ARVR交互设计工作坊

Teaching Team

Lecturer

- Yuan Wang (Yuan.Wang@latrobe.edu.au)
- Background
  - Research Engineer, National University of Singapore
  - Research Engineer, University of Tasmania
  - Senior Software Engineer, Envisage AR Ltd
  - PhD in computer science, La Trobe University
  - Research area: interaction design, computer vision, 2D and 3D computer graphics, visualization display, virtual reality and augmented reality

WHAT IS AR/VR/MR/XR?

The Incredible Disappearing Computer

1960-70's

Room

1970-80's

Desk

1980-90's

Lap

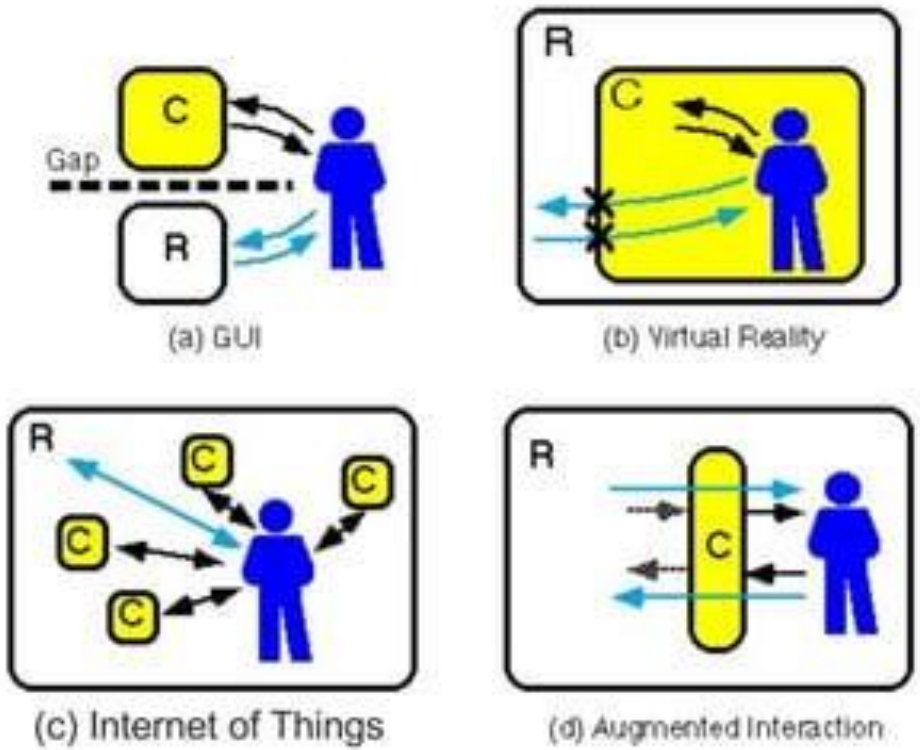
1990-2000's

Hand

2010 -

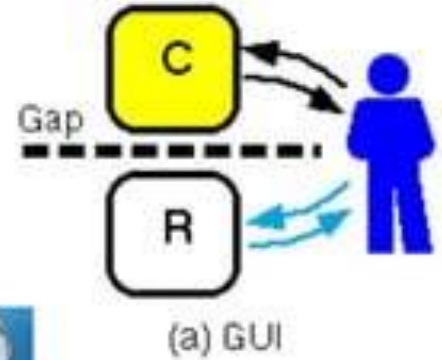
Head

Making Interfaces Invisible



Rekimoto, J. and Nagao, K. 1995. The world through the computer: computer augmented interaction with real world environments.

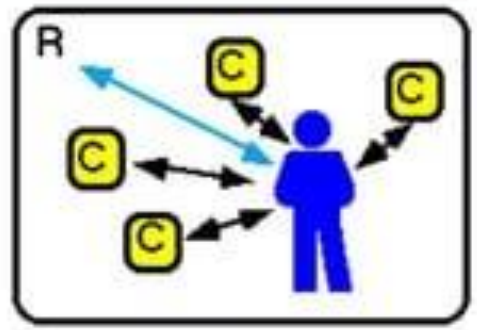
Graphical User Interfaces



(a) GUI

- Separation between real and digital worlds
  - WIMP (Windows, Icons, Menus, Pointer) metaphor

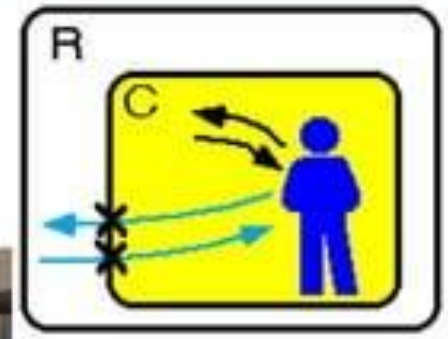
Internet of Things (IoT)..



(c) Internet of Things

- Embed computing and sensing in real world
  - Smart objects, sensors, etc..

Virtual Reality (VR)



(b) Virtual Reality

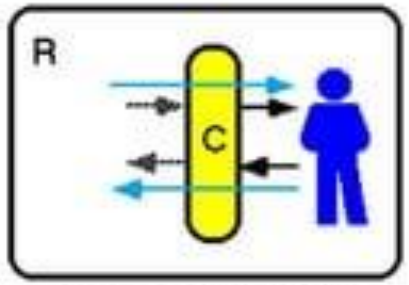
- Users immersed in Computer Generated environment
  - HMD, gloves, 3D graphics, body tracking

Virtual Reality Definition

- Defining Characteristics
  - Sense of Immersion
    - User feels immersed in computer generated space
  - Interactive in real-time
    - The virtual content can be interacted with
  - Independence
    - User can have independent view and reaction to environment

Types of VR

Augmented Reality (AR)



(d) Augmented Interaction

- Virtual Images blended with the real world
  - See-through HMD, handheld display, viewpoint tracking, etc..

Augmented Reality Definition

- Defining Characteristics [Azuma 97]
  - 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.

Strong vs. Weak AR

- Weak AR
  - Imprecise tracking
  - No knowledge of environment
  - Limited interactivity
  - Handheld AR
- Strong AR
  - Very accurate tracking
  - Seamless integration into real world
  - Natural interaction
  - Head mounted AR

