

# *Why study Computer Graphics ?*



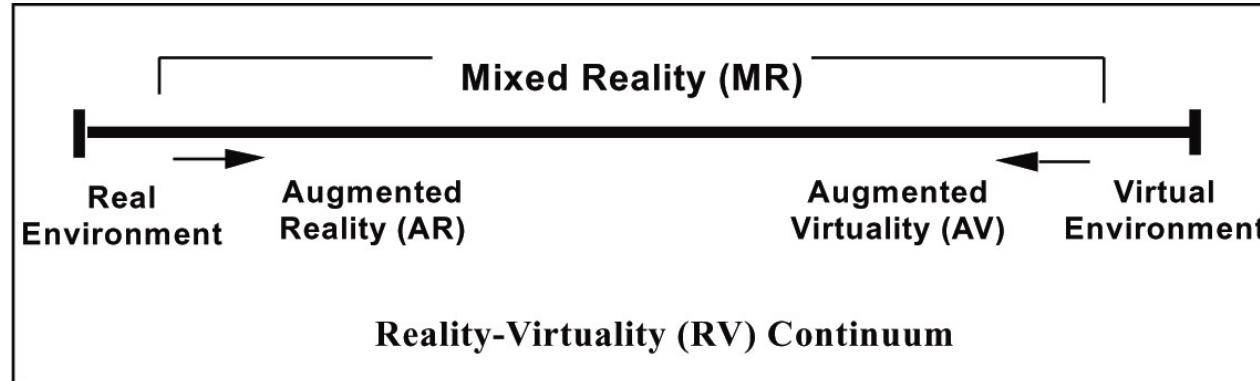
# *Why study Computer Graphics ?*

- Fundamentally Its what the user sees when they interact with a computer .
- Its **computer graphics that gives us a “looking glass into a mathematically wonderland”**
  - (Ivan Sutherland)
- Through the studying of Computer graphics , many computer science concepts can be taught and more importantly the origin of concepts like Object oriented Programming can be understood.

# What's this lecture going to cover

- History of Computer Graphics and where its going
- Current AR / Virtual Reality examples
- Future of Computer graphics in AR
- My Research :Past and Future
- Mobile VR demo

# Mixed & Augmented Realities



Milgram et al (1994)



