

History

History or AR, VR and 3D UIs



Overview

What is AR/MR/VR/XR ... 3D?

History

Technology

Displays

Tracking

3D Graphics

Administrivia

Project IRB (see Syllabus / Project pages)

Papers and Readings page:

Some old papers to get you started; papers in texts are good too
You should find more!

Comment on page, mention in Teams channel, or in class
Most things in Digital Library

ASK QUESTIONS!

If I go to fast ...

If I don't explain things ...

If you disagree ...

3D UI's, Virtual Environments, VR, AR, ...

See books for lots of definitions of lots of terms!

3D Interaction

HCI performed in real or virtual 3D space

Doesn't require 3D displays, 3D devices

3D UIs are UIs with 3D interaction

Virtual Environments are 3D worlds w/ real-time control by user

AR, VR, MR are variations of VEs

XR is ill-defined (I use it as xR, meaning any-R)

Huge variety of non-immersive 3D tech

Image from https://commons.wikimedia.org/wiki/File:NTTICC_ImmersionaDesk.jpg

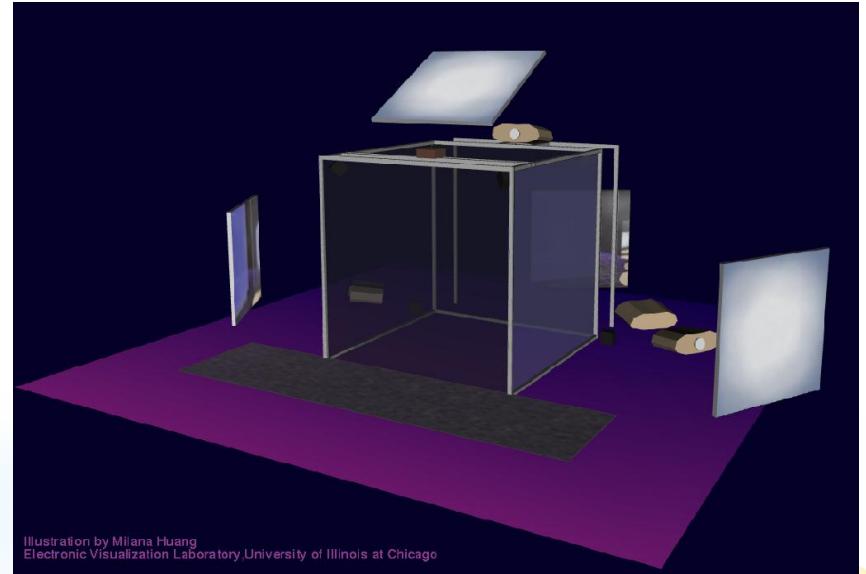


Image from <https://zspace.com>



Copyright 2020 Blair MacIntyre ((CC BY-NC-SA 4.0))

What is Virtual Reality?

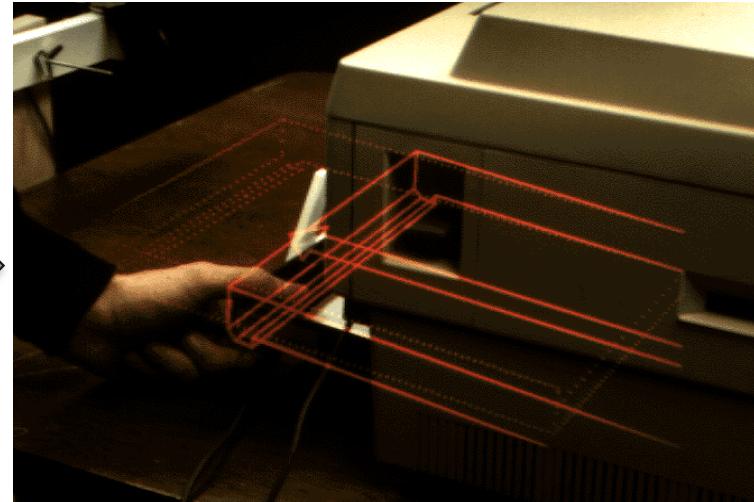
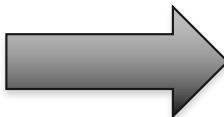
Immerse in a VE with real-time tracking and sensing, immersive displays that try to replace a user's perception of the world



What is Augmented Reality?

Enhance user's senses with computer generated information

Augment, not replace using see-through displays



Images courtesy of Blair MacIntyre. Copyright Columbia University.

In 1994, Milgram Defined AR in Relation to VR and Reality

AR sits between the real world and virtual reality, combining both. Some amount of real-world knowledge is needed to know where to put the virtual content.

AR is closer to the real world than to the virtual world, since most of what the user sees is real.

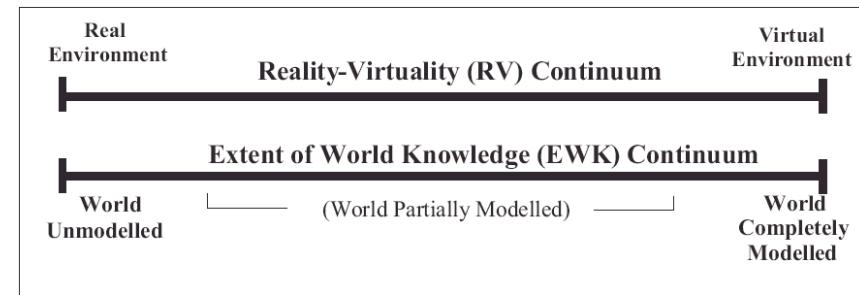


Figure 1.1 Reality-Virtuality (RV) Continuum, in parallel with Extent of World Knowledge (EWK) Continuum.