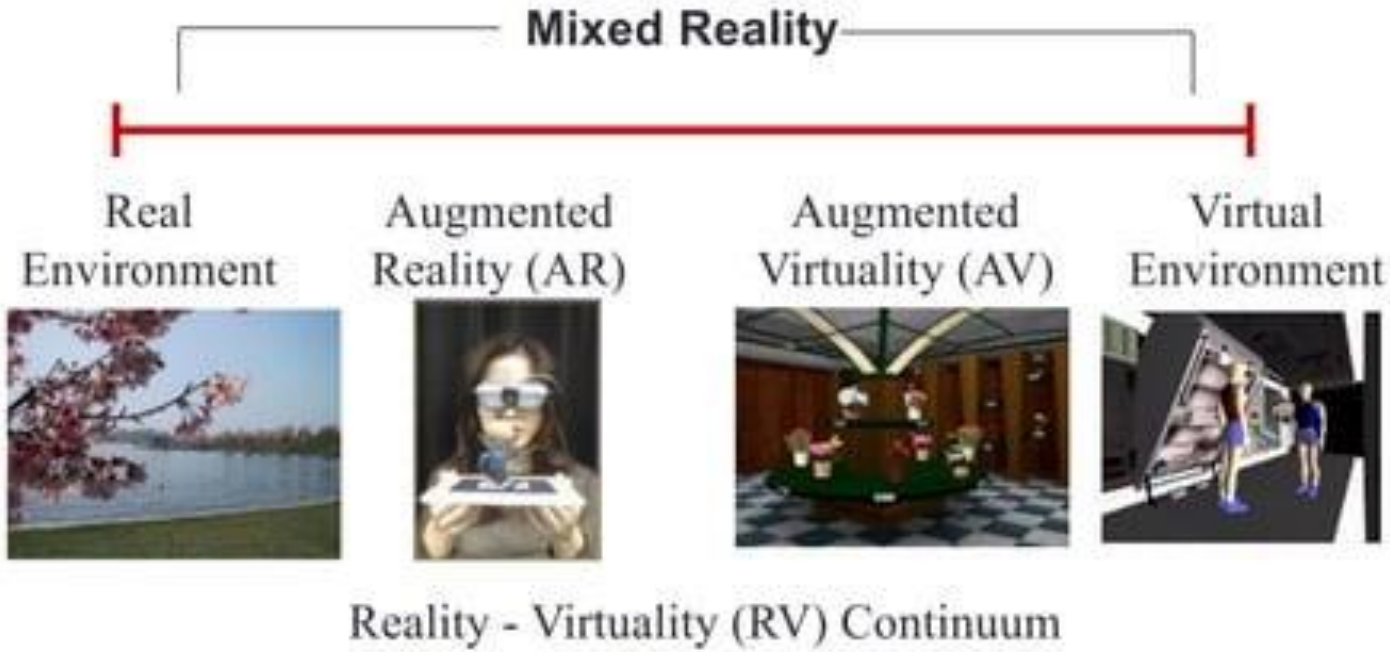
Augmented Reality Applications

AR vs VR

	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

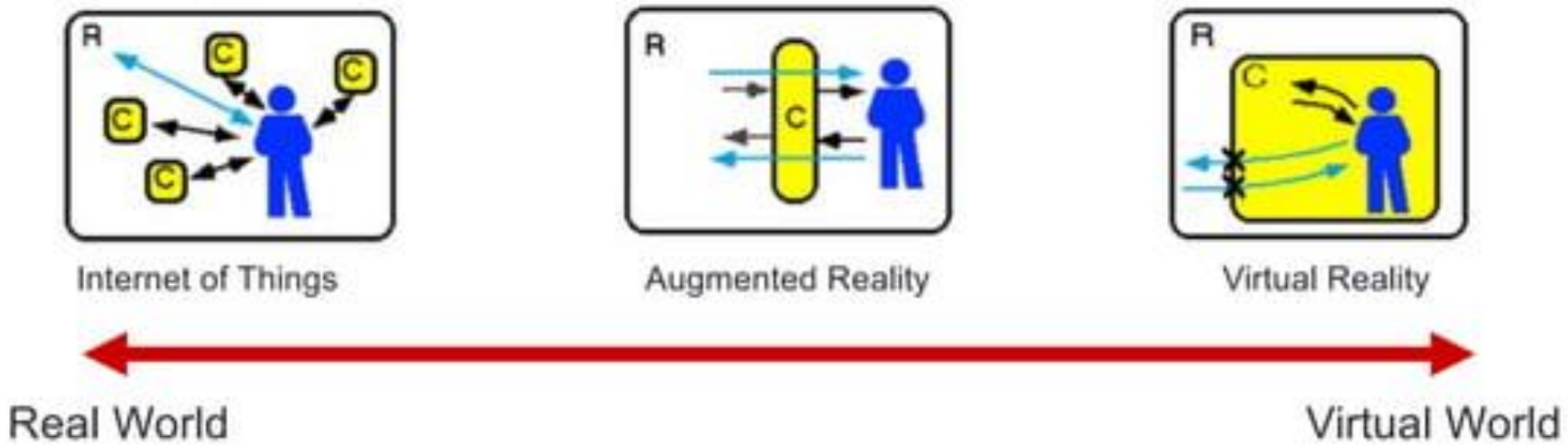
Milgram's Reality-Virtuality continuum

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

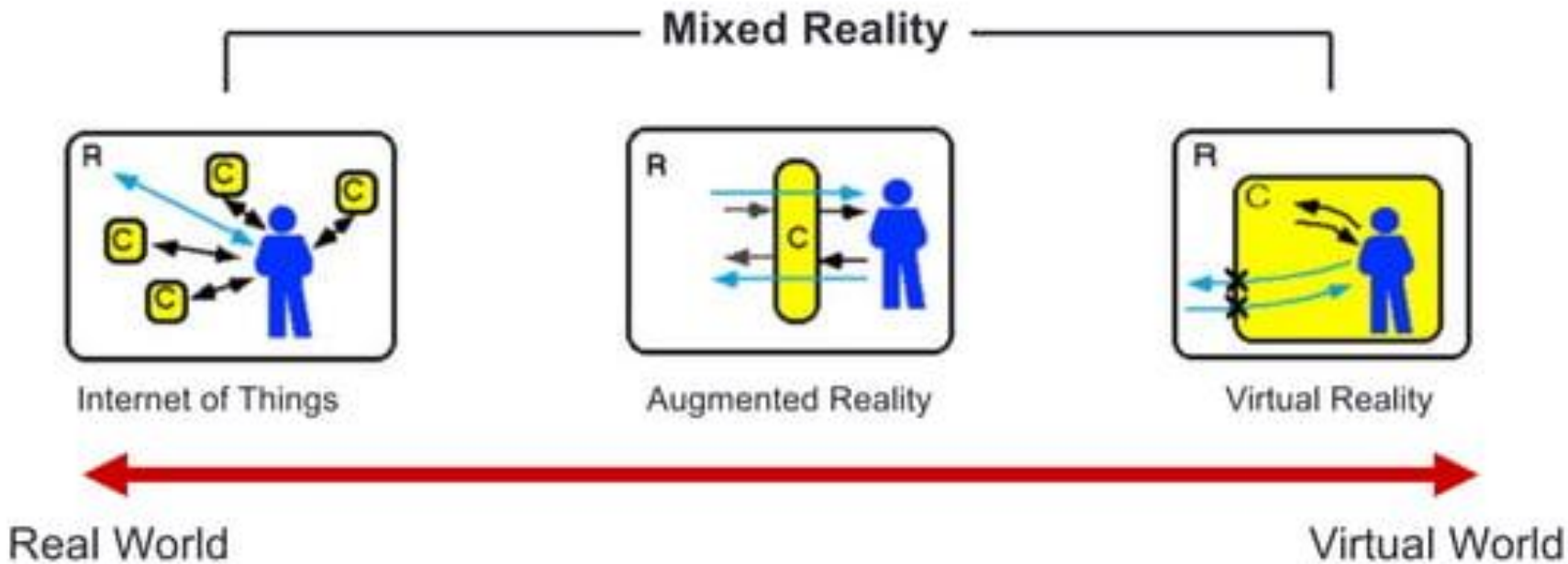


P. Milgram and A. F. Kishino, Taxonomy of Mixed Reality Visual Displays
IEICE Transactions on Information and Systems, E77-D(12), pp. 1321-1329, 1994.

