

VIRTUAL REALITY: THEORY AND PRACTICE

LESSON 5: VR PAST AND FUTURE

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Part 3: Development in Unity

Scripting, Inputs, Character Controllers, and User Interfaces

PART 1: BRIEF HISTORY OF VR

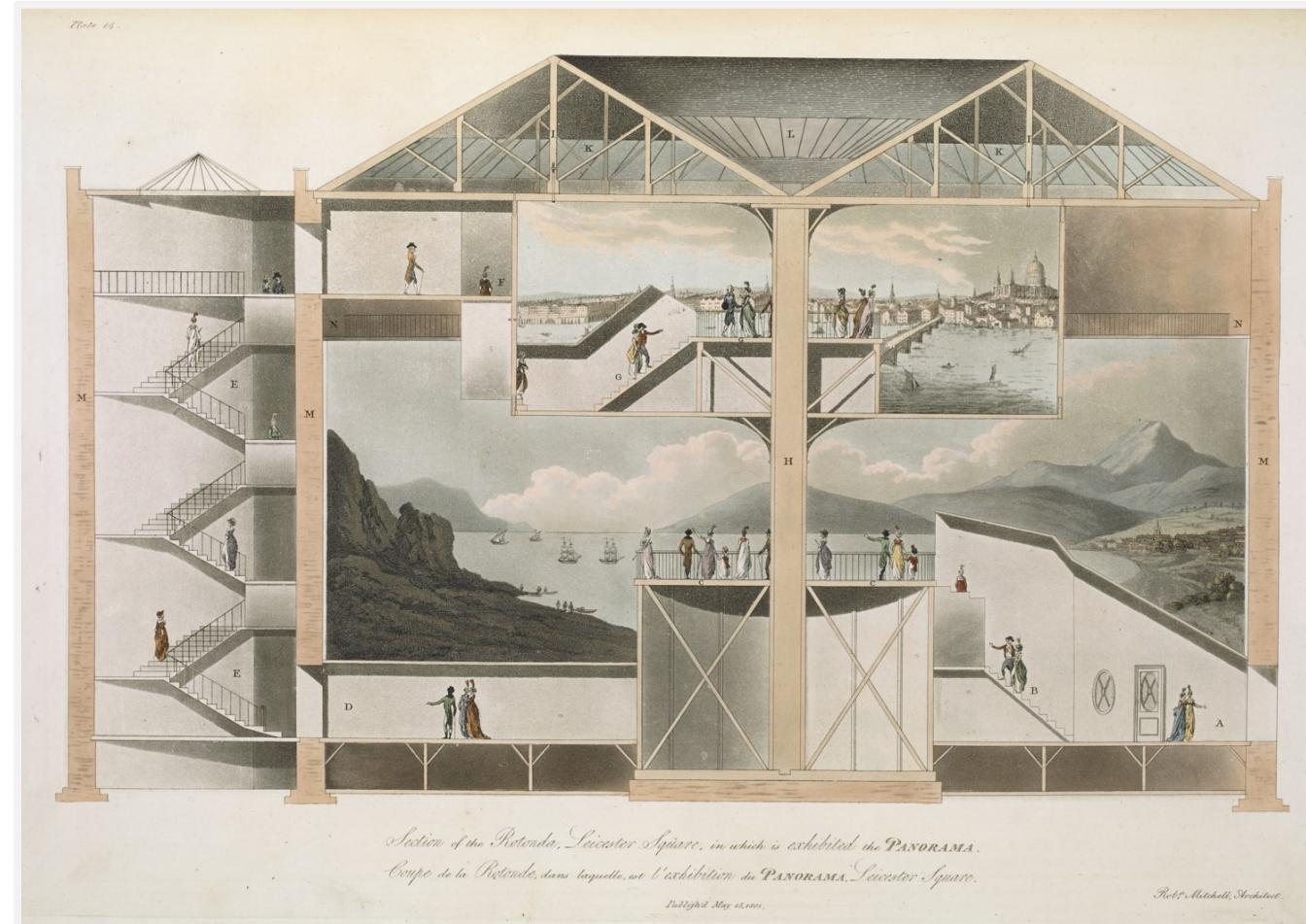
Most of current VR technology is built upon original ideas that date back to the 1800s.

A brief overview of the history of VR-AR technology can help to:

- Understand future trends and predict failures in the current market.
- Get inspiration to design novel VR-AR systems from past technology.
- Identify advantages and limitations of different elements of a VR-AR system.

BRIEF HISTORY OF VIRTUAL REALITY - 1800-1850

1801: Robert Barker designs and builds the Leicester Square Rotunda in London, displaying 2 360-degree panorama paintings of London.



BRIEF HISTORY OF VIRTUAL REALITY - 1800-1850 (2)

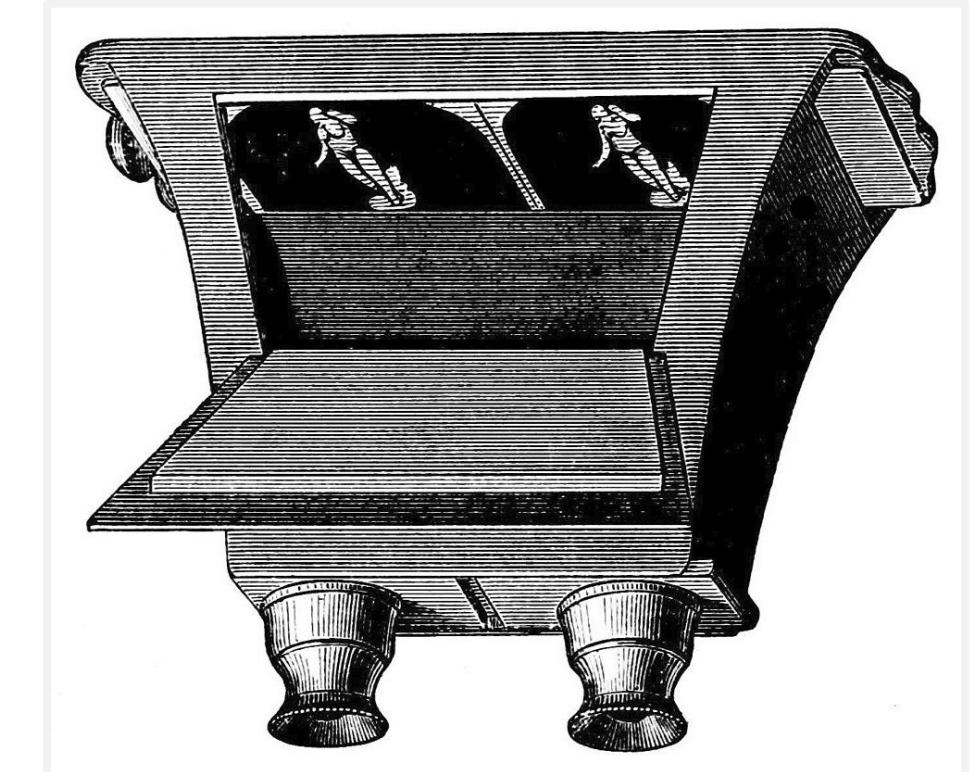
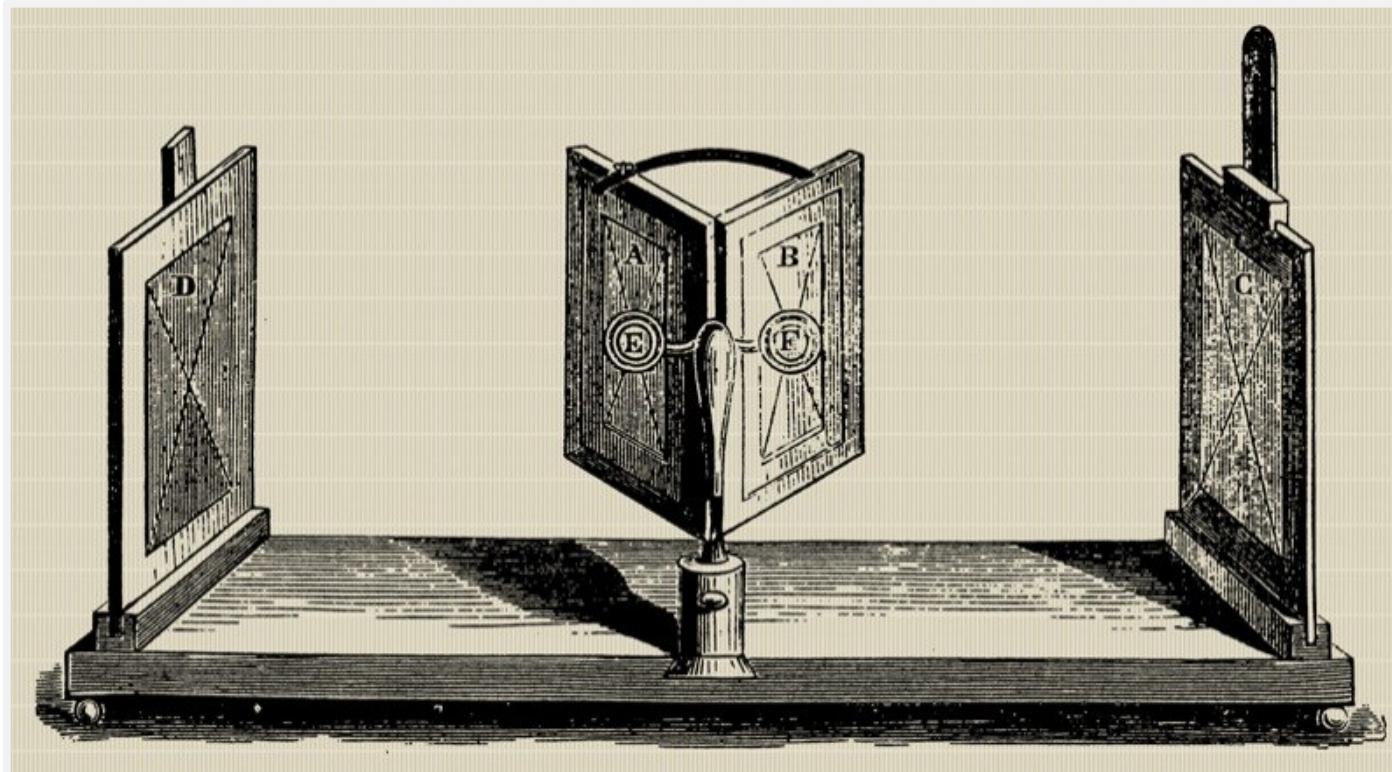
1812: First panoramic paintings designed to cover the entire FOV (top, "Battle of Borodino" by Franz Roubaud in 1812; and, bottom, "Siege of Sevastopol" by Franz Roubaud in 1855).



