

Virtual Reality

**SGN-5406 Virtual Reality
Autumn 2011
stanislav.stankovic@tut.fi**

Objectives of the Course

- To give basic understanding and the big picture of the principles, methods and applications of VR, AR and related topics
- State-of-the-art, various facets and current limitations of VR
- Peek into the future possibilities
- Few formulas, not very practical skills (goto ELE hands-on course)
- Emphasis on overviews, big picture
- VR is very interdisciplinary (both applications & technology), not an isolated island
 - VR tech is far from ripe
 - VR will be applied in many fields, but not only in the ways as we may think currently
- New ideas and perspectives

Course Details

- 5 credit points
- For students of many fields of technology
- Suitable also for doctoral students
- Course web page:

<http://www.cs.tut.fi/~stankovs/VR2011/>

Passing the course

- Exam
 - Three chances for exam
 - Exam dates: 12.12.2011, 30.1.2012, 19.3.2012
 - Typical exam: define terminology & concepts, design a VR application, describe topics and technical issues/components in depth
- A small compulsory laboratory work
 - Atanas Boev, suncho@cs.tut.fi, TE413
 - 3D modeling etc., visualizing the model on an autostereoscopic display. Details on Lecture 5, 3.10.2011
- A small optional lab work
 - Extra work on visualization upgrades your exam points a little



The Lectures 2011

Lectures (11 x 3h) in the 1st and 2nd period

During 5.9.2011 - 21.11.2011 at TC163:

- Mondays at 14-17
- Changes possible! Check the web page!

Lecturer: Stanislav Stankovic

- stanislav.stankovic@tut.fi
- Please remind me to stop for a break

Lectures

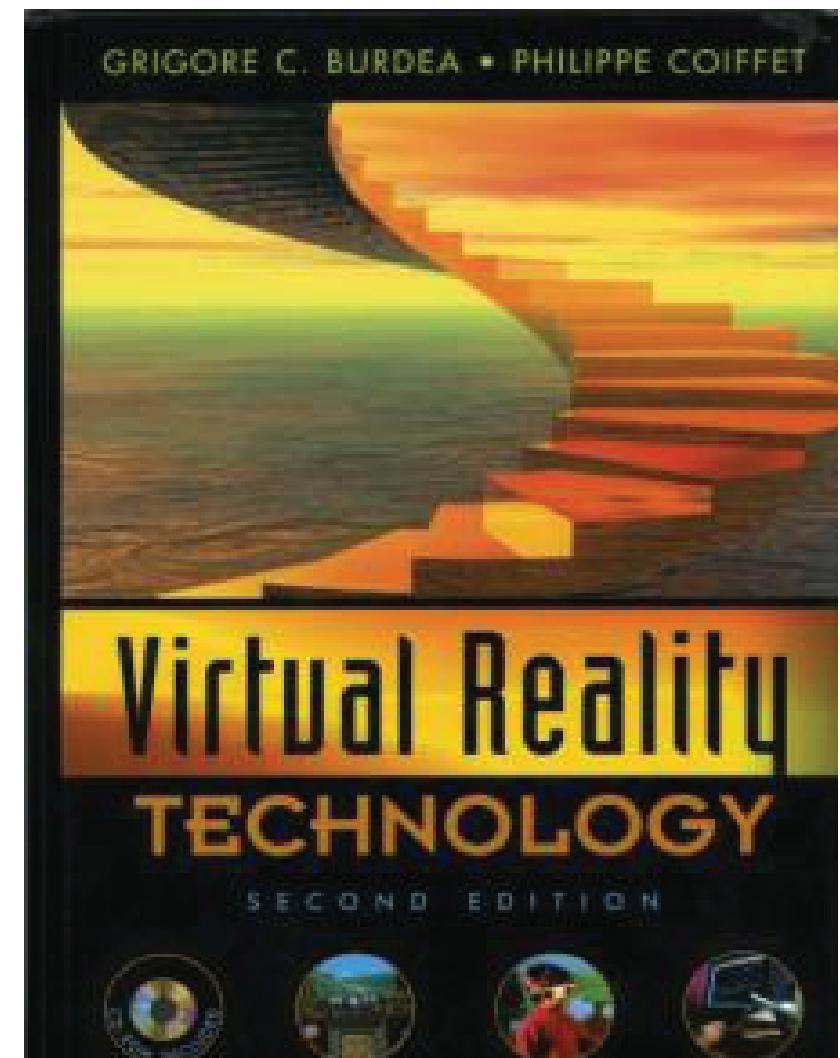
Lecture 1	5.9.2011	Introduction to Virtual Reality
Lecture 2	12.9.2011	Human senses, 3D audio
Lecture 3	19.9.2011	3D graphics & modelingI
Lecture 4	26.9.2011	3D & VR displays (Atanas Boev)
Lecture 5	3.10.2011	Autostereoscopic displays and Labwork (Atanas Boev)
Lecture 6	10.10.2011	I/O devices, haptics
Lecture 7	24.10.2011	Tracking systems for VR
Lecture 8	31.10.2011	Networked VR, web3D
Lecture 9	7.11.2011	Augmented Reality, mobile VR
Lecture 10	14.11.2011	Novel user interfaces
Lecture 11	21.11.2011	Applications of VR

VR Courses/activities at TUT

- SGN-5906 Virtual Reality Seminar in Spring, other seminars
- <http://www.ele.tut.fi/teaching/ele-7200/> (hands-on)
- ELE-7150 (display tech.), ELE Personal electronics
- Machine engineering KSU-5010
- CAD, CAM, design
- Modeling and simulation
- AML-4300/6 Architectural visualization
- Hydraulics and Automation
 - <http://www.ihc.tut.fi/research/vfpr/>
- ROViR - Remote Operation and Virtual Reality Centre
 - <http://www.hermia.fi/rovir/>
- Etc.

Literature

- **Virtual Reality Technology (2nd Ed.)**
 - Grigore C. Burdea & Philippe Coiffet.
John Wiley & Sons, Inc. 2003
 - Recommended course book



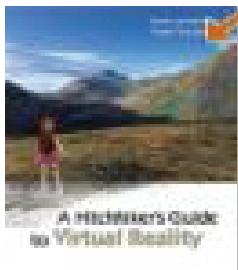
Other books



Stanney (ed.): **Handbook of Virtual Environments**, 2002
Bulky, 1264 pages!



