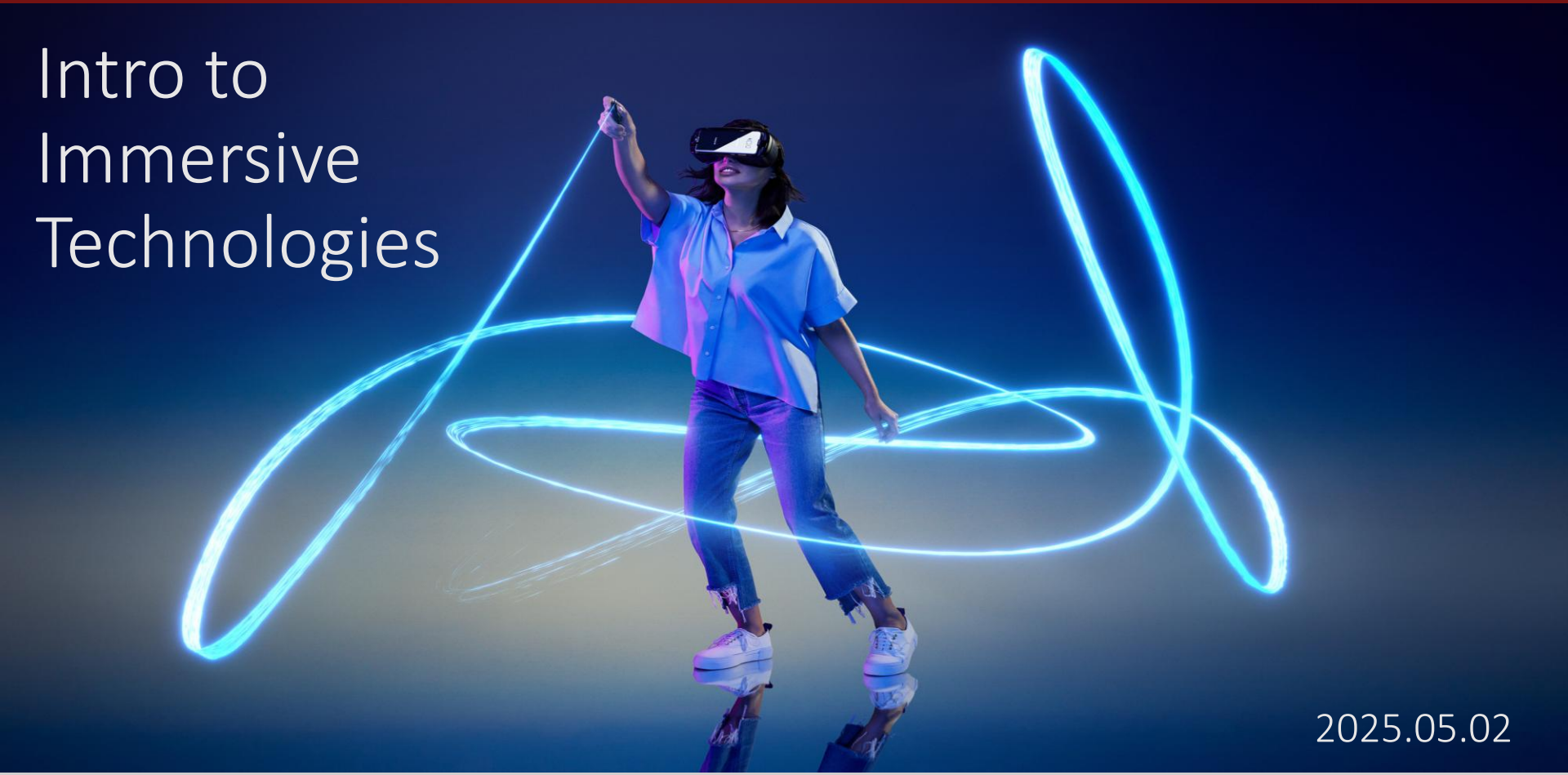
AUEB COMPUTER GRAPHICS GROUP

Intro to Immersive Technologies



2025.05.02

ImmTech – Quote

“When virtual reality gets cheaper than dating, society is doomed.”

- Scott Adams, Cartoonist

About the Instructor

Personal Information

- **1983,** *born in Corfu*
- **2001-2014,** *study in Ioannina*
- **2014-Now,** *live in Athens*

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- **Postdoctoral Researcher,** *AUEB Computer Graphics Group (2019 - now)*
- **Adjunct Professor,** *Informatics, AUEB (5 years)*
  - Interaction Design & Multimedia | C++ | Parallel Programming
- **Adjunct Professor,** *Computer Science & Engineering, Ioannina (2 years)*
  - Advanced Computer Graphics | VR, AR & MR

About the Instructor

Contact Information

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- **Email:** *abasilak@aueb.gr*, *andreas.alex.vasilakis@gmail.com*, *MS Teams*
- **Skype, Github, Twitter, LinkedIn:** *abasilak*

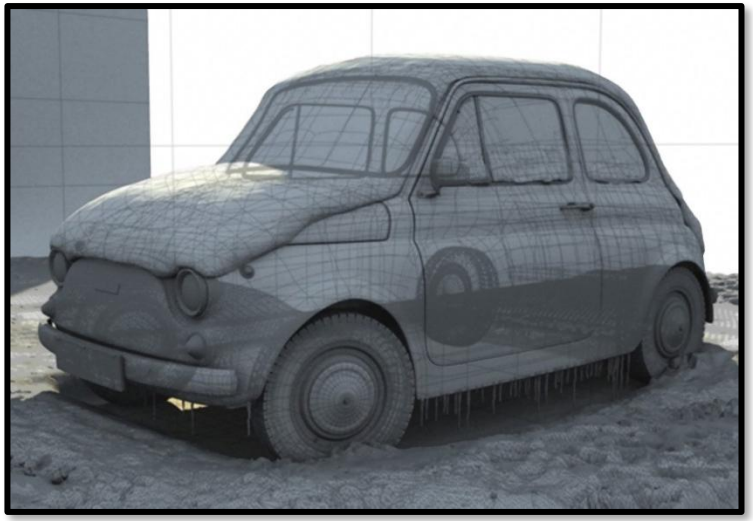
What is Real?

