CS-E4200
Emergent User Interfaces

Introduction to Unconventional User Interfaces & Novel Interaction Paradigms

these slides mostly adapted from 2018 course materials
https://mycourses.aalto.fi/course/view.php?id=16936&section=1 (David McGookin)
https://mycourses.aalto.fi/course/view.php?id=16924&section=1 (Mark Billinghurst)

Welcome

Tapio 'Tassu' Takala
http://www.cs.hut.fi/~tta/
tapio.takala@aalto.fi

Ilyena Hirskyj-Douglas

Introduction

- The common graphical user interface (GUI) is focused on visual display and pointer+keyboard input
- "WIMP" (= window, icon, menu, pointing device)

- In the future this is not the only solution
- Not always the best, or even possible

- What can we use to build more engaging/fun/suitable UI ?

Course Objectives

- You will gain an overview of different **paradigms** for unconventional user interfaces
- You will develop a **good overview knowledge** of the different **modalities** and **technologies** that can be used to develop “post-WIMP” user interfaces
- You will gain **practical** experience by **developing an experimental user interface** to solve a particular problem

Course Overview

- Next 5 weeks lectures
  - including one team matchmaking session
- We will cover a range of background material in multimodal interaction and practical starters for the technologies in the assignments
- Then 1 **project** assignment in teams
- Assessment by report, demo and video
  - reporting in scientific conference format

Timetable (corrected)

Week	Date	Time	Place	Agenda
2	Thu Jan 10	16-18	TU 6	Lecture: Course intro
3	Thu Jan 17	16-18	TU 5	Lecture: Multimodal UI 1
4	Thu Jan 24	16-18	TU 6	Lecture: Multimodal UI 2
5	**Wed Jan 30**	–	–	**Project ideas deadline**
	Thu Jan 31	16-18	TU 5	Team matchmaking
6	Thu Feb 07	16-18	TU 6	Lecture: Physical computing
7	Thu Feb 14	16-18	TU 5	Project pitching
8	–	no session	–	–
9	**Mon Mar 04**	09:00	–	**Project Proposal DL**
10	–			Tutor Meetings …
11	–			…
12	–			…
13	–			…
14	**Thu Apr 04**	16-18	TU 5	**Compulsory Show & Tell**
15	–			Tutor Meetings …
16	–			…
17	–			…
18	**Thu May 02**	16-18	AS 3	**Project Demonstration**
19	–			
20	–			
21	**Mon May 20**	09:00	–	Report & Video Deadline

How to Pass

- Active Lecture Participation
- Project Assignment
  - Small teams of 3-4
  - A substantial Physical Interaction Device
  - 1-2 page plan - mostly as “sanity check” (4th March at 9.00AM)
  - Mid-Term Show and Tell (on 4th April)
  - Demo (on 2nd May)
  - Report (by 20th May at 9AM)
- Teams are collectively graded

HCI

- Human Computer Interaction
  - Study of how humans interact with computers
  - How we can make that interaction better
  - How can we support interaction with people through technology
- ~~Not a course on HCI!~~

A Model of HCI

gap between a user's goal for action and the means to execute that goal

Gulf of Execution

Gulf of Evaluation

difficulty of assessing the state of the system

A Computer Model of the World

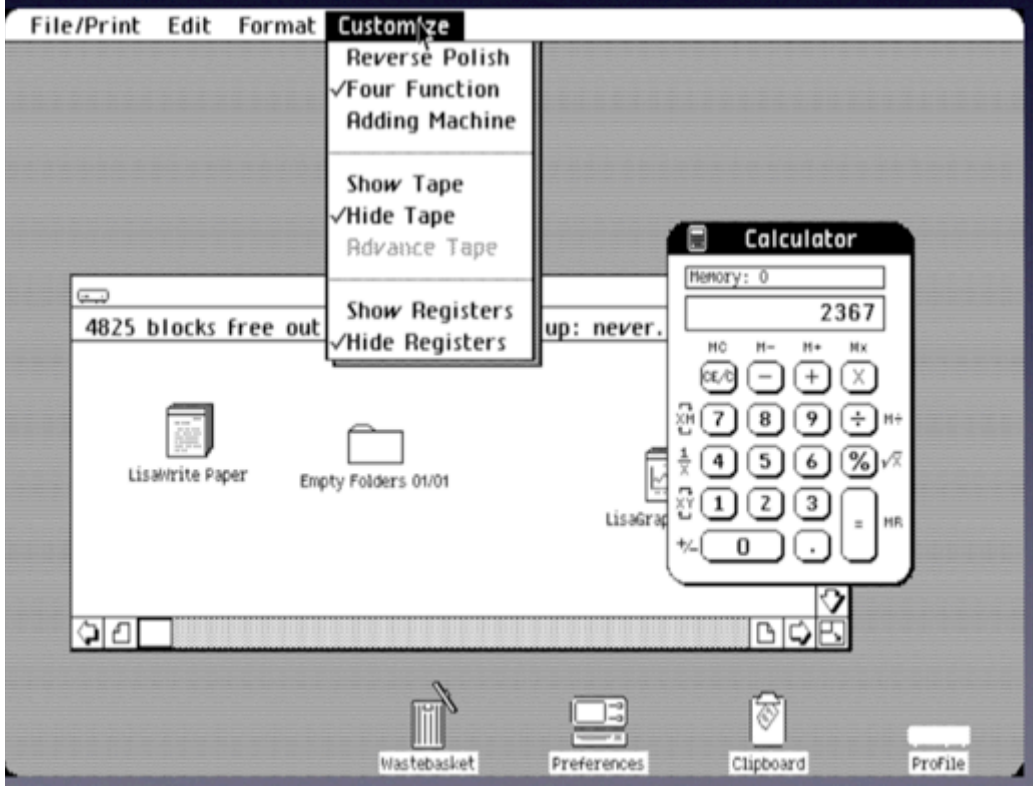
What's the Difference?