BRIEF HISTORY OF VIRTUAL REALITY - 1800-1850 (3)

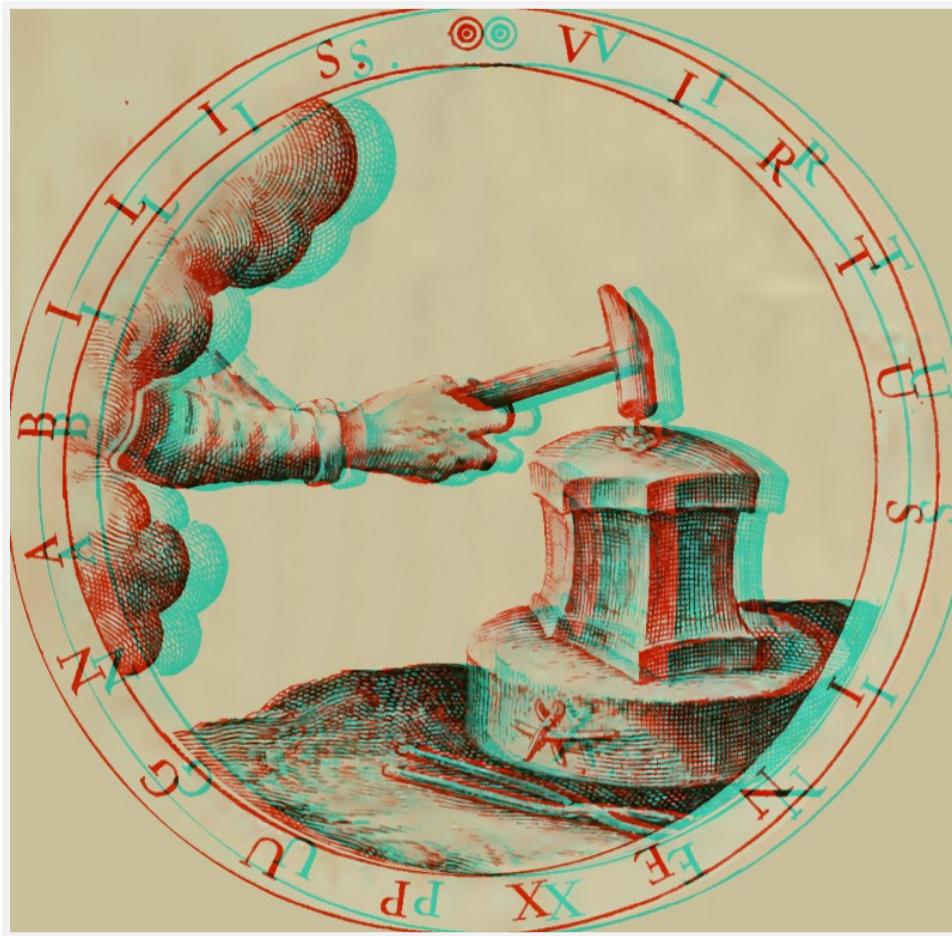
1838: Charles Wheatstone demonstrates stereopsis inventing the first reflective stereoscope (left).

1849: David Brewster invents the first lenticular stereoscope (right).



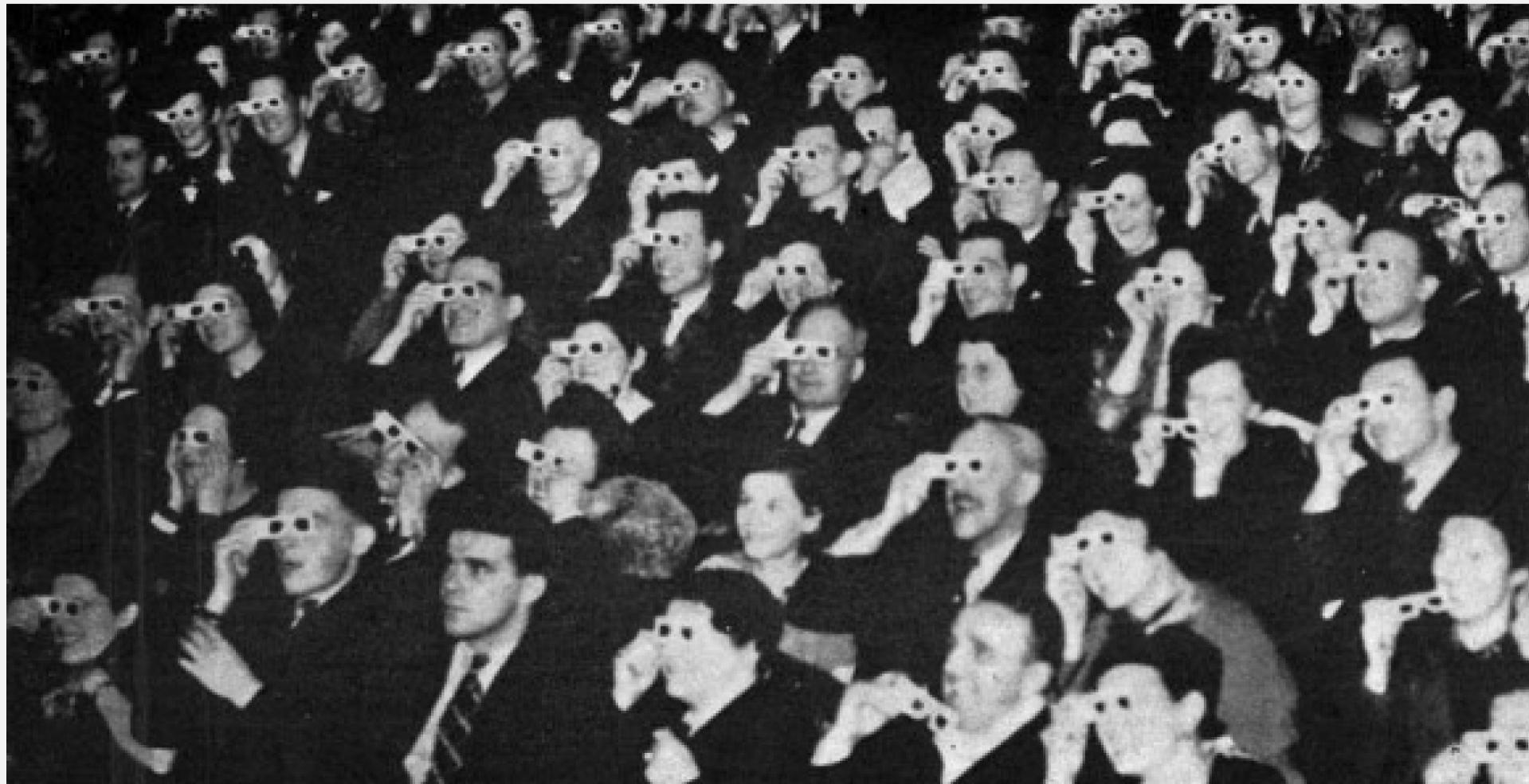
BRIEF HISTORY OF VIRTUAL REALITY – 1800-1850 (4)

1853: First description of anaglyphs by W. Rollmann, using Y/B drawing with R/B glasses (in figure an example of a red/cyan anaglyph).



BRIEF HISTORY OF VIRTUAL REALITY - 1900-1950

1922: First commercial 3D movie "The Power of Love" is released using anaglyph glasses (in figure, the audience of a 3D movie using anaglyph glasses in early 1900).



BRIEF HISTORY OF VIRTUAL REALITY - 1900-1950 (2)

1929: Edward Link creates the first flight simulator (the "Link Trainer", patented in 1931).



BRIEF HISTORY OF VIRTUAL REALITY - 1900-1950 (3)

1935: Stanley G. Weinbaum writes a sci-fi novel ("Pygmalion's Spectacles") in 1935 introduces the concept of VR, inventing the idea of VR goggles (allowing the user to experience a virtual world through holographics, smell, taste and touch).



BRIEF HISTORY OF VIRTUAL REALITY - 1900-1950 (4)

1939: The View-Master stereoscope is patented by William Gruber, including only stereo vision (in figure, the original View-Master manufactured by Sawyers).