Kalawsky: **The Science of Virtual Reality and VE**, 1993
An old classic, deep VR technology book



McMenemy, Ferguson: **A Hitchhiker's Guide to Virtual Reality**,
2007

Other books



Malizia: **Mobile 3D Graphics**, Sept. 2006



Bimber, Raskar: **Spatial Augmented Reality**, Sept. 2005
<http://www.uni-weimar.de/medien/ar/SpatialAR/download.php>



Hainich: **The End of Hardware (3rd ed.)**
- **Augmented Reality and Beyond**, April 2009

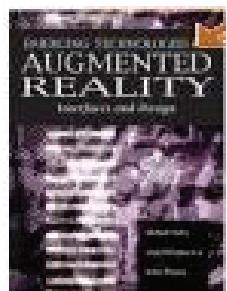
Other books



Pulli et al.: **Mobile 3D Graphics**, Nov. 2007



Cawood, Fiala: **Augmented Reality: A Practical Guide**, Jan. 2008



Haller et al.: **Emerging Technologies of Augmented Reality: Interfaces and Design**, Nov. 2006

Other books



Ozaktas, Onural: **Three-Dimensional Television: Capture, Transmission, and Display**, 2007

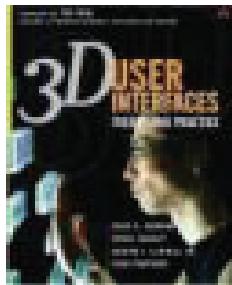


Schreer, Kauff, Sikora: **3D Video Communication**, 2005



Javidi, Okano (Eds.): **3D TV, Video and Display Tech.**

Other books



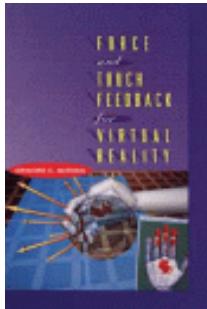
Bowman et al.: **3D User Interfaces: Theory and Practice**



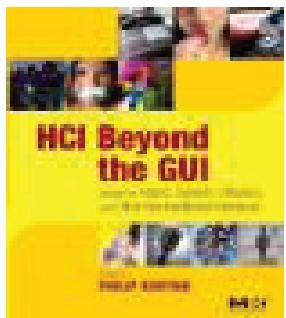
Poon: **Digital Holography and Three-Dimensional Display**

Intuition network: **State-of-the-Art in VR reports**
<http://www.intuition-eunetwork.net/>

Other books



Burdea: **Force and Touch Feedback for Virtual Reality**

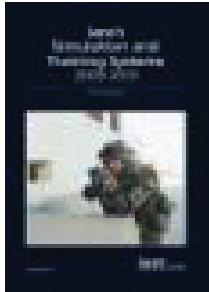


Kortum et al.: **HCI Beyond the GUI**, 2008



Moller, Haines: **Real-Time Rendering**
<http://www.acm.org/tog/resources/RTR/>

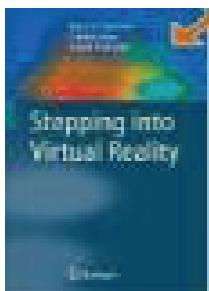
Other books



Jane's Defence: **Simulation and Training Systems 2009-2010**



Foley et al.: **Computer Graphics**

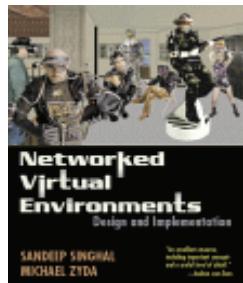


Gutierrez: **Stepping into Virtual Reality**, 2008

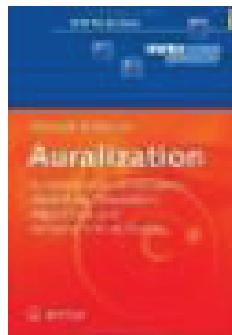
Other books



Mendiburu: **3D Movie Making**, 2009



Singhal, Zyda: **Networked Virtual Environments**



Vorländer: **Auralization**, 2007

Other books



Grunwald: **Human Haptic Perception**, 2008



Craig et al.: **Developing Virtual Reality Applications**, 2009



Girod (ed.): **Principles of 3d Image Analysis and Synthesis**

Other books



Kim: Designing Virtual Reality Systems: The Structured Approach, 2005



Brutzman, Daly, X3D: Extensible 3D Graphics for Web Authors, 2007



Hillis: Digital Sensations - Space, Identity, and Embodiment in Virtual Reality

Heim: The Metaphysics of Virtual Reality



What is Virtual Reality?

- Lectures usually begin with dictionary definition:
- Virtual – from latin *virtualis*... blah blah blah





What is Virtual Reality?

2011!

No explanation needed!





Virtual Reality

- Matrix
- Holodeck
- Tron
- GUI like they have it in Johny Mnemonic, Neuromancer, Lawnmower man (if someone still remembers it)





Virtual Reality

- The term coined in 30ies
- Concept invented in 30ies
- Sci-Fi, Media – created the public expectation
- Everyone knows what VR is
(or at least what VR is supposed to be)





This was supposed to be the future?!

- This presentation is disappointing
- Where is our virtual teacher in virtual classroom?
- Where are avatars of my virtual students?
- Where is my HMD and Power Glove?



2010 - Reality



- The most popular game – (61 000 000+ users!)
- Second Life = dead





VR - Nostalgia

- The course is retrofuturistic relic from 1990ies,
- TUT might discontinue it from next year.
- It will get absorbed by 3D TV course.





VR – Utopia

- Real VR still far
- Why do we still bother, after all these years?
- 1000 little reasons can be invented
- All are justifications





Only one real reason

- For every Neo that took a red pill, there are millions of people who would beg on their knees to take the blue one!
- VR is Ultimate Escapist Dream!
- And people are willing to pay good money for it.