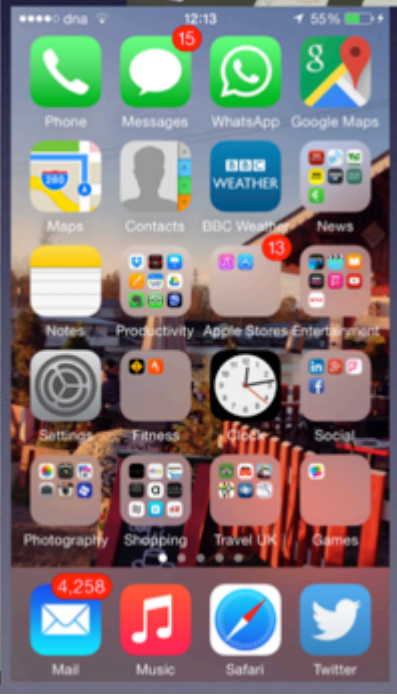
Have we changed? Or just our understanding of technology?

Or had we just not figured out how to build tech for the world?

Existing Paradigms don't work (well)

WIMP & Post-WIMP





Leads to New Paradigms

- Virtual Reality (VR)
- Augmented Reality (AR)

also called…

Mixed/Extented Reality (MR/XR)

Physical Computing

- Tangible User Interfaces (TUI)
- Organic User Interfaces (OUI)

Reality Based Interaction (RBI)

Natural User Interfaces (NUI)

- Embedded Environments
- Wearable Technology

Ubiquitous/Pervasive Computing

- etc.

Symbiotic Computing

What would be an ideal user interface ?

- which features are important?
- for what purpose?
- in which context?

- feels like acting in the real world?

Virtual Reality

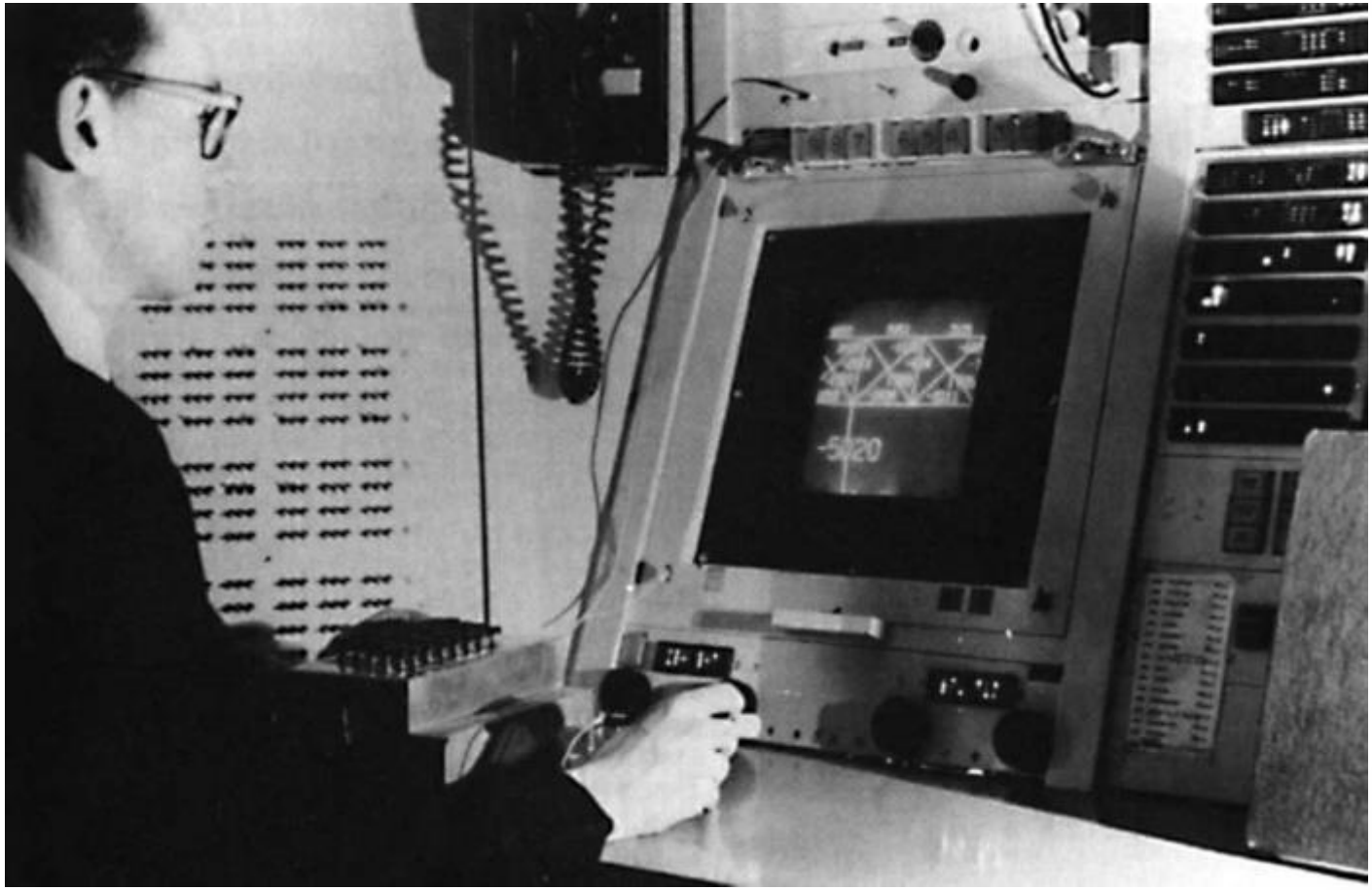
Adapted from lectures by

Bruce Thomas, Mark Billinghurst

University of South Australia

https://www.slideshare.net/marknb00/comp-4010-lecture1-introduction-to-virtual-reality

Ivan Sutherland (1963)