What is Real?

*Images credit: *Rikk the Gaijin, model sculpted in Zbrush & rendered in Octane*

Image Synthesis

3D



2D

*Images credit: *"Graphics and Visualization: Principles & Algorithms" Book Material*

Immersive Technology

Definition: *“Any technology that **extends** reality or **creates** a new one* by leveraging the **360º space.**”

Immersive Technology

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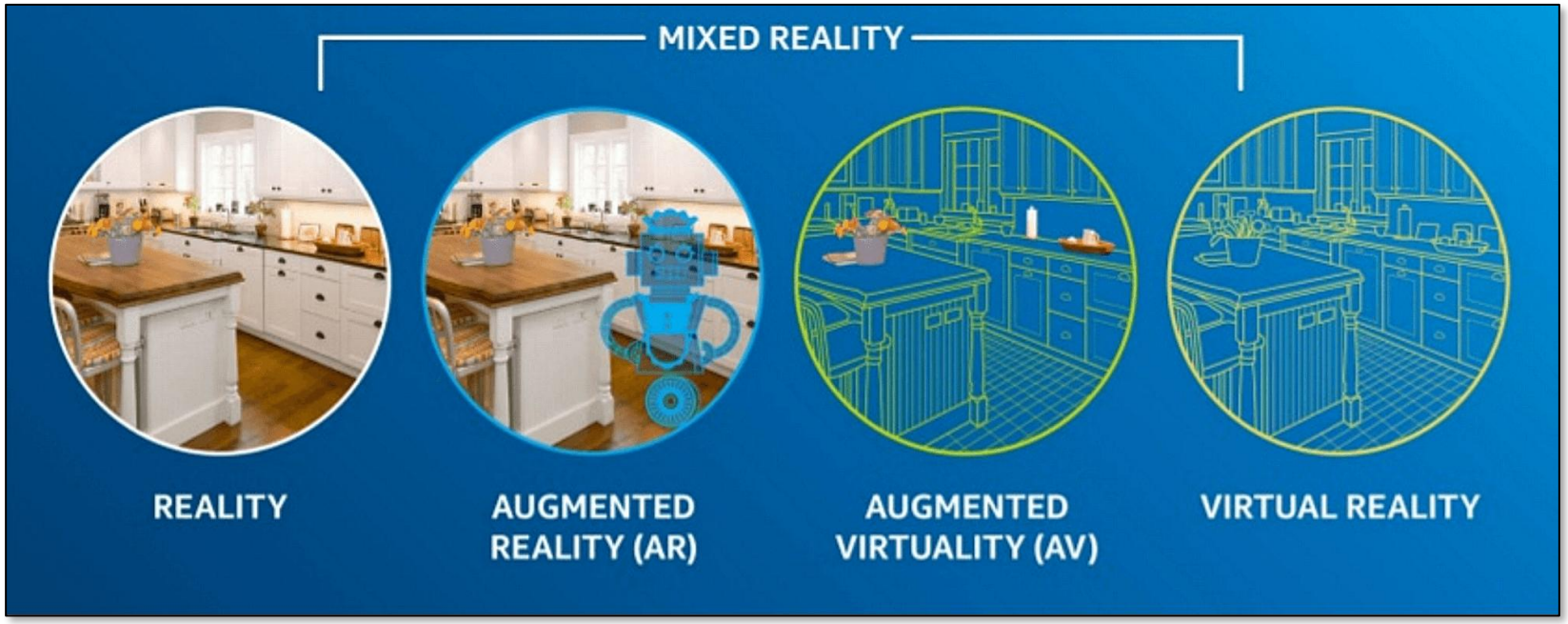


Source: Milgram & Kishino. A taxonomy of Mixed Reality Visual Displays. IEEE TIS, 77(12), 1994.

Immersion vs Presence

Immersion

- perception of being physically present in a non-physical world
- cut off from the natural environment

Immersion vs Presence

Immersion

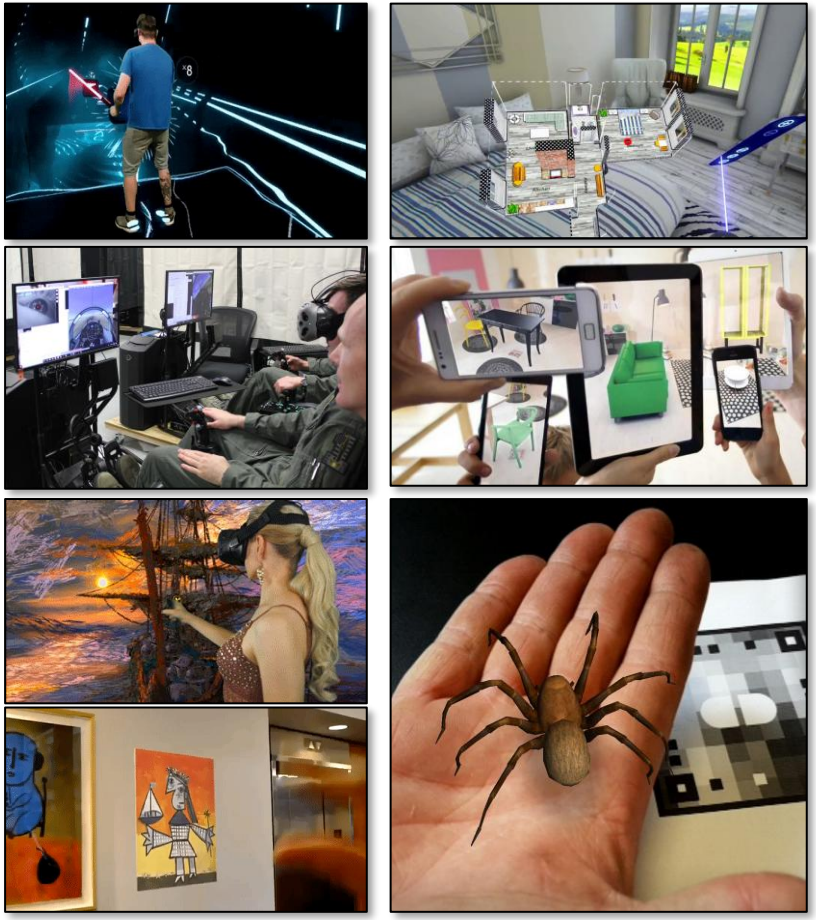
- perception of being physically present in a non-physical world
- cut off from the natural environment