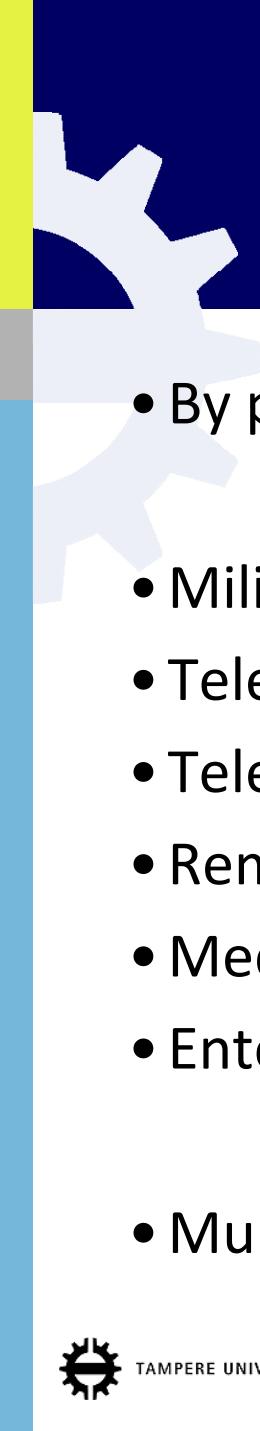




VR – Lives on

- VR – Utopian Concept.
- Spawned – 1000 of applications.
- Influenced many technologies
- 3D graphics, 3D movies, 3D TV, Flight simulators, Google Earth and street view, virtual communities, On-Line Gaming, WoW, virtual cash, virtual cows in Farmville and virtual furniture in Habbo Hotel





VR – Applications

- By product of inventing reasons – Applications!
- Military simulators.
- Teleconferencing.
- Telepresence.
- Remote sensing.
- Medical applications.
- Entertainment industry.
- Multi billion euro business





What is Reality?

- Mind + Senses
- Part of Phylosophy called Ontology.
- Aside from input from the senses, mind can know only of its own existance.
- Solipsism.





Perception of Reality

- Input + Processing
- Input – comes from senses
- Processing – what mind extracts from input
- To alter the perception of reality:
 - Trick the senses.
 - Twist the mind.





Tricking the mind

- Psychologically
(hypnosis, day dreams, autosuggestion, placebos, political manipulation, schizophrenia, paranoia)
- Chemically
(booze and drugs, coffee, sugar,... each human society has at least one mind altering substance)
- Not all of these methods socially acceptable in any given society





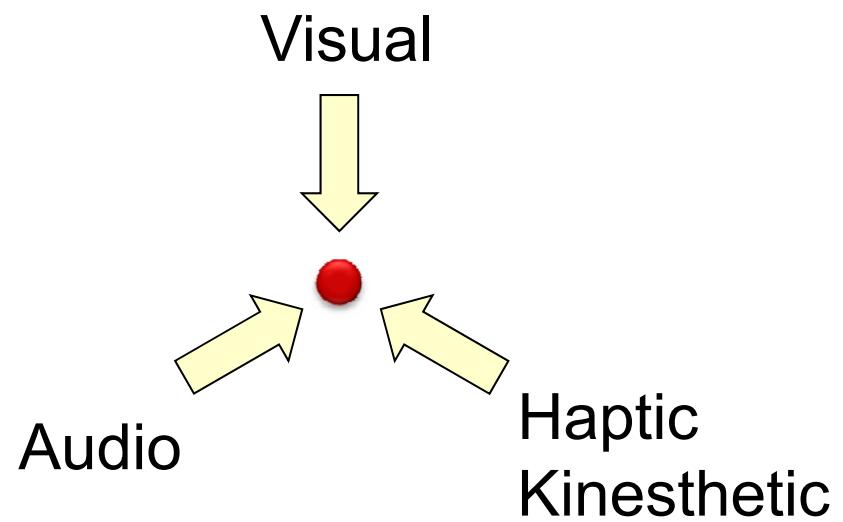
Tricking the senses

- VR – takes the different approach.
- Try to trick the senses.
- Using technology.



 VR

- Artificial computer generated.
- Believable experience -> Perfect Illusion
- Perception of reality:
 - Place
 - Time
 - Situation





VR - Experience

- Contemporary systems:
 - Primarily visual experiences
 - Secondarily Audio
 - Sometimes heptic feedback



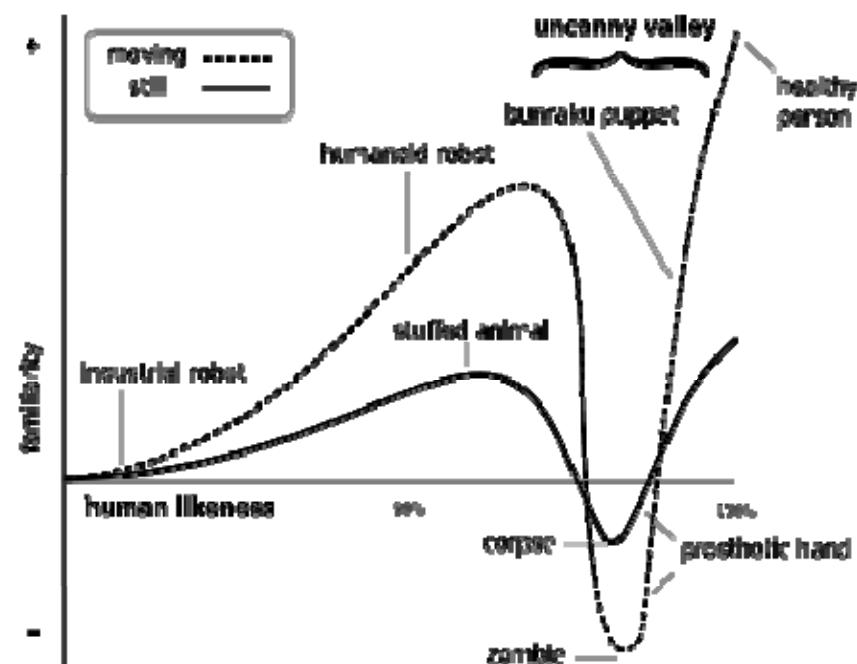


Tricking senses

- VR – originally meant fully immersive (“perfect” illusion)
- Senses hard to trick
- Mind – good at abstract thinking (ready to accept a “lie”)
- Senses good at picking up tiny inconsistencies



Uncanny Valley





Uncanny Valley

- Alternate reality readily accepted at some level.
- If something too similar to reality it gets perceived at different level.
- Different mental mechanisms kick in.