- Sketchpad – first interactive graphics program

Ivan Sutherland Sketchpad Demo

- https://www.youtube.com/watch?v=USyoT_Ha_bA (Part I)
- https://www.youtube.com/watch?v=BKM3CmRqK2o (Part II)

The Ultimate Display

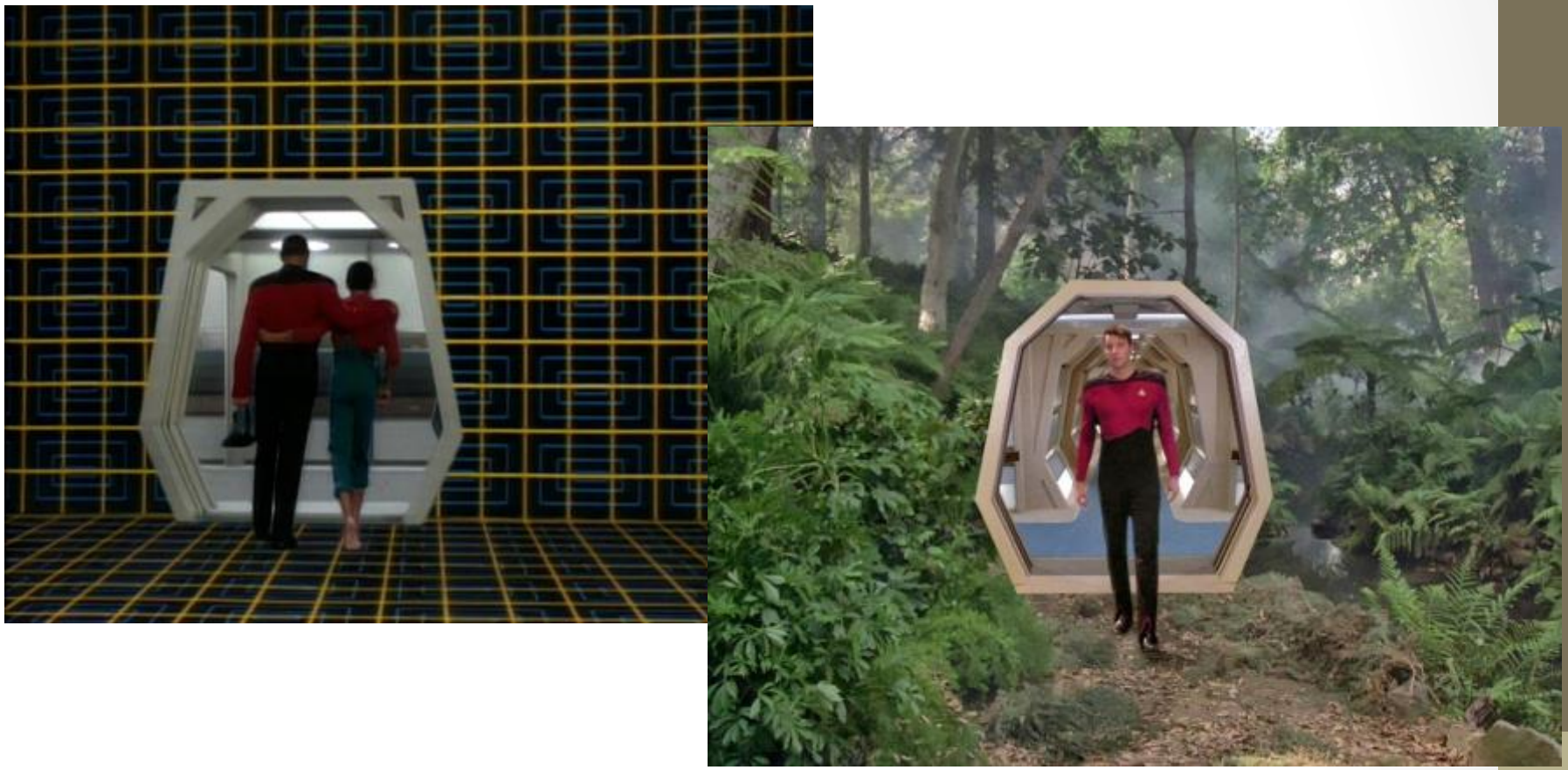
"The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal".

Ivan Sutherland, 1965

An Invisible Interface

"With appropriate programming such a display could literally be the Wonderland into which Alice walked."

Holodeck (1974)

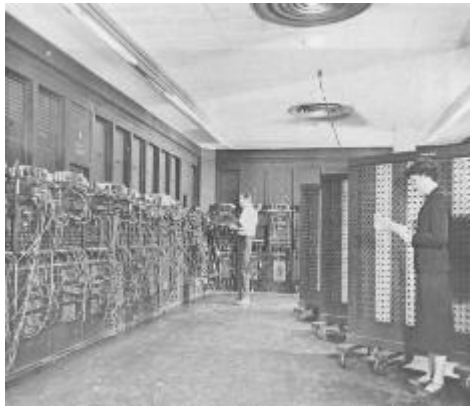


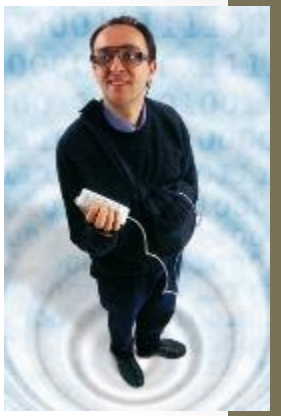
- First shown in Star Trek; The Animated Series