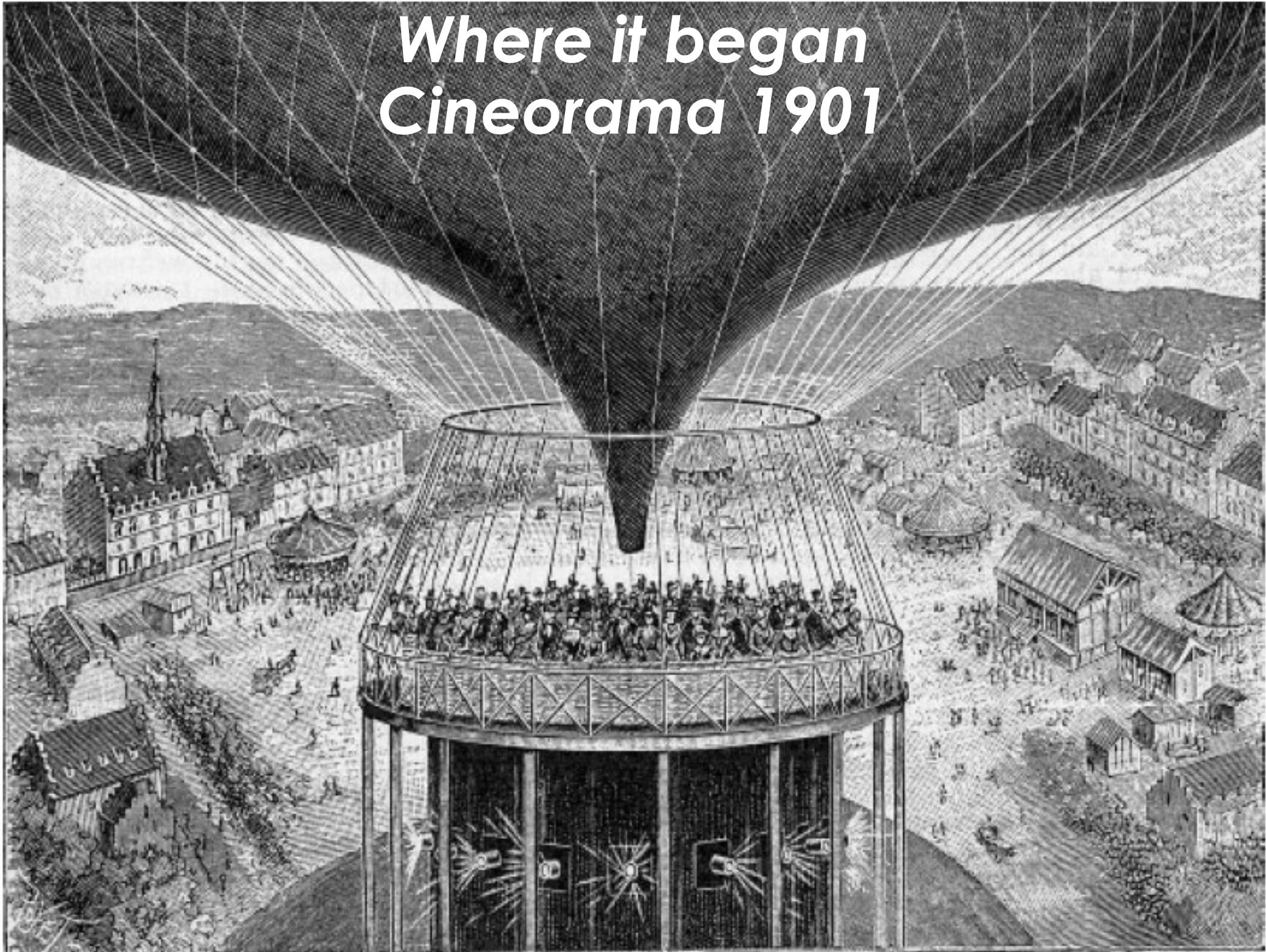
Augmented Reality



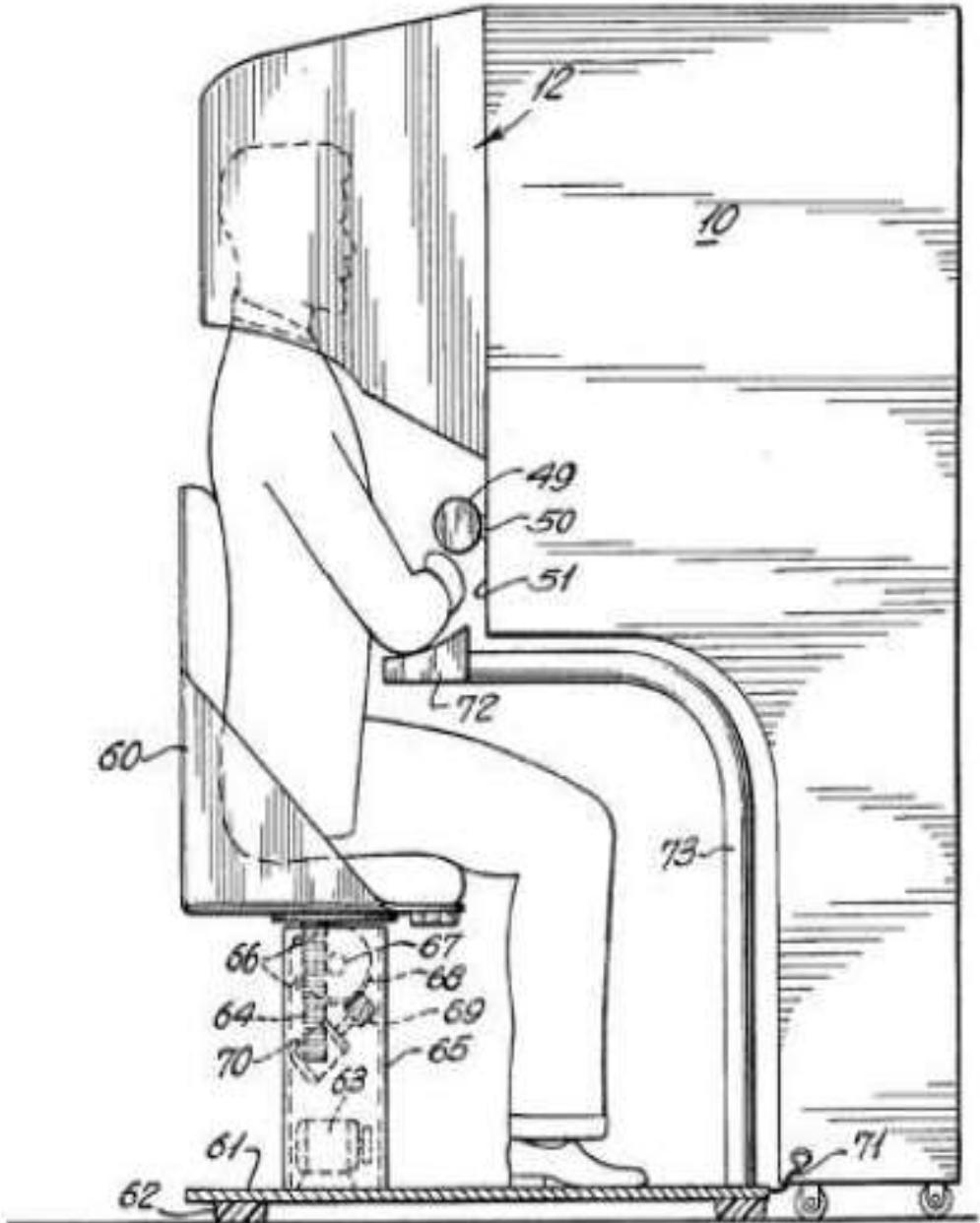
Augmented Virtuality

# *Where it began*

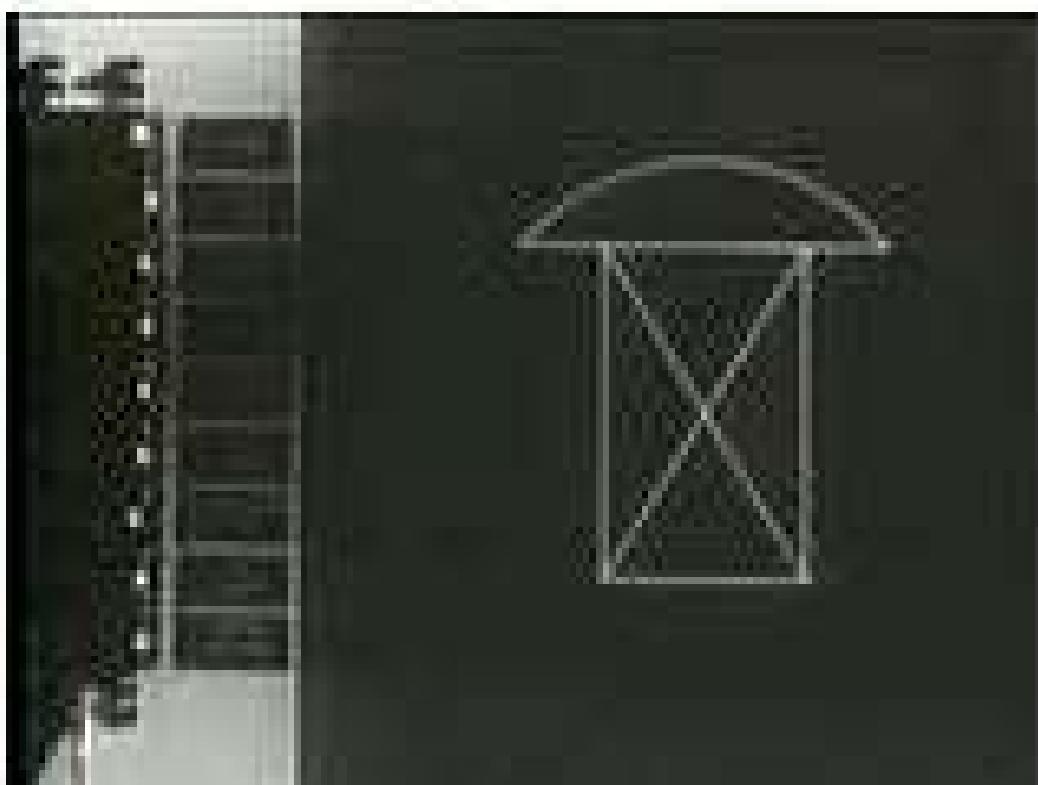
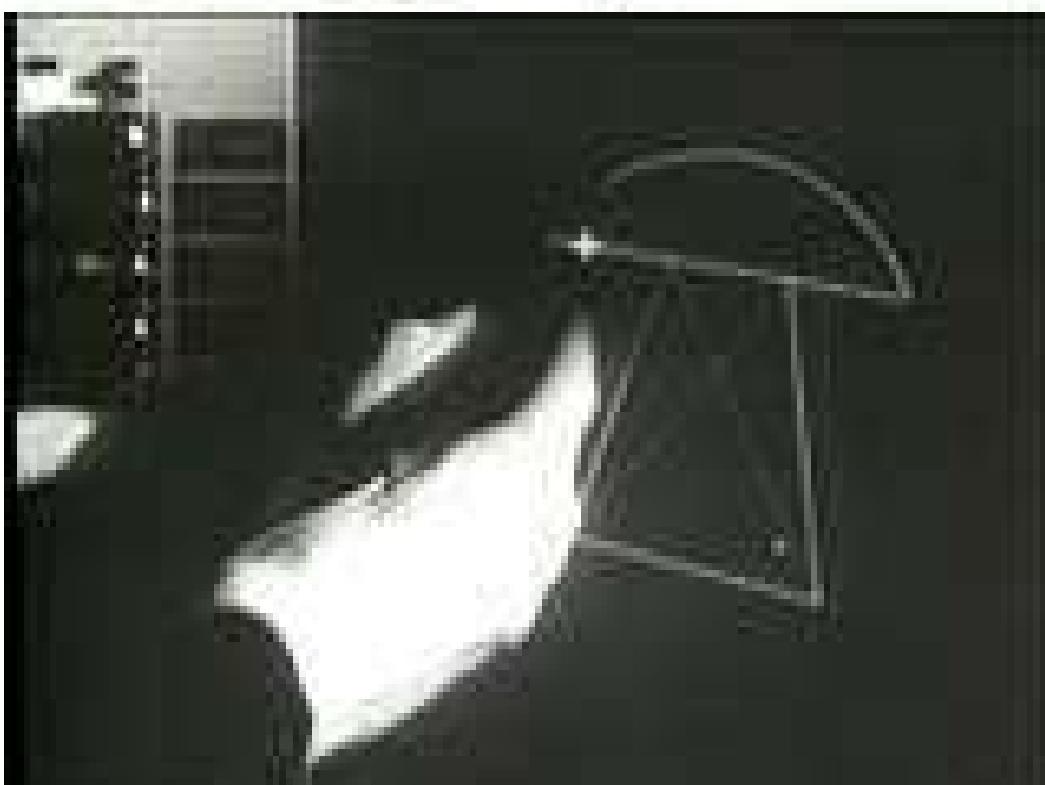
## Cineorama 1901



