and AR

KARMA (1993) AR for maintenance



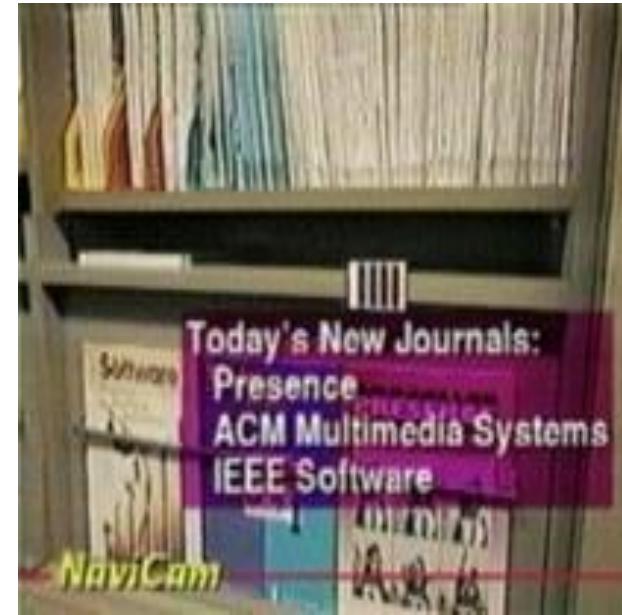
History...VR and AR

UNC Ultrasound Pregnancy Visualization (1994)



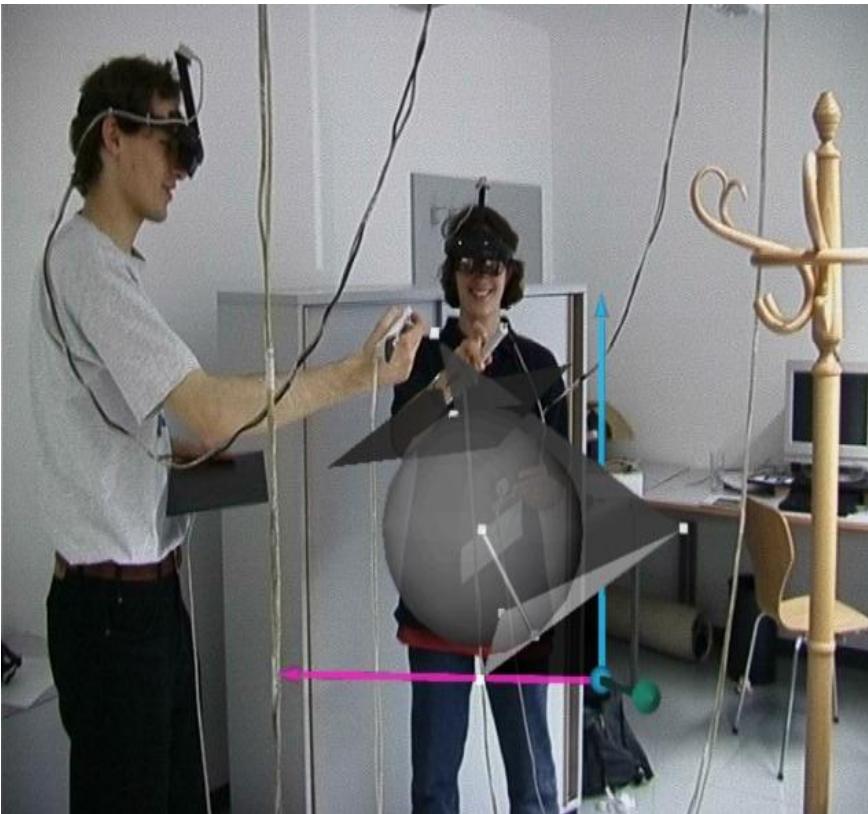
History...VR and AR

The NaviCam (Handheld AR (1996))



History...VR and AR

Studierstube – Collaborative AR (1996)



History...VR and AR

- HITLab ARToolKit (1999)
- ARToolKit is still used





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ROBOTICA E INGEGNERIA DEI SISTEMI

Today

AR and VR: devices



Microsoft HoloLens (2016)

- Dedicated HW
- Optical see-through display
- Wearable PC
- Many sensors
- INDUSTRIAL STANDARD!**