From Reality to Virtual Reality



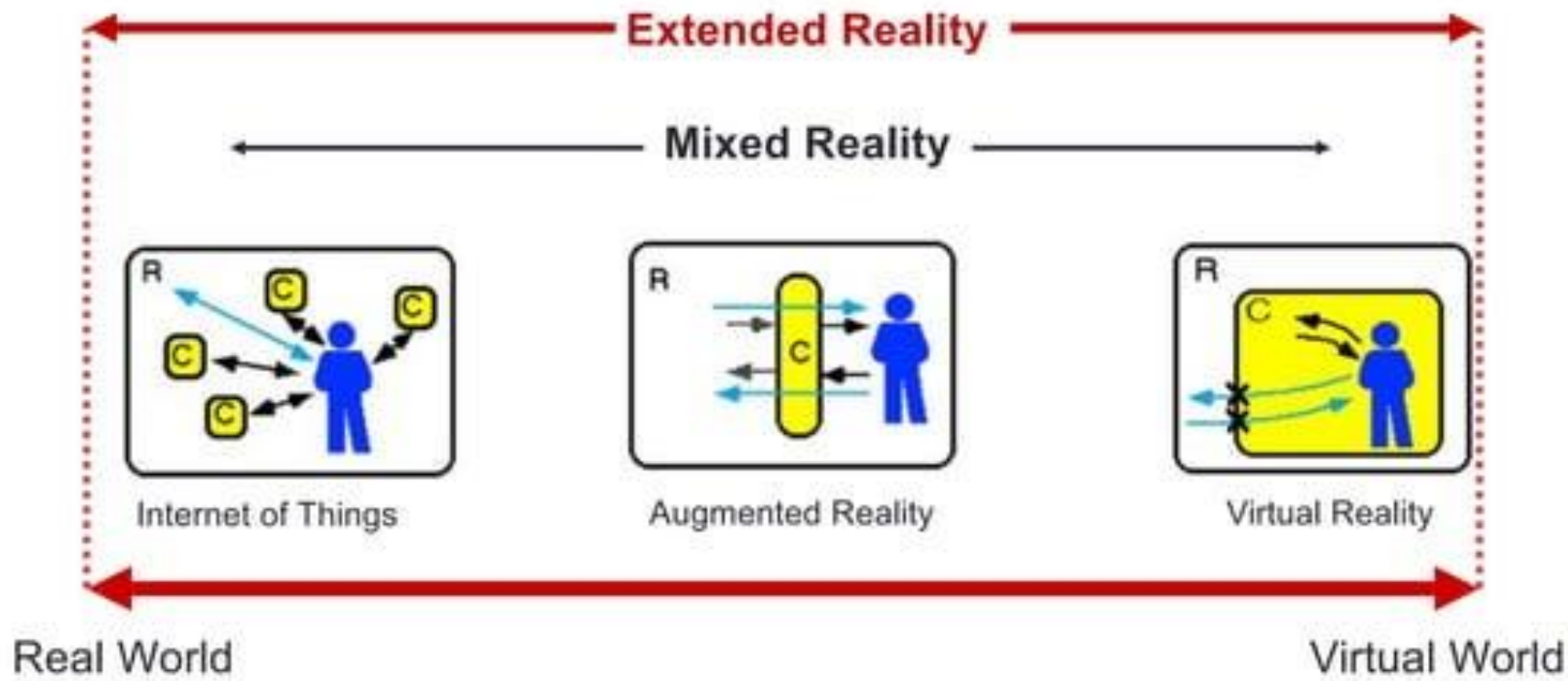
Milgram's Mixed Reality (MR) Continuum



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

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

Extended Reality (XR)

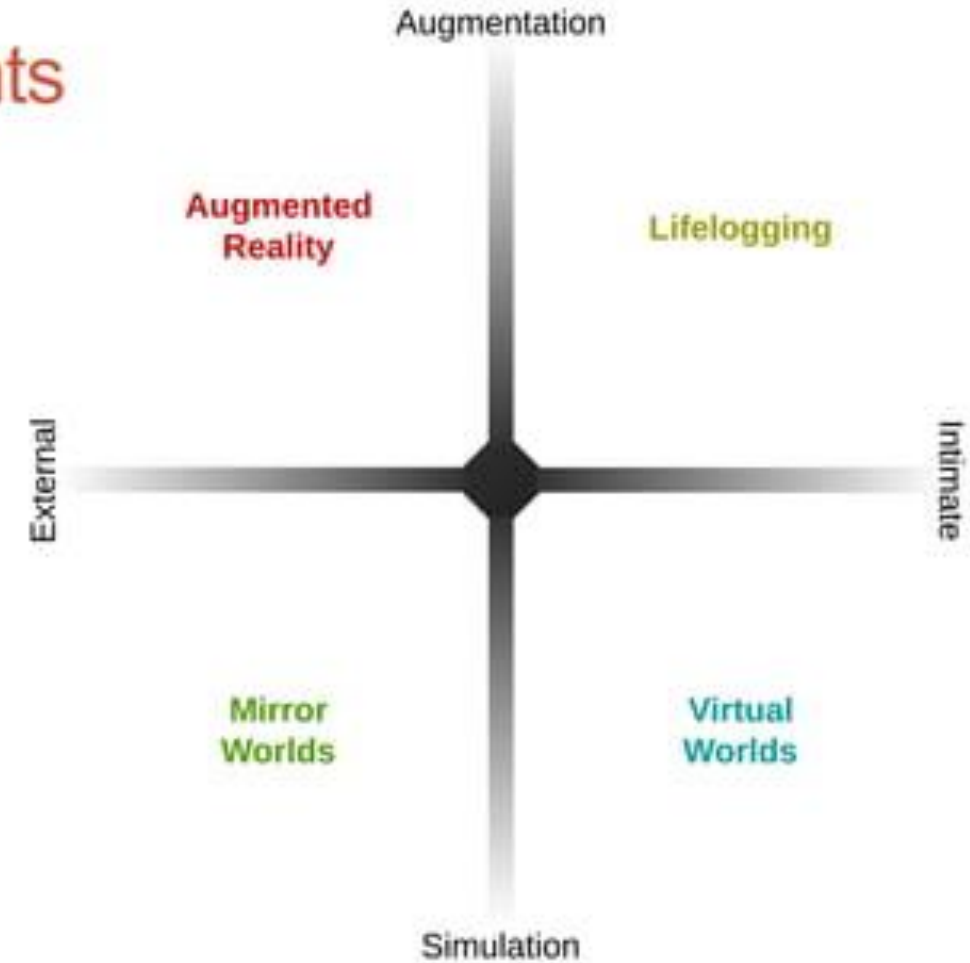


Metaverse Dimensions

- Augmentation technologies that layer information onto our perception of the physical environment.
- Simulation refers to technologies that model reality
- Intimate technologies are focused inwardly, on the identity and actions of the individual or object;
- External technologies are focused outwardly, towards the world at large;