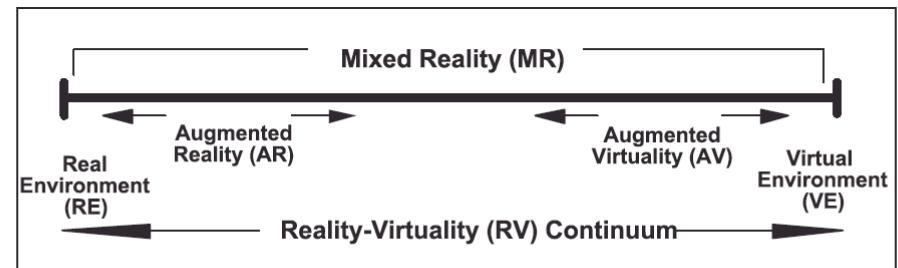


Figure 1.7 Definition of Mixed Reality, within the Context of the RV Continuum.

The First 3D (AR) Display

Ivan Sutherland created the first see-through head-mounted AR display at Harvard in 1968

The display was tracked in 3D by the mechanical linkage holding it to the ceiling

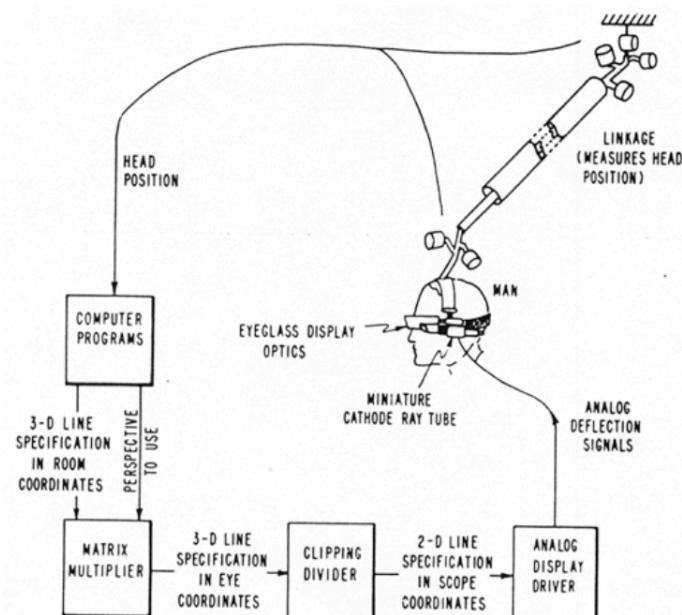
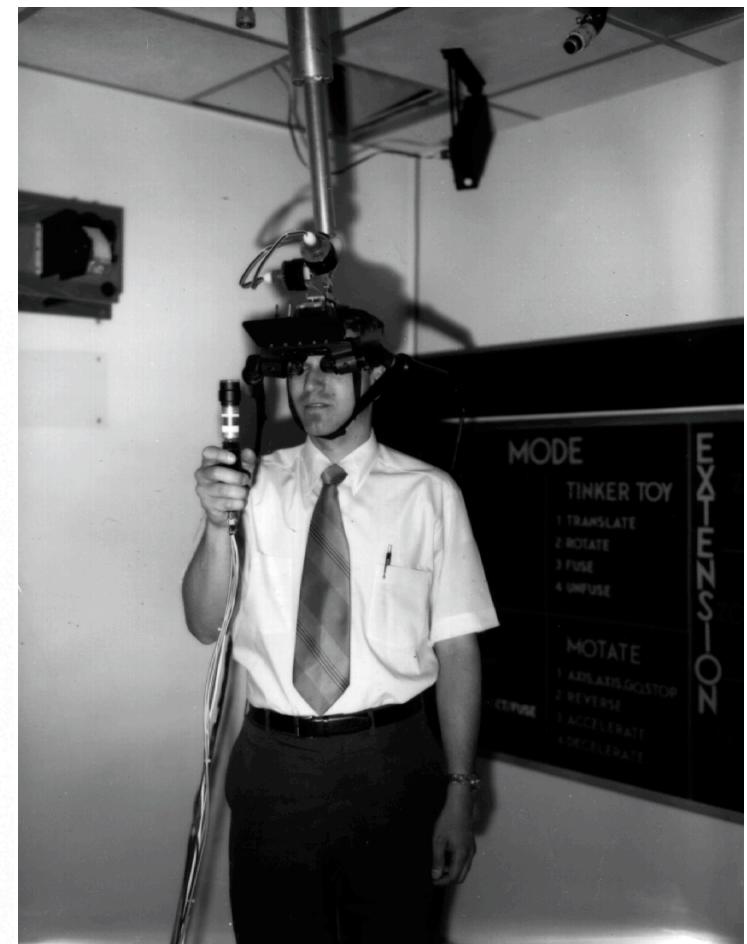


FIGURE 1—The parts of the three-dimensional display system



Ivan E. Sutherland, *A Head-Mounted Three-Dimensional Display*, 1968 Fall Joint Computer Conference