Oculus Rift and HTC Vive



+



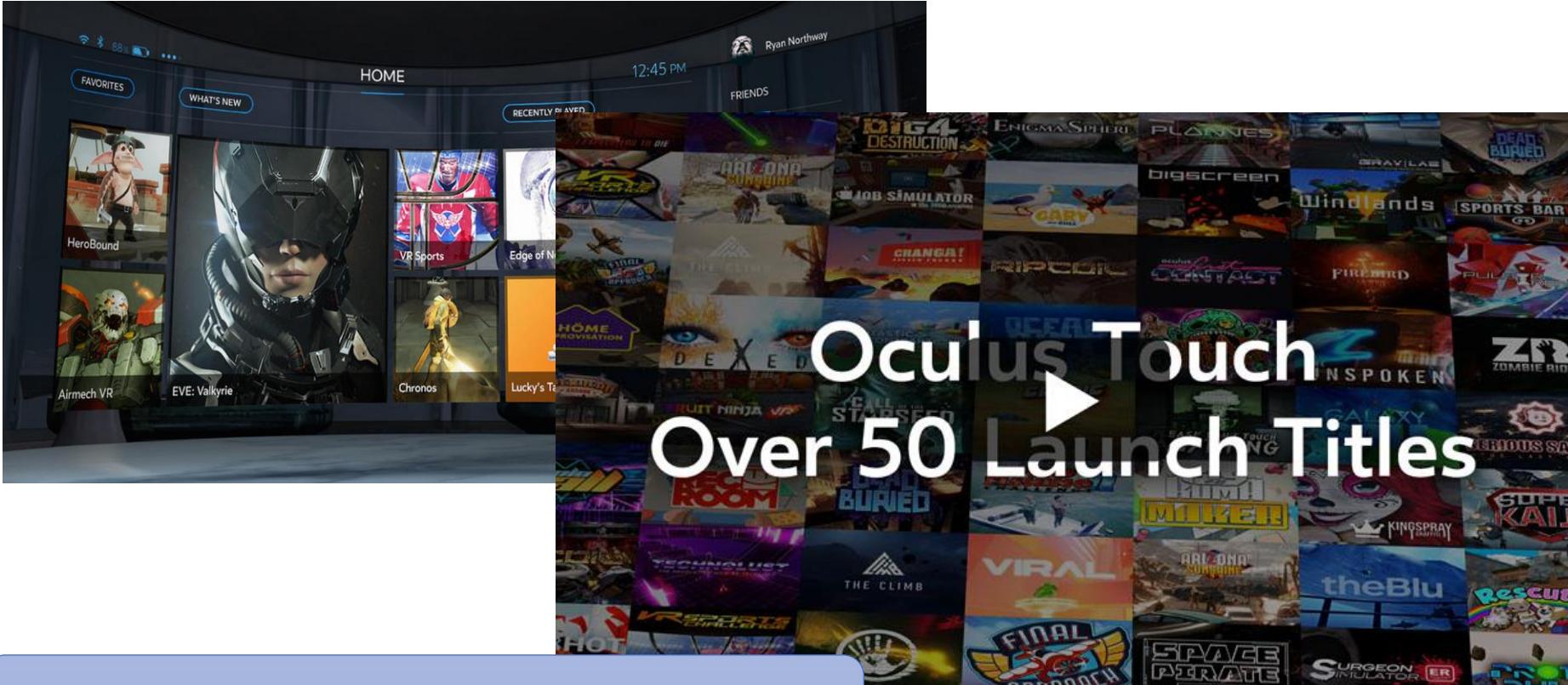
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Meta Quest 3 and Apple Vision Pro