Metaverse Components

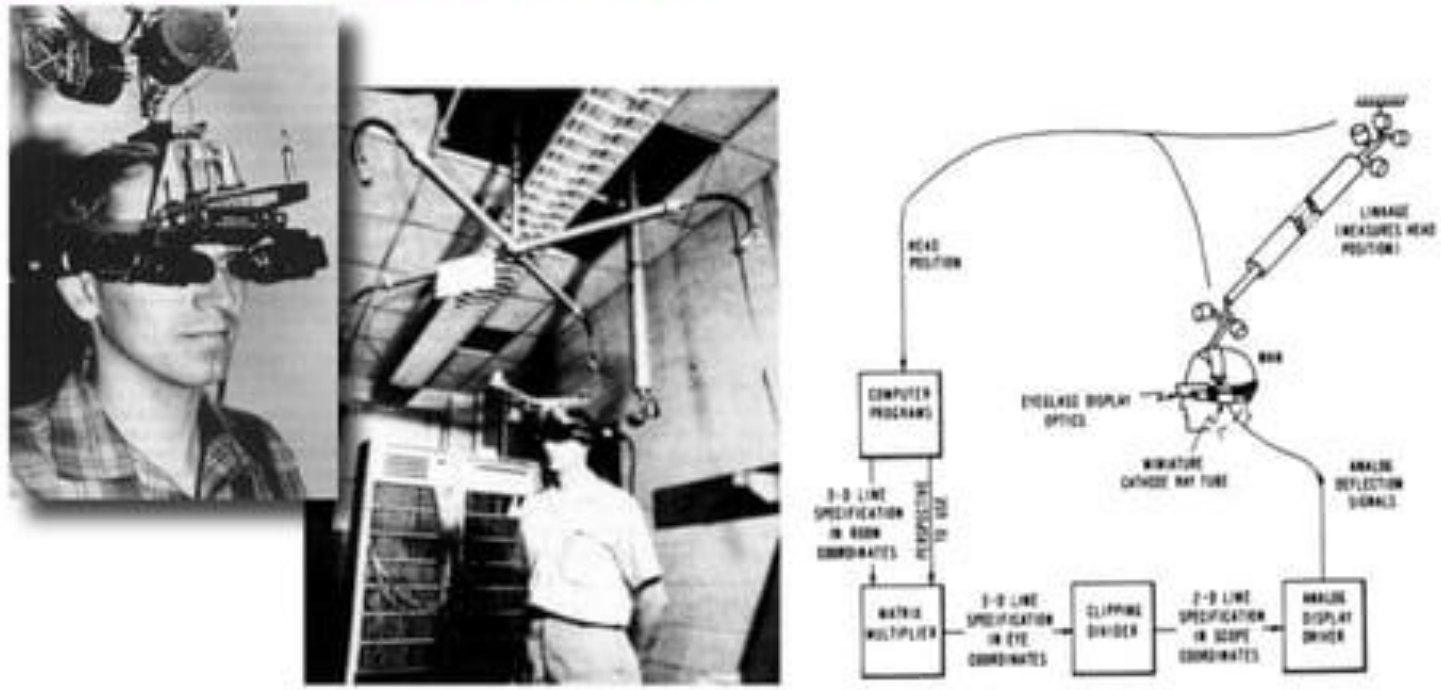
- Four Key Components
  - Virtual Worlds
  - Augmented Reality
  - Mirror Worlds
  - Lifelogging



Adapted from Smart, E.J., Cascio, J. and Paffendorf, J., Metaverse Roadmap Overview

HISTORY OF AR/VR

Ivan Sutherland (1960s)



Ivan Sutherland's Head-Mounted Display (1968)

Sutherland Display

Super Cockpit (1965-80's)

- US Airforce Research Program
  - Wright Patterson Air Force Base
- Tom Furness III
- Multisensory
  - Visual, auditory, tactile
  - Head, eye, speech, and hand input
- Addressing pilot information overload
  - Flight controls and tasks too complicated
- Research only
  - big system, not safe for ejecting

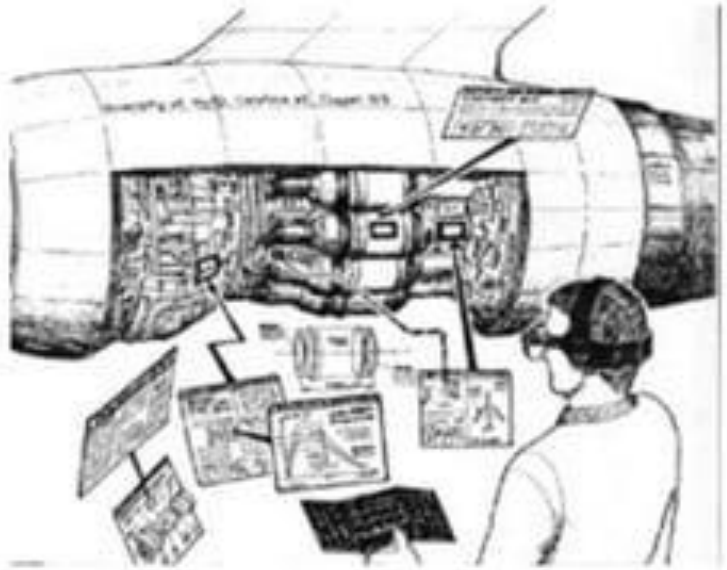
NASA VIEW/VIVED (1981-86)

- Early HMD (McGreevy Humphries)
  - LCD "Watchman" displays
- VIEW (Scott Fisher)
  - Polhemus tracker
  - LEEP-based HMD
  - 3D audio (Convolvotron)
  - DataGlove gesture input
  - Simple graphics

VPL Research (1985 – 1999)

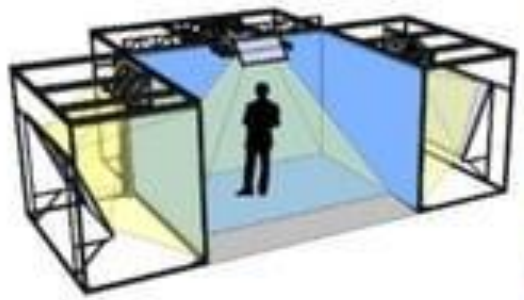
- First Commercial VR Company
  - Jaron Lanier, Jean-Jacques Grimaud
- Provided complete systems
  - Displays, software, gloves, etc
  - DataGlove, EyePhone, AudioSphere

First Industrial Use of AR (1990's)



- 1992: Tom Caudell at Boeing coined the term "AR."
- Wire harness assembly application begun
  - Lead by Tom Caudell, and David Mizell

CAVE (1992)



- Projection VR system
  - 3-6 wall stereo projection, viewpoint tracking
  - Developed at EVL, University of Illinois Chicago
- Commercialized by Mechdyne Corporation(1996)

C. Cruz-Neira, D. J. Sandin, T. A. DeFanti, R. V. Kenyon and J. C. Hart. "The CAVE: Audio Visual Experience Automatic Virtual Environment", *Communications of the ACM*, vol. 35(6), 1992, pp. 64–72.

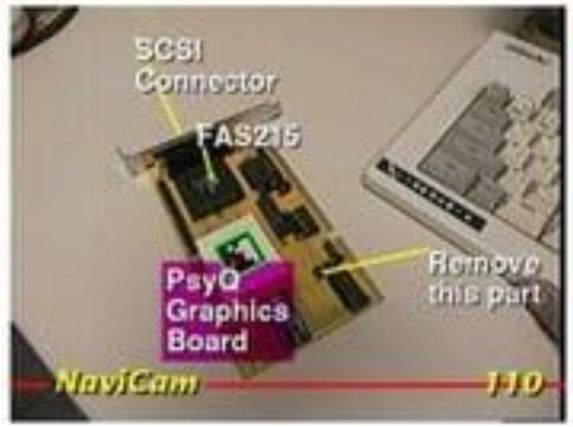
Desktop VR - 1995

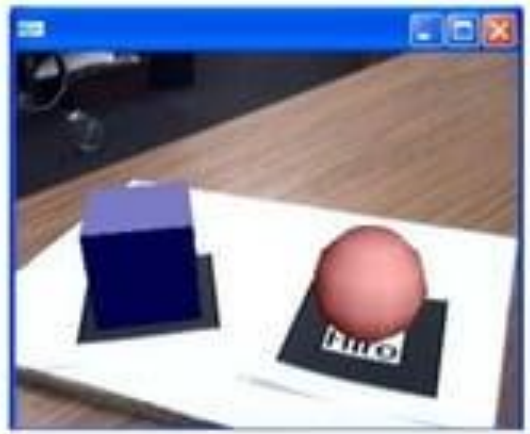
- Expensive - $150,000+
- 2 million polys/sec
- VGA HMD – 30 Hz
- Magnetic tracking