# Morton Heilig's Sensorama

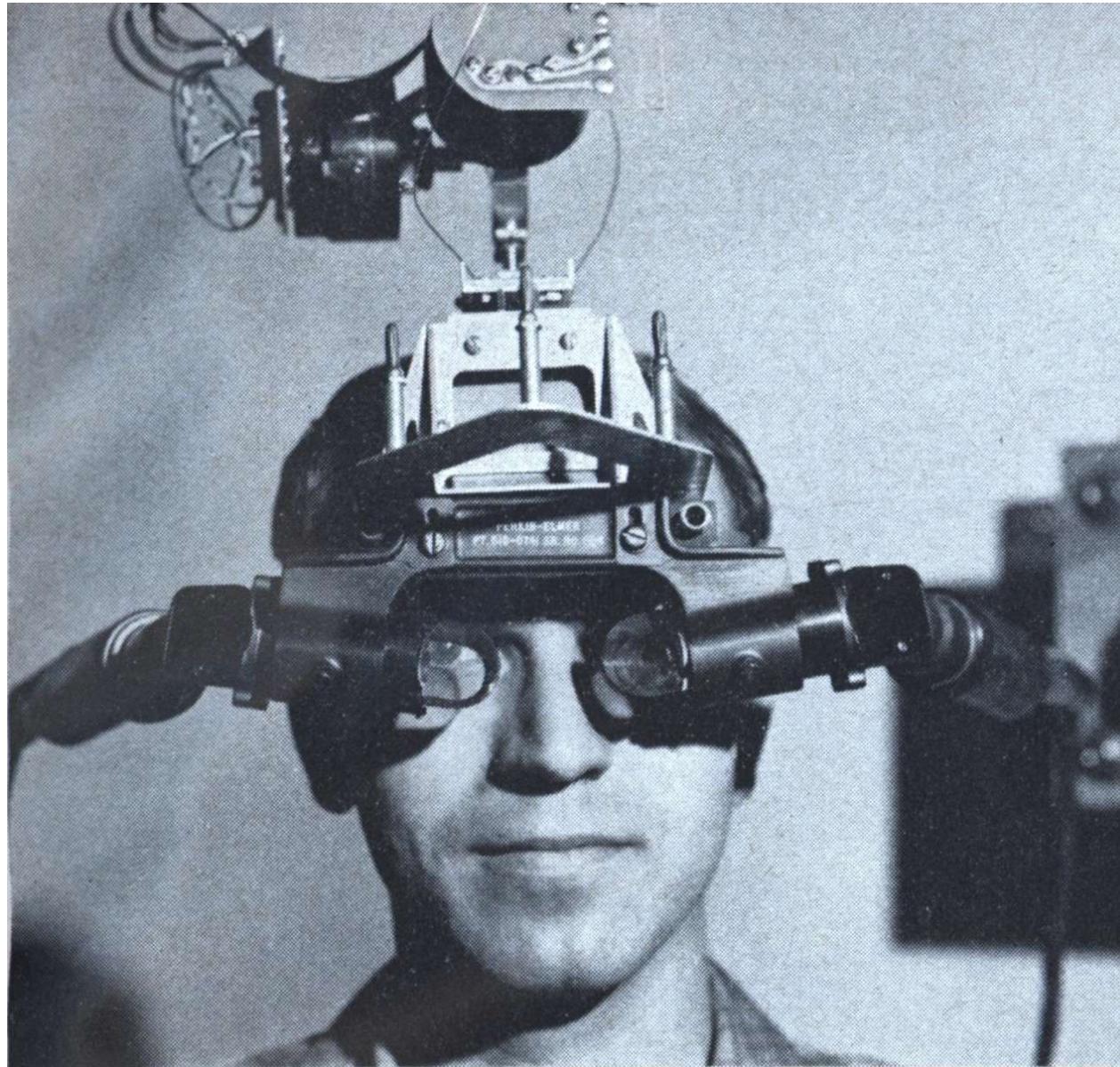


# *Computer Graphics is born by Dr. Sutherland and his SKETCHPAD*



# Sword of Damocles

## First VR/AR head mounted Display



# *Film again hints at the future*



# *Shared Reality/ Artificial Reality*

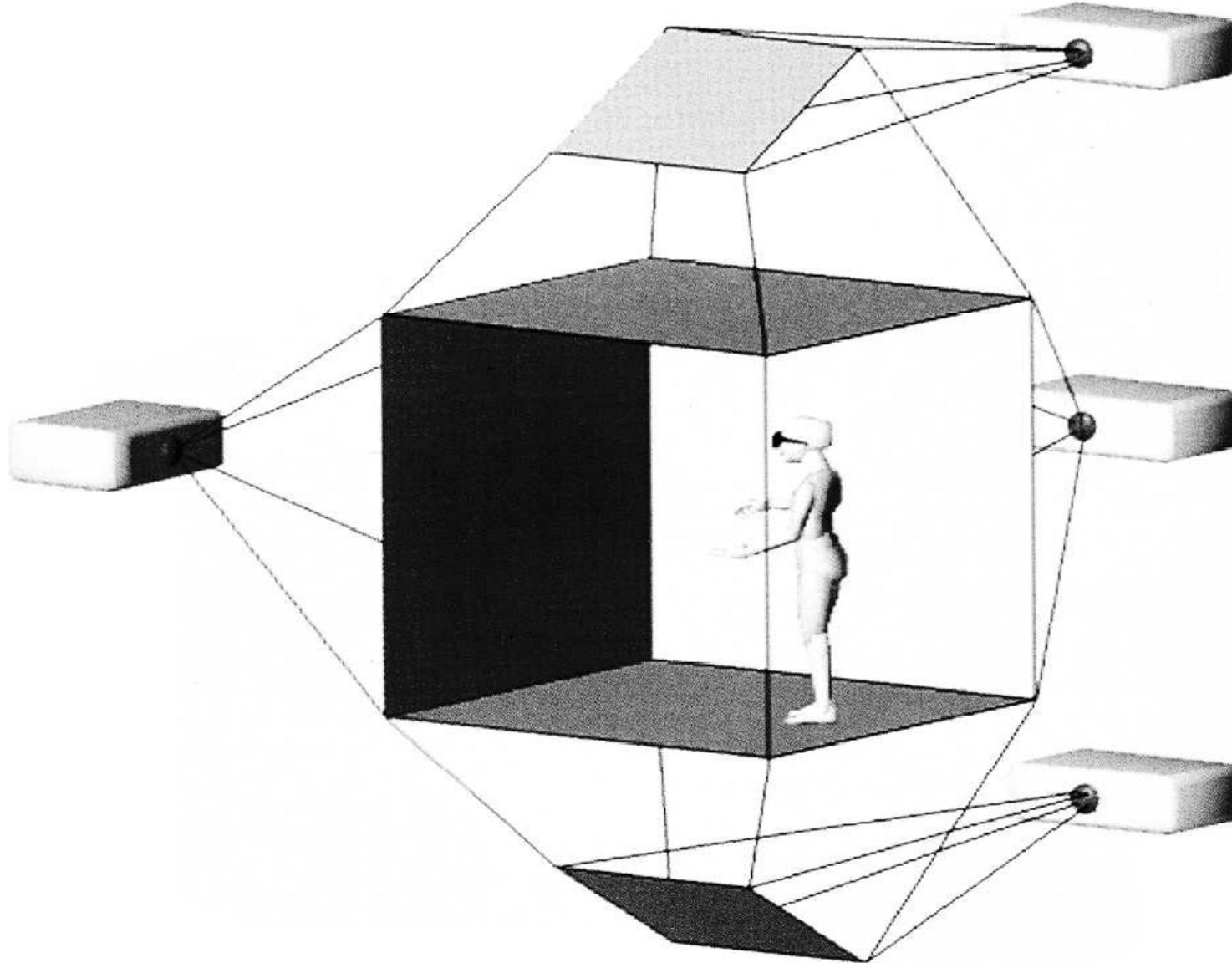
## (Myron Krueger)