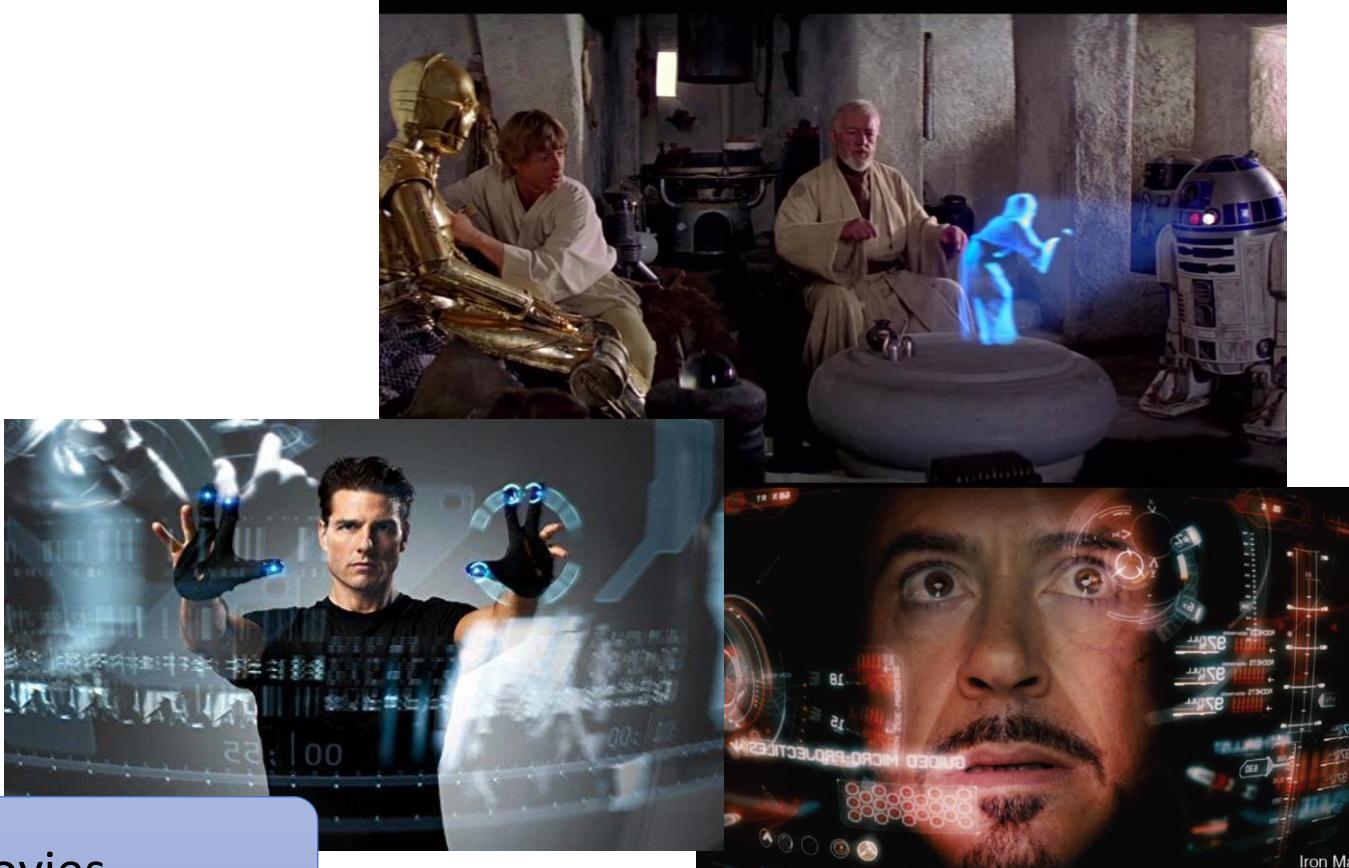


VR: software



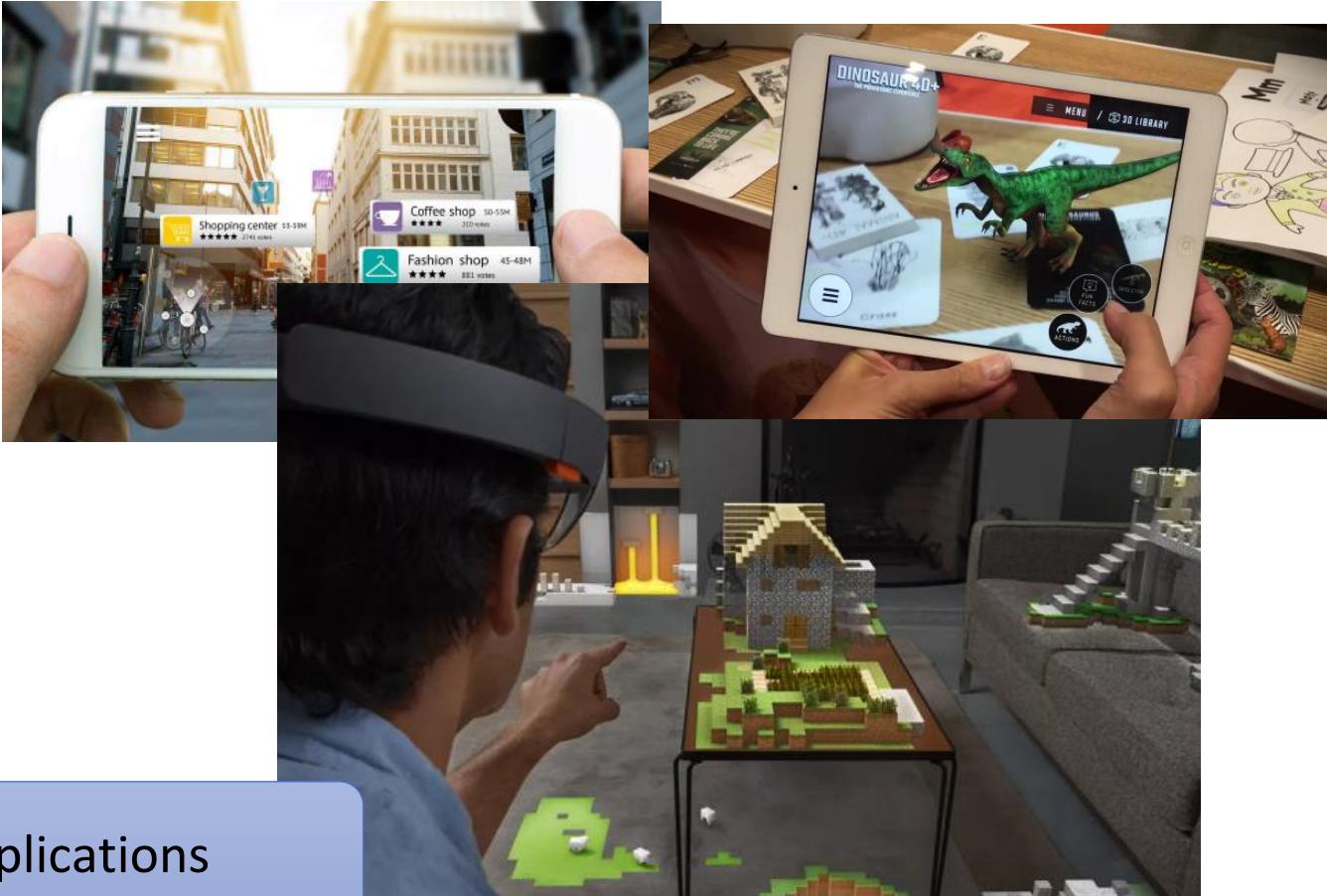
Videogames/entertainment/media

AR: software



Movies

AR: software