HoloDeck Video

- https://www.youtube.com/watch?v=oZwtVz7z0wM

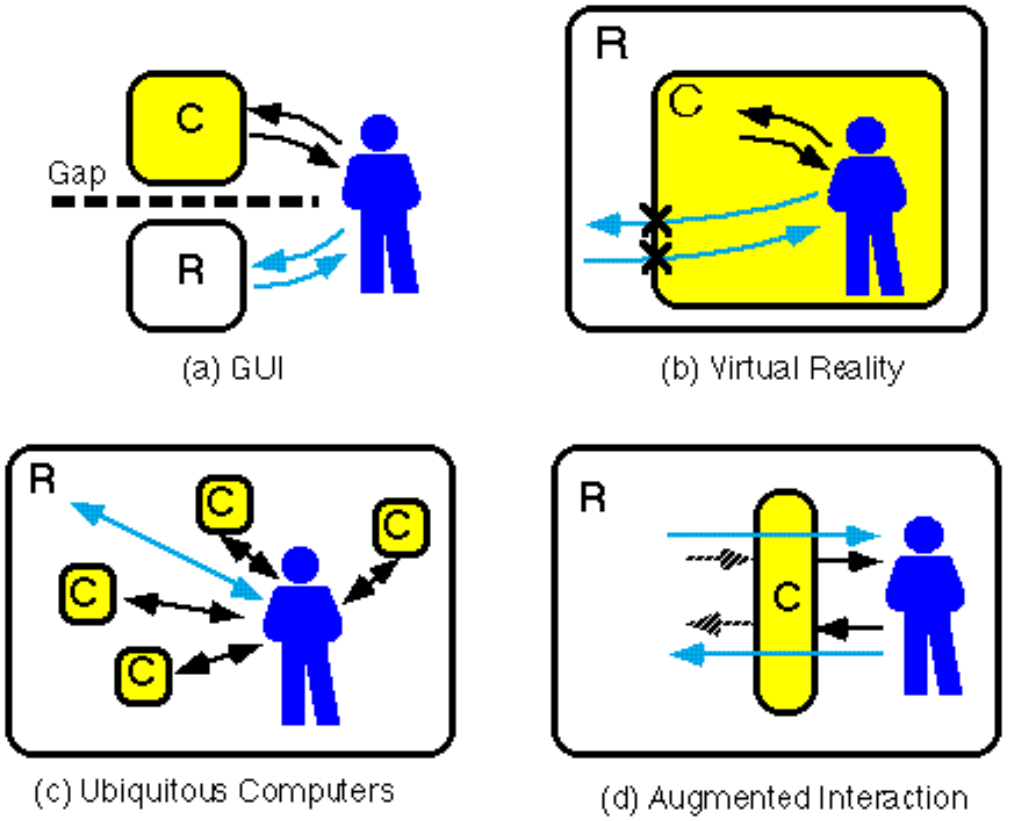
Trend Towards Invisible Interfaces



- Trend from room scale to invisible computing
- Making Computers Invisible
  - hide the computer in the real world
    - Ubiquitous Computing
  - put the user inside the computer
    - Virtual Reality

Making Interfaces Invisible

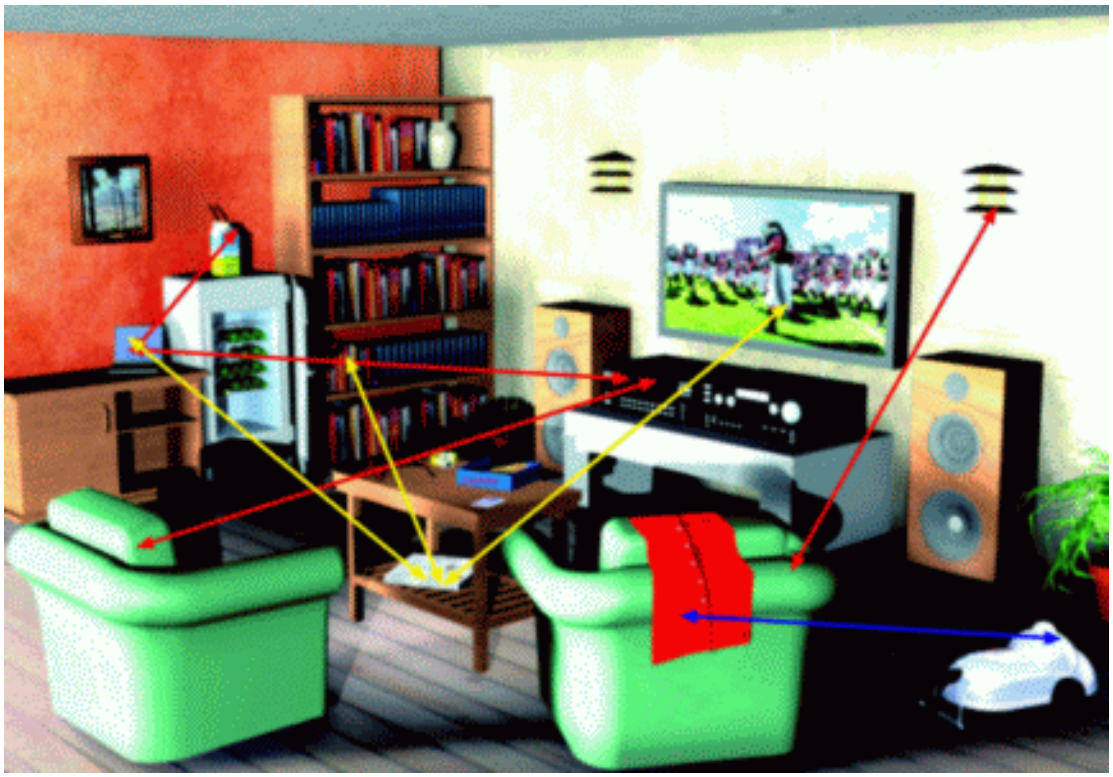


Rekimoto, J. and Nagao, K. 1995. The world through the computer: computer augmented interaction with real world environments. In *Proceedings of the 8th Annual ACM Symposium on User interface and Software Technology. UIST '*95. ACM, New York, NY, 29-36.