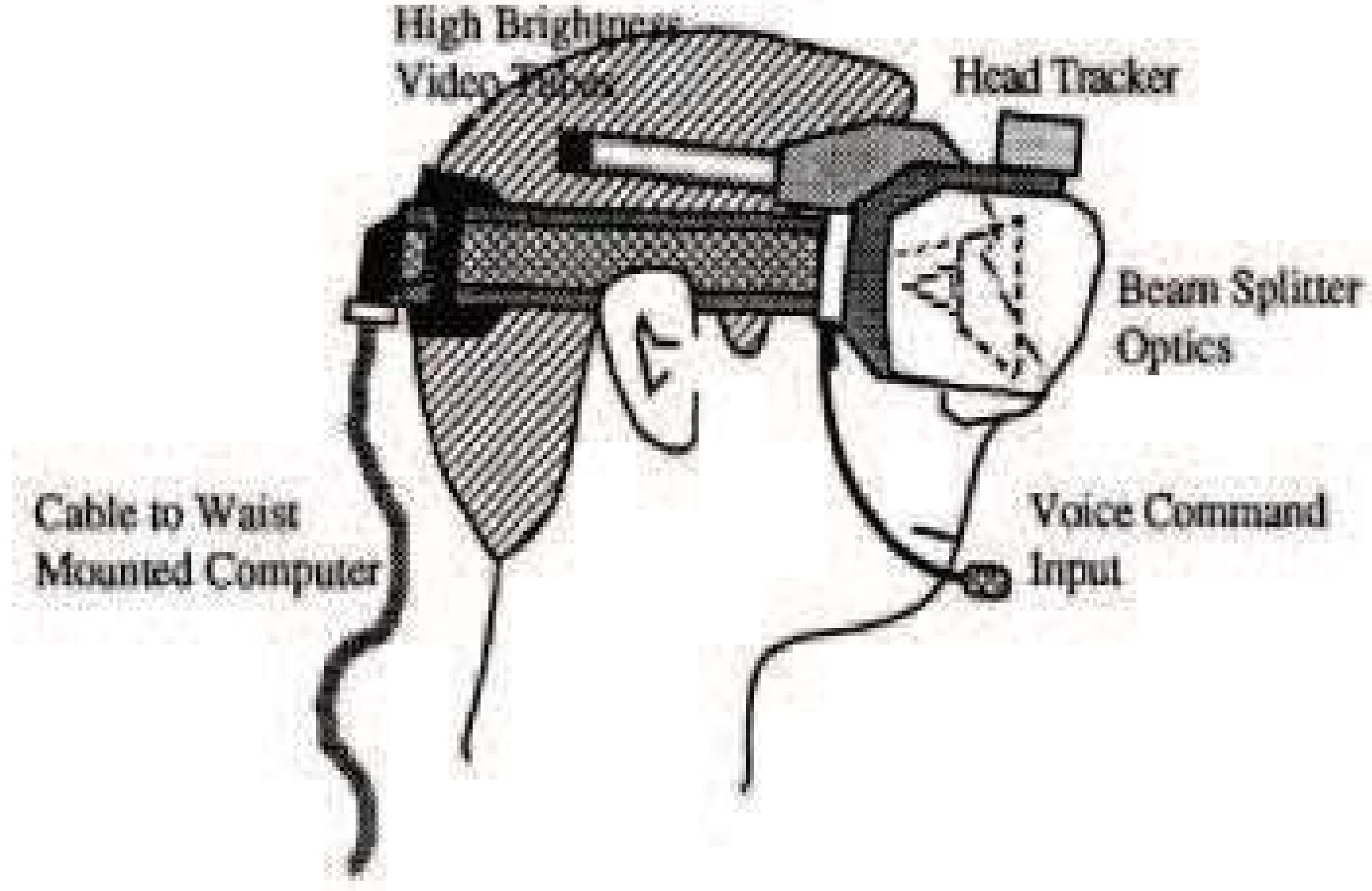
# *Hollywood inspires again*



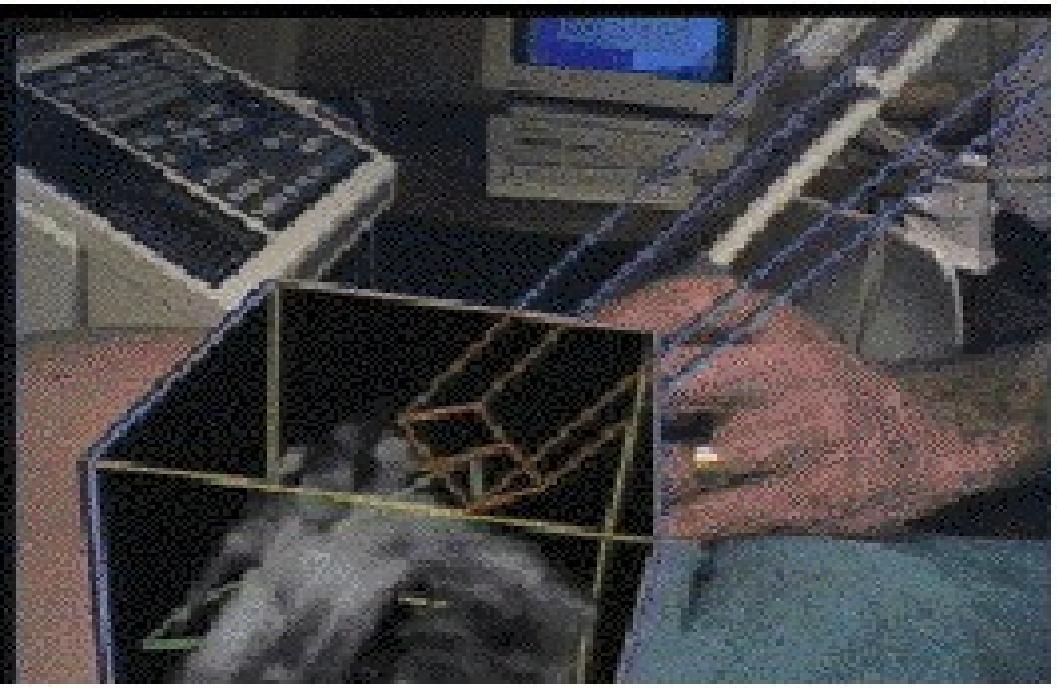
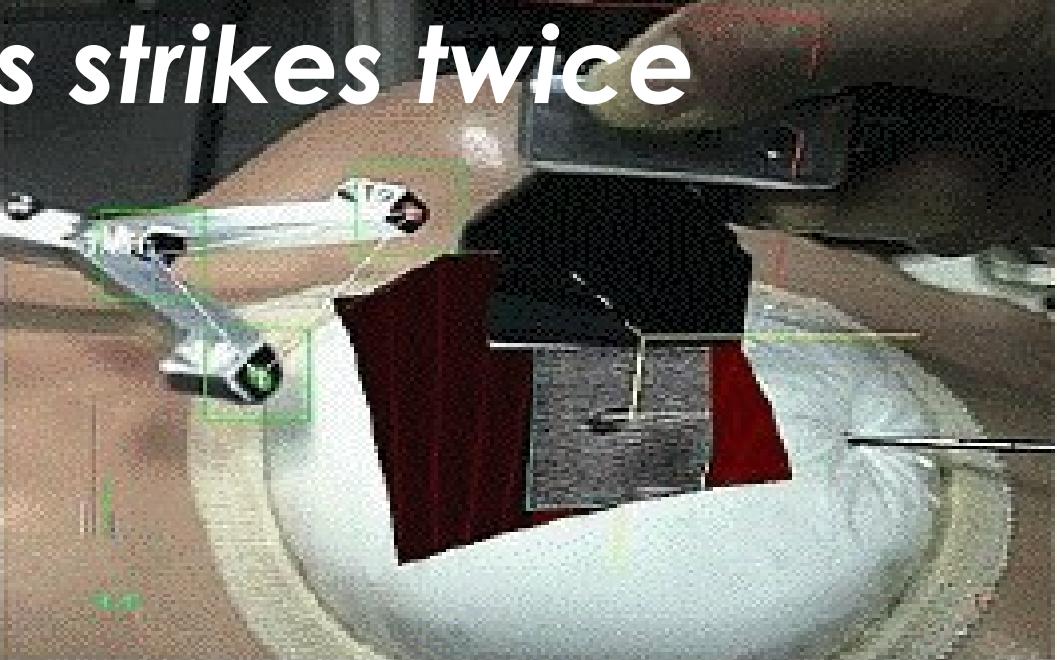
# *Plato would be proud of Cruz-Neira's Cave*



# Boeing's Augmented Reality Idea, giving AR its name



Ideas always strikes twice



# *AR toolkit Markers(Billinghurst and Kato)*



# Camera's begin the modern age



1:20





PlayStation®Move

I MOVE YOU!

WII MOVE YOU!



VS.

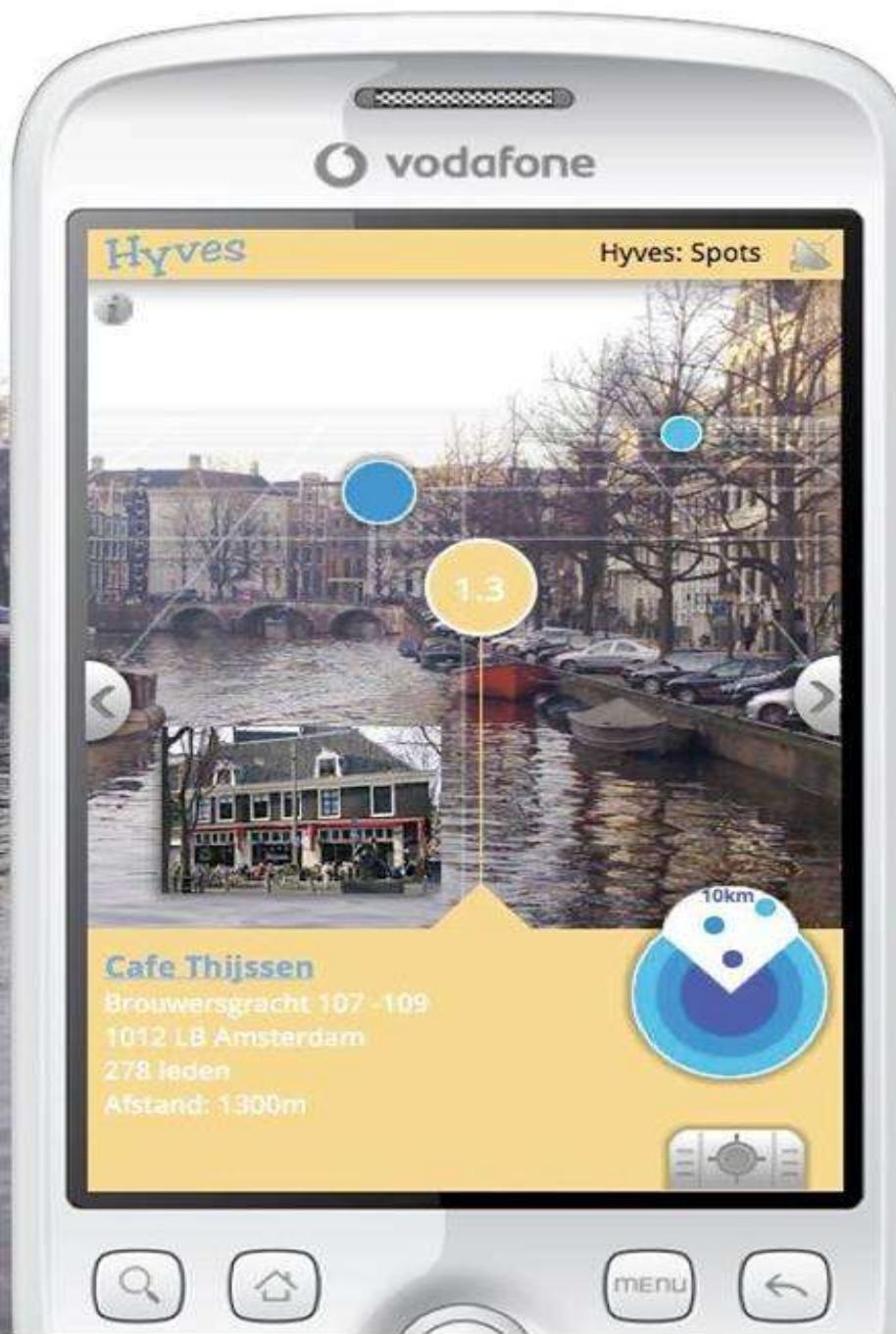
Wii

VS.

KINECT™



KINECT TO ME!











My Snapshots



## My Items



Quantity  \$16.99 **\$7.50**

## Tools

Get Marker [Read + Email / IM](#)

Set size

Motion Detection [Read + Email](#)

Take Snapshot!