Nothing till the 80's and 90's

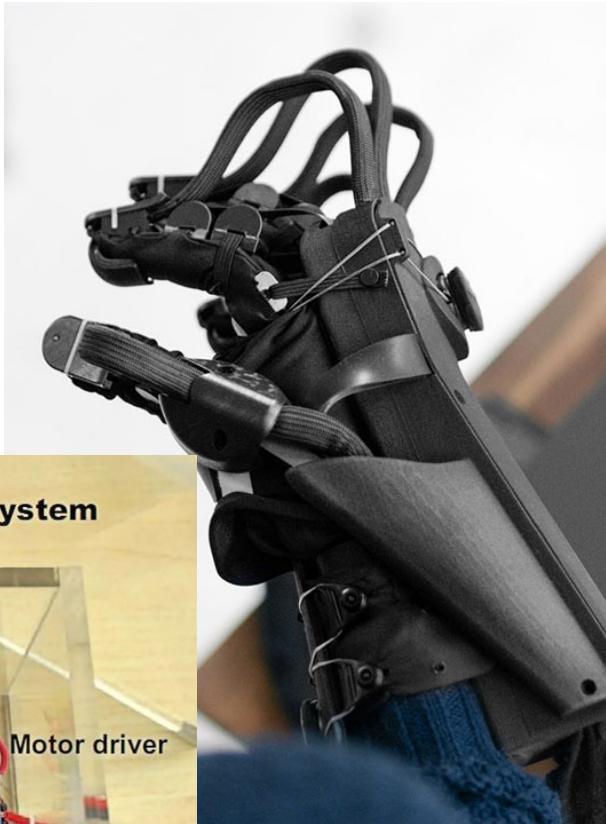
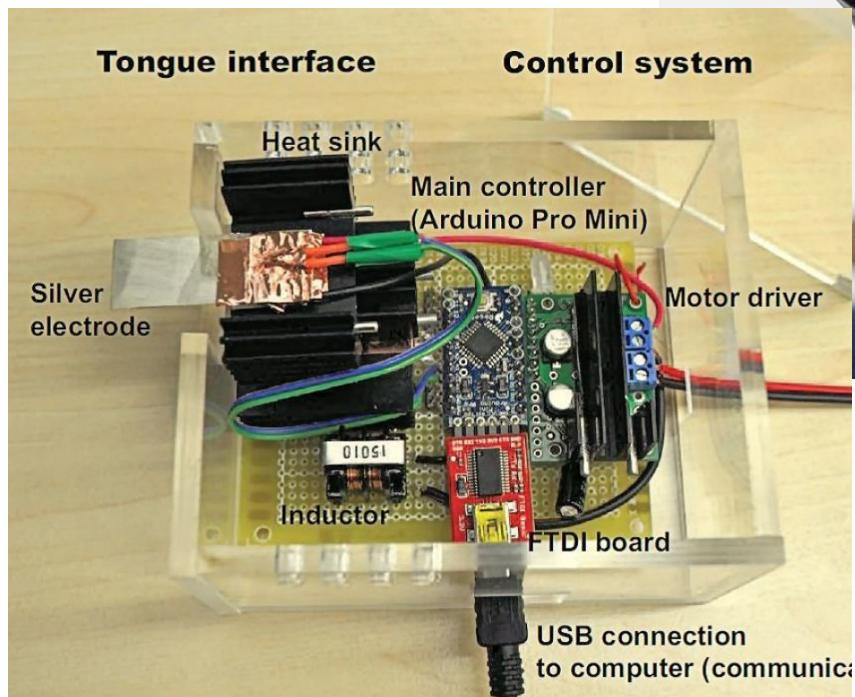
First attempt at commercializing
symbolized by VPL
(eyephone, dataglove)

Too expensive, too low quality
computers
displays
input



Image from https://en.wikipedia.org/wiki/Wired_glove

All Senses have been explored



VR has reached consumers



AR finally reaching enterprise / verticals



Backpack Computer

Tablet Computer

High-end PDA

Cellphones, Game consoles

courtesy Daniel Wagner, Graz



Question: Handhelds vs Headmounts?

Many of the examples here used HMDs

Some require them, some don't

Worth thinking seriously about the differences

Many applications appropriate for one but not the other

Why use AR vs shared displays?

“Zero Effort”
Interaction

Continuous
Peripheral
Information



Privacy

**In Place
Display**

Per-user Customization

The Term “Augmented Reality” is Coined at Boeing

In 1990, a group of Boeing researchers imagines aligning manufacturing instructions with a person’s view of the world using see-through head-worn displays

They coin the term “Augmented Reality” to distinguish the concept from “Virtual Reality”

The project eventually results in a working prototype to assist with wire-bundle assembly in 1997