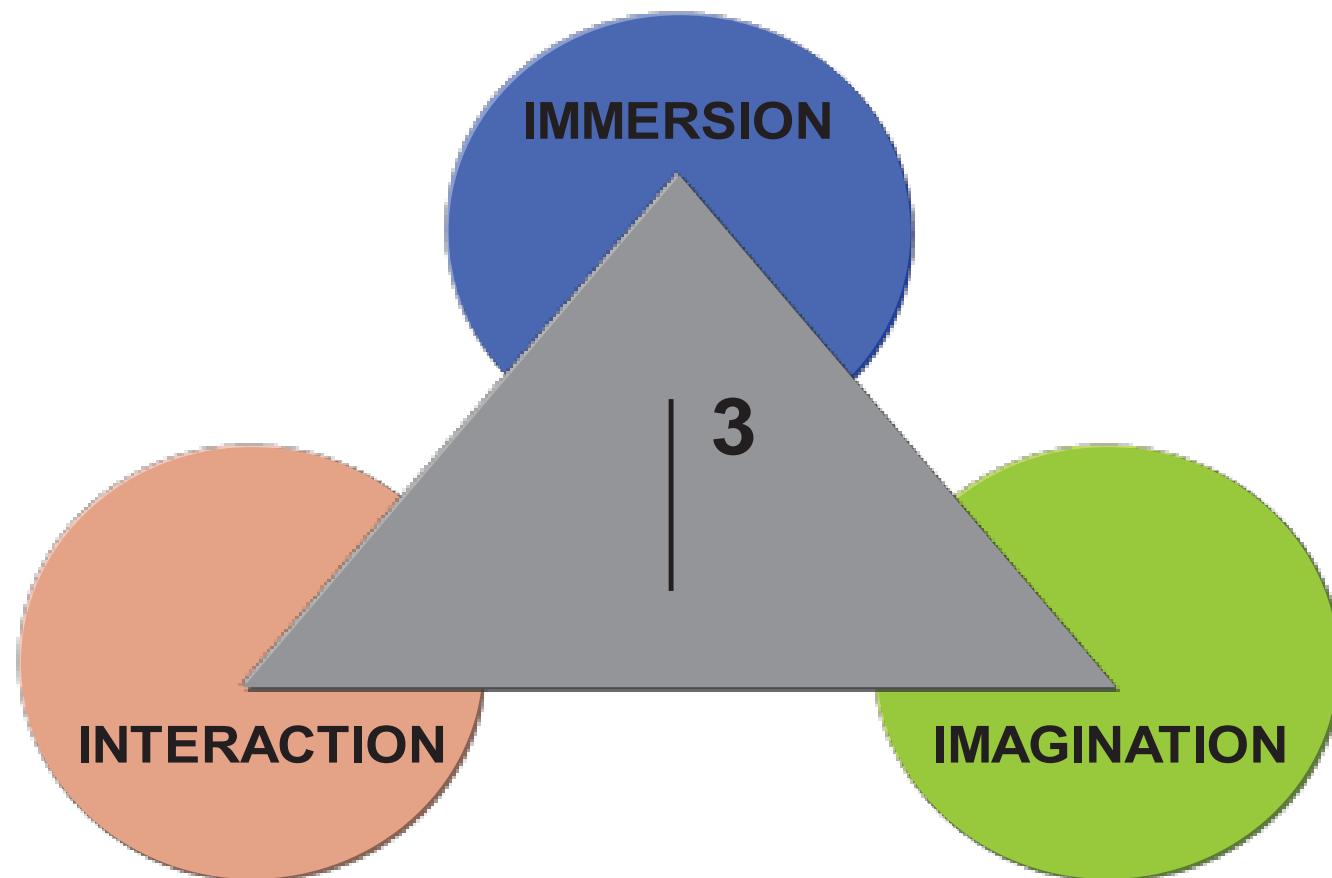


Full immersion not needed

- Good enough experience.
- Reading a book is low-tech, yet often fully immersive.
- Complexity of tech – not correlated with quality of experience.
- Subltle cues – often very important



Virtual Reality Triangle



The Three I's of Virtual Reality

- **Immersion**
 - The feeling of presence, being there
 - The amount and quality of stimuli and sensations
 - Real time: very little latency accepted
 - around 50 ms is a threshold of visual noticability, but varies for all senses
- **Interaction**
 - Not just passive watching
 - Moving in the virtual world
 - Doing all kind of things there
- **Imagination**
 - The applications
 - The ideas
 - The virtual worlds

Immersion & Presence

Immersion

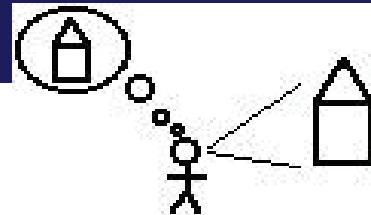
1. Dipping or plunging into water or other liquid, and transf. into other things
2. transfig. and fig. Absorption in some condition, action, interest, etc.

Presence

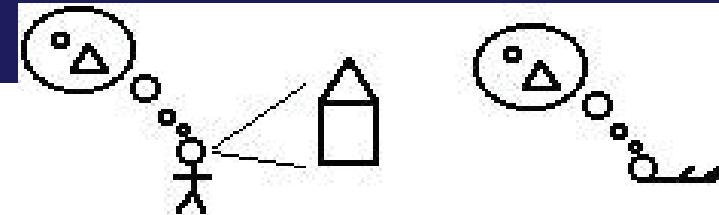
- 1.a. The fact or condition of being present; being there
- 1.b An instance of being present

- *The Oxford English Dictionary, Second Edition, Vol. XII, Clarendon Press, Oxford, 1991.*

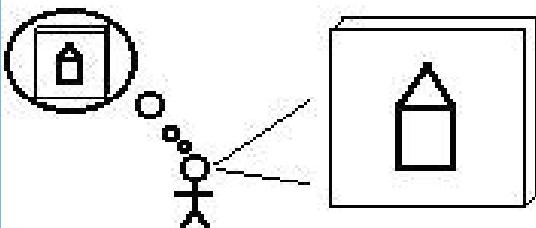
- Immersions ...