Presence

- sense of natural feeling like being in a physical world

Applications

- Entertainment
  - Games, Cinema
- Architecture & Urban Design
- Digital marketing
- Training & Education
  - Flight, Military, Space
- Healthcare
  - Phobias, anxiety disorders
- Modelling & Design
- Art

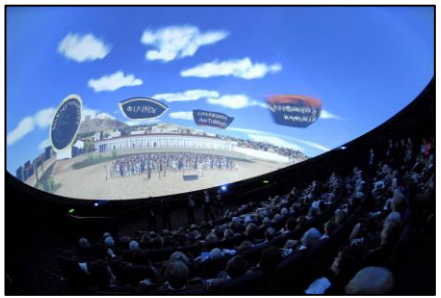


XR-related Industry in Greece

- OramaVR (Medical Surgery Training)

- Lightbuzz (Motion Tracking for XR apps)

- Foundation of the Hellenic World, Diadrasi, Moptil, Nousvr, ViRA (Cultural Heritage)



XR-related Industry in Greece

- Magos (VR gloves)

- Dataverse (VR/AR apps)

XR-related Industry in Greece

- ArtSteps (Metaverse)

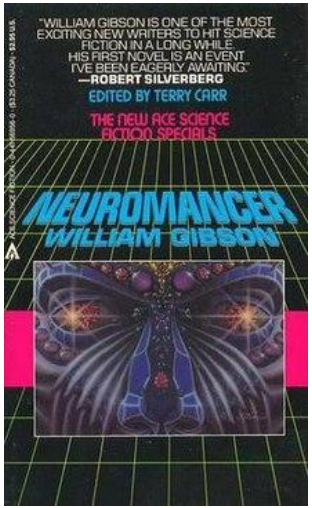
- Smartify (AR in Art Museums)

- BETA CAE (VR collaboration/AR exhibitions)

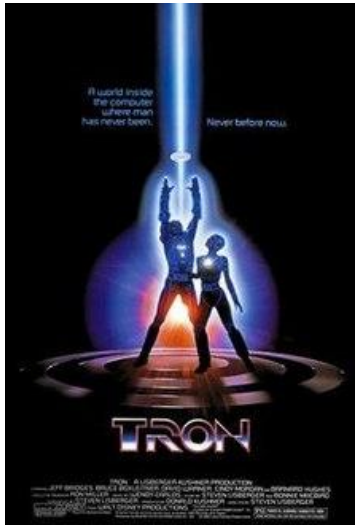
XR-related Industry in Greece

- Phasmatic (3D/VR/AR)

Science Fiction



Books



Movies

Contradictory Definition

Virtual Reality

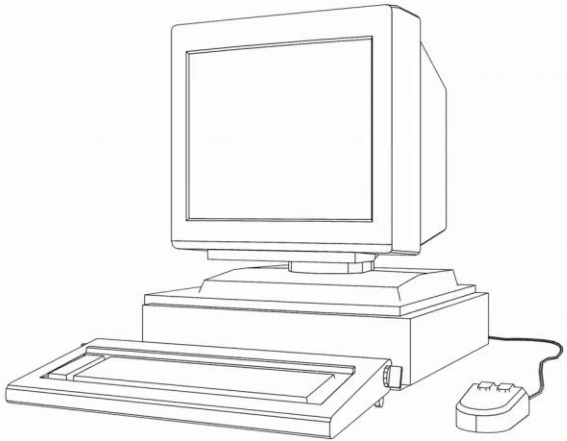
The Ultimate Display

"The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal".

Ivan Sutherland, 1965

https://www.wired.com/2009/09/augmented-reality-the-ultimate-display-by-ivan-sutherland-1965/

The Incredible Disappearing Computer



1960-70's
Room

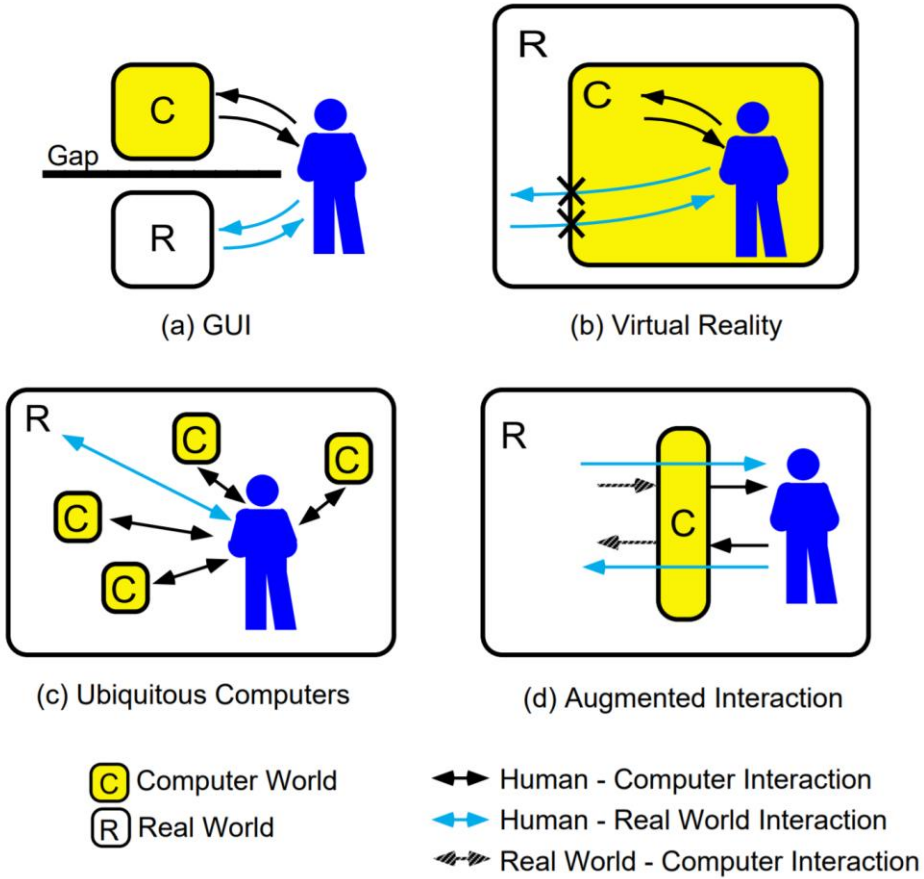
1970-80's
Desk

1980-90's
Lap

1990-2000's
Hand

https://www.theverge.com/2017/5/25/15686870/walt-mossberg-final-column-the-disappearing-computer