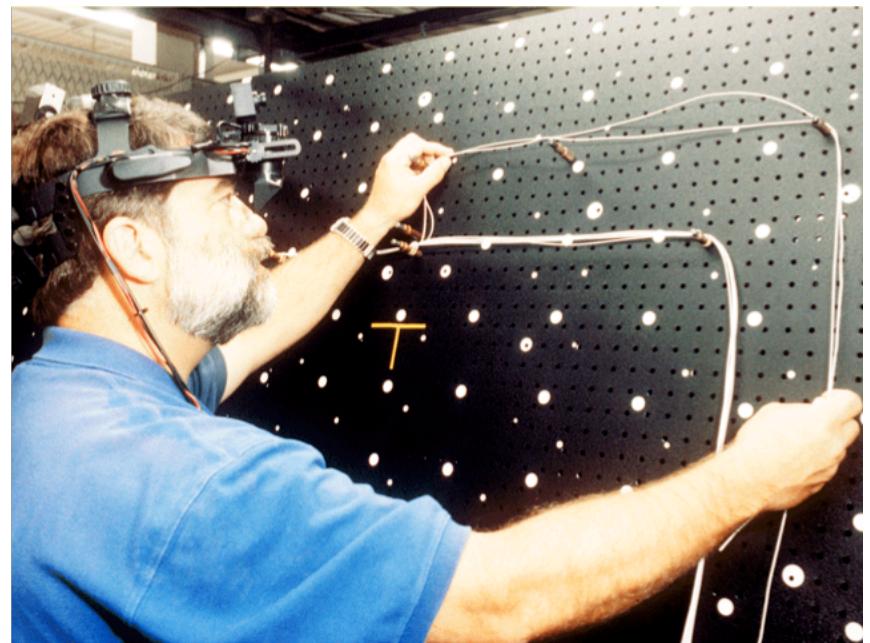
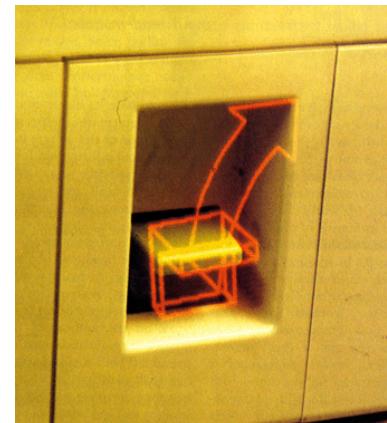
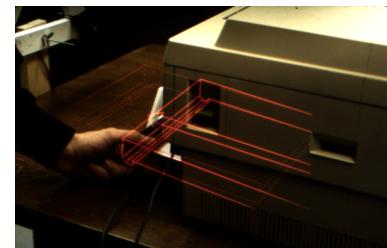


Image courtesy of David Mizell.

AR research in the 1990's: KARMA

KARMA (Knowledge-based Augmented Reality Maintenance Assistant) was one of the first AR demonstration systems, built by Blair MacIntyre, Dorée Seligmann and Steven Feiner in 1991 at Columbia University.

- Using a hand made display and four computer to handle the computation, KARMA had an integrated knowledge-based system that design maintenance instructions, dynamically based on where the user was looking, where the objects were located, and what needed to be communicated.



Images courtesy of Blair MacIntyre. Copyright Columbia University.

AR research in the 1990's: Merging Ultrasound Imagery

Henry Fuchs and others at UNC Chapel Hill presented a first demonstration of merging ultrasound data of a fetus onto a live patient in 1992.

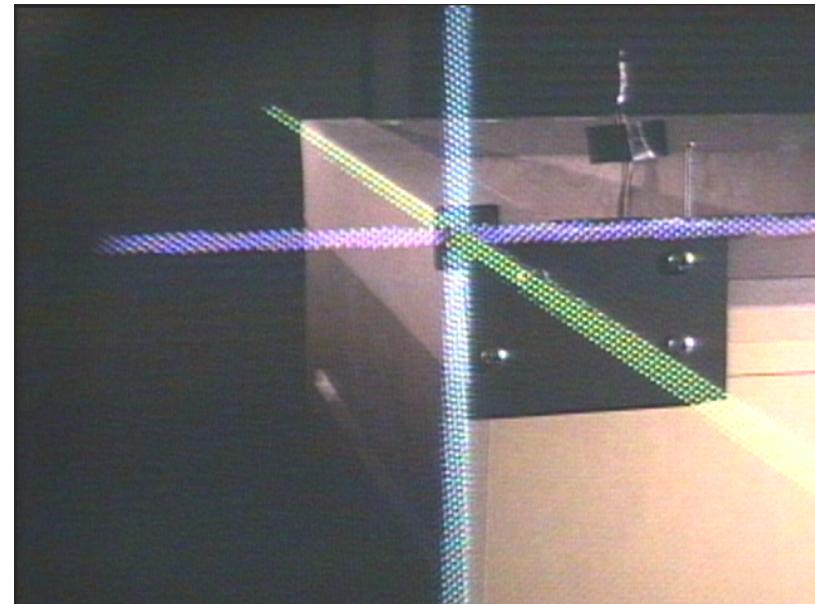
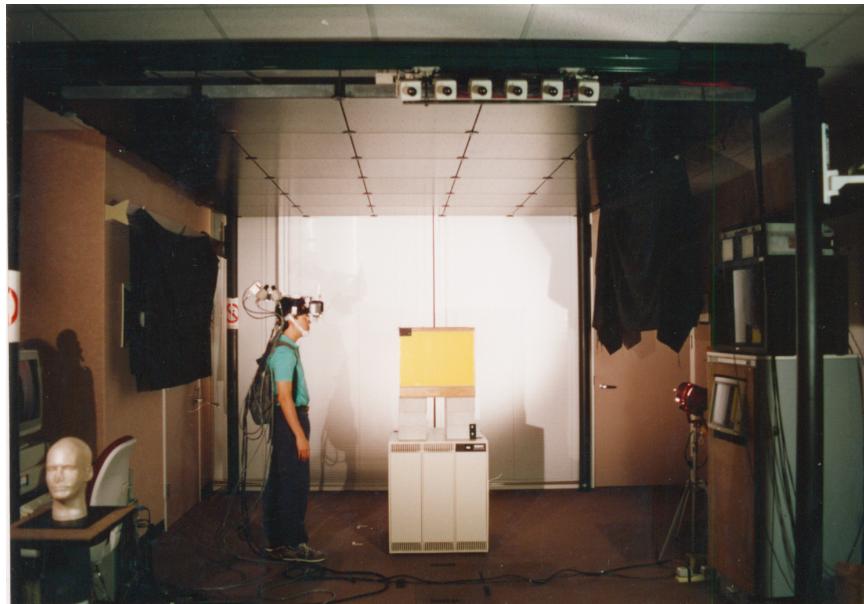
In 1996, doctors tested a follow-on system for needle biopsy guidance.