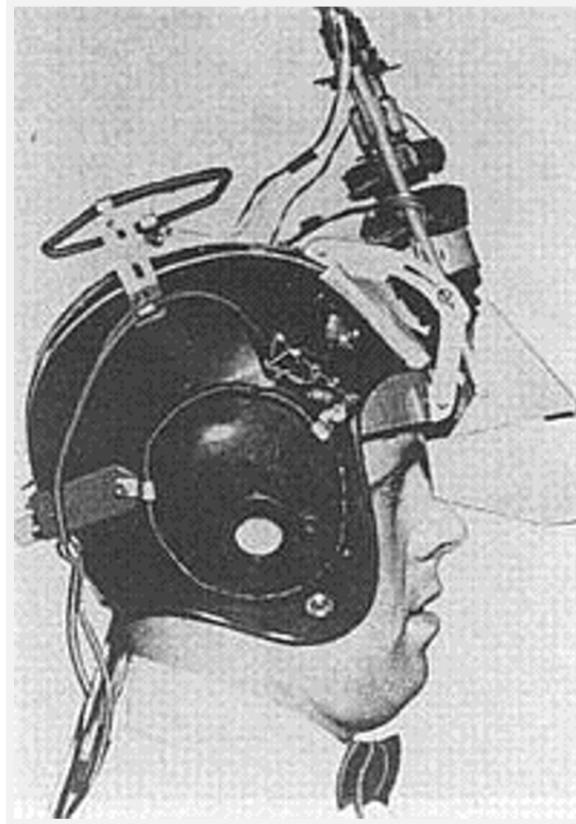
BRIEF HISTORY OF VIRTUAL REALITY - 1950-1970

- 1956: The Sensorama system was invented by Morton Heilig, a virtual city the user can visit riding a motorbike with stereovision, audio, vibrations, and smells (left, see [video](#)).
- 1960: The Telesphere Mask (HMD) was invented by Morton Heilig, designed for non-interactive films with stereo wide-vision and audio, but no motion tracking (right).



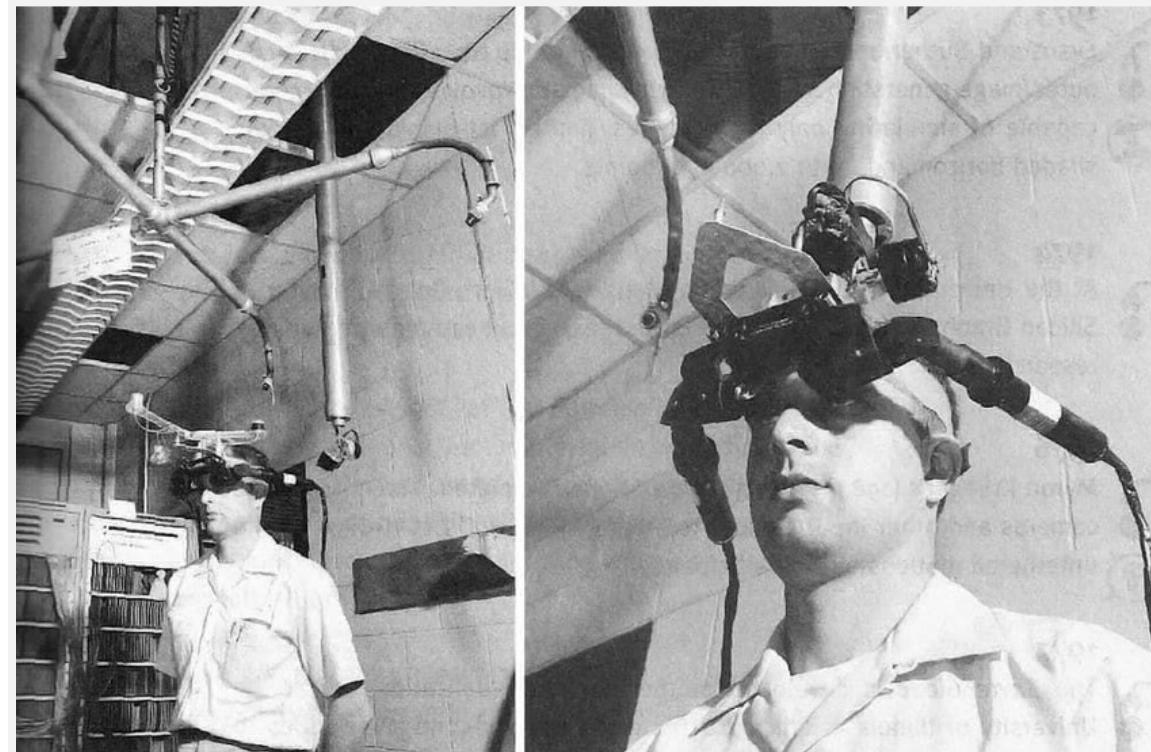
BRIEF HISTORY OF VIRTUAL REALITY - 1950-1970 (2)

1961: The Headsight system (HMD) invented by Philco Corporation (engineers Comeau and Bryan) for military use, it was a non-portable HMD including magnetic motion tracking (computer graphics were not integrated).



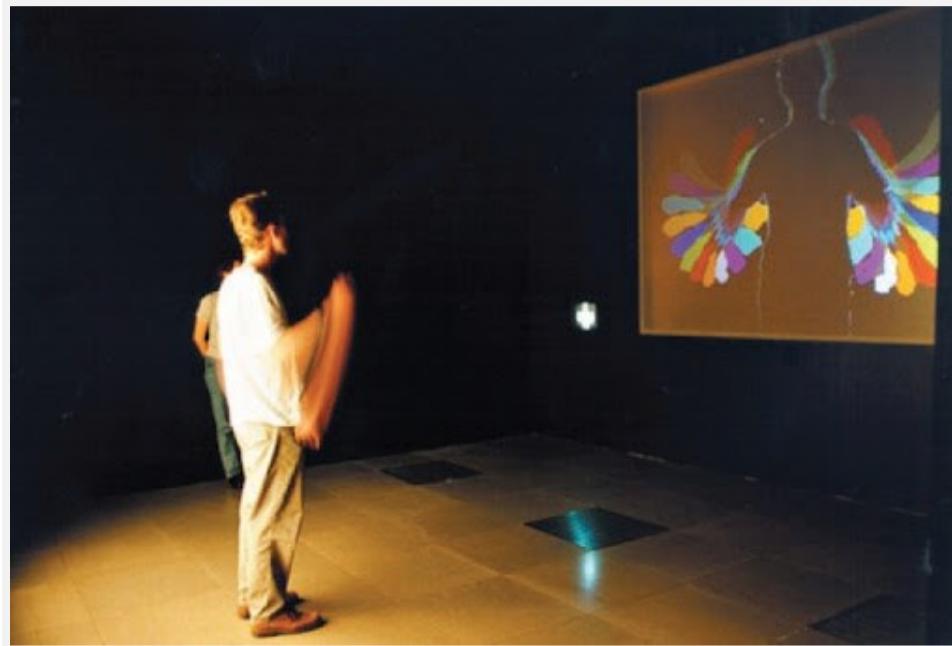
BRIEF HISTORY OF VIRTUAL REALITY - 1950-1970 (3)

- 1965: The “Ultimate Display” (HMD) was invented by Ivan Sutherland (non-portable and connected only to cameras, with no computer graphics)(figure, see [paper](#)).
- 1968: The “Sword of Damocles” (VR-AR HMD) was invented by Ivan Sutherland and Bob Sproull (non-portable but integrating computer graphics(see [video](#)).



BRIEF HISTORY OF VIRTUAL REALITY - 1970-1990

- 1969: Virtual artistic experiences ("Artificial Reality") designed by Myron W. Krueger, including computer-generated environments interacting to internal users (figure).
- 1975: The first interactive VR (AR) system (the "VIDEOPLACE") is designed by Myron W. Krueger, using a mix of CG, projectors, cameras, and screens (included tracking of user position, but did not include any headset).



BRIEF HISTORY OF VIRTUAL REALITY - 1970-1990 (2)

1971: The “Visually Coupled Airborne Systems Simulator” (VCASS) co-developed by Tom Furness, the first modern flight simulator engineered for the military.



BRIEF HISTORY OF VIRTUAL REALITY - 1970-1990 (3)

1972: A fully digital (CG-based) flight simulator is designed by General Electric (GE), including 3-screens in a 180-degree setup arranged in a training cockpit.



BRIEF HISTORY OF VIRTUAL REALITY - 1970-1990 (4)

1977: A VR interactive map (the "Aspen Movie Map") is designed at MIT, allowing users to visit Aspen (CO) in VR (using video filmed from a car, with no HMD) (see [video](#)).



BRIEF HISTORY OF VIRTUAL REALITY - 1970-1990 (5)

1979: The first non-research VR HMD (the VITAL helmet) is designed by McDonnell-Douglas, including a head tracker and basic computer-generated virtual content.

The runway isn't real.
The experience is.