Graphical User Interfaces

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

Ubiquitous Computing



- Computing and sensing embedded in real world
  - Particle devices, RFID, motes, arduino, etc

Virtual Reality

- 1985…

Virtual Reality

- Immersive VR
  - Head mounted display, gloves
  - Separation from the real world

What is Virtual Reality?

virtual reality

noun

Simple Definition of VIRTUAL REALITY

Popularity: Bottom 40% of words

: an artificial world that consists of images and sounds created by a computer and that is affected by the actions of a person who is experiencing it

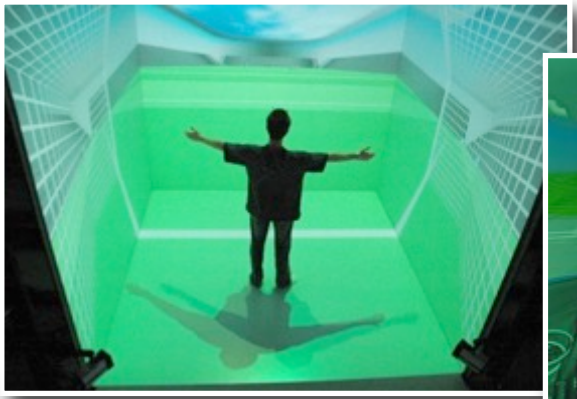
Source: Merriam-Webster's Learner's Dictionary

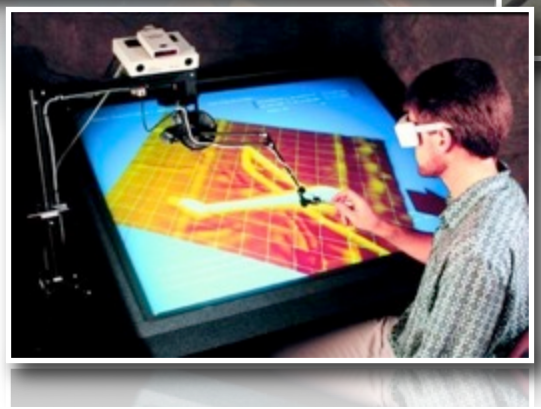
VR Goggles and Gloves

- https://www.youtube.com/watch?v=Ak-Bt7IM8Jc

VR Demo

Types of VR





Other Definitions

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 Characteristics for VR

- Virtual Reality has three key 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

Defining Characteristics

- https://www.youtube.com/watch?v=FPcbBJbGhmk

VR Experience

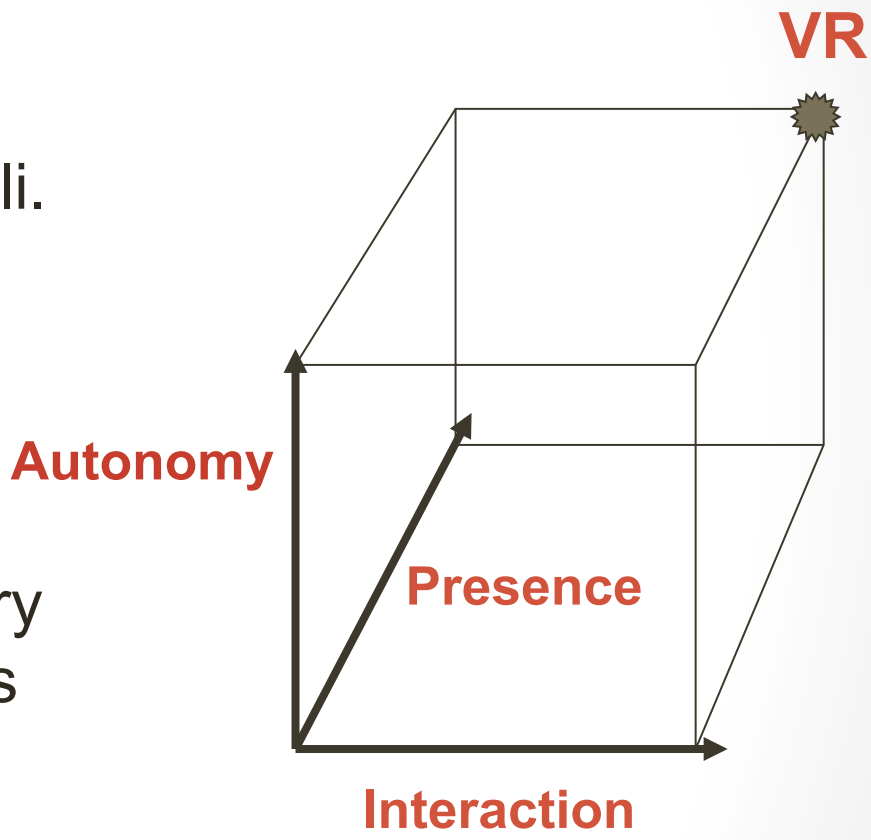
- “This is so real..”
- https://www.youtube.com/watch?v=pAC5SeNH8jw

Defined in Terms of Presence

- Presence is the key to defining VR in terms of experience
- Presence is defined as the sense of being in an environment
- Telepresence is defined as the experience of presence in an environment by means of a communication medium.
- A “virtual reality” is defined as a real or simulated environment in which a perceiver experiences telepresence.

David Zeltzer's AIP Cube

- **Autonomy –** User can react to events and stimuli.
- **Interaction –** User can interact with objects and environment.
- **Presence –** User feels immersed through sensory input and output channels



Zeltzer, D. (1992). Autonomy, interaction, and presence. *Presence: Teleoperators & Virtual Environments*, *1*(1), 127-132.