Images courtesy of Ron Azuma. Copyright UNC Chapel Hill.

AR Research in the 1990's: Tracking and Registration

Throughout the early 1990's, researchers at UNC Chapel Hill worked on a high-accuracy optical ceiling tracker (now available as the HighBall from 3rdTech), culminating in Ronald Azuma's PhD work demonstrating near-perfect registration of a simple scene using this system combined with inertial sensors and carefully integrated with custom rendering hardware and a custom head-worn display.



AR Research in the 1990's: FoxTrax and Broadcast AR

The NHL started US broadcasts in 1995, and a common complaint was difficulty following the puck. The FoxTrax puck was developed by Fox Sports, and used between January, 1996, and the end of the 1998 season.

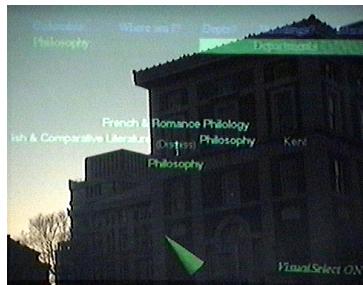
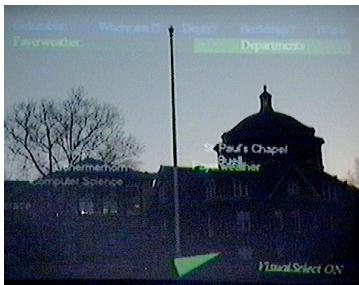
The technology was spun off in 1998 to form Sportvision, which created much of the broadcast TV sport enhancements seen today.

These systems work because the fixed broadcast cameras are heavily instrumented, the environment is measured and accurately modeled, and the broadcast signal can be delayed to give engineers time to correct problems. Often, multiple live engineers monitor a system.



AR Research in the 1990's: The Touring Machine

Built in 1996 at Columbia University, the "Touring Machine" was the first working demonstration of a mobile AR tour guide. The backpack contains a GPS, wireless network, and computer. The user's see-through head-worn display overlays labels on the surrounding buildings, and the handheld tablet displays additional detailed information.



Images courtesy of Blair MacIntyre. Copyright Columbia University.

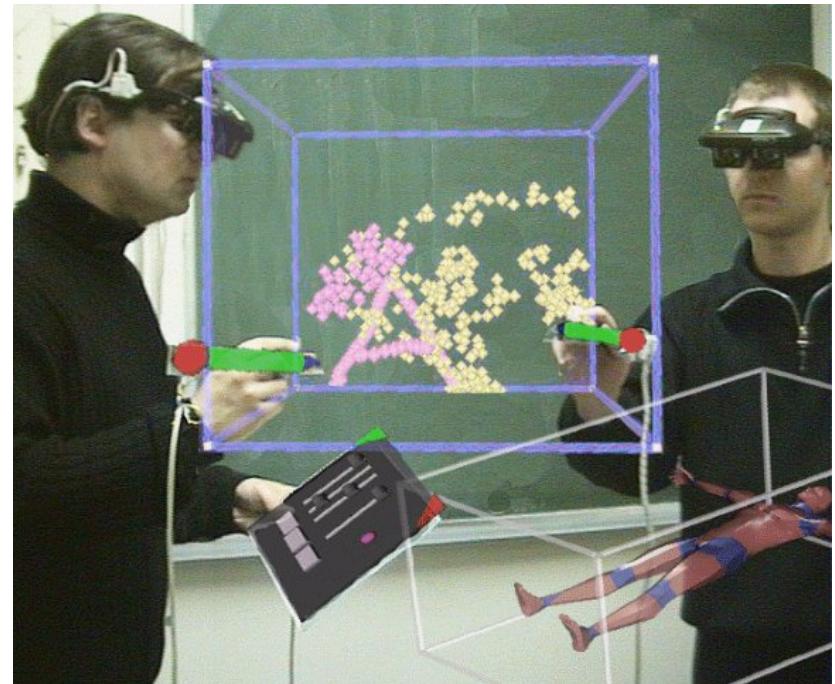
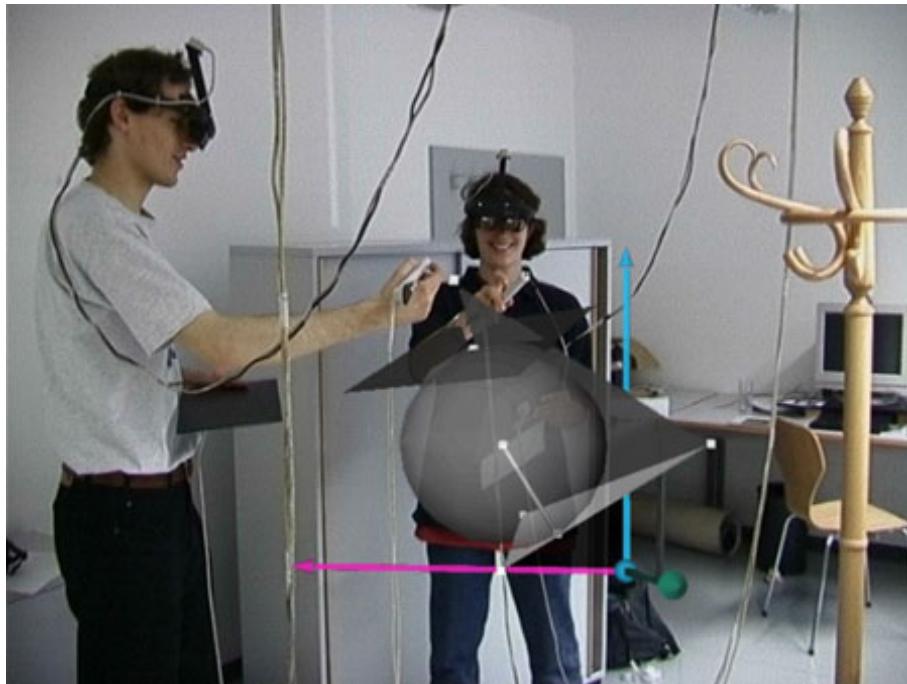
AR Research in the 1990's: The Touring Machine