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worldwide than any other visual system.**

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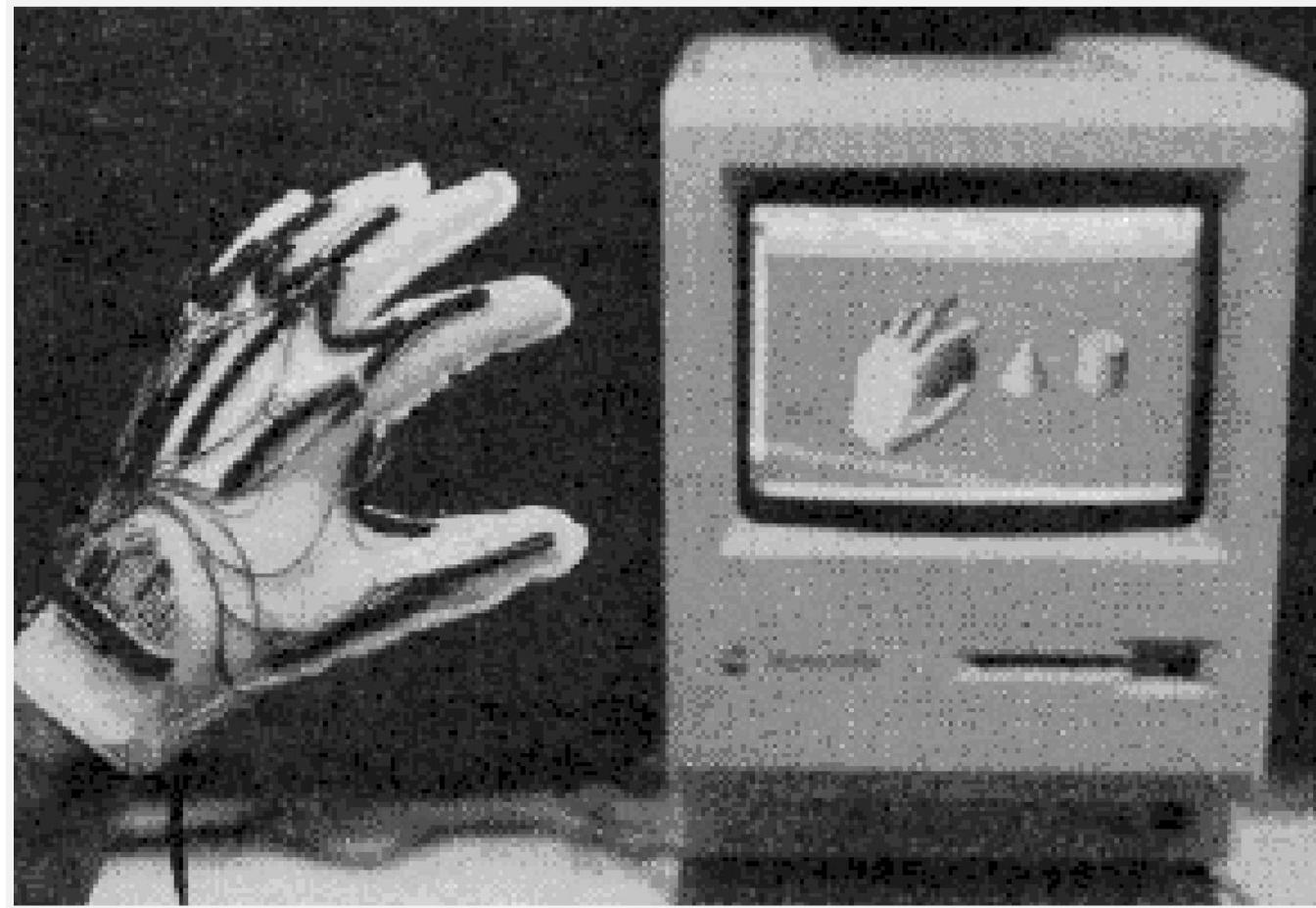
BRIEF HISTORY OF VIRTUAL REALITY - 1970-1990 (6)

1980: Steve Mann creates the "Eye Tap" HMD, a backpack-PC connected to a helmet-camera including a beam splitter allowing the overlay of real-time data (for AR).



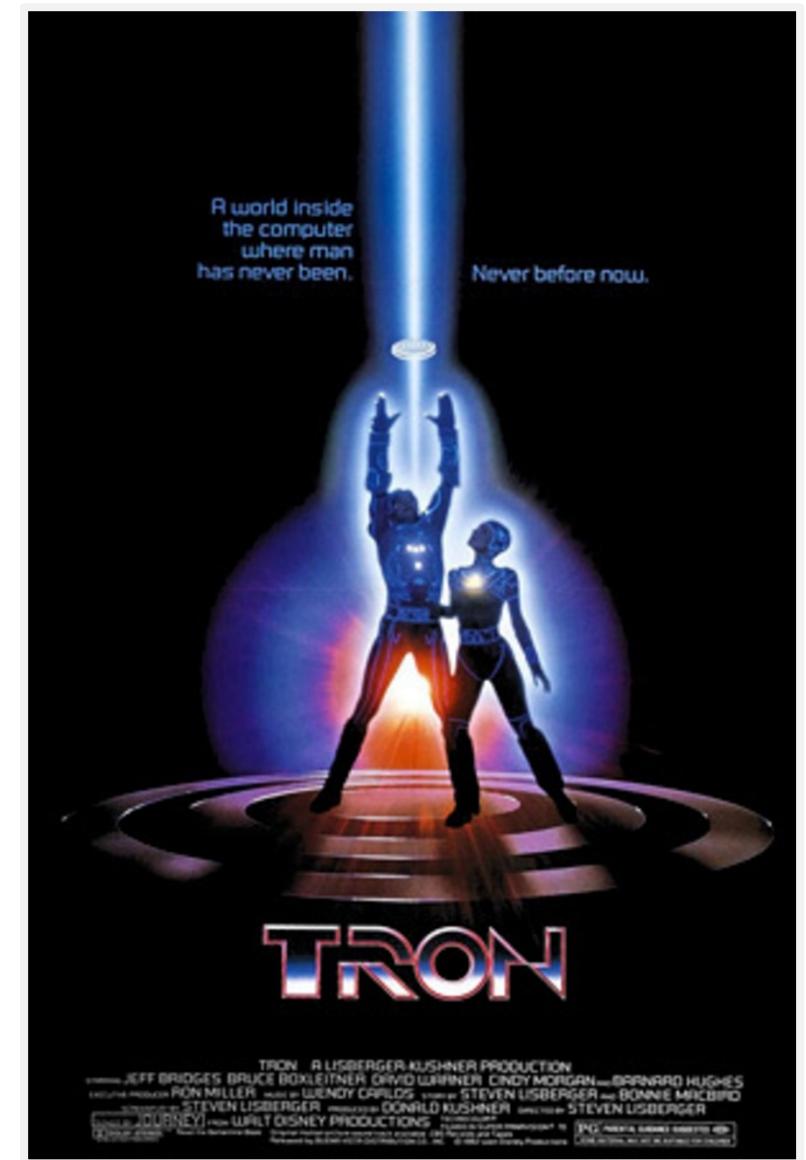
BRIEF HISTORY OF VIRTUAL REALITY - 1970-1990 (7)

1982: The first VR gloves ("Sayre Gloves") invented by Daniel Sandin and Thomas DeFanti, connected to a PC and using optical sensors to track finger movement.



BRIEF HISTORY OF VIRTUAL REALITY - 1970-1990 (8)

1982: The movie "Tron" introduces characters involved in a videogame/VR adventure.



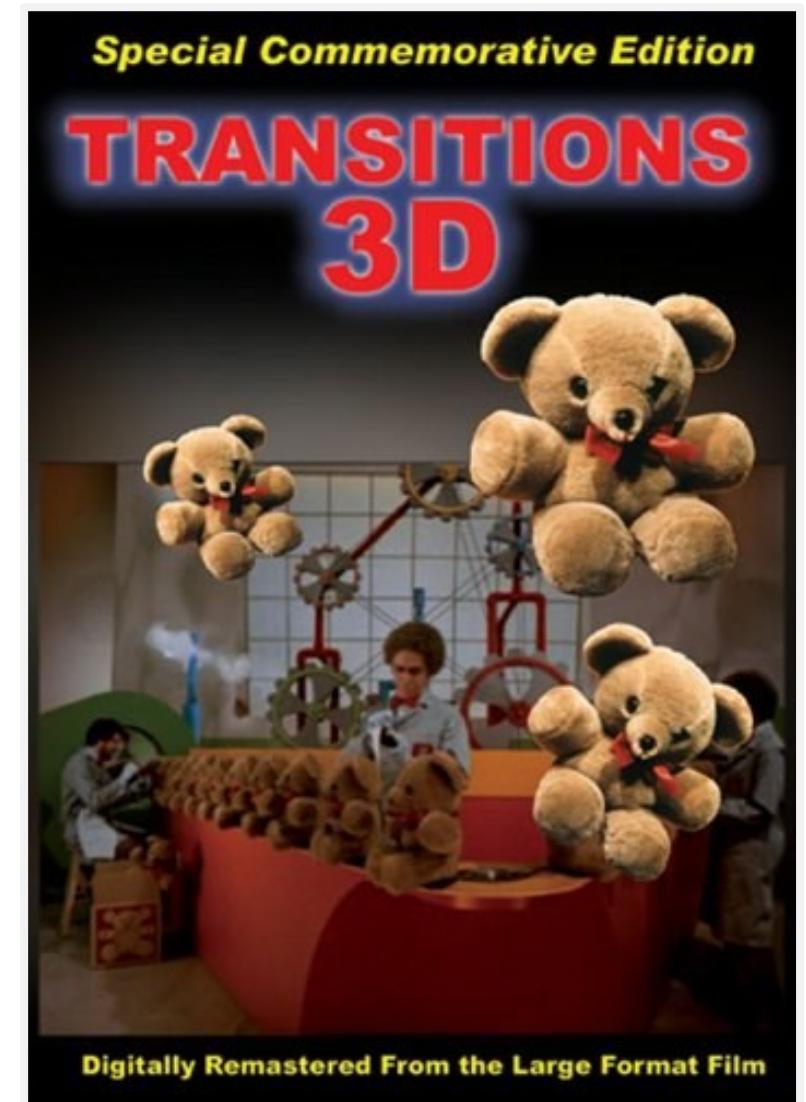
BRIEF HISTORY OF VIRTUAL REALITY - 1970-1990 (9)

1985: The VIEW system was invented by Scott Fisher at NASA, included a modern research HMD and haptic gloves.