Mobile/Wearable Systems (1995)

- 1995 Navicam (Rekimoto)
  - Handheld AR
- 1997 Touring Machine (Feiner)
  - Backpack AR, GPS, see-through display
- 1998 Tinmith (Thomas, UniSA)
  - Outdoor gaming, CAD

Development of AR Tools





- 1996 CyberCode (Rekimoto)
  - First matrix code tracking
- 1999 ARToolKit (Kato & Billinghurst)
  - Open source tracking library

Mobile Phone AR (2005)

- Mobile Phones
  - camera
  - processor
  - display

- AR on Mobile Phones
  - Simple graphics
  - Optimized computer vision
  - Collaborative Interaction

AR Advertising (HIT Lab NZ 2007)

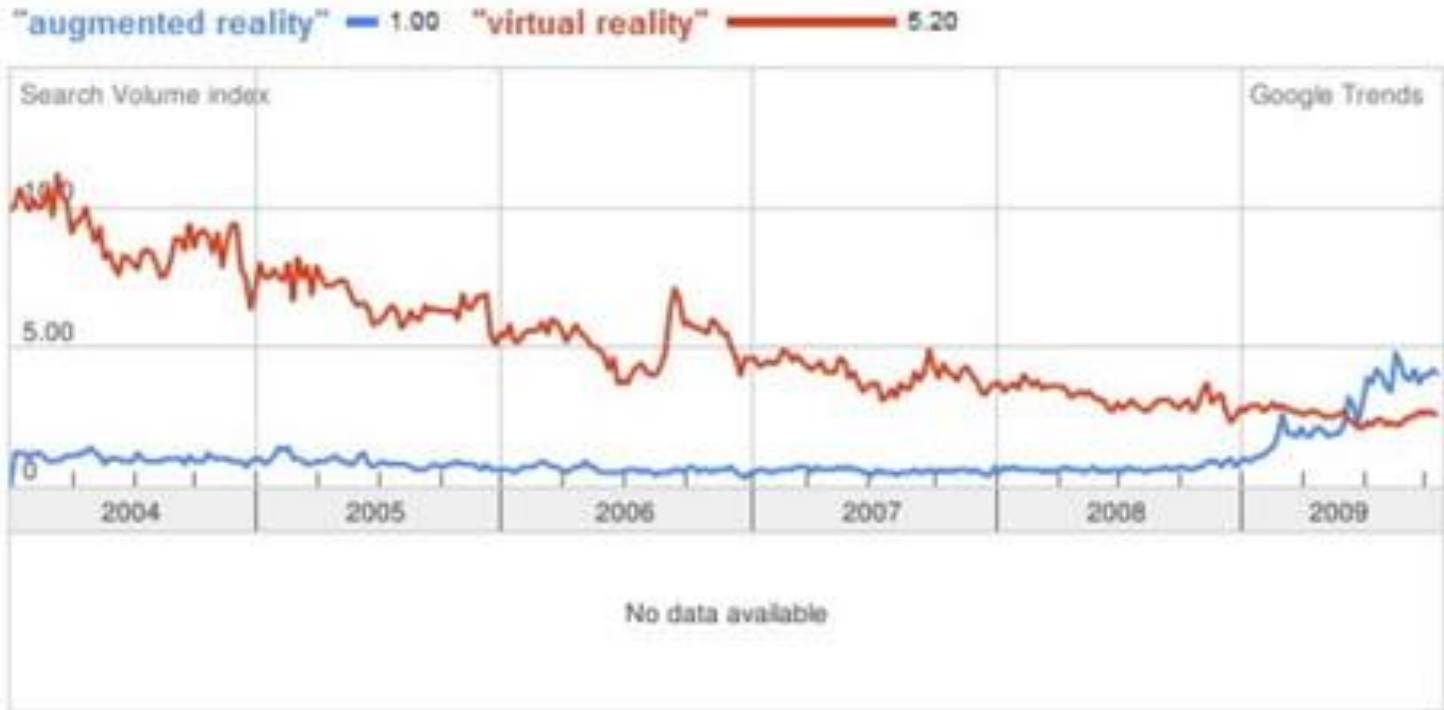
- Txt message to download AR application (200K)
- See virtual content popping out of real paper advert
- Tested May 2007 by Saatchi and Saatchi

Wellington Zoo Demo

Eye of judgement (2007)

- Sony Playstation3 game
- First AR console game
- Over 300,000 copies sold
- Used Eye camera + tracking cards

Google Searches for AR



- Cross over in 2009, with more interest in AR than VR

2008 - Browser Based AR

- Flash + camera + 3D graphics
  - ARToolKit ported to Flash
- High impact
  - High marketing value
- Large potential install base
  - 1.6 Billion web users
- Ease of development
  - Lots of developers, mature tools
- Low cost of entry
  - Browser, web camera