1:08 / 1:55





# The possible future of Augmented Reality ?



# *My research:*

**Problem :**

***How to we create future AR apps?***

**The Task requirements:**

***Complex environment***

***Manage multiple sensors to track***

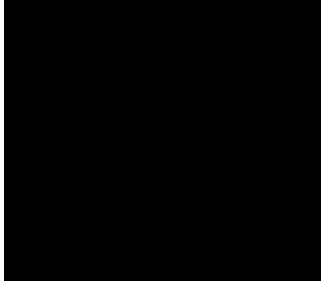
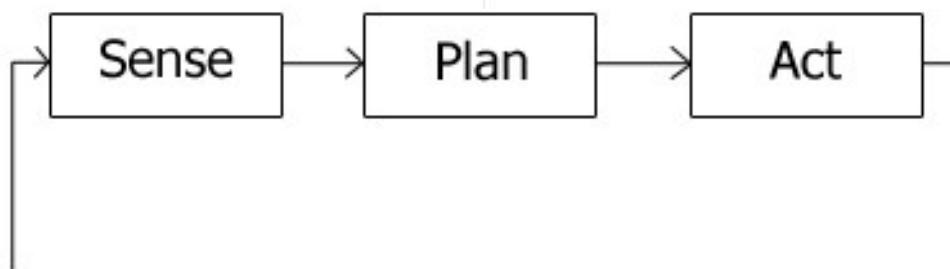
***Complex HCI interactions***

***Shared World with other users***

# What's abstraction in terms of Computer Programming ?

```
simple_loop:  
# parameter 1: %rdi  
.B1.1:  
..__tag_value_simple_loop.1:    # Preds ..B1.0  
    xorl    %eax, %eax    #3.19  
    xorl    %edx, %edx    #5.8  
    testq   %rdi, %rdi    #5.16  
    jle     ..B1.5        # Prob 10% #5.16  
    .B1.3:  
    addq    %rdx, %rax    #6.5  
    addq    $1, %rdx      #5.19  
    cmpq    %rdi, %rdx    #5.16  
    j1     ..B1.3        # Prob 82% #5.16  
.B1.5:  
    ret  
.align 2,0x90
```

```
public class HelloWorld {  
  
    /**  
     * @param args  
     */  
    public static void main(String[] args) {  
        // TODO Auto-generated method stub  
        System.out.println("Hello world!\n");  
    }  
}
```

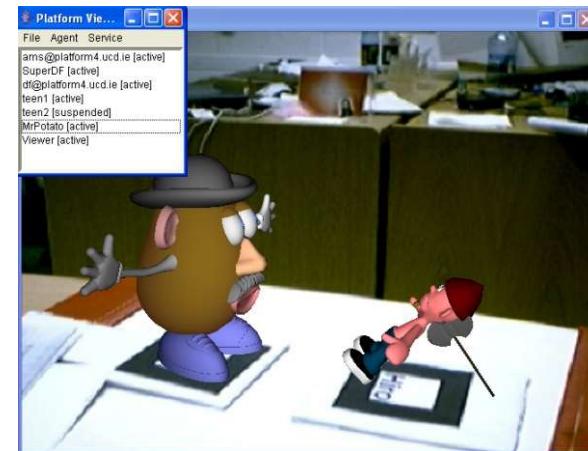


Solution:  
**Use a branch of Artificial Intelligence  
know as Multi-Agent systems.**

**AR Apps must exist and indirectly  
interact with the Real world**  
**Thus a possible solution is to use the the  
same programming paradigms /  
Abstract that we use for robotics.**

# AUgmented Reality Agent

-The right Abstraction for the problem



Teen's Beliefs

Goal(Avoid\_Light)

World State



At each timestep the "illumination"  
Perceptor checks for objects  
within the agent's "LoS"

Teen's Beliefs

Belief(I\_want\_to\_  
move(Right))

Goal(Avoid\_Light)

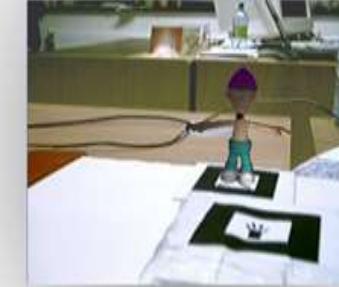
World State



Commitment rules drive the agent  
into generating a new belief state  
to achieve the goal of avoiding the  
light

The "I want to move" belief  
causes the "Change World"  
Actuator to change the state of  
the world.

World State



Teen's Beliefs

Belief(I\_see(Light,  
left))

Goal(Avoid\_Light)

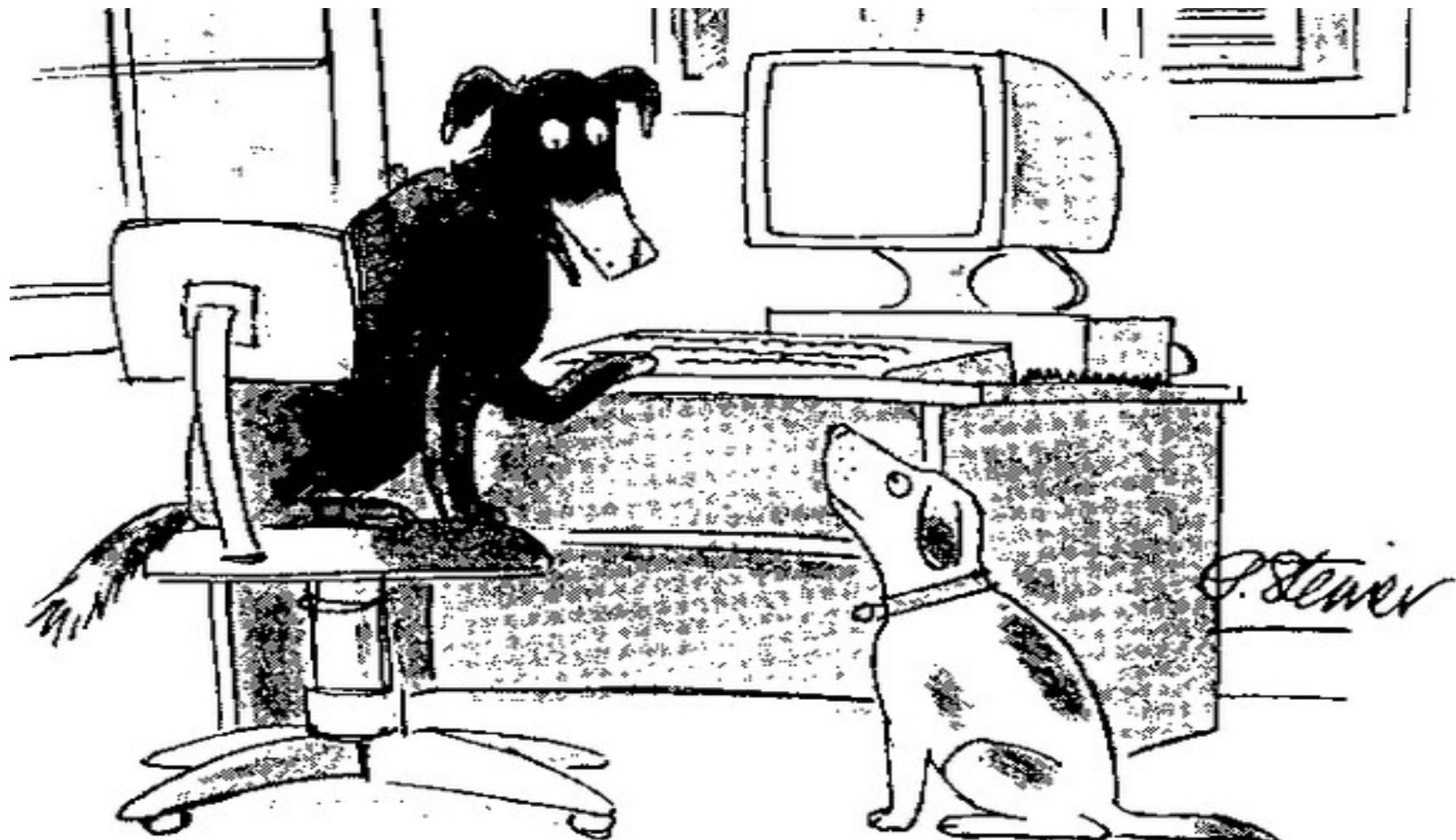
World State



Teen's Beliefs

Goal(Avoid\_Light)

# **Virtual Agents don't care which reality they are in, so perfect for AR simulation**



*"On the Internet, nobody knows you're a dog."*

# Future Research Questions

- New form of Distance Learning
  - Can VR/AR solve the current problems with distance learning
- Can we scan a lecturer in Ireland in 3D, and project them into a class room in China ?
- Can VR / AR be used everyday for teaching ?
- Telepresence , can we feel and act somewhere we are not ?

# Where is VR / AR right now

- Oculus Rift Dk1 / Dk2
- Google Glass
- Epson Moverio BT-100 ( TBA Space Glasses)
- Final versions
  - Samsung Gear
  - Oculus CV 1
  - HTC VIVE

# What's different

- New displays offering new experiences that where thought impossible before
- Achieving the vision of Ivan Sutherlands Ultimate Room
- Advances require new ways of Human Computer Interaction
  - Accurate tracking/ scanning – SLAM ,
  - Speech recognition
  - Human Brain interfaces