Augmented Reality

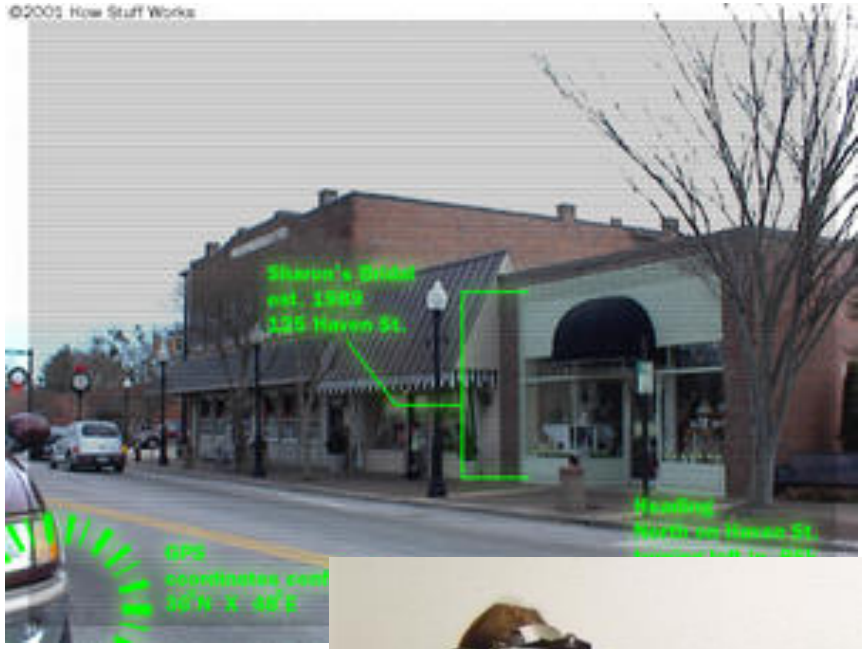
1977 – Star Wars

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.

Augmented Reality Examples

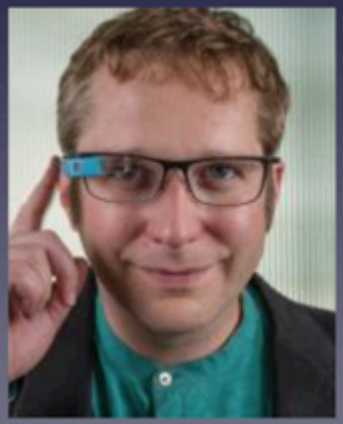


2008 - CNN

https://www.youtube.com/watch?v=v7fQ_EsMJMs

AR Technologies

- Steve Mann & Thad Starner
- Smartphones were first for consumers in 2010 (ish)
  - Camera, GPS, Orientation Sensor
- Apple ARKit
  - https://developer.apple.com/videos/play/wwdc2017/602/
- Google
  - https://developers.google.com/ar/



Audio-AR

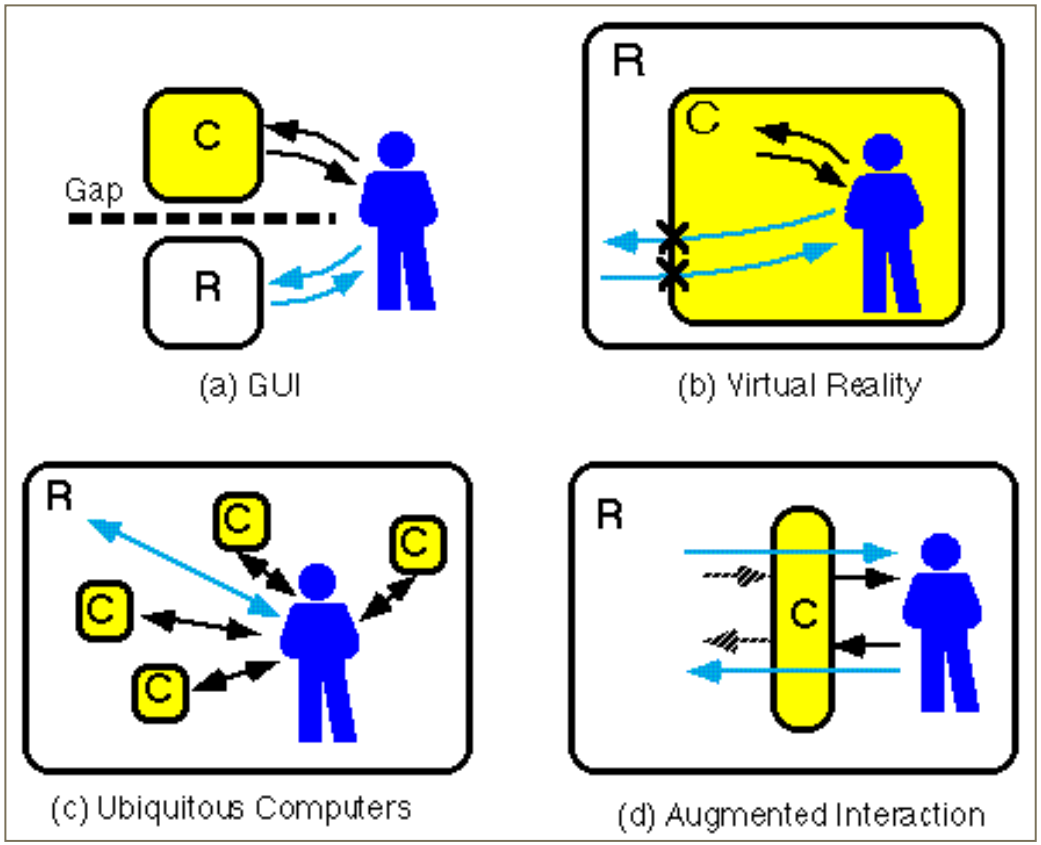
- Doesn't need to be visual at all
- Can use a 3D sound environment geographically correlated to physical environment.
- Useful for stories or interactive experiences
- Heads-Up interaction and for Disabled users

Pokemon GO..