Making Interfaces Invisible

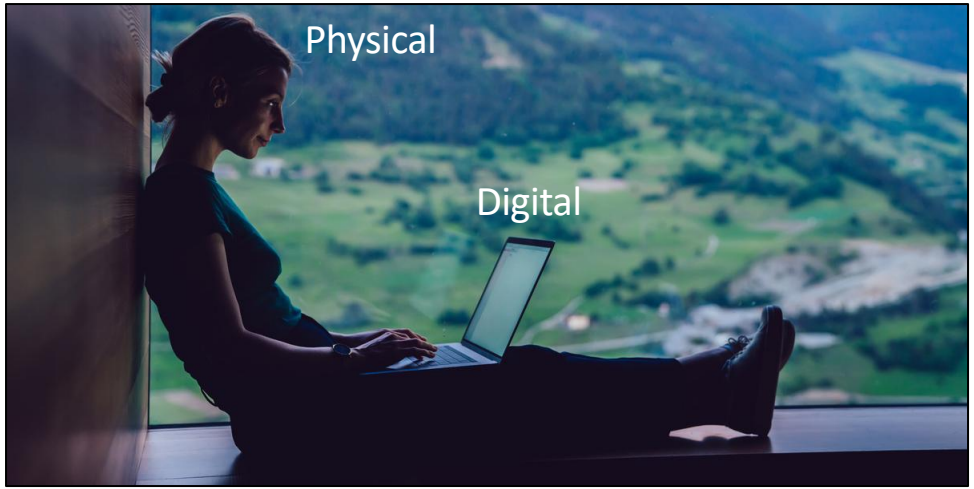


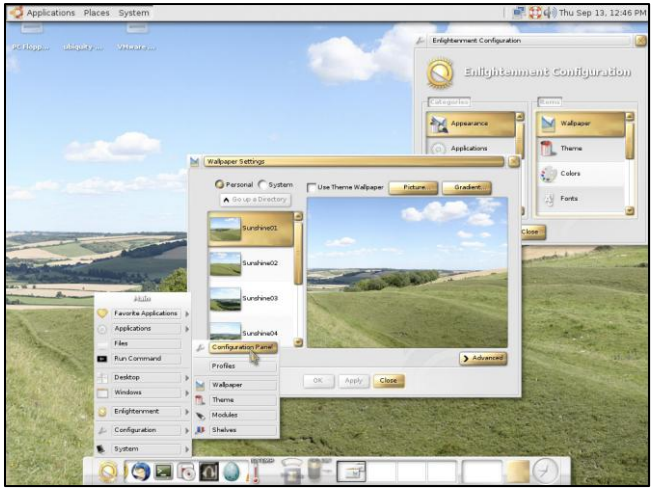
Rekimoto, Nagao, 1995.

The world through the computer: computer augmented interaction with real world environments.

In *Proceedings of the 8th Annual ACM Symposium on User interface and Software Technology. UIST '95*. ACM, New York, NY, 29-36.