Subsequent TM
versions added
3D content



AR Research in the 1990's: Studierstube

In 1996, Dieter Schmalstieg created Studierstube, the first comprehensive architecture for collaborative augmented reality. Many applications and technology concepts were developed and demonstrated in Studierstube over the years, and followon projects still bear the same name.



Images courtesy of Dieter Schmalstieg. Copyright TU Vienna.

AR Research in the 1990's: The Virtual Retinal Display

In 1998, researchers at the HITLab at the University of Washington demonstrated the Virtual Retinal Display, a revolutionary head-worn display that scans the image directly on the wearers retina. The VRD holds forth the promise of a small, light display for mobile AR. The technology has been commercialized by Microvision.



Images courtesy of Microvision.

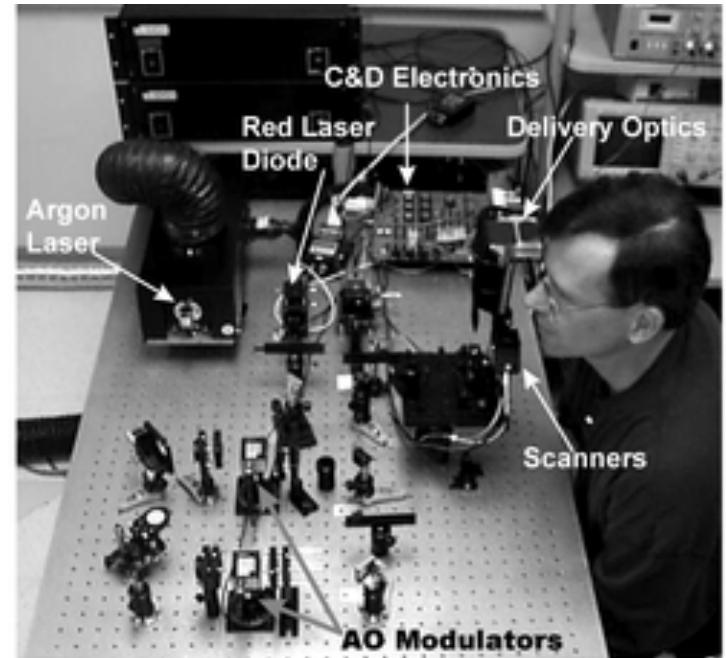


Image from Pryor, Homer L., Furness, Thomas A. and Viirre, E. (1998). The Virtual Retinal Display: A New Display Technology Using Scanned Laser Light. In *Proceedings of Human Factors and Ergonomics Society, 42nd Annual Meeting*, pp. 1570-1574.

Magic Books

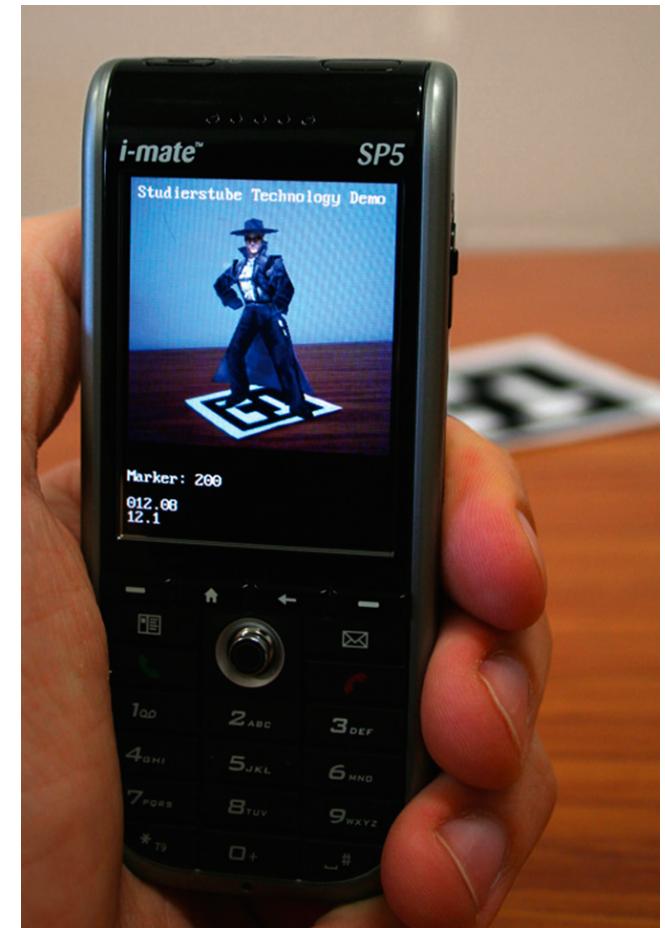
In 2001, Mark Billinghurst, Hikazu Kato and Ivan Poupyrev pioneered the concept of the “Magic Book”, using desktop computers and handheld see-through displays to create interactive stories where the content literally jumps off the page.