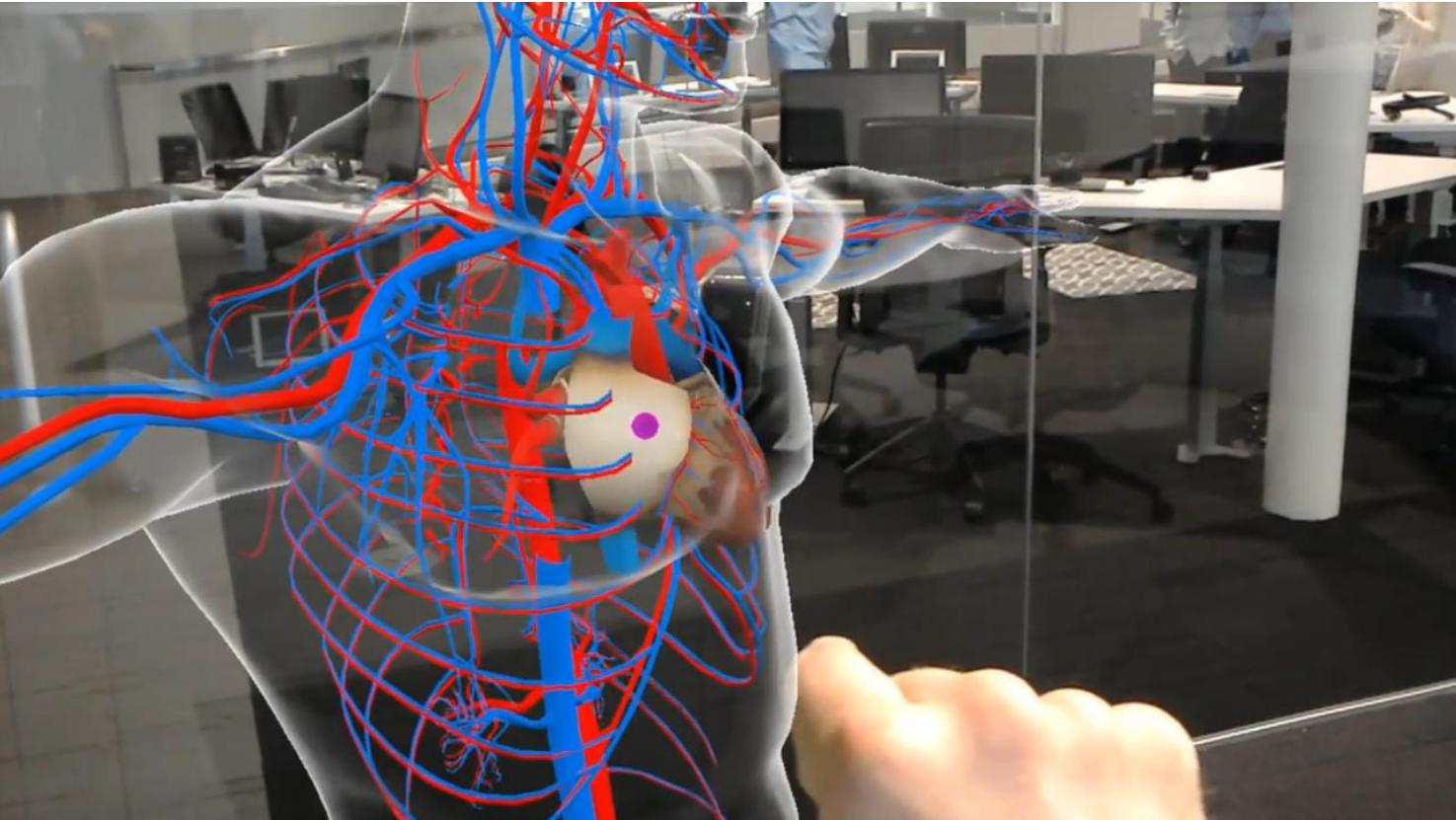


VR: industrial applications



- Virtual Reality for maintenance
- Mechatraining LLC - <https://www.youtube.com/watch?v=dq2RSlsIQcU>

AR: visualization applications



- Transforming Medical Education with Microsoft HoloLens - Case Western Reserve University
- <https://www.youtube.com/watch?v=h4M6BTYRlKQ&t=46s>