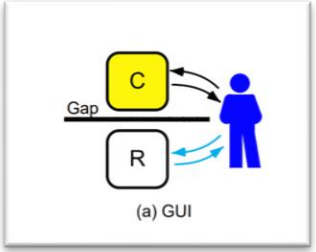
Graphical User Interfaces



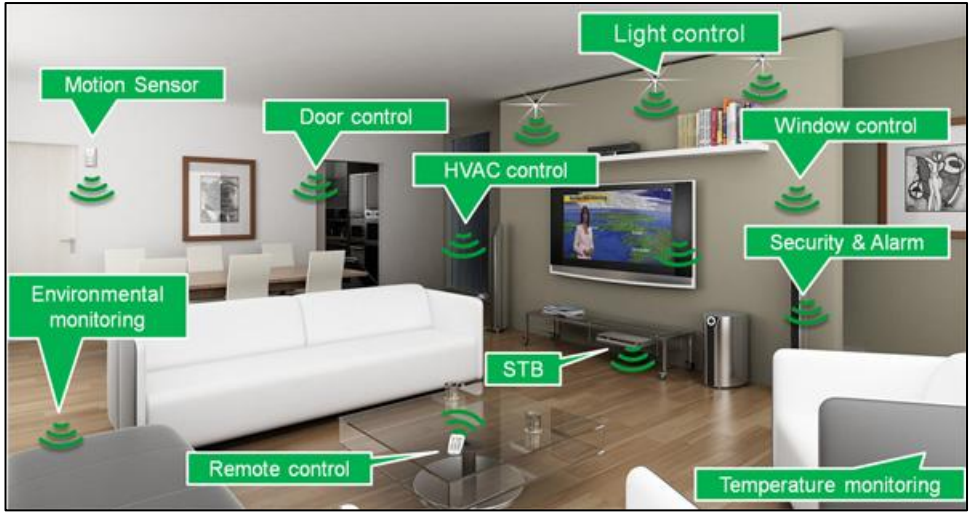


- Separation between real and digital worlds

- WIMP (Windows, Icons, Menus, Pointer) metaphor

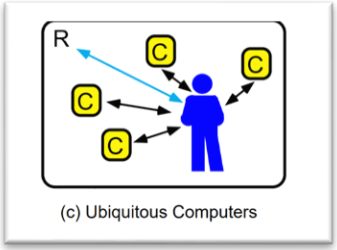


Ubiquitous Computing/IoT

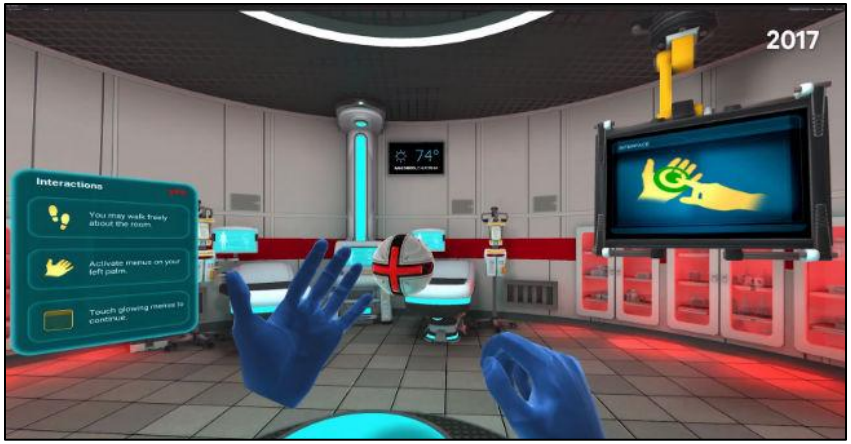


- Embed computing and sensing in real world

- Smart objects, sensors, etc.

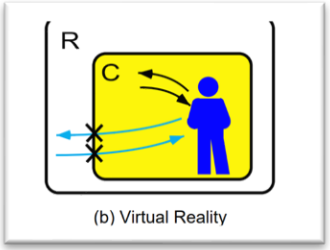


Virtual Reality (VR)



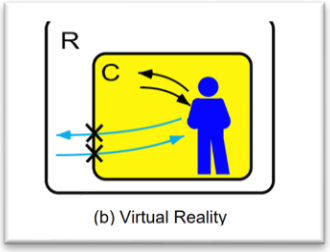
- Users immersed in Computer Generated environment

- HMD, gloves, 3D graphics, body tracking



Typical VR System

https://youtu.be/eJCiyf8Kn9w



What is Virtual Reality?

Merriam-Webster SINCE 1828

GAMES | BROWSE THESAURUS | WORD OF THE DAY | WORDS AT PLAY

virtual reality

Dictionary | Thesaurus

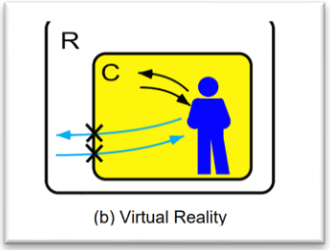
virtual reality noun

Save Word

Definition of *virtual reality*

: an artificial environment which is experienced through sensory stimuli (such as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment

also **:** the technology used to create or access a virtual reality



(b) Virtual Reality

What is Virtual Reality?

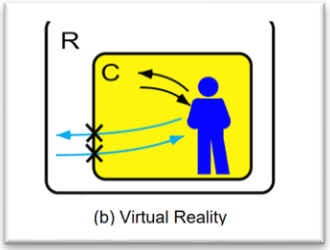
Virtual reality is..

a computer technology that replicates an environment, real or imagined, and simulates a user's physical presence and environment to allow for user interaction. (**Wikipedia**)

electronic simulations of environments experienced via head mounted eye goggles and wired clothing enabling the end user to interact in realistic three-dimensional situations. (**Coates, 1992**)

an alternate world filled with computer-generated images that respond to human movements. (**Greenbaum, 1992**)

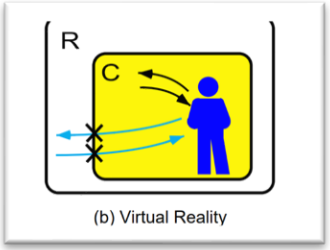
an interactive, immersive experience generated by a computer (**Pimental 1995**)



Key Tech Characteristics for VR

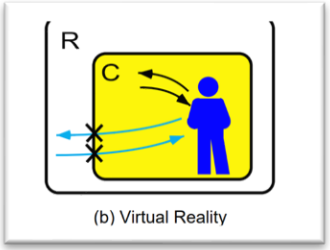
- Virtual Reality has three Key Technological Characteristics
  - 3D stereoscopic display
  - Wide field of view display
  - Low latency (head) tracking

- When these three things are combined, they provide a compelling immersive experience



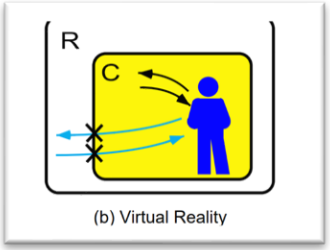
Key Tech Characteristics for VR

https://youtu.be/FPcbBJbGhmk



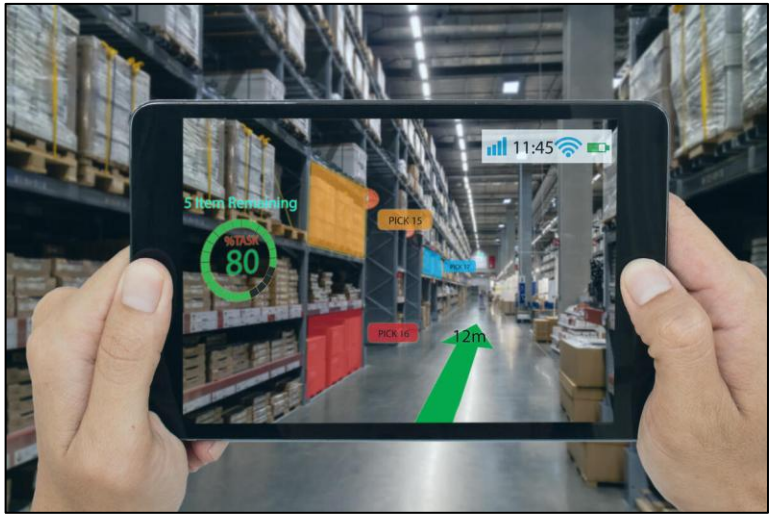
VR User Experience

https://youtu.be/pAC5SeNH8jw



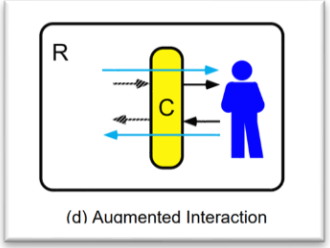
- "This is so real…"

Augmented Reality (AR)



- Virtual images blended with the real world.