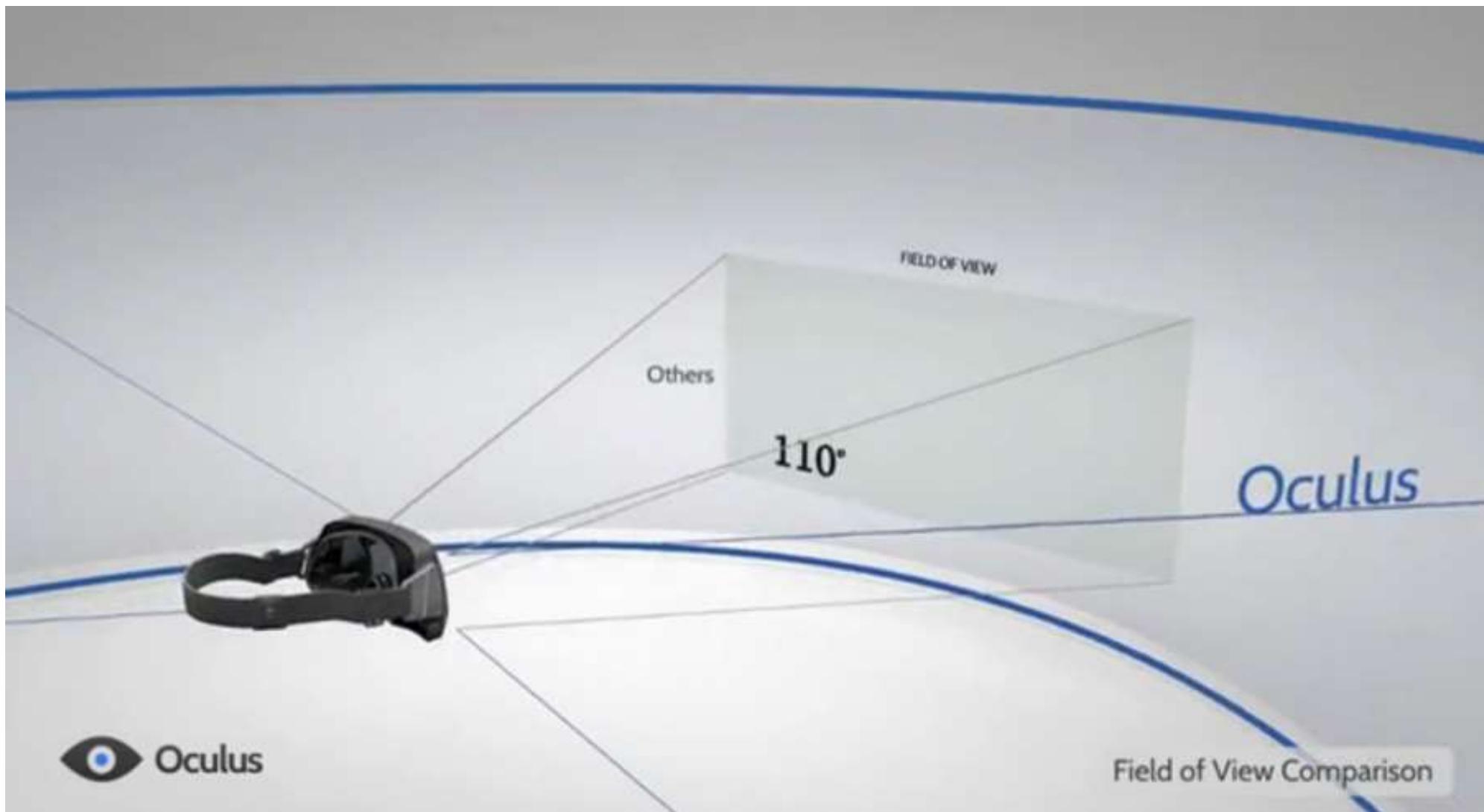
# Oculus Rift

- Invented in 2012 by Palmer Luckey
- Successfully KickStarted in 2012
- First Developer kits came out in 2013
- Leading a revolution in Virtual Reality

# Rift



- FOV: 110 degrees Horizontally
- Res: 1280 X 800
- Each eye: 640×800
- Sensors Acc/Mag/Gyro



# Oculus Screen

- Simple Flat panel that uses lens to wrap the screen for the user



# DK2 Oculus Rift



# Dk2 Cont.

- AMOLED 5” display –low persistence <3ms
- Overall resolution 1920 x 1080
- Per eye 960×1080
- FOV 100
- Tracking
- 72°x52° - 0.5m - 2.5m range

# Dk2 head tracking



# Project Morpheus

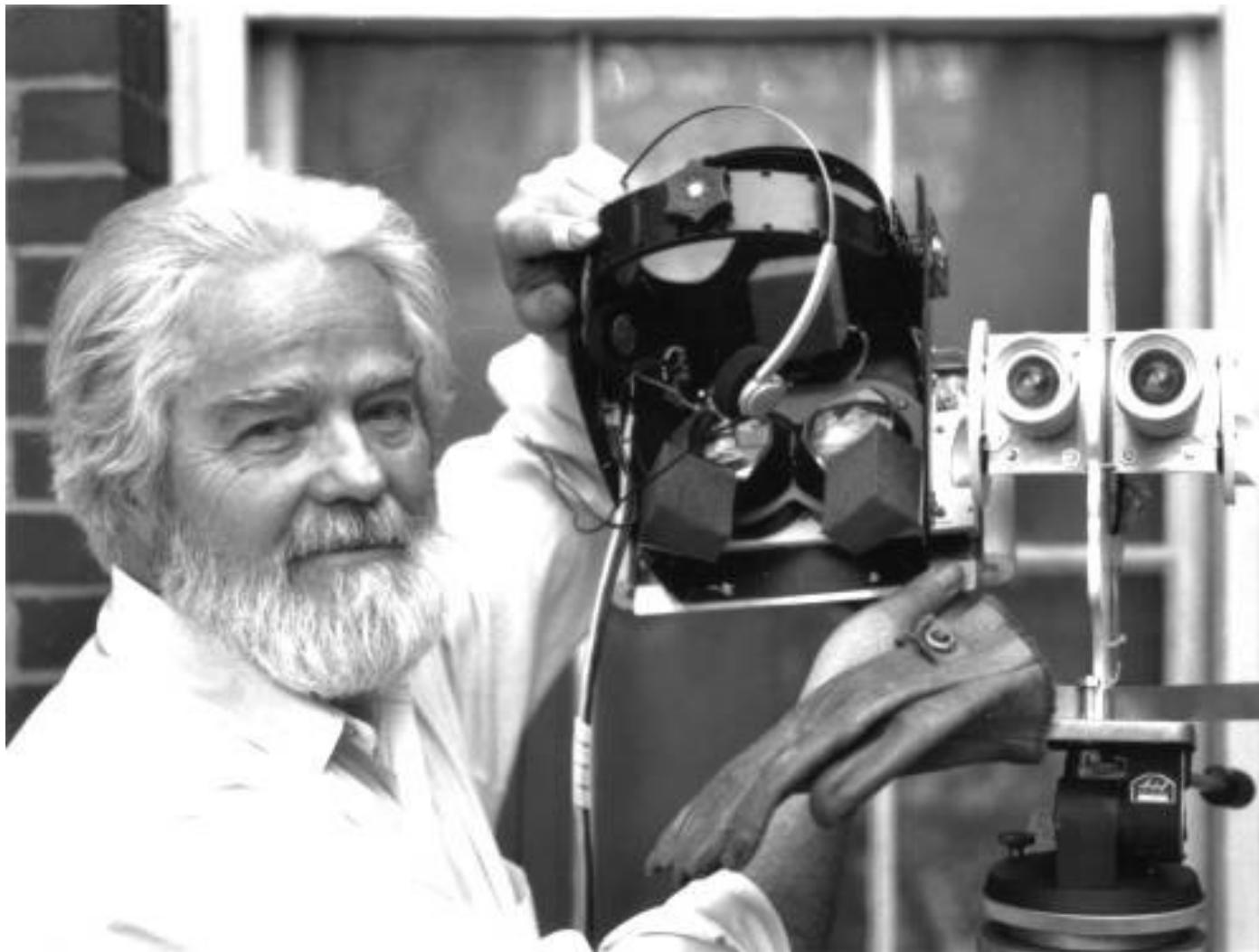


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Design and specifications are subject to change without notice.