BRIEF HISTORY OF VIRTUAL REALITY - 1970-1990 (10)

1986: The 3D movie "*Transitions*" is released using full-color 3D IMAX technology, including polarized glasses to refract anaglyph images to the proper eye.



BRIEF HISTORY OF VIRTUAL REALITY - 1970-1990 (11)

1986: The “Super Cockpit” is invented by Tom Furness (a flight simulator designed for VR training including CG, real-time interactivity, motion tracking, and aircraft control).



BRIEF HISTORY OF VIRTUAL REALITY - 1970-1990 (12)

1985: VPL Research is founded by Jaron Lanier and Thomas Zimmerman. It is the first VR company manufacturing consumer-grade HMDs and VR gloves (data gloves).

1987: First use of the term “virtual reality” and “data gloves”(Jaron Lanier, VPL Research).

1989: A demo of “EyePhones”(VR goggles) and “DataGloves” (VR gloves) developed by VPL Research.



BRIEF HISTORY OF VIRTUAL REALITY - 1970-1990 (13)

1989: The same technology of the NASA VIEW system (i.e., its gloves) is used to design the Nintendo NES Power Glove.



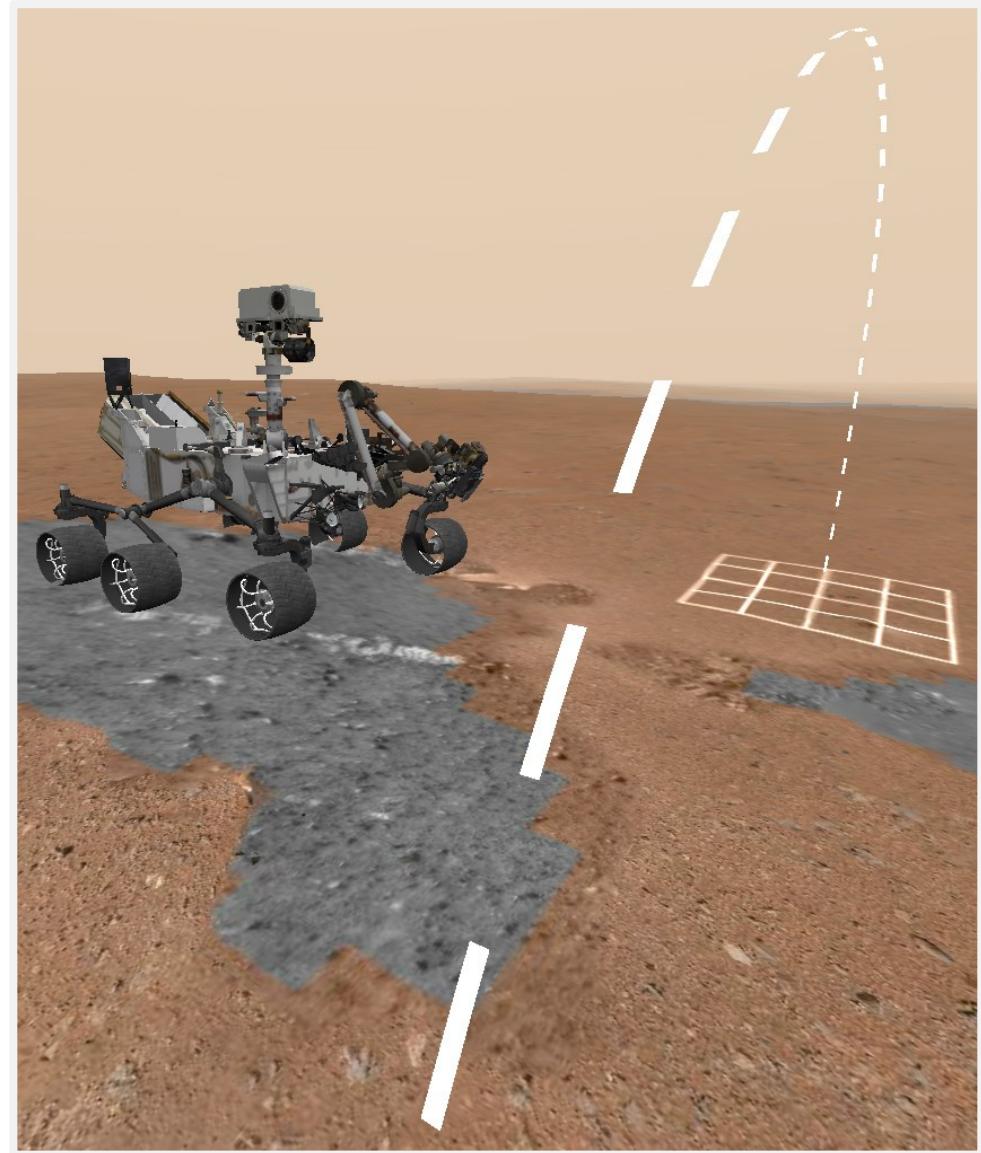
BRIEF HISTORY OF VIRTUAL REALITY - 1990-2000

1991: The Virtuality Group launches multiple VR arcade games/machines with VR goggles, real-time immersive stereoscopic 3D graphics, and networked multiplayer.



BRIEF HISTORY OF VIRTUAL REALITY - 1990-2000 (2)

1991: A NASA engineer (Antonio Medina) develops a VR system to pilot a Mars rover in teleoperation (i.e., a computer-simulated teleoperation).



BRIEF HISTORY OF VIRTUAL REALITY - 1990-2000 (3)

1992: The movie "The Lawnmower Man" introduces the concept of VR to a wider audience.



BRIEF HISTORY OF VIRTUAL REALITY - 1990-2000 (4)

- 1993: Sega announces the new Sega VR headset for the Sega Genesis console, including head tracking, stereo sound, and LCD screens (left).
- 1994: Sega releases the VR-1 arcade motion simulator, including HMDs (right).



BRIEF HISTORY OF VIRTUAL REALITY - 1990-2000 (5)

1995: Nintendo releases the Virtual Boy (aka VR-32) the first 3D gaming portable console.



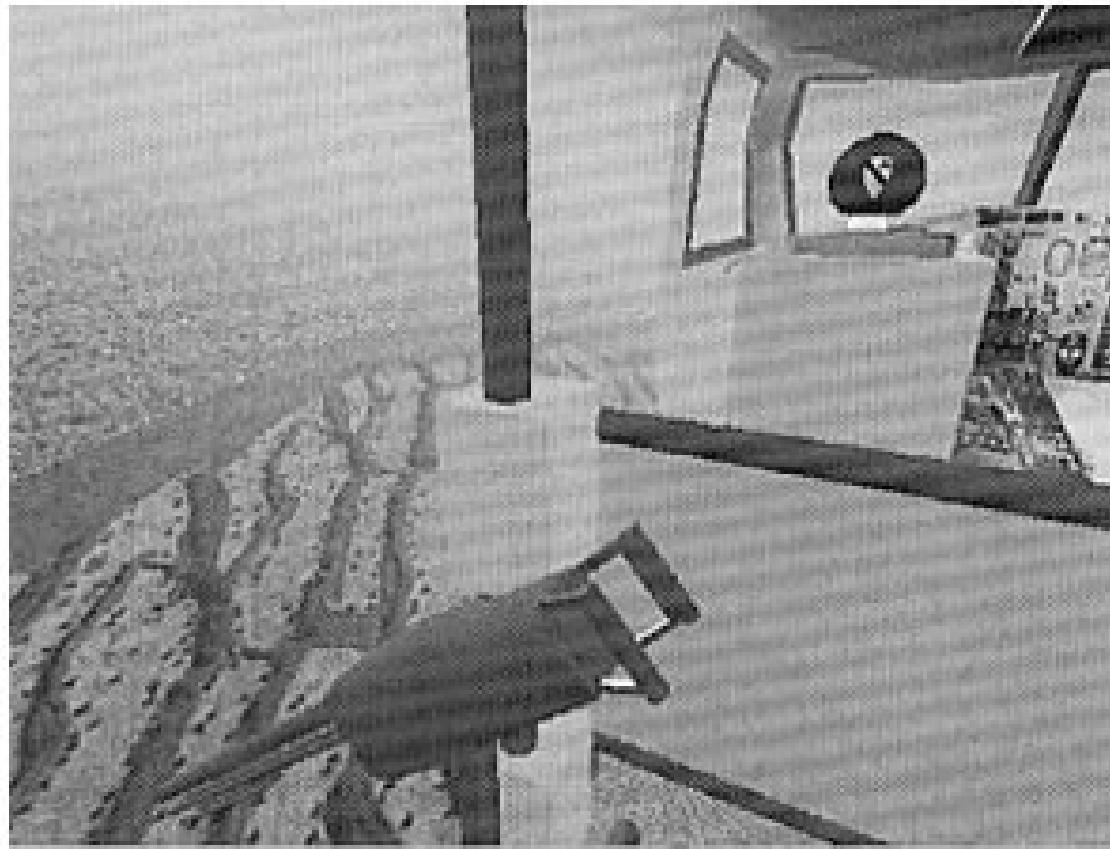
BRIEF HISTORY OF VIRTUAL REALITY - 1990-2000 (6)

1995: CAVE Automatic Virtual Environment (CAVE) is invented at the University of Illinois, including stereoscopic LCD shutter glasses and wall projections for multi-user VR.