Demo: GE Smart Grid

2008: Location Aware Phones

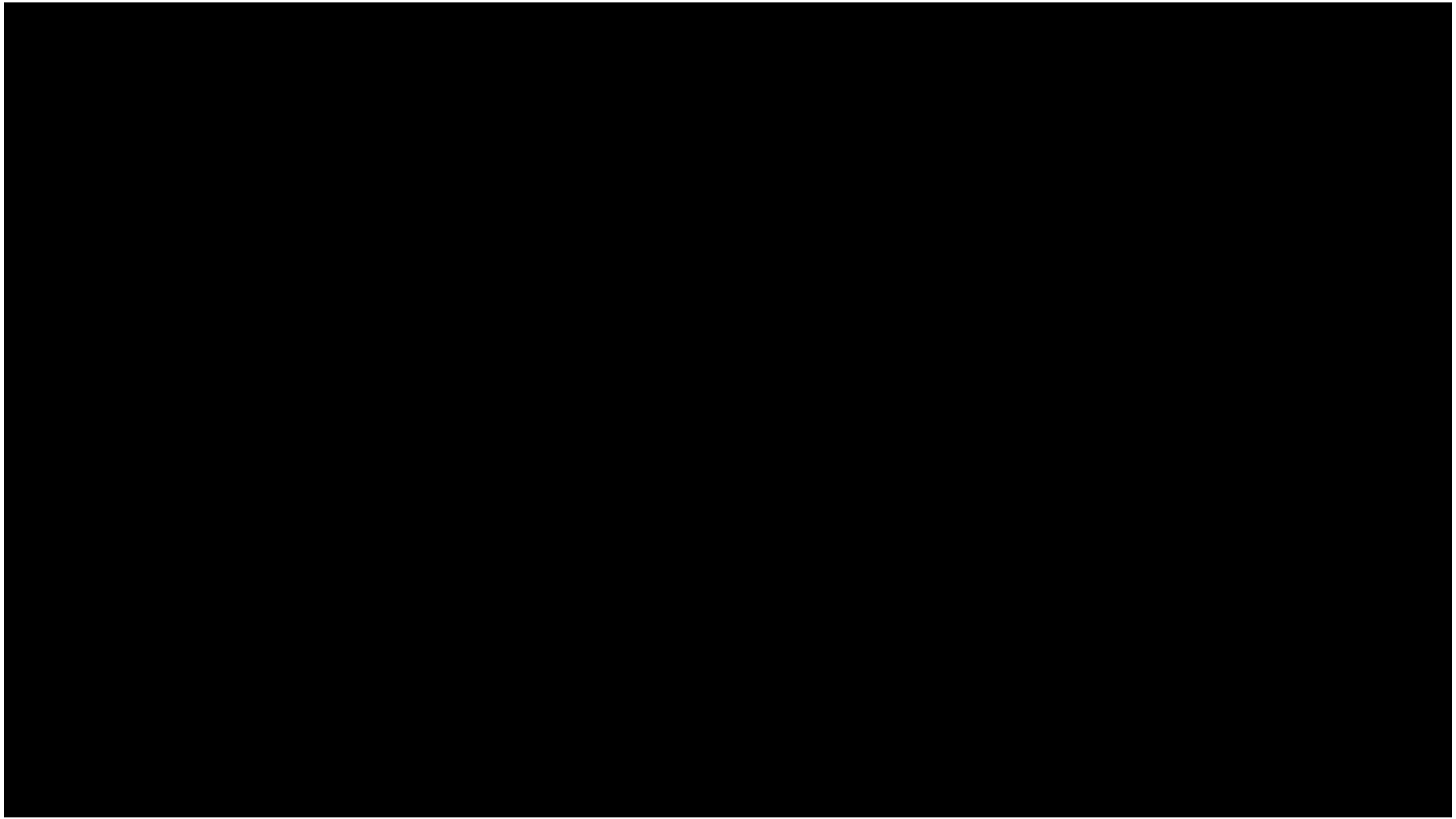
Motorola Droid

Nokia Navigator

Outdoor Information Overlay

- Mobile phone based
- Tag real world locations
  - GPS + Compass input
  - Overlay graphics on live video
- Applications
  - Travel guide, Advertising, etc.
- Wikitude, Metaio, Layar, etc..
  - iOS/Android, Public API released

Layar Demo (2008)



AR in Magazines (2009-)

- Esquire Magazine
  - Dec 2009 issue
  - 12 pages AR content
- Many Others
  - Wired
  - Colors
  - Red Bull
  - etc.

Google Glass (2011 -)

VR Second Wave (2010 -)

- Palmer Luckey
  - HMD hacker
  - Mixed Reality Lab (MxR) intern

- Oculus Rift (2011 -)
  - 2012 - $2.4 million kickstarter
  - 2014 - $2B acquisition FaceBook
  - $350 USD, 110º FOV

Desktop VR in 2016

- Graphics Desktop
  - $1,500 USD
  - >4 Billion poly/sec
- $600 HMD
  - 1080x1200, 90Hz
- Optical tracking
  - Room scale

2016 - Rise of Consumer HMDs

Oculus Rift

HTC/Valve Vive

Sony Morpheus

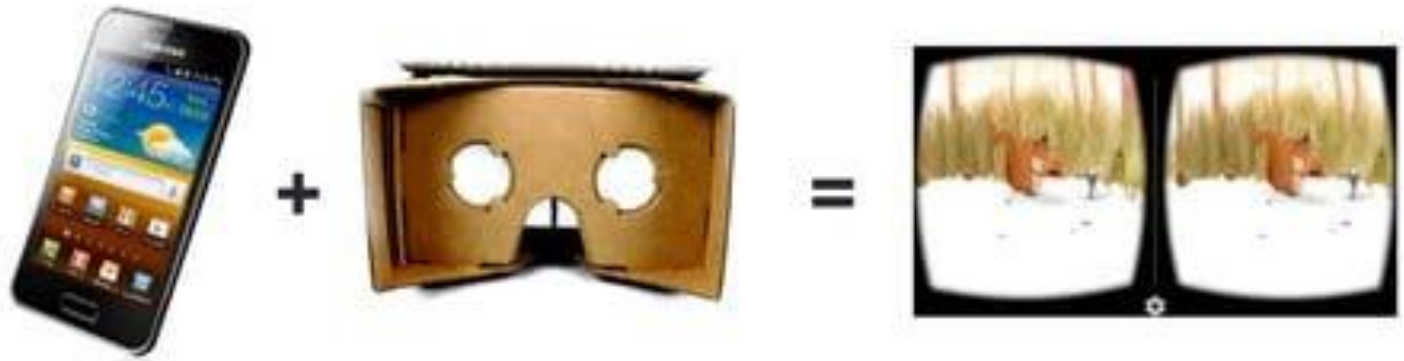
HTC Vive

- Room scale tracking
- Gesture input devices

VR2GO (2013)

- MxR Lab
  - 3D print VR viewer for mobiles
  - Open source hardware + software
  - http://projects.ict.usc.edu/mxr/diy/vr2go/
- Early Mobile VR viewer

Google Cardboard



- Released 2014 (Google 20% project)
- >5 million shipped/given away
- Easy to use developer tools

Multiple Mobile VR Viewers Available

Epson Moverio BT-300

- Stereo see-through display ($700)
  - 1280 RGB x 720 pixels, 23 degree FOV, 30Hz, 69g
  - Android Powered, separate controller
  - VGA camera, GPS, gyro, accelerometer

Smart Glasses Available

Google Glass

Epson BT200

Vuzix m100

Optinvent ORA-X

Recon Jet

Laster SeeThru

Meta Pro

Atheer One

Lumus DK40

ODG Consumer

Sony SmartEyeGlasses

Microsoft Hololens

Social Mobile Camera AR Apps (2015 -)

- SnapChat - Lenses, World Lenses
  - Cinco de Mayo lens > 225 million views
- Facebook - Camera Effects
- Google – Word Lens/Translate

Hololens (2016)

- Integrated system – Windows
- Stereo see-through display
- Depth sensing tracking
- Voice and gesture interaction
- Note: Hololens2 coming September 2019

ARKit/ARcore (2017)

- Visual Inertial Odometry (VIO) systems
- Mobile phone pose tracked by
  - Camera (Visual), Accelerometer & Gyroscope (Intertial)
- Features
  - Plane detection, lighting detection, hardware optimisation
- Links
  - https://developer.apple.com/arkit/
  - https://developers.google.com/ar/

ARKIT3 Demo

MagicLeap ML-1 (2018)

- Bi-Focal Display – two focus planes
  - Horizontal FoV of 40°, vertical FoV of 30°, diagonal value of 50°
  - 1280×960 resolution, Eye-tracking
- Separate display and computer
  - Nvidia "Parker" Tegra X2 CPU, 8GB RAM, 128 GB storeage
  - 6 DOF handheld controller, magnetic tracking