- See-through HMD, handheld display, viewpoint tracking, etc..



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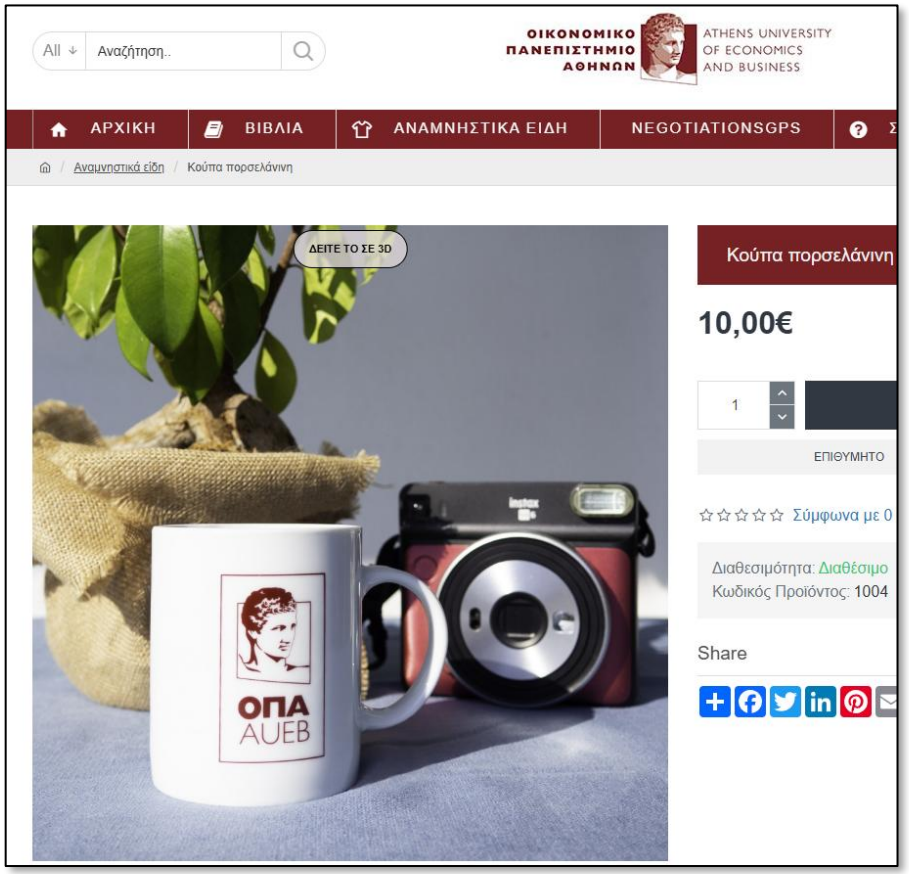
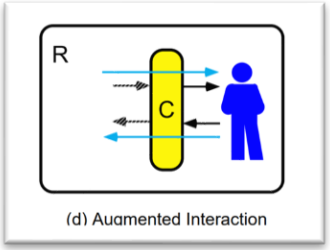


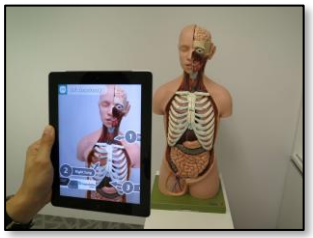
Enter @ AUEB STORE

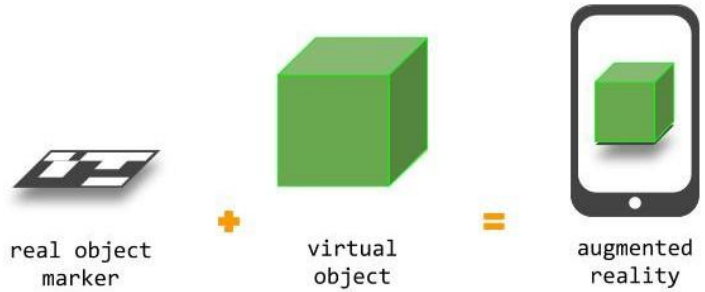
https://www.shop.aueb.gr/

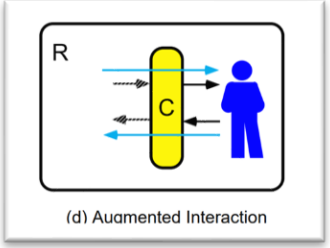


Augmented Reality Definition

- Combines Real and Virtual Images
  - Both can be seen at the same time
- Interactive in real-time
  - The virtual content can be interacted with
- Registered in 3D
  - Virtual objects appear fixed in space

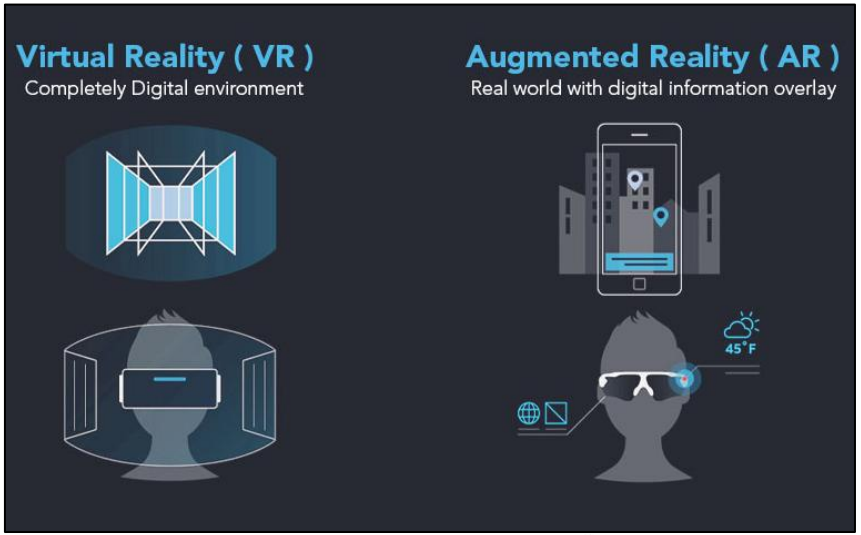






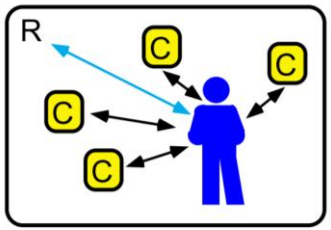
Azuma, R. T. (1997). A survey of augmented reality. Presence, 6(4), 355-385.