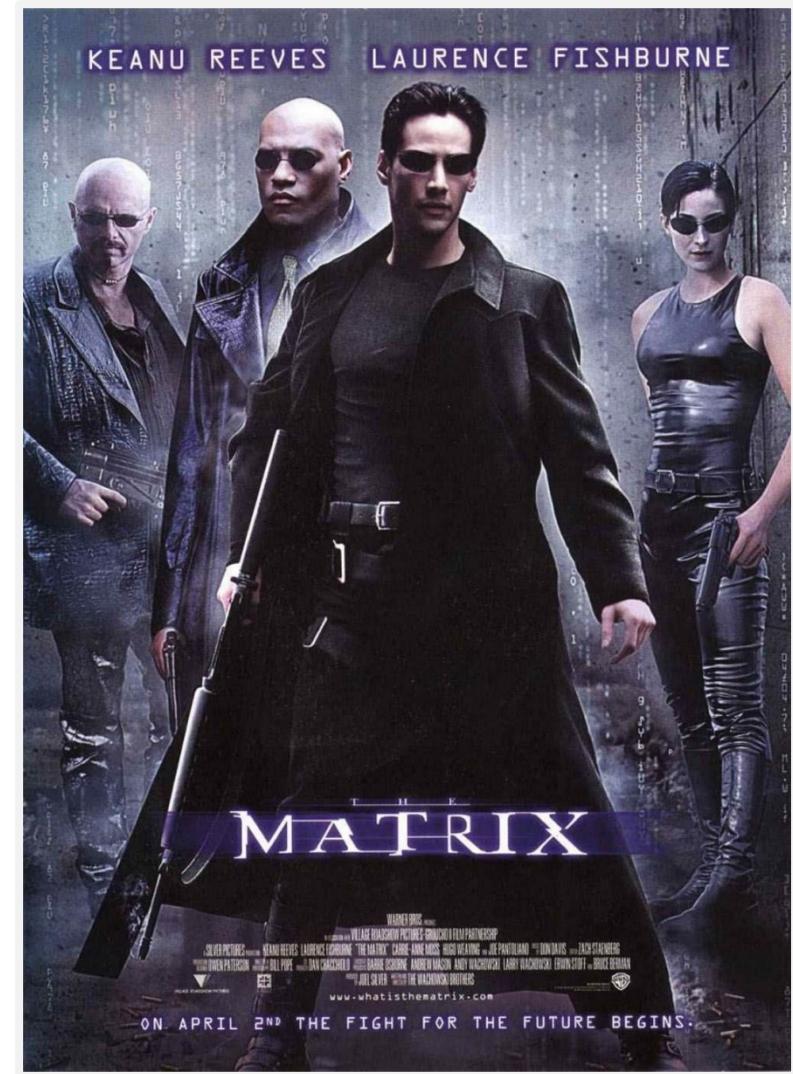
BRIEF HISTORY OF VIRTUAL REALITY - 1990-2000 (7)

1997: Georgia Tech and Emory University invent the "Virtual Vietnam" VR system (research grade) to study and treat PTSD in war veterans.



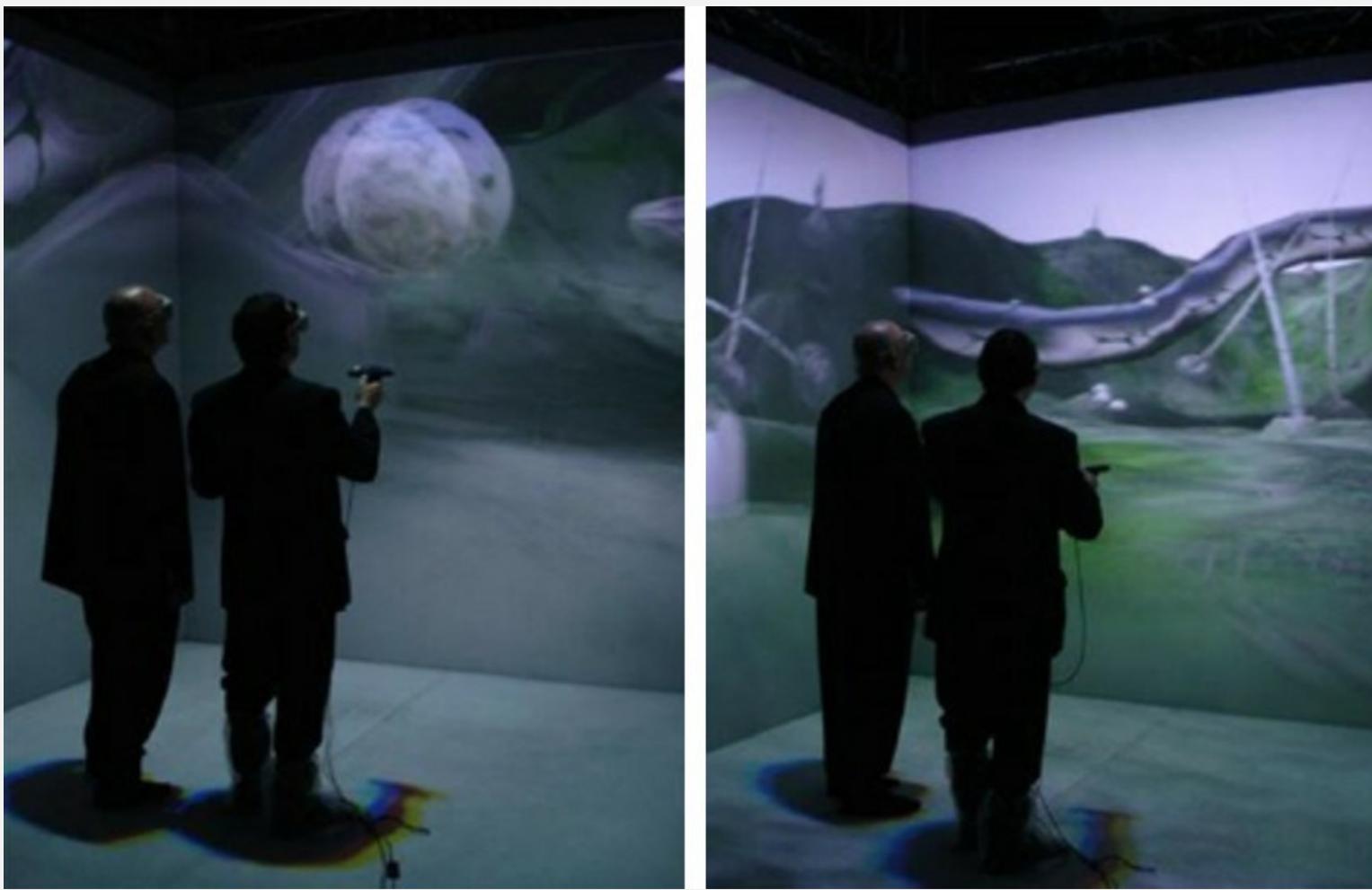
BRIEF HISTORY OF VIRTUAL REALITY - 1990-2000 (8)

1999: The movie "The Matrix" is released featuring characters living in a fully simulated world.



BRIEF HISTORY OF VIRTUAL REALITY - 2000-2010

2001: SAS Cube is commercialized by Z-A Production, a PC-based cubic room (CAVE).