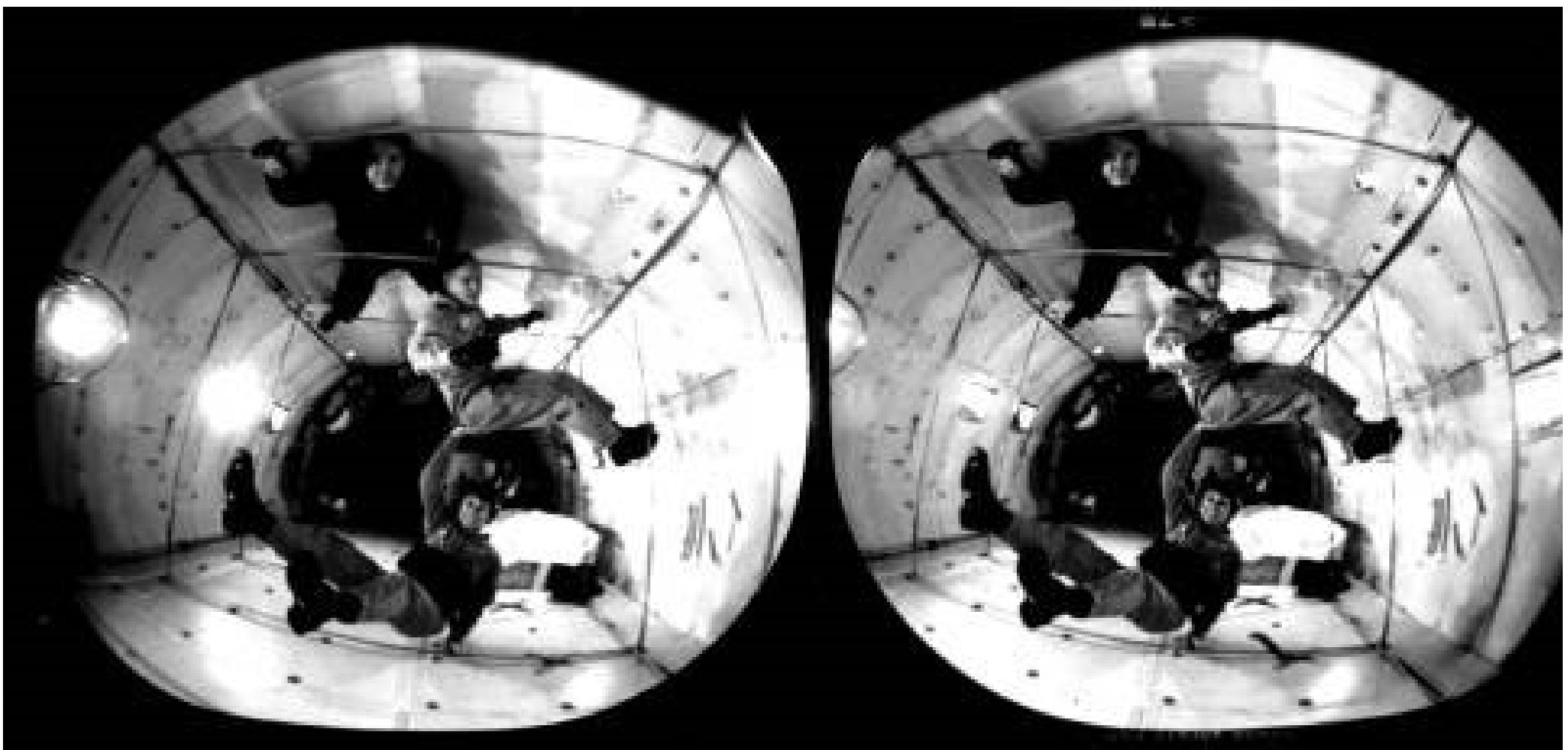
# Project Morpheus cont

- 90 degree field of view
- 1080p resolution
- DUALSHOCK 4 Wireless Controller and PlayStation Move integration
- Built from previous experience with HMD-T1,HMD-T2 and HM-T3 ( 720p devices)

# Right time and right place



# 1985 LEEP optics



# Low resolution & no GPU (NASA VR HMD) using LEEP



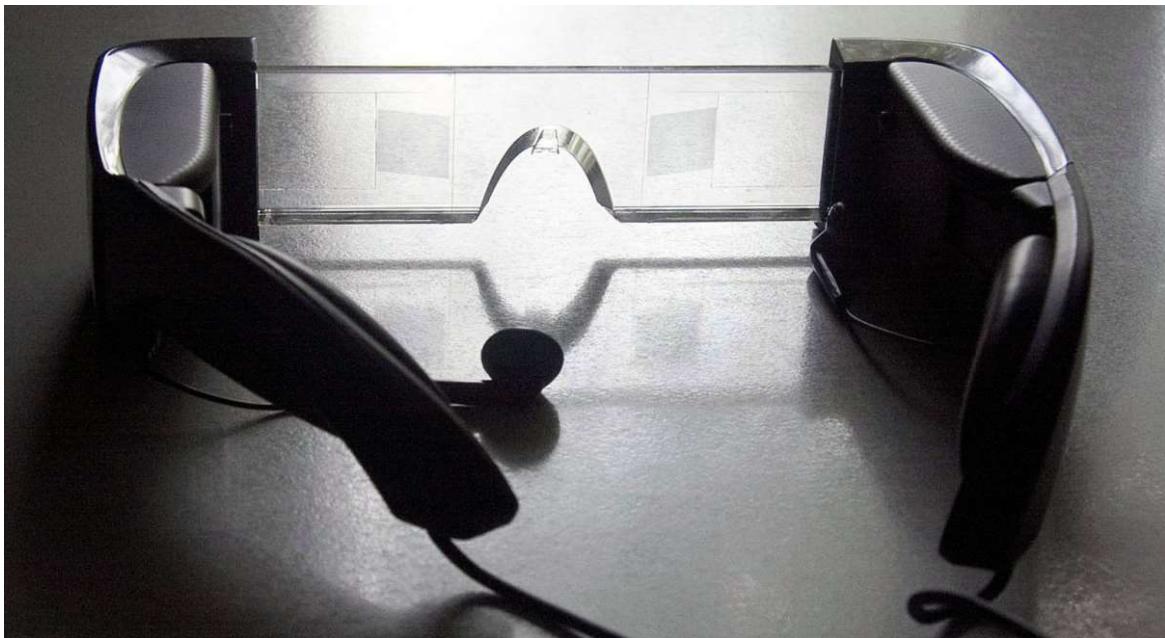
# So if it's the right time and place for VR, is the right time for AR

- Problems with current Augmented Reality Devices
  - Poor Field of View
  - Battery problems
  - Real R&D Investment limited
  - Tracking issues (Time of Flight sensors )

# New solutions

- Time of Flight sensors
  - Project Tango (google) may solve this
  - Movidius Dublin office
- New Optics
  - WaveGuide Hologram displays
- Kickstarter funding (just like VR)
  - Cast AR funded
- Sensor infrastructure
  - Internet of Things leading to the development of more sensor networks

# Epson Moverio BT-100



- FOV: 23 degrees Horizontally
- Res: 960 x 540
- Each eye: 960 x 540 but only half in stereo
- No sensors

# New version

- BT 200- in house by Epson
- Space Glasses = BT 100 + sensors



- Pro version of Space glasses has 40 degree field  
of view but costs 5 times more

# Google Glass

GLASS



# Google Glass



- Monocle
- 640×360 display
- Sensors:  
Acc/Mag/Gyro
- FOV 14 degree

# Where are we now

- Oculus CV 1 & VIVE released
- UCD has now got a dedicated VR lab



# Oculus 2016



# HTC VIVE



## Oculus Rift



## HTC Vive

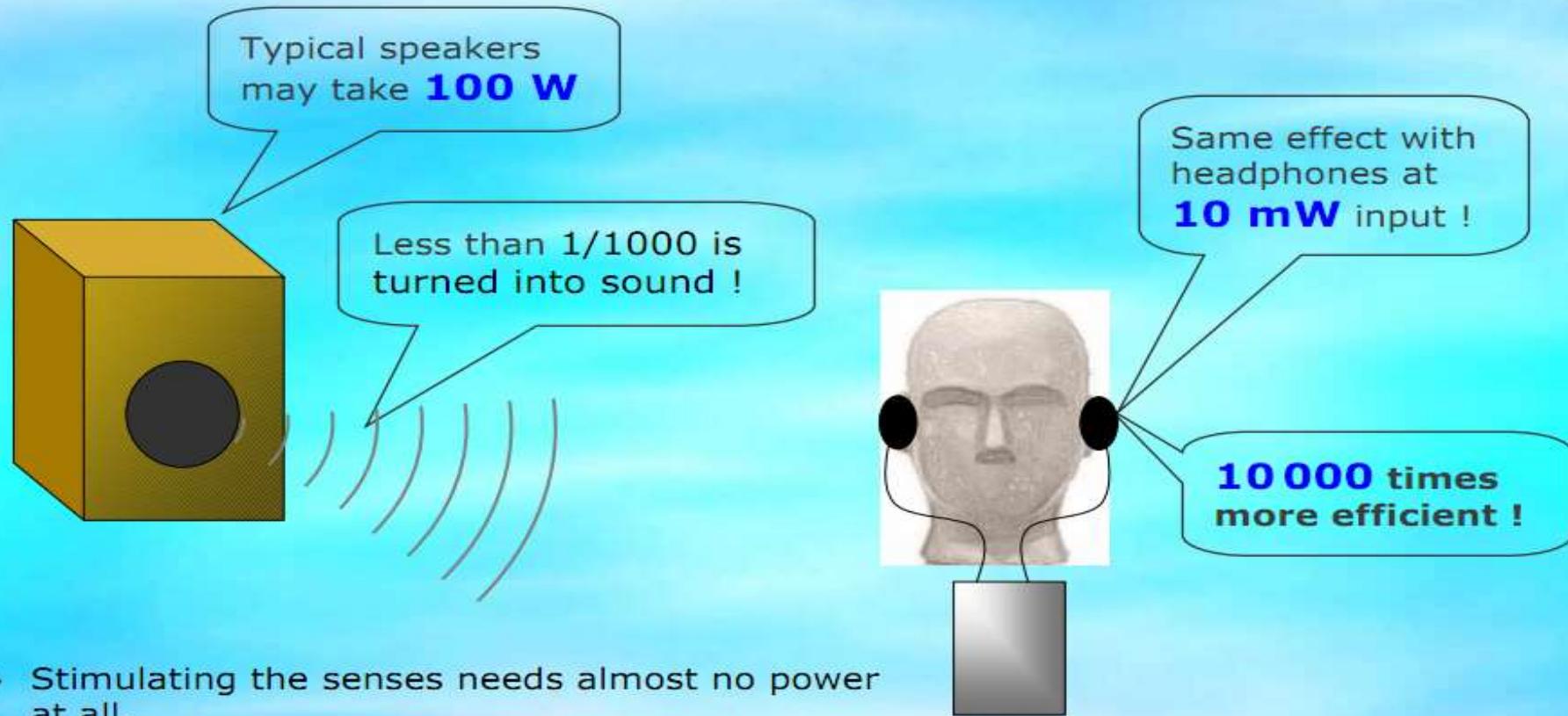


Display	OLED	OLED
Resolution	2160 x 1200	2160 x 1200
Refresh Rate	90Hz	90Hz
Platform	Oculus Home	SteamVR
Field of view	110 degrees	110 degrees
Tracking area	TBA	15 x 15 feet
Built-in audio	Yes	Promised, not yet available
Built-in mic	Yes	TBA
Controller	Oculus Touch, Xbox One controller	SteamVR controller, any PC compatible gamepad
Sensors	Accelerometer, gyroscope, magnetometer, 360-degree positional tracking	Accelerometer, gyroscope, laser position sensor, front-facing camera
Connections	HDMI, USB 2.0, USB 3.0	HDMI, USB 2.0, USB 3.0
Requirements	NVIDIA GTX 970 / AMD 290 equivalent or greater Intel i5-4590 equivalent or greater 8GB+ RAM Compatible HDMI 1.3 video output 2x USB 3.0 ports Windows 7 SP1 or newer	TBA