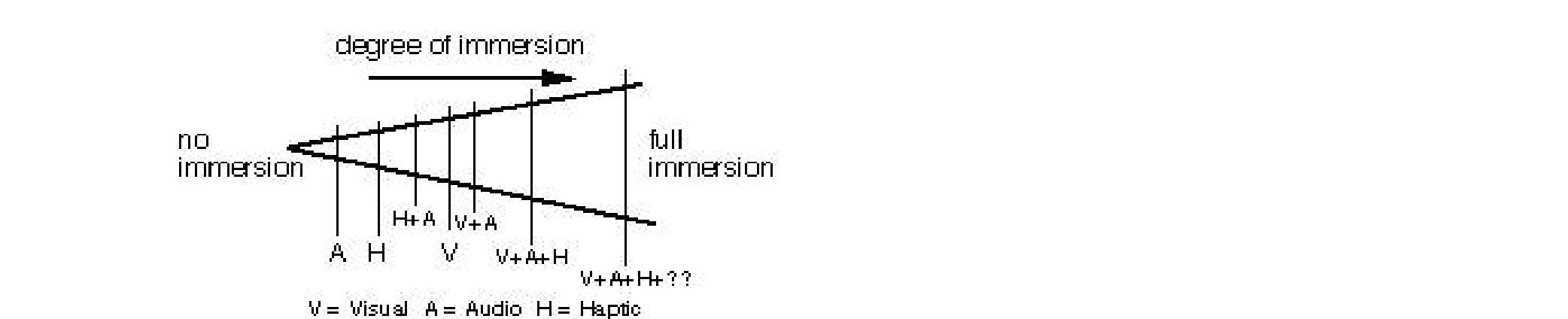
- Immersion in reality



- Daydreaming and dreaming



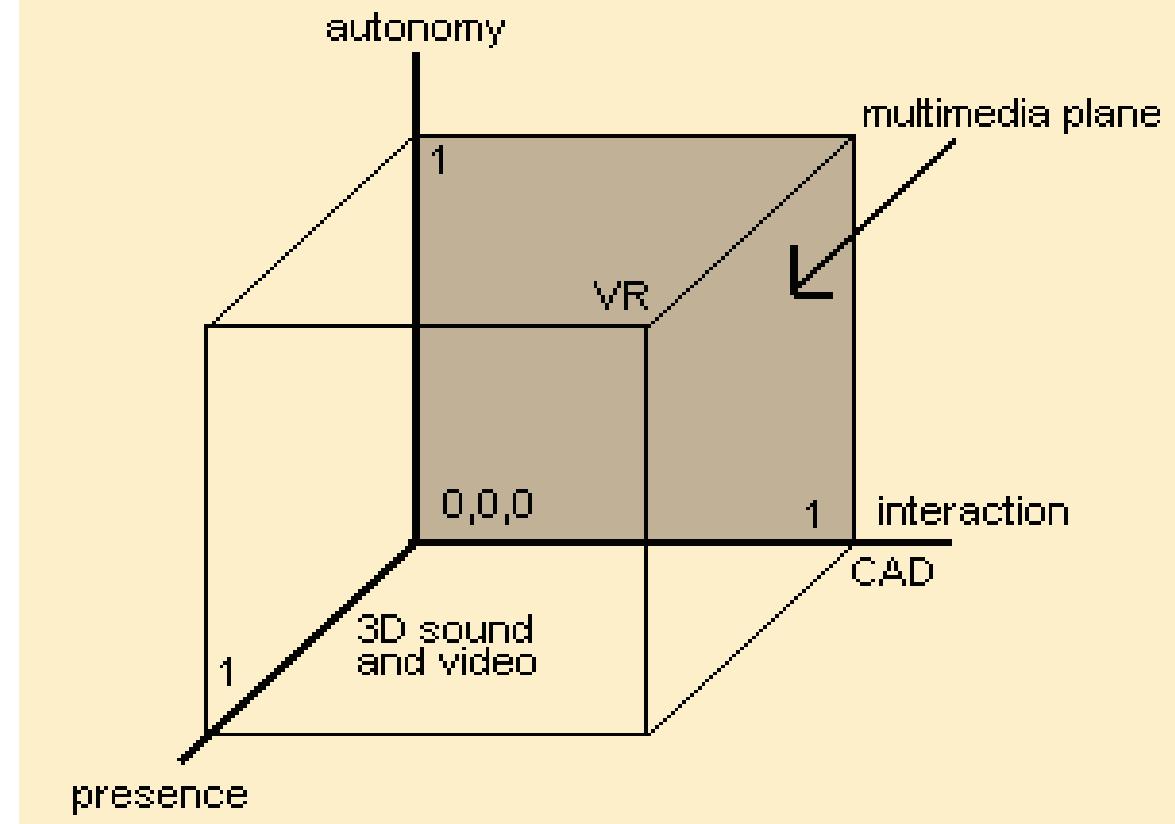
- Cinema (text) without and with immersion



- Degrees of immersion classification

Virtuality

- Zeltzer classification
 - Autonomy
 - modeling of objects and processes
 - Interaction
 - The possibility to transform the environment or the experience
 - Presence
 - Deceiving the senses in a believable manner



$$VR = (1, 1, 1)$$

IMAX, Omnimax
movies = (presence)

To be considered

- Technically better systems don't always give a better immersion than simpler systems
 - Like reading a book vs. watching the movie based on that book
 - Like playing a MUD instead of a modern 3D game
 - When the system doesn't give all the details, users must use their imagination
- Imagination and mental immersion is the most important also in VR experiences, not the technical hi-fi