AR vs VR

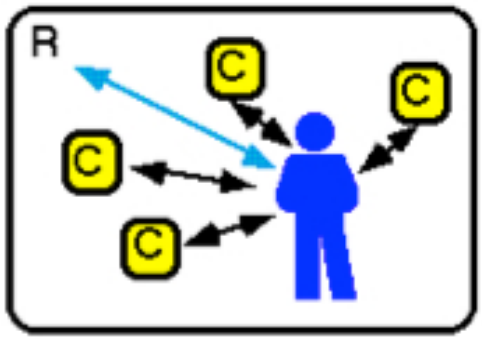
	Virtual Reality *Replaces Reality*	**Augmented Reality** *Enhances Reality*
Scene Generation	Requires realistic images	Minimal rendering okay
Display Device	Fully immersive, wide field of view	Non-immersive, small field of view
Tracking	Low to medium accuracy is okay	The highest accuracy possible

Making Interfaces Invisible

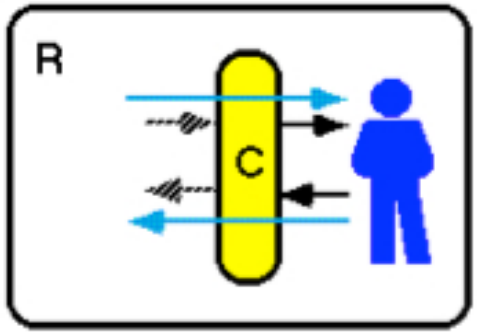


Rekimoto, J. and Nagao, K. 1995. The world through the computer: computer augmented interaction with real world environments. In *Proceedings of the 8th Annual ACM Symposium on User interface and Software Technology. UIST '*95. ACM, New York, NY, 29-36.

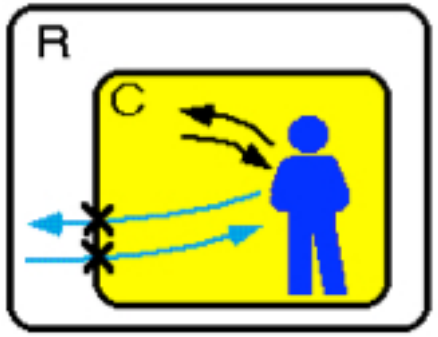
From Reality to Virtual Reality



Ubiquitous Computing



Augmented Reality

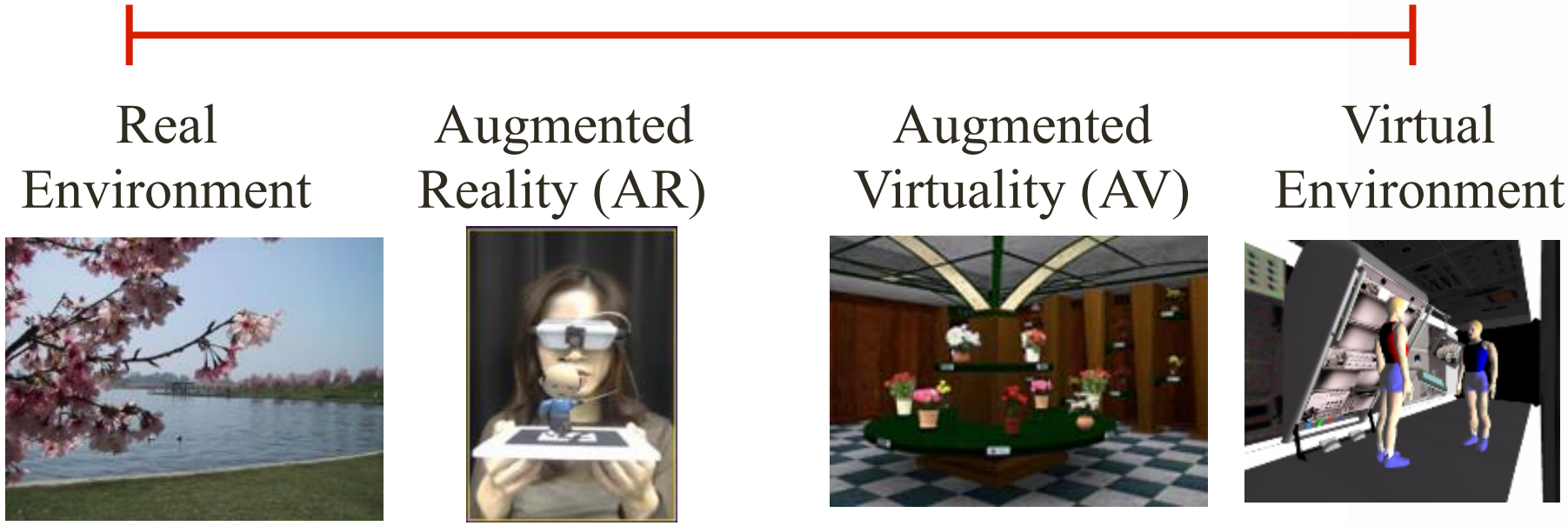


Virtual Reality

Milgram's Reality-Virtuality continuum

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

Mixed Reality



Reality - Virtuality (RV) 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.

Augmented Virtuality

- VR with windows into the real world

VR Summary

- Virtual Reality can be defined in a number of ways
  - In terms of technology
  - From a Presence perspective
- VR can also be classified with other technologies
  - Invisible Interfaces
  - Milgram's Mixed Reality continuum

- VR is the ultimate case where all possible interaction techniques may meet !

Tangible User Interfaces

- Tangible Bits - Ishii & Ulmer (1997)
- We build virtual versions of real things (e.g. buttons).
- Instead augment real things with computational powers.
- Manipulate the world through manipulating physical objects.