Images courtesy of Mark Billinghurst. Copyright University of Canterbury.

Handheld Augmented Reality

In 2003, Daniel Wagner and Dieter Schmalstieg demonstrated the first working handheld augmented reality system running on an unmodified PDA. Over the next four years, they refined the technology to run on mobile phones and handheld game consoles such as the Gizmondo.



Images courtesy of Daniel Wagner. Copyright TU Graz.

AR Areas: Tours of Historic Sites

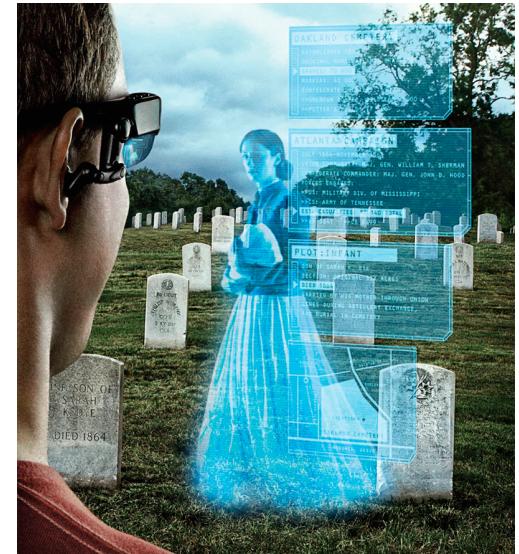
ARCHEOGUIDE was the first major project to use AR to recreate historic sites. The project ended in 2002, but other projects have tried to use AR to improve on audio or text-based tour guides.



ARCHEOGUIDE.



Copyright 2020 Blair MacIntyre ((CC BY-NC-SA 4.0))



Mock-up of a mobile AR tour. Courtesy IEEE Spec

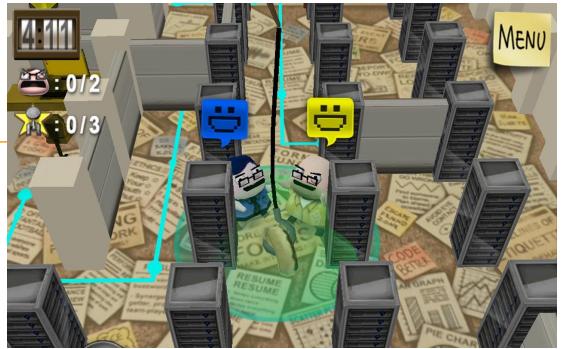


Recreation of a building at Columbia University.

AR Areas: Games and Entertainment

Canon created some of the first room-sized AR games, including R/V Border Guards (demonstrated in 2000, shown below).

Many other game prototypes have been created, including AR versions of Quake and Pacman.

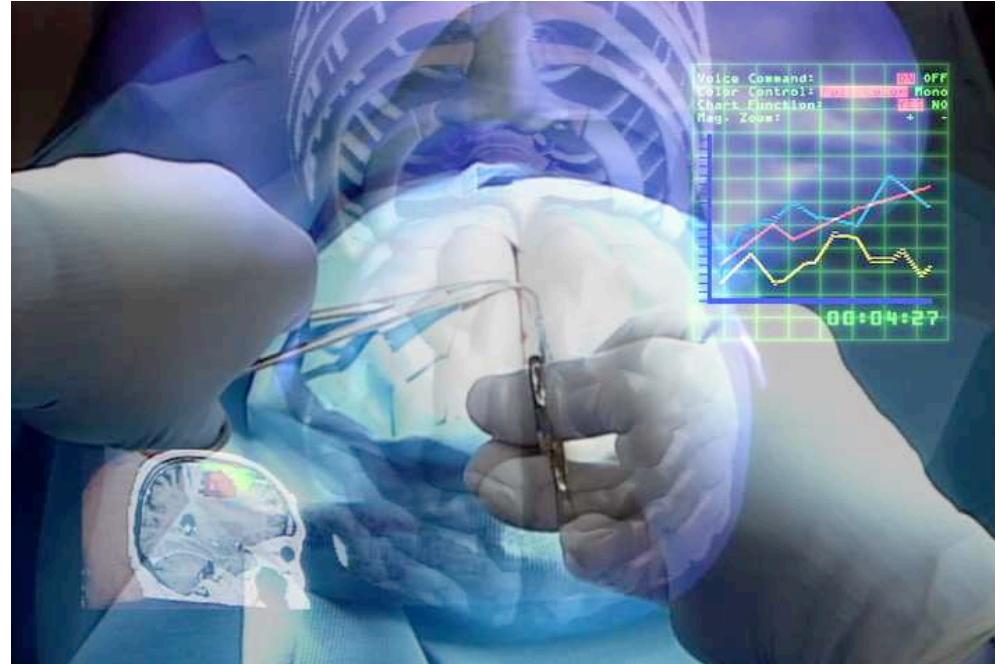
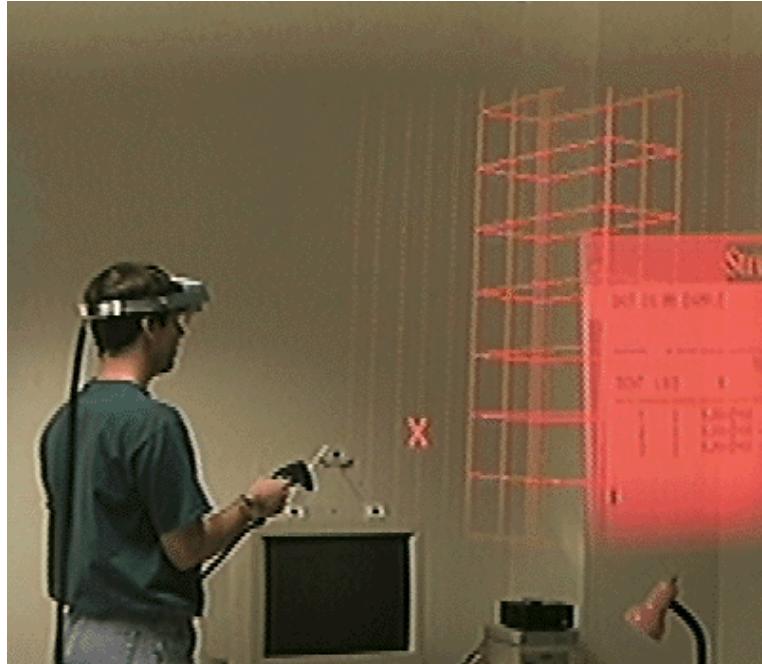