Virtual vs Augmented Reality

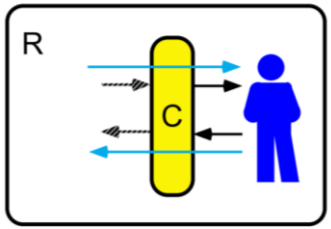


	Virtual Reality *Replaces Reality*	**Augmented Reality** *Enhances Reality*
Scene Generation	Requires realistic images	Minimal rendering okay
Display Device	Fully immersive, wide field of view	Non-immersive, small field of view
Tracking	Low to medium accuracy is okay	The highest accuracy possible

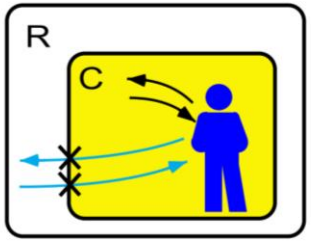
From Reality to Virtual Reality



(c) Ubiquitous Computers



(d) Augmented Interaction

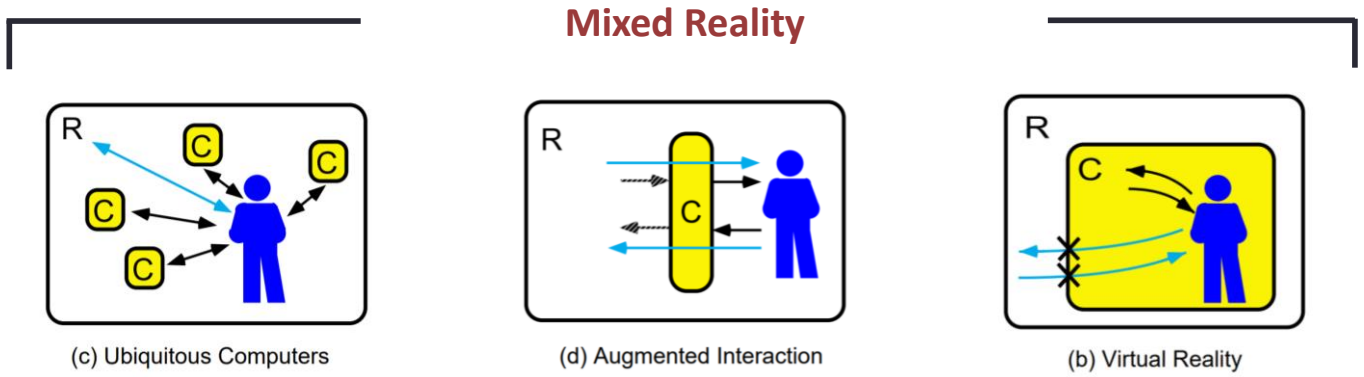


(b) Virtual Reality

Real World

Virtual World

Milgram's Mixed Reality Continuum



"...anywhere between the extrema of the virtuality continuum."

P. Milgram and A. F. Kishino, (1994). A Taxonomy of Mixed Reality Visual Displays.

Augmented Virtuality (AV)

“Enhancing the virtual world by objects of the real world”

https://youtu.be/ZkBQbDQiRUg

Diminished Reality (DR)

“removing perceivable stimuli from the real world”

https://youtu.be/aBf0NGGCMOk

Mixed Reality (MR)

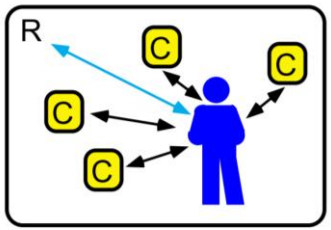
“Any combination of real and virtual environment”

https://youtu.be/3o1orHS3w5A

Impact on the physical environment must adapt to the virtual !!!

Extended Reality (XR)

Extended Reality



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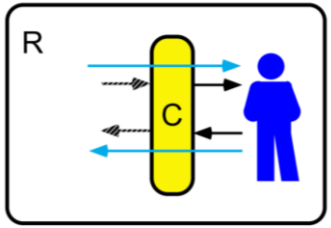

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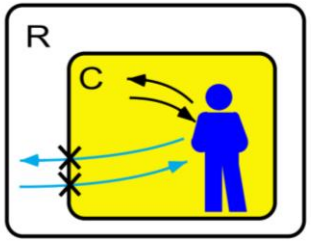


(b) Virtual Reality

Real World

Virtual World

ImmTech – Virtual Reality Concerns

- Motion or **VR sickness**
  - Inconsistence between sensory input (aural, motor, visual) leads to disorientation and nausea
  - Display latency also contributes to this
  - Involuntary or/and unnatural motion conflicts with our motion prediction

ImmTech – Virtual Reality Concerns

- Motion or **VR sickness**
  - Inconsistence between sensory input (aural, motor, visual) leads to disorientation and nausea
  - Display latency also contributes to this
  - Involuntary or/and unnatural motion conflicts with our motion prediction
- **Natural interfacing** is not easy to achieve
  - Sometimes it is preferable to avoid “natural” interfaces (and lose some immersion) to improve ergonomics
  - Many tasks harder than the desktop interaction paradigm (flat surface constraints more reassuring and precise, fewer DoF)

ImmTech – IxD Goals (Reminder*)

- Performance
  - Efficiency, accuracy, productivity
- Usability
  - Ease of use, of learning, user comfort
- Usefulness
  - Users focus on tasks
  - Interaction helps users meet them

ImmTech – Is 3D Interaction Difficult?