Applications

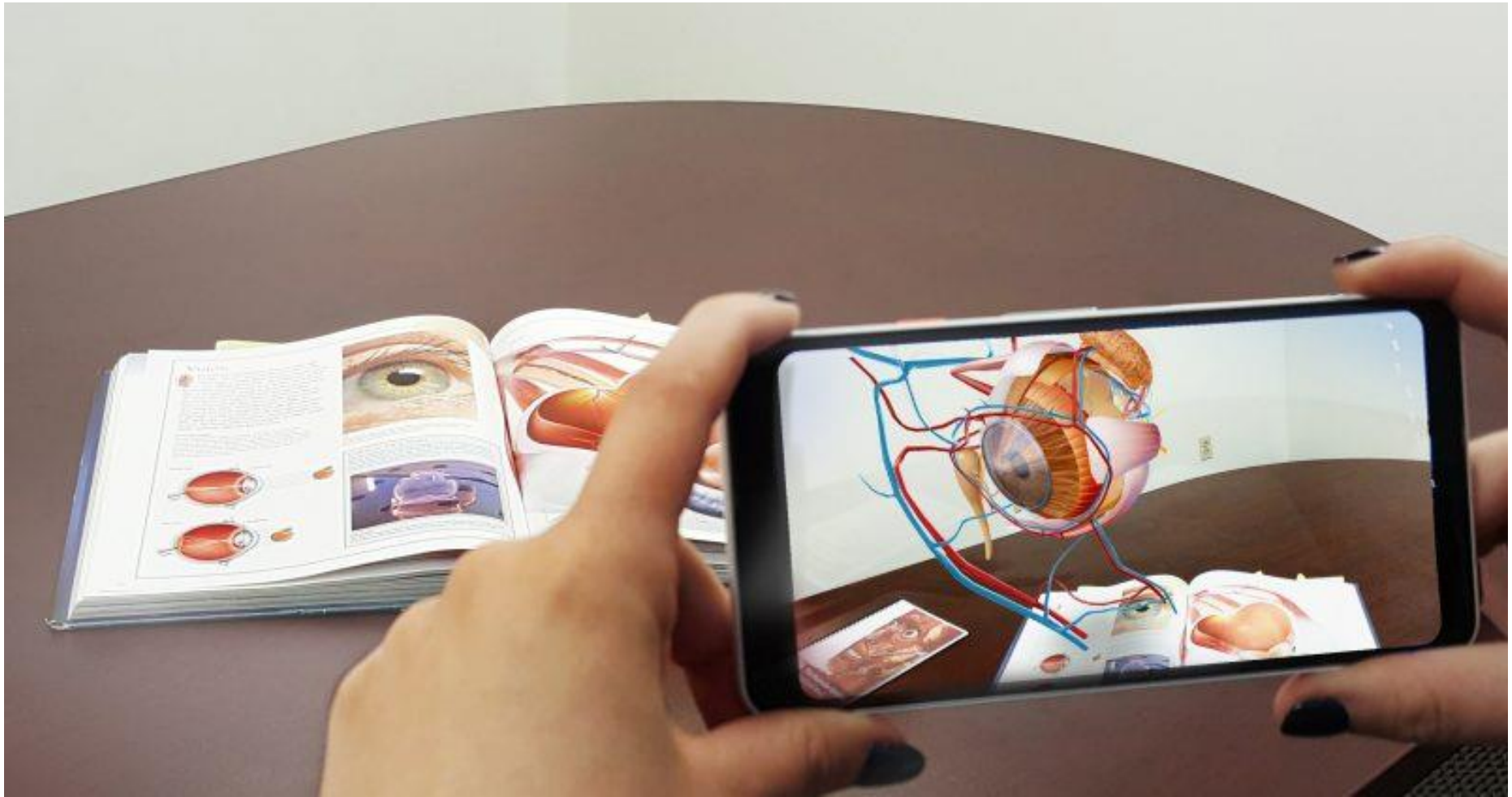
- Medicine
- Visualize complex structures such as molecules
- Clinical diagnosis: image visualization such as CT
- Clinical surgery
- Education
- Other areas