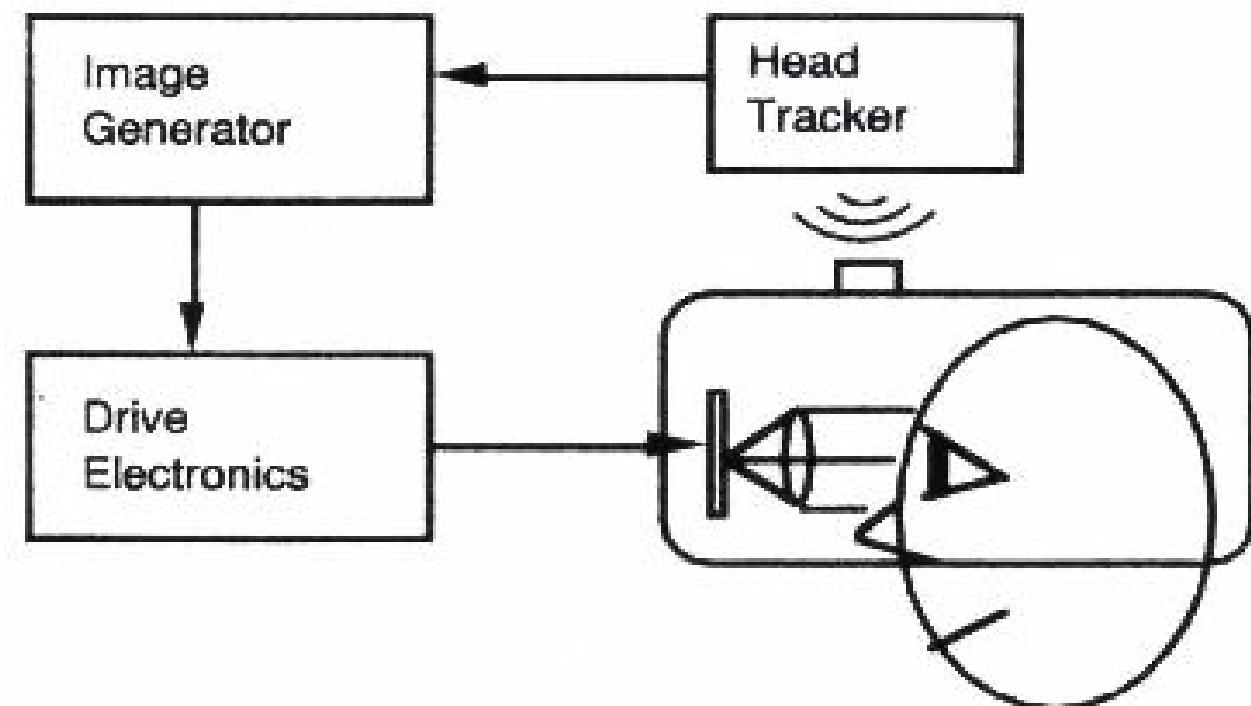
Properties of VR

- Synthetically generated environment
 - Computers, 3D, real-time
- Sensory feedback
 - I/O devices
- Interaction, moving
 - In time
 - In space
 - In scale
- Immersion
 - Being there