# The future of AR

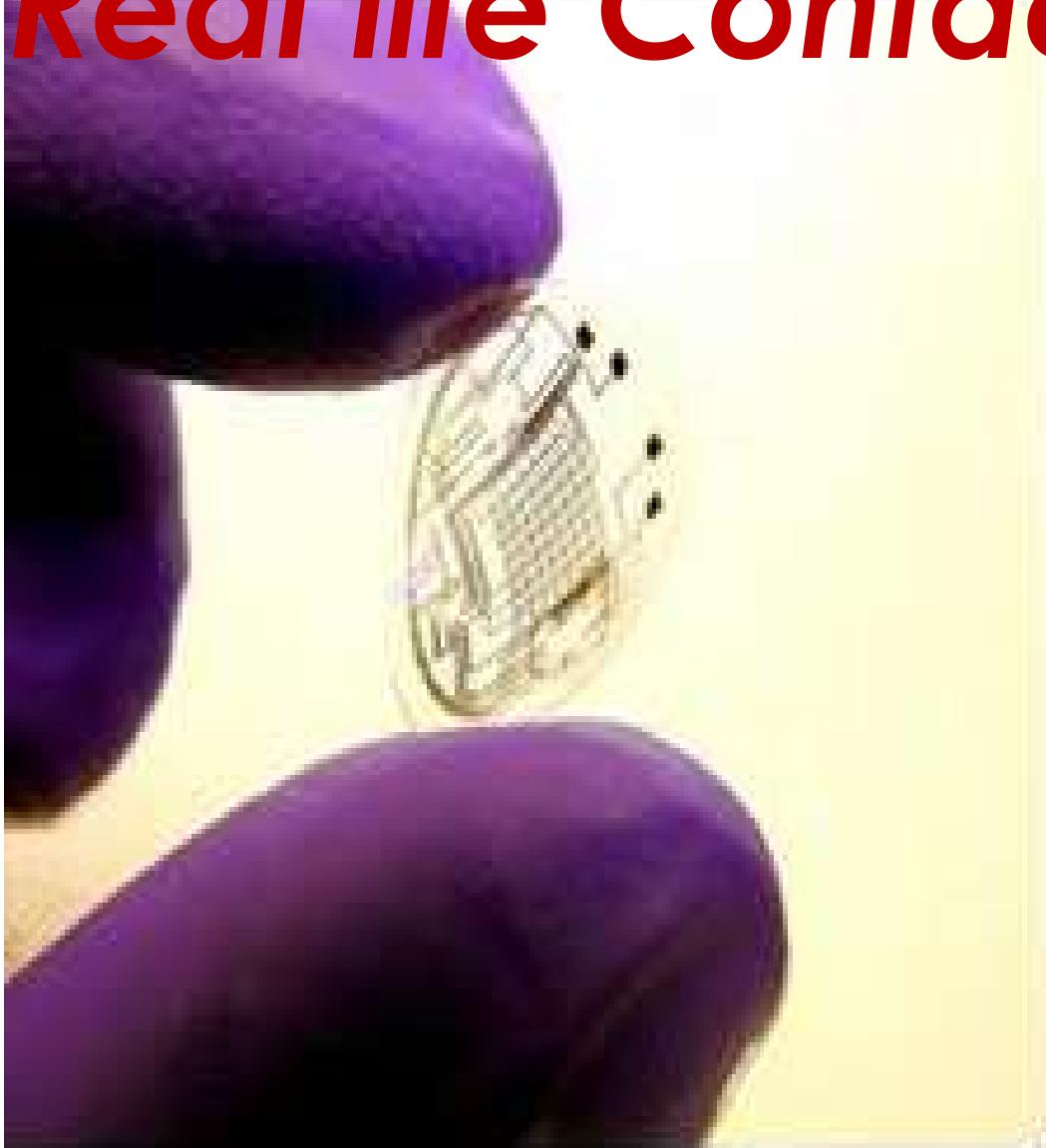
18

## Sound

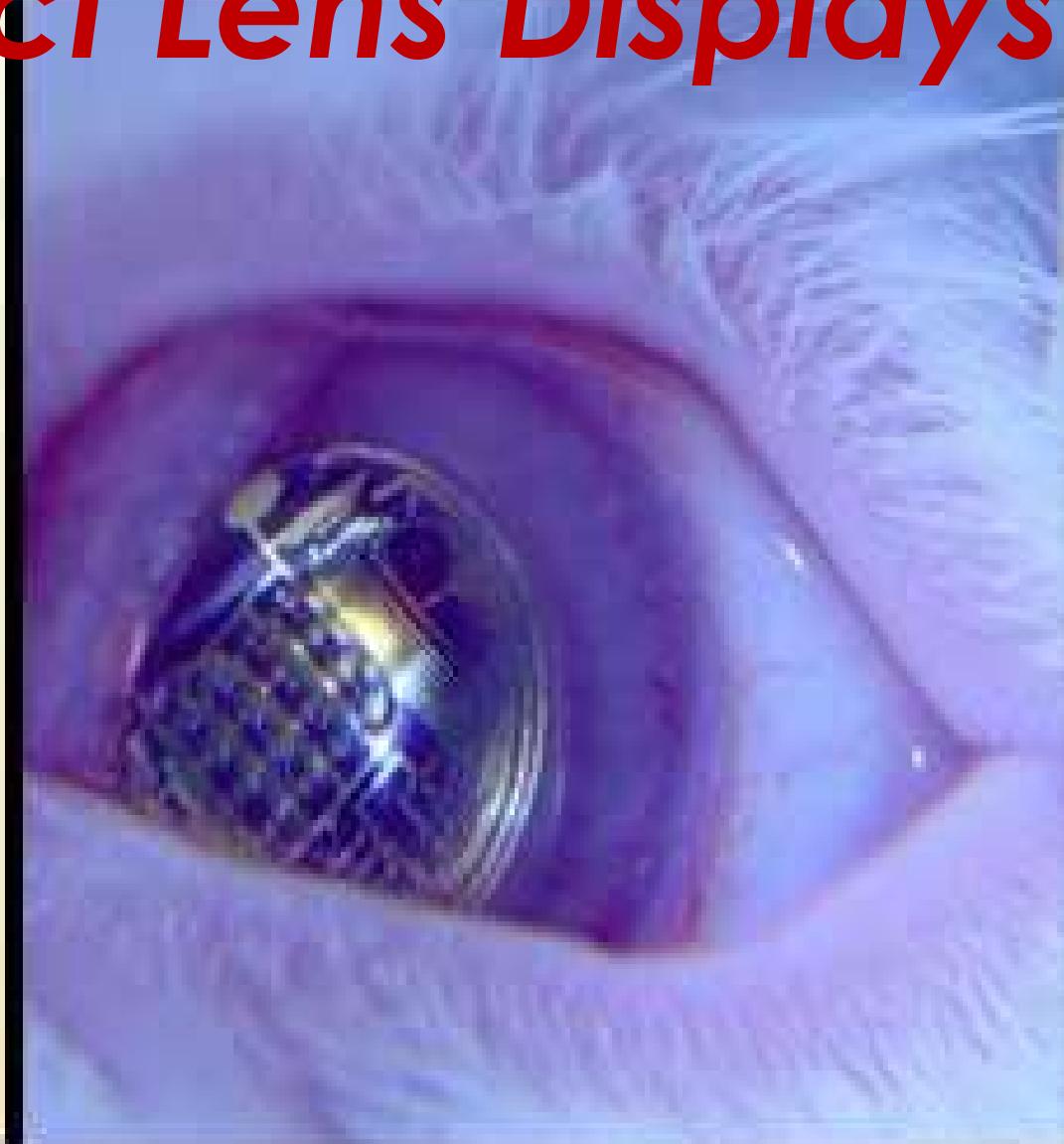


- ☛ Stimulating the senses needs almost no power at all.
  - Most of the power consumption of advanced near eye displays will go into signal processing
  - **Low power computing and signal processing will be an essential counterpart !**

# Real life Contact Lens Displays



A researcher holds one of the completed lenses.



Contact lenses with metal connectors for electronic circuits were safely worn by rabbits in lab tests.

*In the mean time we could have this*



# *A Virtual Reality Future ?*



# *OR an Augment Reality Future ?*



A dark, atmospheric image showing two hands emerging from the shadows. The hand on the left holds a bright red, glowing capsule. The hand on the right holds a bright blue, glowing capsule. The background is dark and textured.

*Our Choice*

<http://www.theendofhardware.com/>

<http://gamesalfresco.com/>