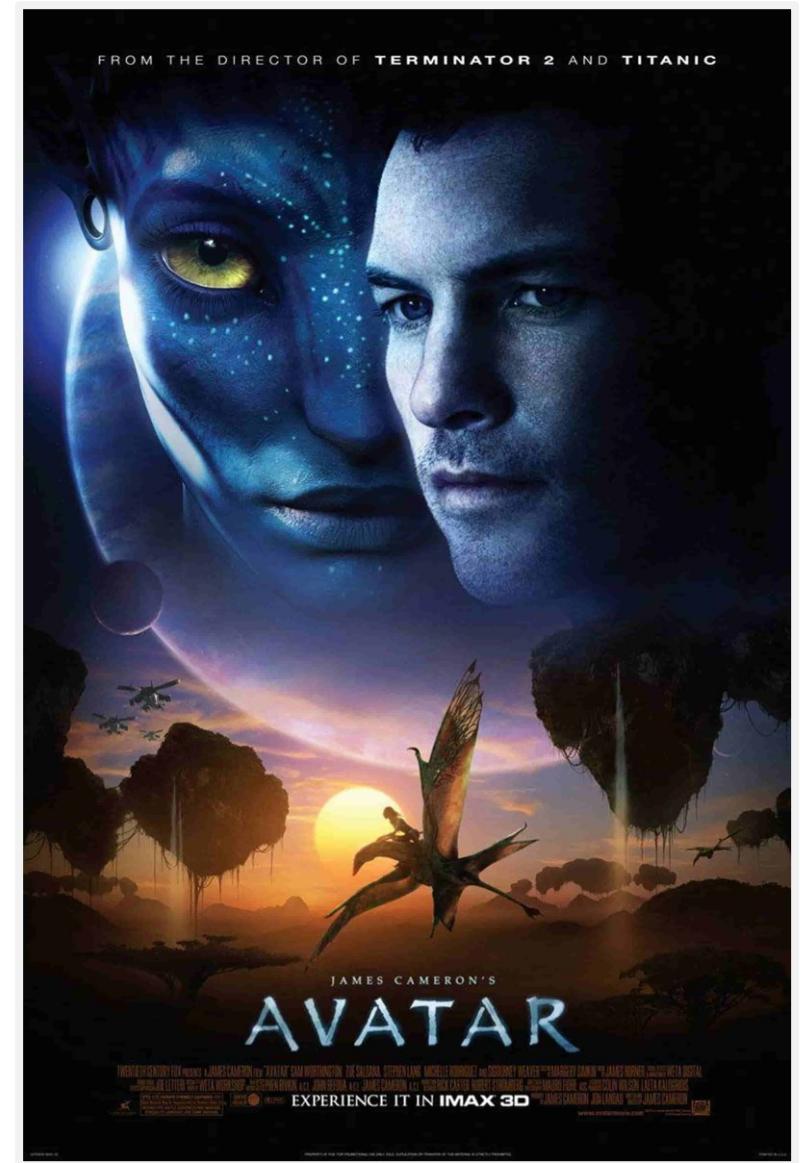
BRIEF HISTORY OF VIRTUAL REALITY - 2000-2010 (2)

2007: Google releases Street View for its Maps service, including street-level 360-degree images (right) captured by custom dodecahedral cameras (center) mounted on cars roofs (left).



BRIEF HISTORY OF VIRTUAL REALITY - 2000-2010 (3)

2009: The 3D movie "Avatar" is released, filmed with custom-built stereo cameras and 3D software represents the most expensive movie ever made because of this new tech.



BRIEF HISTORY OF VIRTUAL REALITY - 2000-2010 (4)

2010: Palmer Luckey invents the first prototype of the Oculus Rift HMD (later commercialized collaborating with John Carmack).



BRIEF HISTORY OF VIRTUAL REALITY - 2010-2020

- 2012: Palmer Luckey launches a Kickstarter to fund the product development of his Oculus Rift HMD prototype (the campaign raises ~2.5 million \$).
- 2014: Facebook buys Oculus, Sony releases the PlayStation VR, Google launches the Google Cardboard, and Samsung markets the Samsung Gear VR.
- 2016: Every tech company releases its own VR products (Oculus Rift and HTC Vive leading).
- 2018: The Oculus Half-Dome HMD is announced, including varifocal lenses, a wide FOV (140 degrees), face-tracking, eye-tracking, hand-tracking, etc. (see [video](#)).
- 2019: “Beat Saber”(VR) is the first SW app to sell over 1 million copies in less than 1 year.
- 2020: Standalone VR (non-wired) is leading the market with the Oculus Go and the Oculus Quest, while mobile VR is declining rapidly.

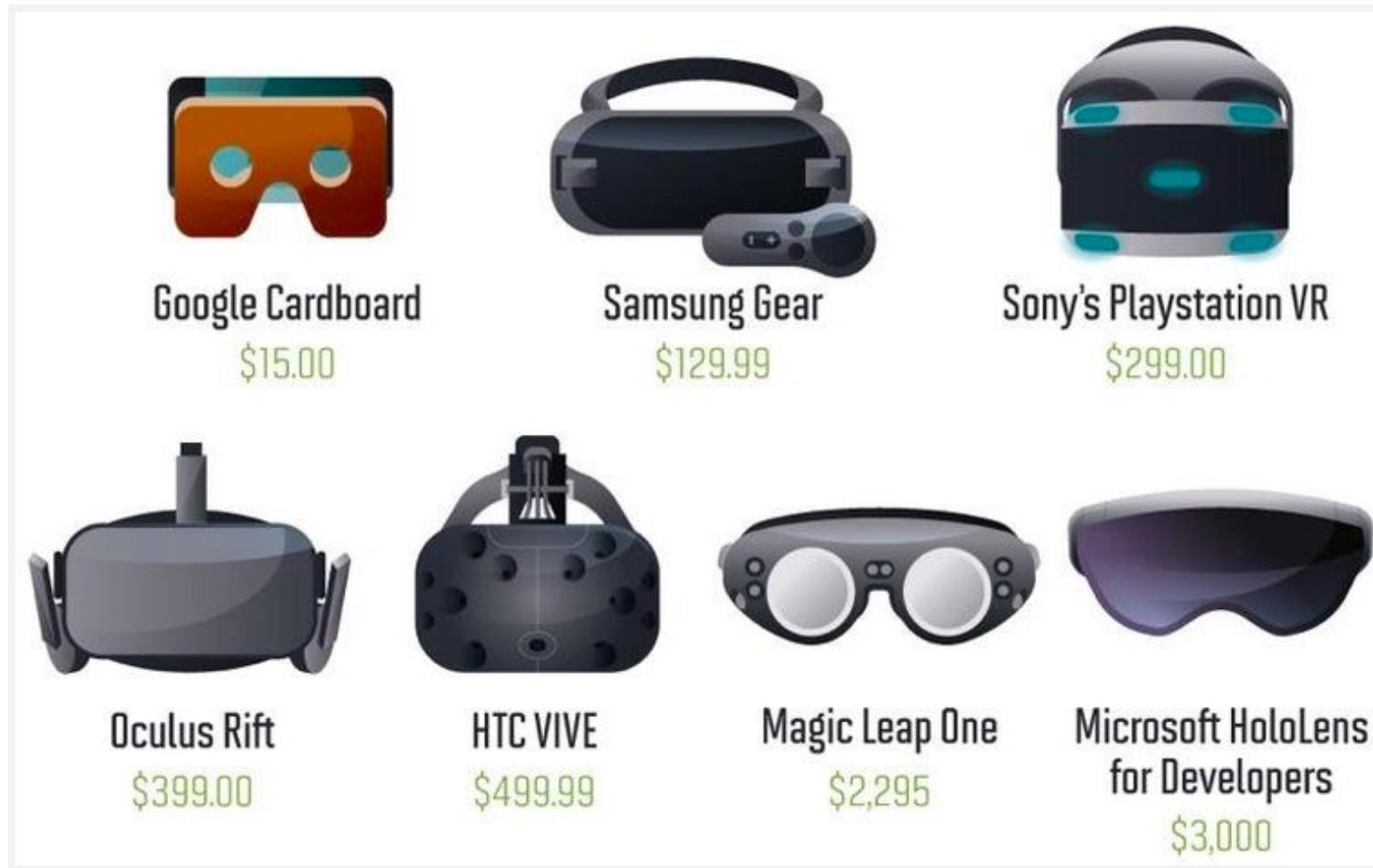
BRIEF HISTORY OF VIRTUAL REALITY - 2010-2020 (2)

2019: Oculus Quest introduces wireless, standalone VR.



BRIEF HISTORY OF VIRTUAL REALITY - 2010-2020 (3)

2020: The VR-AR market in 2020 includes multiple different headsets designed for various targets (consumer, research etc.) and marketed with different prices.



BRIEF HISTORY OF VIRTUAL REALITY - 2022

THE WILD
IMMERSIVE COLLABORATION
FOR TEAMS

2022 Business VR Headset Comparison Chart (Q1)

| | Meta Quest 2 | Pico Neo 3 | HP Reverb G2 | Valve Index | Vive Pro 2 | Vive Pro |
|------------------------------|--|--|---|---|---|---|
| |  |  |  |  |  |  |
| Official Support in The Wild | ✓ | ✓ | ✓ | □ | □ | ✓ |
| Resolution / Eye | 1832 x 1920 | 1832 x 1920 | 2160x2160 | 1440x1600 | 2448 x 2448 | 1440x1600 |
| Refresh Rate (HZ) | 90/120 | 90 | 90 | 144 | 120 | 90 |
| Field of View | 100° | 98° | 114° | 130° | 120° | 110° |
| Weight | 503g | 620g | 544g | 570g | 850g | 563g |
| Tracking | Inside-out | Inside-out | Inside-out | Base Stations (more equipment = more precise hand tracking) | Base Stations (more equipment = more precise hand tracking) | Base Stations (more equipment = more precise hand tracking) |
| Type | Standalone (no wires, less powerful processor) + option to wirelessly stream or tether to a PC with a cable | Standalone (no wires, less powerful processor) + option to wirelessly stream to a PC | Tethered (wired to your PC, more powerful, can run larger models) | Tethered (wired to your PC, more powerful, can run larger models) | Tethered (wired to your PC, more powerful, can run larger models) | Tethered (wired to your PC, more powerful, can run larger models) |
| Price | \$299 | \$699 | \$599 | \$999 | \$1399 \$1599 | \$1199 \$1399 |
| Summary | A great standalone headset for personal or business use. What you lose in processing power you gain in easy setup and freedom of movement. AirLink and the Link cable makes this a great option for running larger models as well. | A fantastic Enterprise standalone (or optional PC-streaming) headset focused on privacy and control, with ability to deploy software through Multiple Device Managers. | An affordable, high-res, tethered headset for running large models from your PC. | A top-of-the-line gaming headset. Base stations and wires require more setup and configuration, but create a smooth and powerful experience in-headset. | A top-of-the-line gaming headset. Base stations and wires require more setup and configuration, but create a smooth and powerful experience in-headset. | An older but still powerful gaming headset. Base stations and wires require more setup and configuration, but create a smooth and powerful experience in-headset. |

PART 2: FUTURE OF VR

The future of VR holds even greater promise with emerging technologies and innovations pushing the boundaries of what is possible.