VR: rehabilitation applications

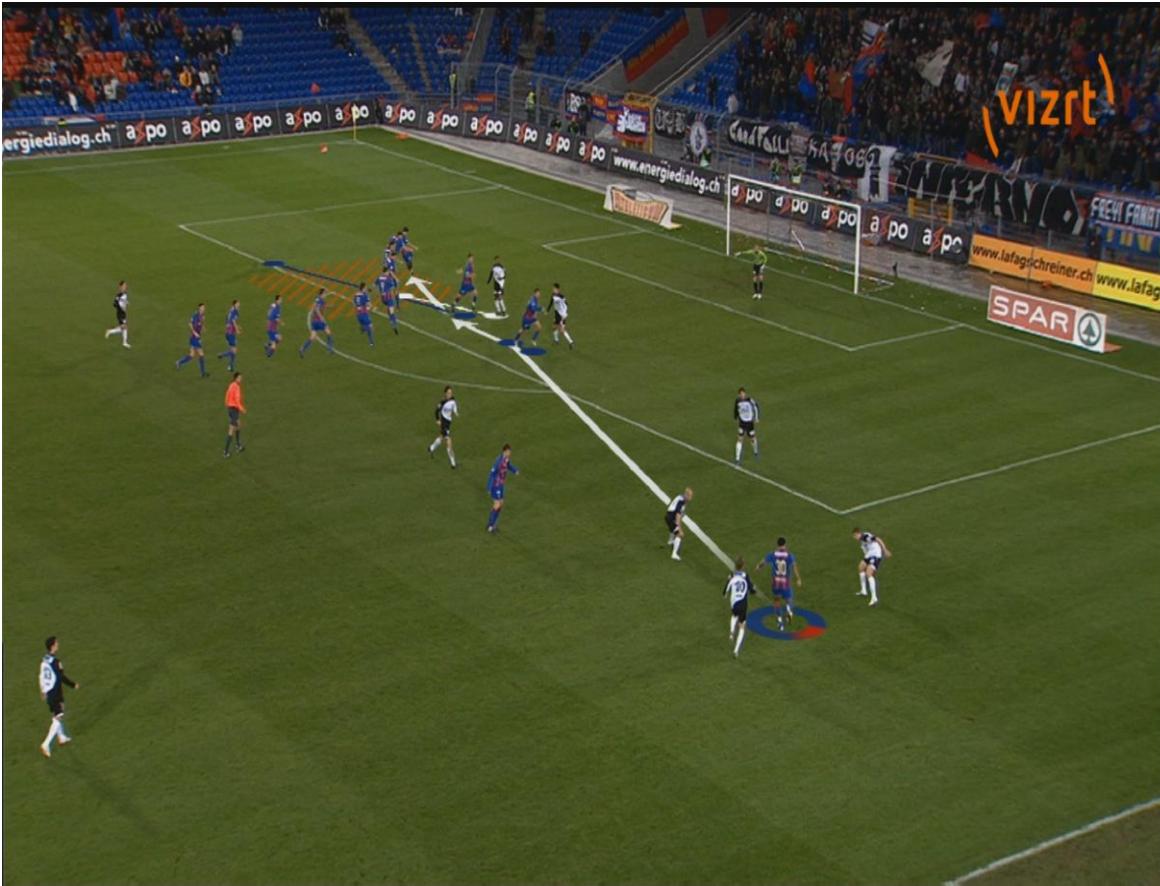


- Virtual Reality-based stroke rehabilitation – Gleechi
- <https://www.youtube.com/watch?v=PCfiAA84Yhs>

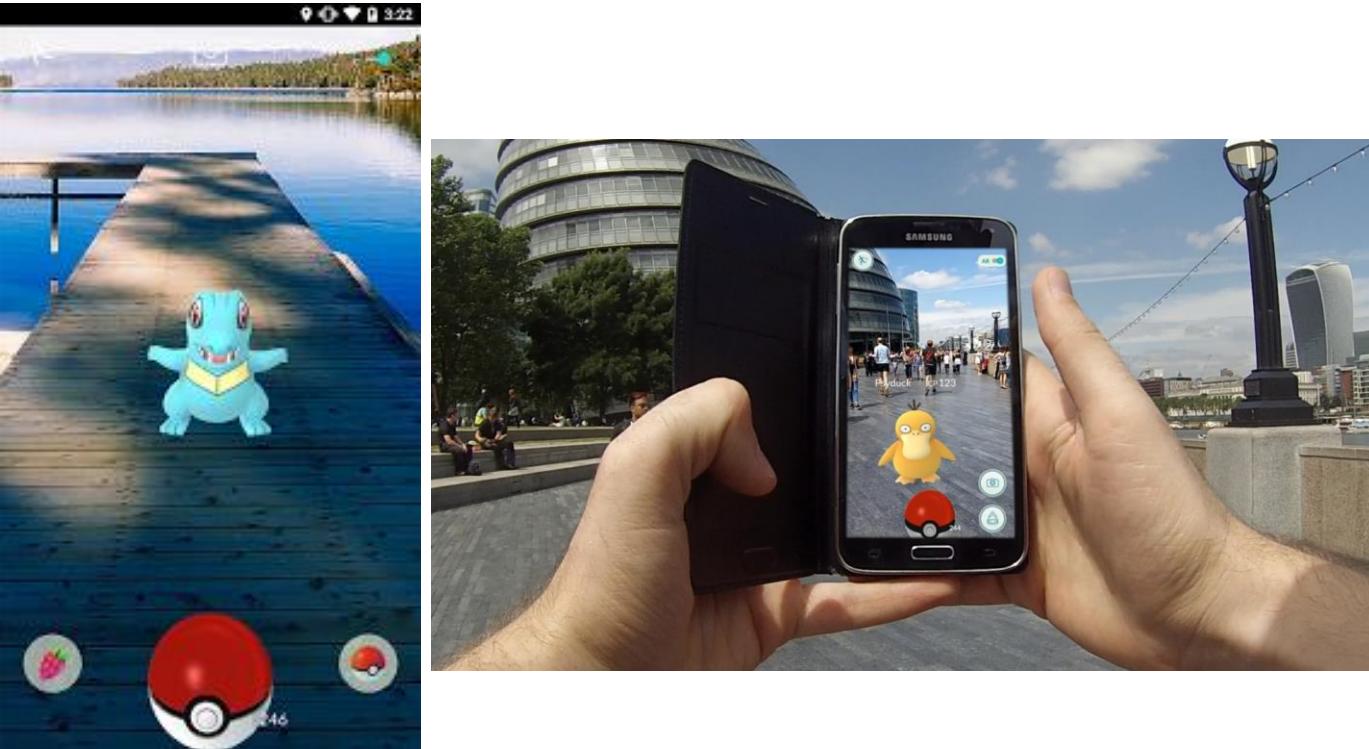
AR: everyday applications



AR: everyday applications



AR: everyday applications (gaming)



AR: everyday applications



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