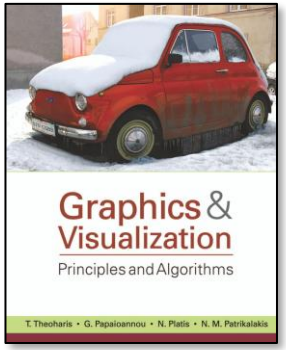
- Spatial input
- Lack of constrains
- Lack of precision
- Layout more complex
- Fatigue

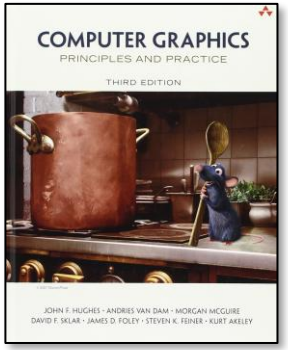
ImmTech – Summary

- Definition
- Reality–Virtuality Continuum
- Technology Types
- Concerns and Challenges
- Applications
- 3D Interaction Design

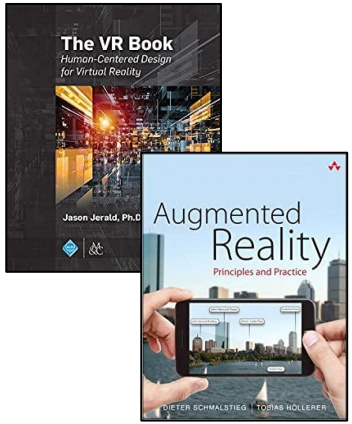
Suggested Reading

- Greek:
  - Γραφικά και Οπτικοποίηση
  - Γραφικά και Εικονική Πραγματικότητα



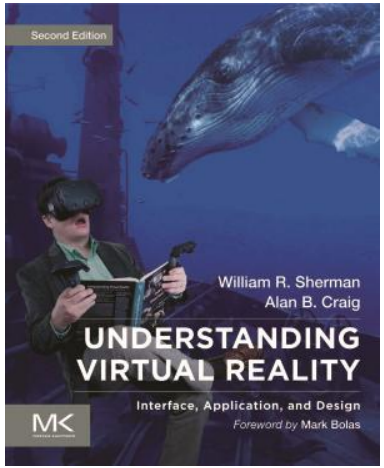


- Foreign:
  - Virtual Reality (free online version)
  - 3D User Interfaces: Theory and Practice
  - The VR Book: Human-Centered Design for Virtual Reality
  - Augmented Reality: Principles and Practice

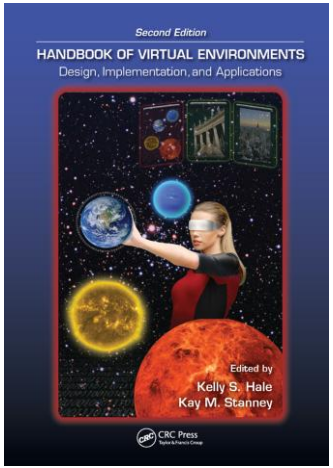


Further Resources

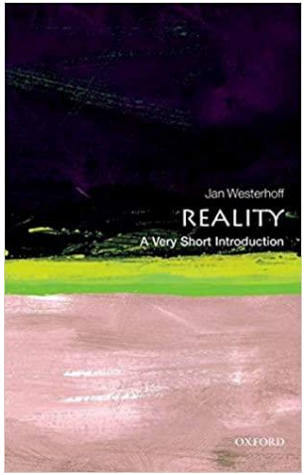
- Extra Reading



Understanding Virtual Reality

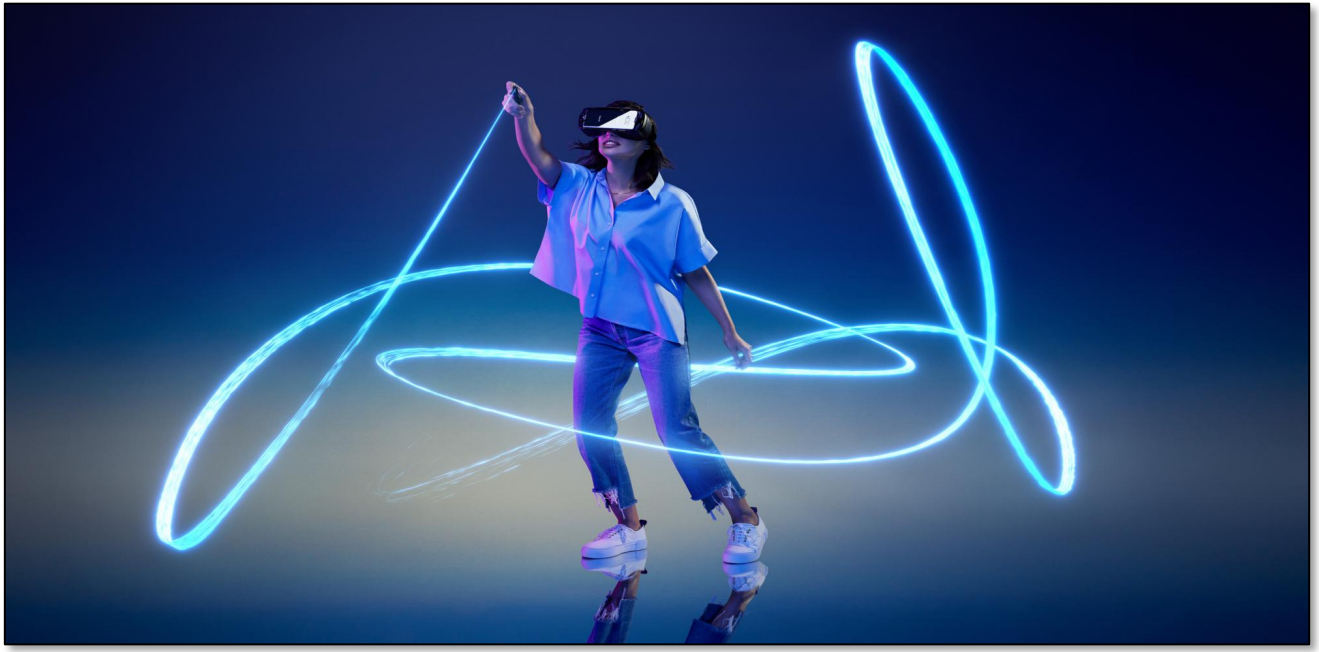


Handbook on Virtual Environments



Reality: A Very Short Introduction

Q/A



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