This section summarizes the main emerging technologies and innovations in VR:

- **Advanced hardware** (new VR headsets, novel displays, innovative tracking tech, etc.).
- **Haptic feedback** (novel force/tactile feedback interfaces).
- **Tracking systems** (eye tracking, hand/finger tracking, full-body tracking, etc.).
- **Spatial computing** (object recognition, context awareness, etc.).
- **AI-powered interactions** (adaptive gameplay, virtual assistants, etc.).
- **Biometric feedback** (monitoring physiological responses).
- VR collaborative work platforms (virtual desktops, collaborative VR design, etc.).
- Healthcare applications (VR-based therapy, etc.).
- Virtual tourism and entertainment.

NEW VR HARDWARE



See: ovrtechnology.com

NEW HAPTIC INTERFACES



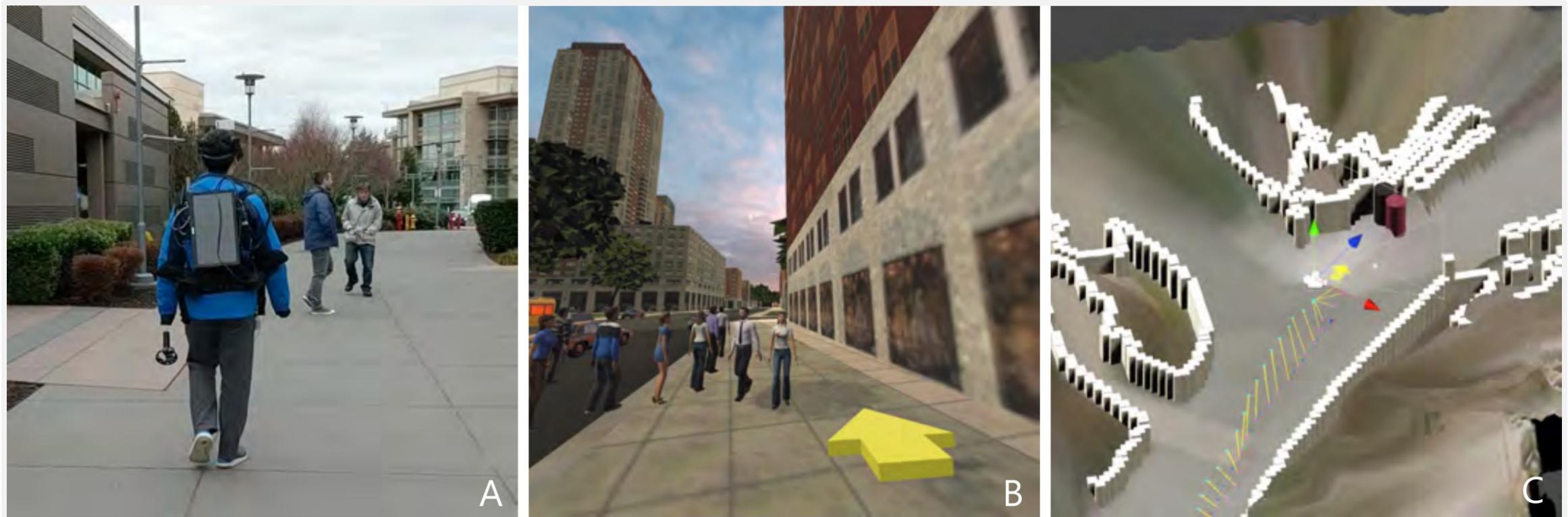
See: docs.ultraleap.com/haptics

NEW TRACKING SYSTEMS



See: techcrunch.com/2024/01/22/disney-holotile

NEW SPATIAL COMPUTING APPLICATIONS



See: www.microsoft.com/en-us/research/publication/dreamwalker

NEW AI APPLICATIONS FOR VR



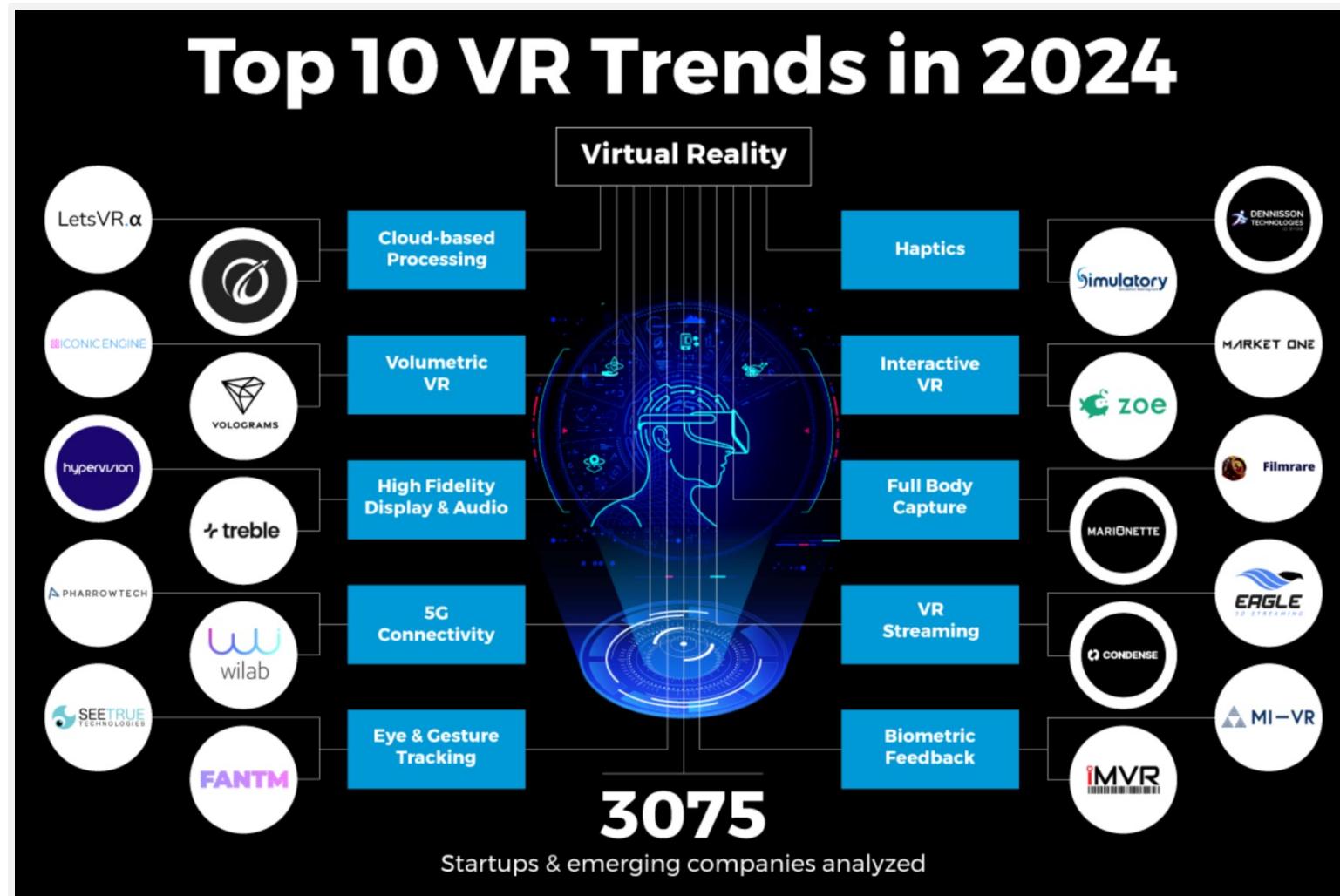
See: www.computationalimaging.org/publications/neuralholography

NEW BIOMETRIC FEEDBACK FOR VR



See: spectrum.ieee.org/brainy-startup-neurable

CURRENT VR TRENDS



See: www.startus-insights.com/innovators-guide/vr-trends

PART 3: VR SW DEVELOPMENT IN UNITY

"Unity is so much more than the world's best real-time development platform - it's also a robust ecosystem designed to enable your success. Join our dynamic community of creators so you can tap into what you need to achieve your vision."

UNITY TECHNOLOGIES

Applicazion Fields: videogames, architecture, automotive, movies, XR, etc.

"Create once, deploy across 25+ leading platforms and technologies to reach the largest possible audience."

UNITY TECHNOLOGIES

See: unity.com

REFERENCES

- These slides are available online at: github.com/turinig/vrphd
- Unity website: unity.com
- "History of VR" virtualspeech.com/blog/history-of-vr
- "The History of VR" vrx.vr-expert.com/the-timeline-of-virtual-reality
- "History of Virtual Reality" www.vrs.org.uk/virtual-reality/history
- "Future of Virtual Reality: Emerging Technologies and Innovations"
- "Explore the Top 10 Virtual Reality Trends in 2024"