TUI examples

MIT Media Lab
Tangible Media Group

Projects

https://tangible.media.mit.edu/projects/

I/O Brush

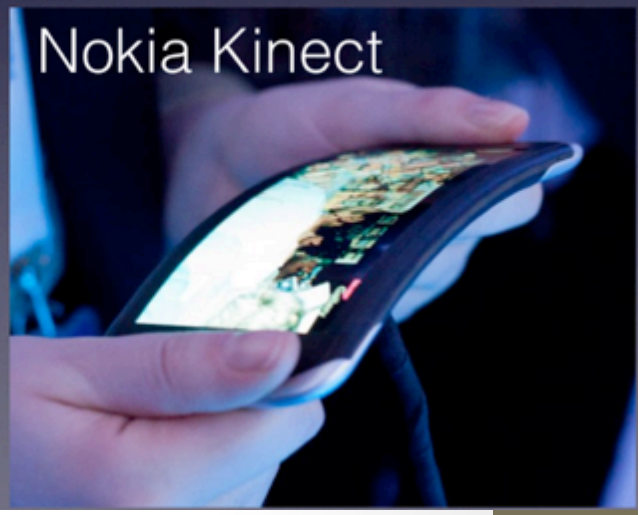
musicBottles

another TUI example

https://en.wikipedia.org/wiki/Reactable

Organic User Interfaces/Shape Changing Interfaces

- Vertegaal & Poupyrev (2008) introduced OUIs
  - Consideration of e-ink displays and how we would interact with them.
  - How do we interact with them?
- Covers the area of flexible user interfaces and displays that can mould to any shape.
  - E.g. car dashboards, flexible mobile devices
- Some commercial prototypes
  - Nokia Kinect



Shape Changing UI

- Physical properties of the device change to reflect device state or notification
  - Can be either visual (e.g. the display bends)
  - Or in some other modality
    - Shape, weight, size etc.
- An extension of the tangible work we saw earlier
- Arguments how these relate to Tangibles

Embedded Environments

- Logical extension is to directly embed interaction abilities into the environment.
  - Projectors - on all walls
  - Pervasive audio systems
- How do we interact with these, and what can we do?
- As relates to tangible sensing.
- Many of the same techniques for AR and VR

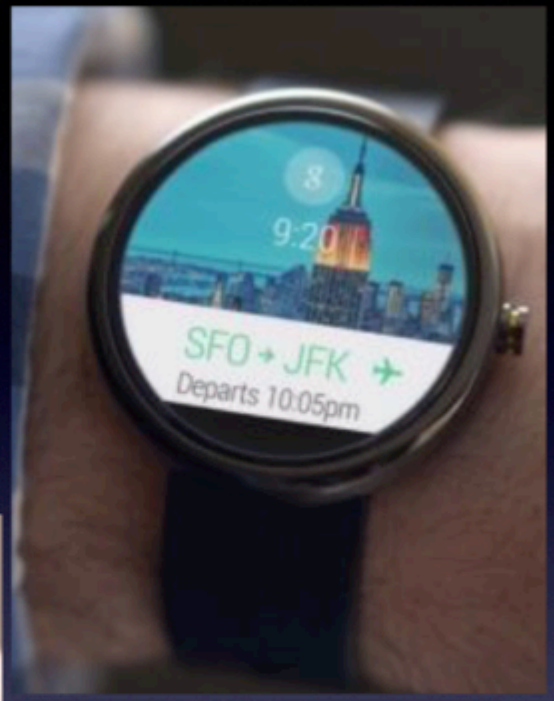
https://www.youtube.com/watch?v=acRIKE66bwM

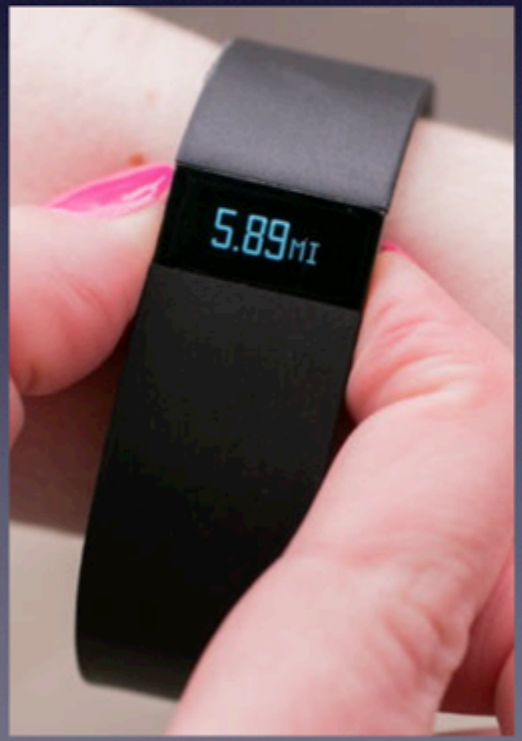
Wearables

- If computation is disappearing into the walls, then what of the mobile phone?
- Two ways to think
  - Nearterm
  - Longterm

Nearterm

- Smartwatches, Google Glass, FitBits, Nike+
- What do you think of these?
- What are they good for?





LongTerm

- Computation is embedded, we can remotely sense things.
  - Clothing, injections, implants
- Can lead to using the body as an input or computation device.
- To store data
- For input and output.


Google Smart Contact Lens

iSkin

Flexible, Strechable and Visually Customizable On-Body Touch Sensors for Mobile Computing

Martin Weigel, Tong Lu, Gilles Bailly, Antti Oulasvirta, Carmel Majidi, Jürgen Steimle

Max Planck Institute for Informatics and Saarland University, Carnegie Mellon University, CNRS LTCI, Telecom-ParisTech, Aalto University

Conclusions

- We've tried to cover a number of paradigms of emerging User Interfaces
- Some have been around longer than others
- All meet at some point

- Not really covered how these are done
- But most can be done with regular technology

- Next weeks we will start looking at multimodal interaction: how different modalities can be used, their issues and technologies a bit more

Next topics…

- Audio
  - interaction using sound/speech
- Haptics
  - utilizing the tactile and kinesthetic senses of touch and force
- Movement
  - tracking position and motion of limbs and body to interact
- Other senses/modalities
  - taste and smell (still experimental), biosensors, brain…

- Technology for implementing emerging UI
  - sensors and actuators
  - interface hardware (Arduino) and software (IDE, Processing)