AR Quake. Copyright University of South Australia.



Human Pacman. Copyright Mixed Reality Lab, Singapore.

AR Areas: X-Ray Views

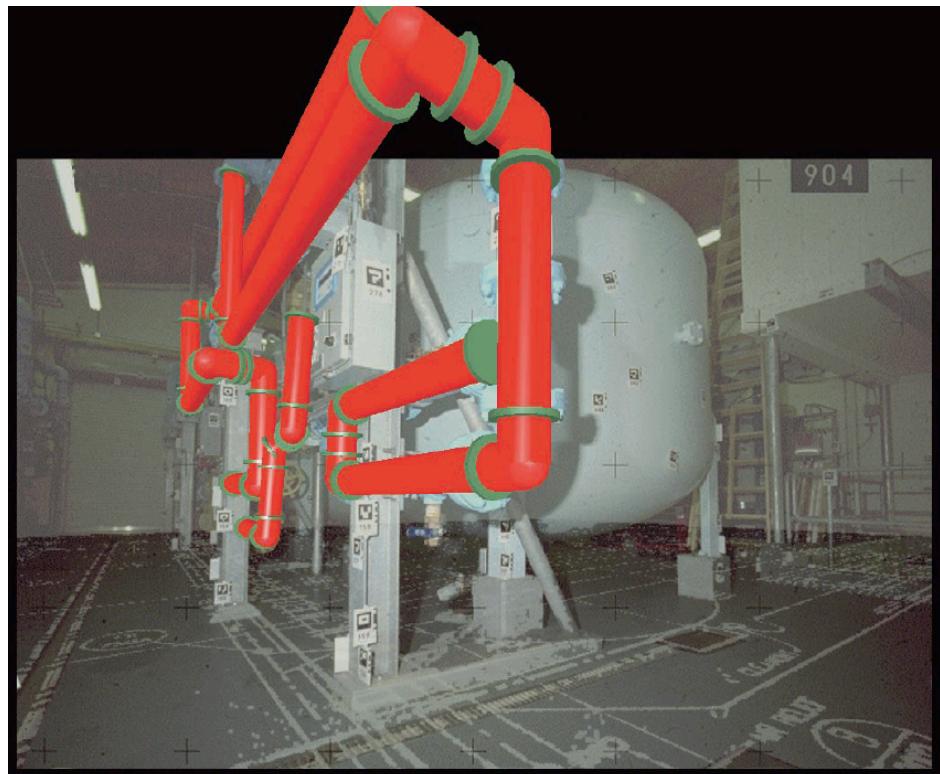


Others: views through hills, buildings

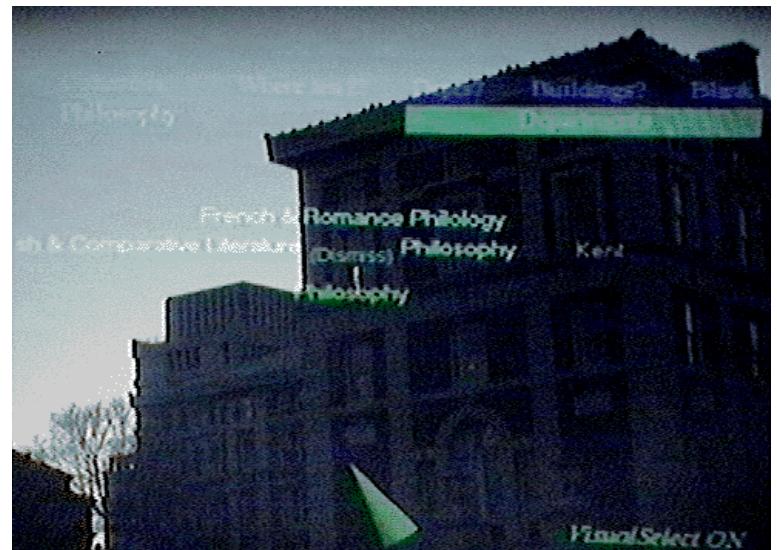
AR Areas: Enhanced Views

Merging virtual information and sensor data onto user view
E.g., aircraft HUD

For both visible and invisible entities



Courtesy Nassir Navab, Siemens Corporate Research



AR Areas: Training and Education

Includes same apps as M & R

Different interface, requirements

Similar use to VR, but “in place”

Experience more of real environment
ie. UAV Takeoff, Landing

Integrate with simulation (ie. MODSAF)