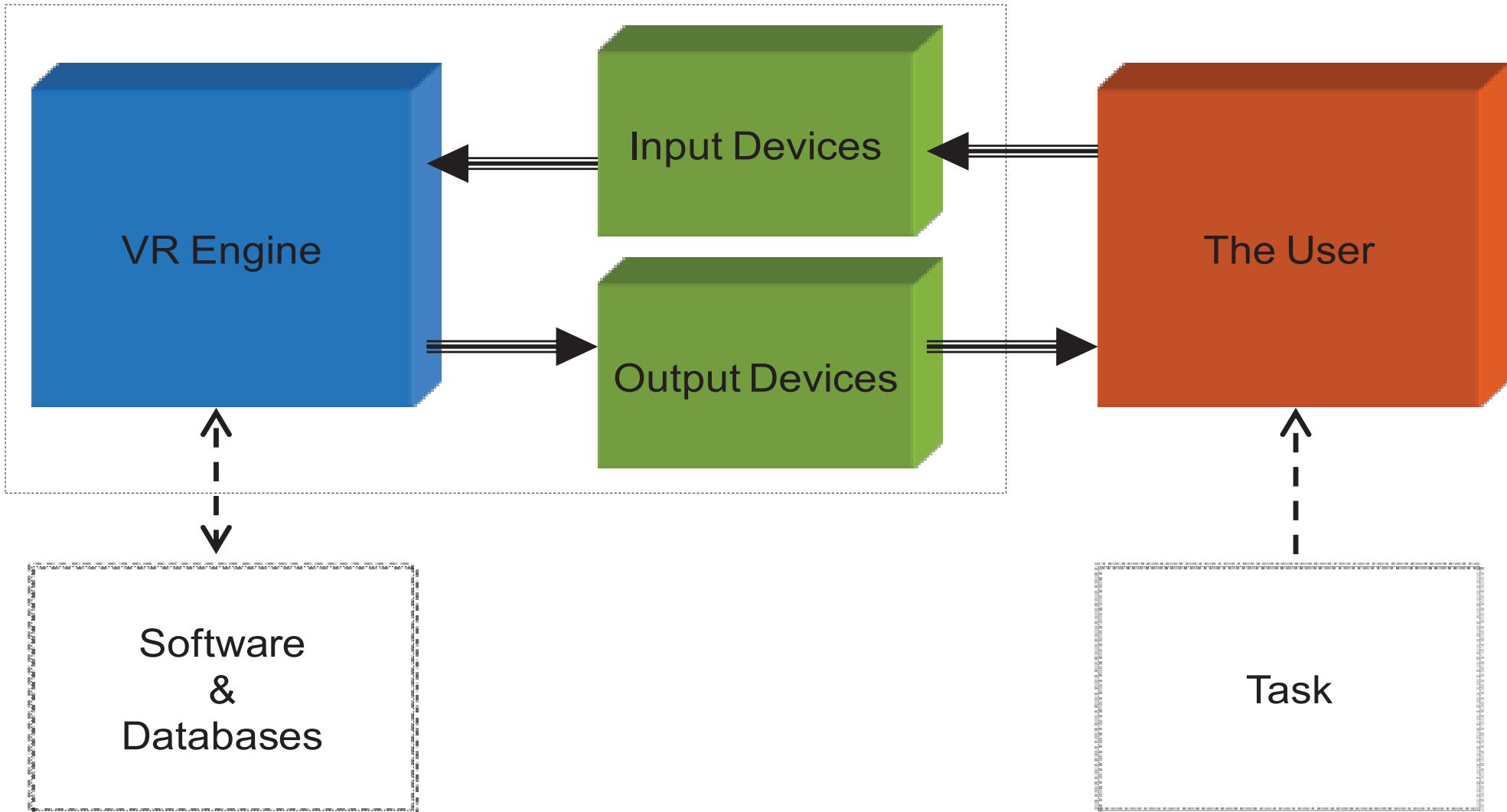


The Basic Components of VR

- Computing
- Displays (visual, audio, haptics, etc)
- Tracking
- Input



The VR System Architecture



VR Input Devices

- **The ways to transfer information from the user to the computer**
- Mouse, keyboard
- Trackball, joystick, mouse, ...
- Position tracking
- Orientation tracking
- Datagloves
- Exoskeleton (external hardware on hands etc.)
- Data suit
- Motion capture (tracking of body)
- Eye tracking
- Videoanalysis
- Brainwaves (EEG), EMG, EOG
- ...

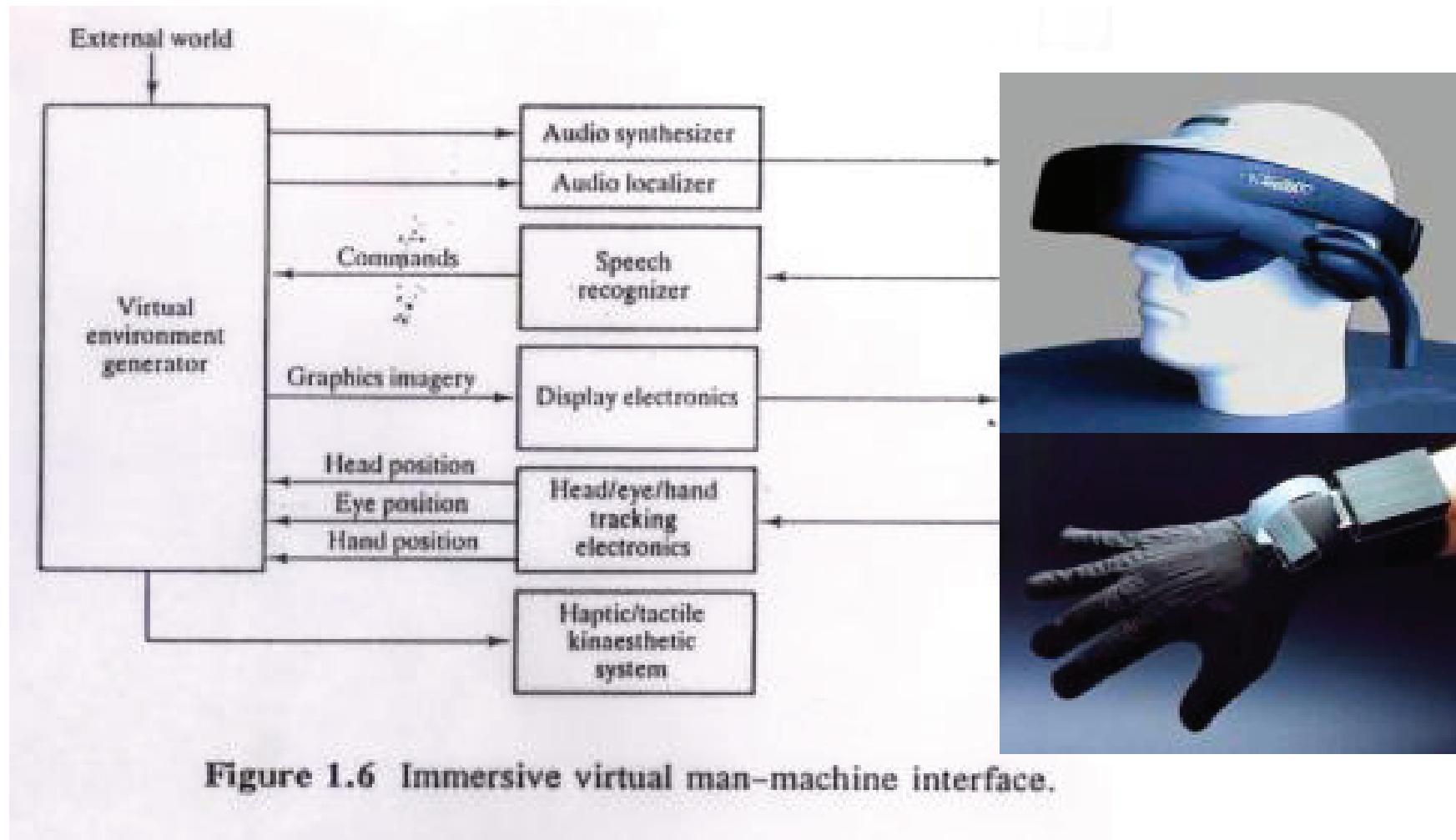
VR Output Devices

- **Transferring data from the computer to the senses of the user**
- Fooling of ALL(?) senses?
 - Displays
 - Monitors, projectors, HMDs, etc.
 - Localized audio
 - Loudspeakers, headphones
 - Tactile & haptic
 - Force feedback
 - Smell, balance, etc.