https://youtu.be/Xmpe1uYTDgI

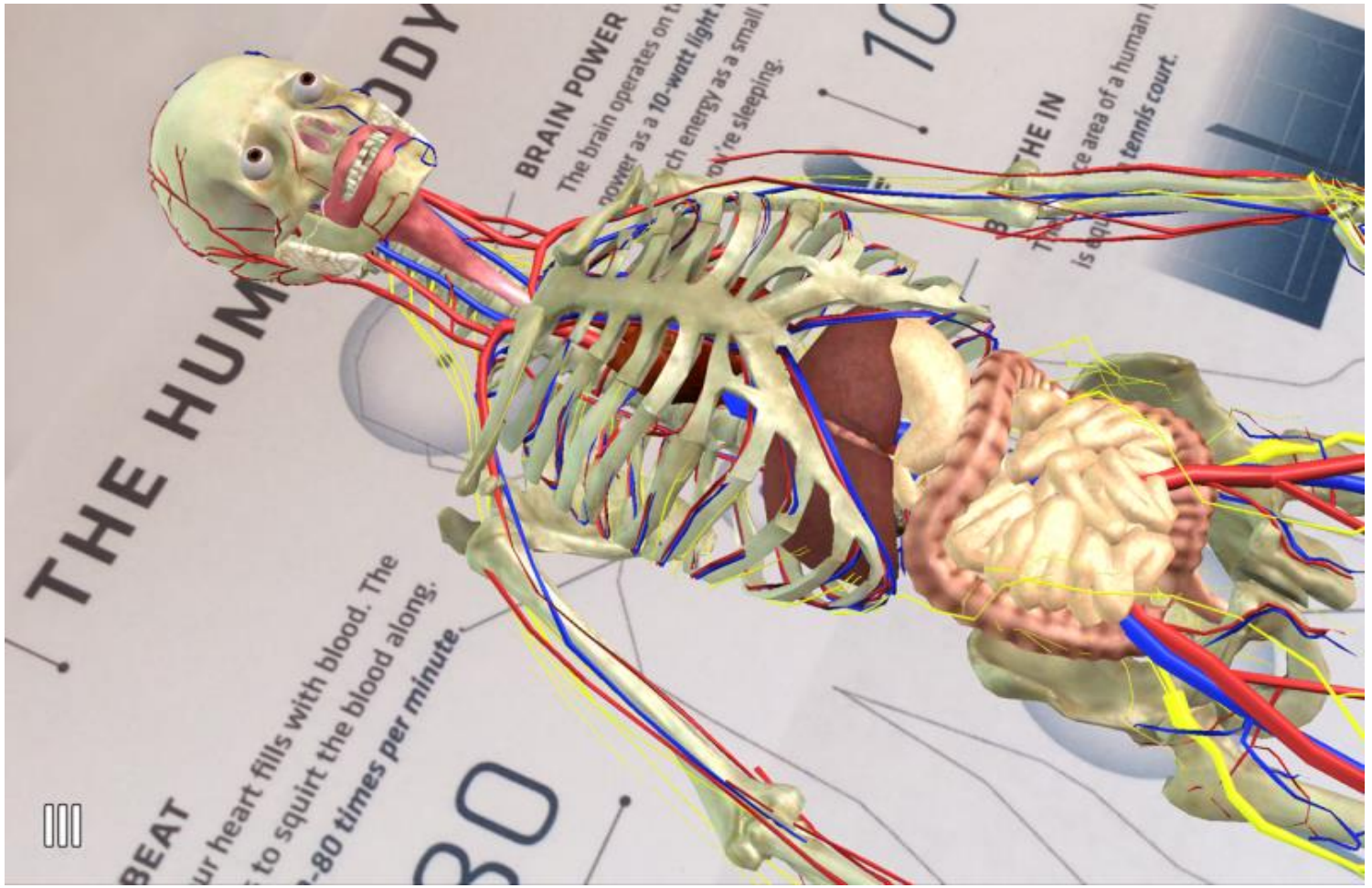
https://youtu.be/cDqACT5sc7U

https://youtu.be/d3YT8j0yYl0

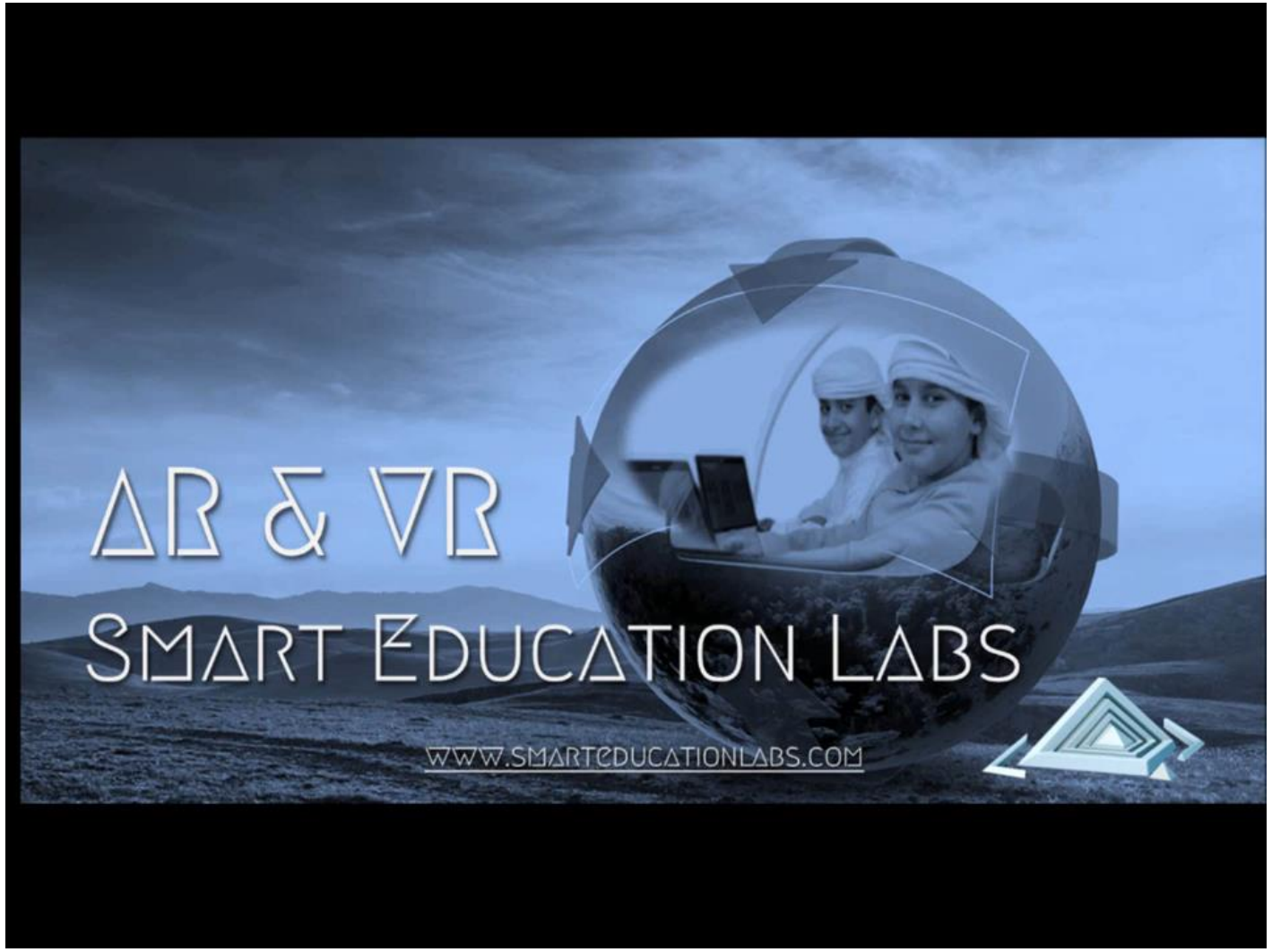
Touch Surgery helps medical students learn different surgical procedures



Anatomy4D learns about human organs, bones, etc.



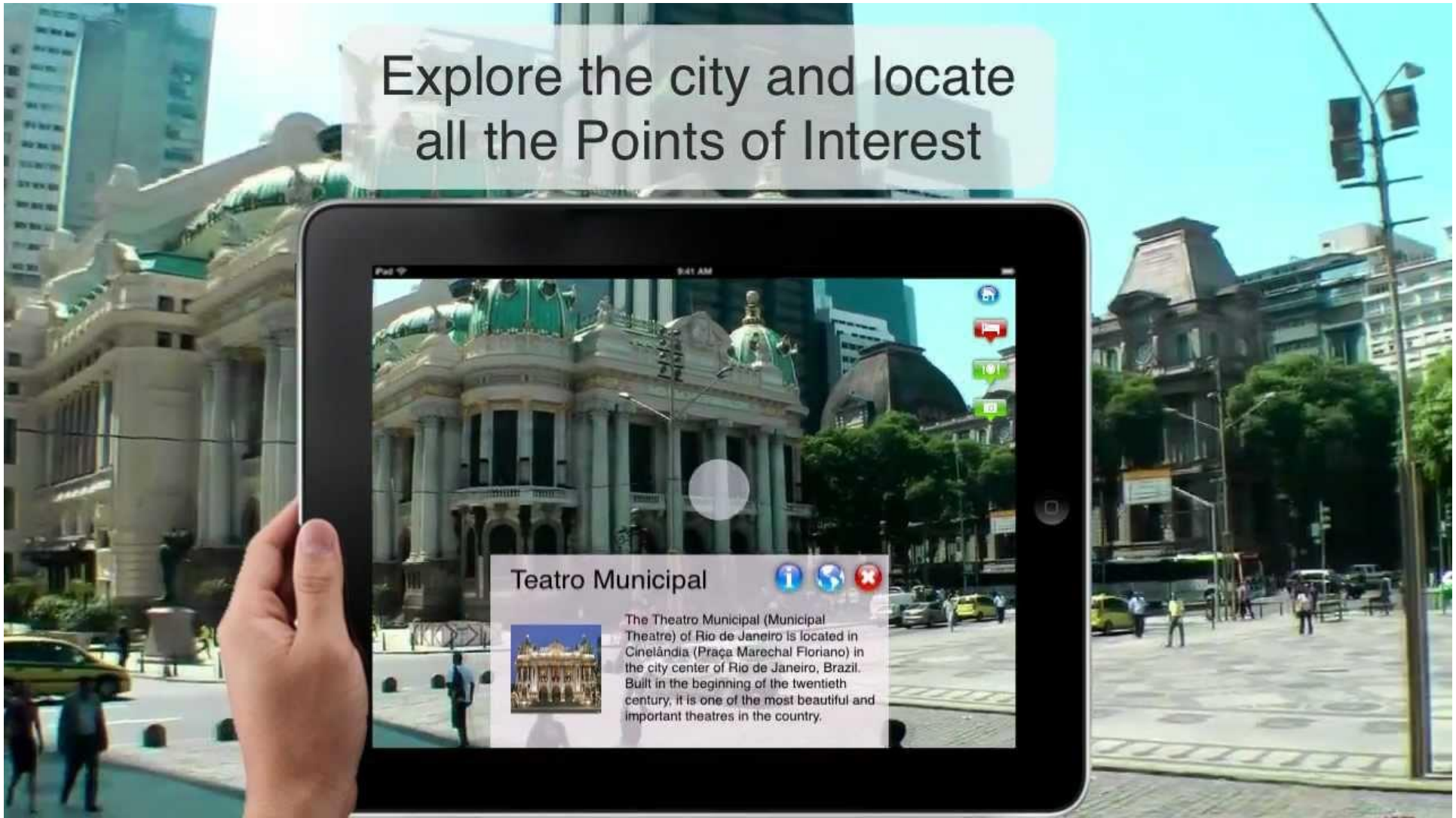
Anatomy4D Demo



Popular AR game: Pokémon Go

Sony VR game: Job Simulator
get familiar with a professional skill

Tourism


Explore the city and locate
all the Points of Interest
Teatro Municipal
The Theatro Municipal (Municipal Theatre) of Rio de Janeiro is located in Cinelândia (Praça Marechal Floriano) in the city center of Rio de Janeiro, Brazil. Built in the beginning of the twentieth century, it is one of the most beautiful and important theatres in the country.