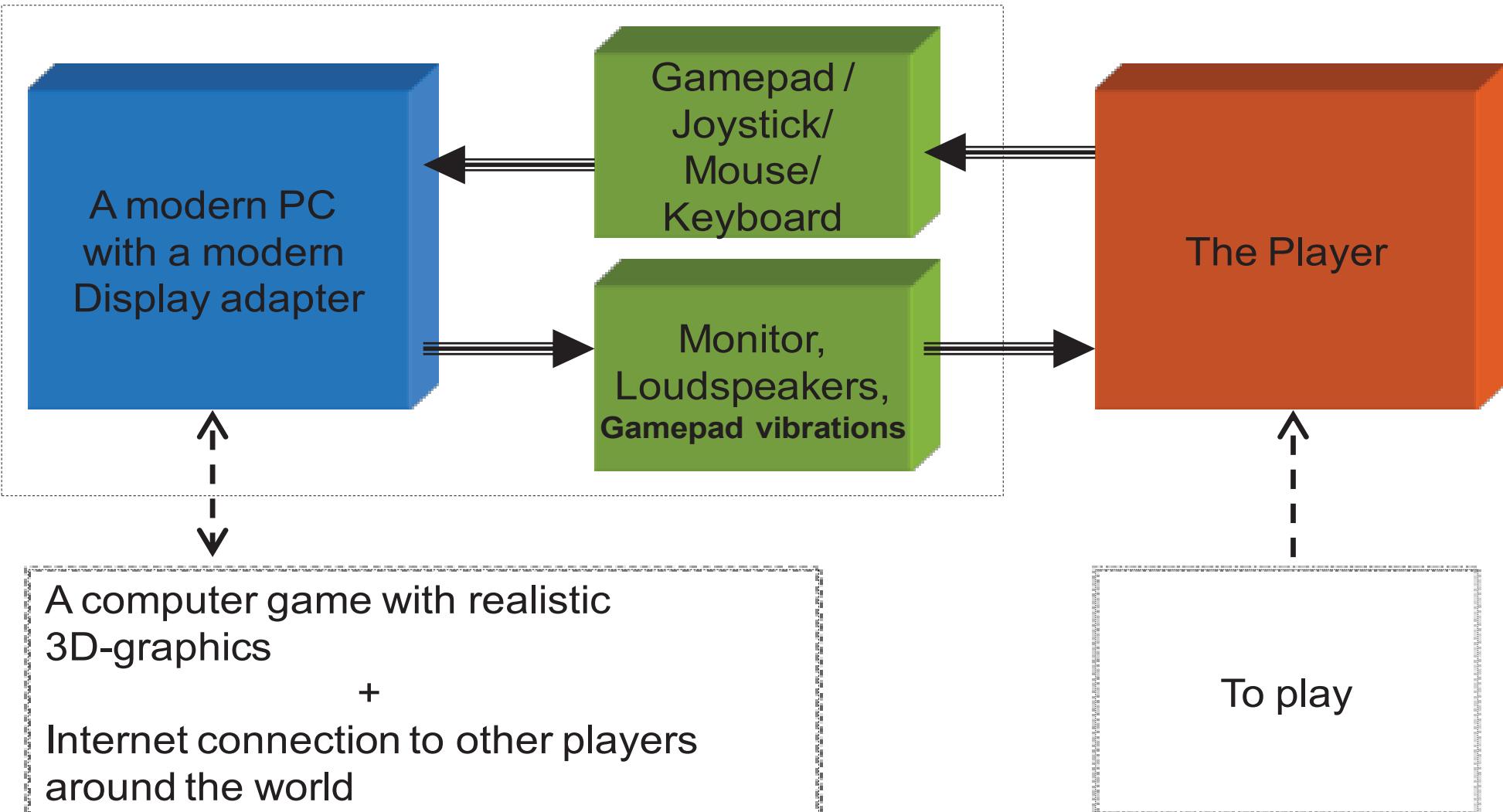
Requirements for the System

- Real time, >25 frames/s
 - So the environment is smooth
- Latency < 50 ms
 - Processing power
 - Input devices
- Big data size
 - Enough memory & hard disk space
- 3D speed, as much polygon/s as possible
 - PC: new and powerful graphics cards
 - If not enough power in GPU, fps drops or details drop
- CPU processing power for other calculations & simulations
- Fast networking
- VR may be expensive, or low-cost...

A VR system example



A very common VR System Architecture



What is virtual reality...

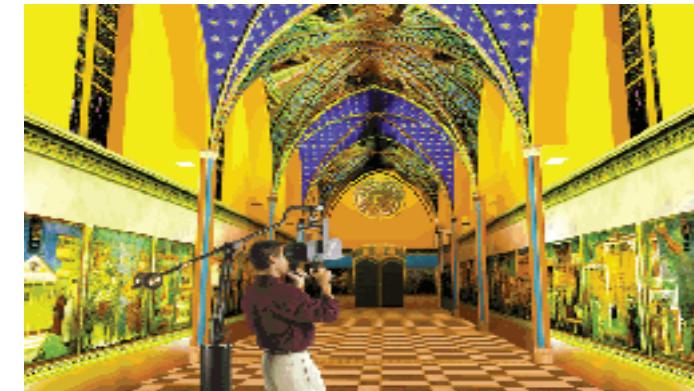
- VR is commonly associated with head-mounted displays, sensing gloves, or virtual rooms (CAVEs)
- Virtual reality is often made without these things
 - HMDs, gloves, etc. are still quite rare
- Mostly normal PC computers and monitors (and reduced immersion) are used in VR applications
 - Mouse, keyboard, gamepads, joysticks, trackballs, ...



Virtual Dialects



- Immensely diverse forms, devices, applications and flavors
 - Many different device types
 - Lots of applications
 - As diverse as life itself
 - “Basic” VR: no such thing!
- Games, entertainment
- Telepresence, teleoperation
- Nano-, macropresence
- Augmented Reality (AR)
- Mixed Reality (MR)
- Web3D (X3D etc.)
- etc. etc.



Is it all good?

- Technology advances
 - Real and synthetic get mixed
 - The possibilities of VR will increase
- VR will be used for evil, too
- VR - escape from reality?
 - Like drugs / alcohol
- Addiction?
 - Some people spend all their time in a virtual world instead of the real one (e.g., "Second life" addicts)
- Will it connect people in new ways, or isolate them?
- "Too real" sensory feedback causes problems
 - Simulator sickness etc.

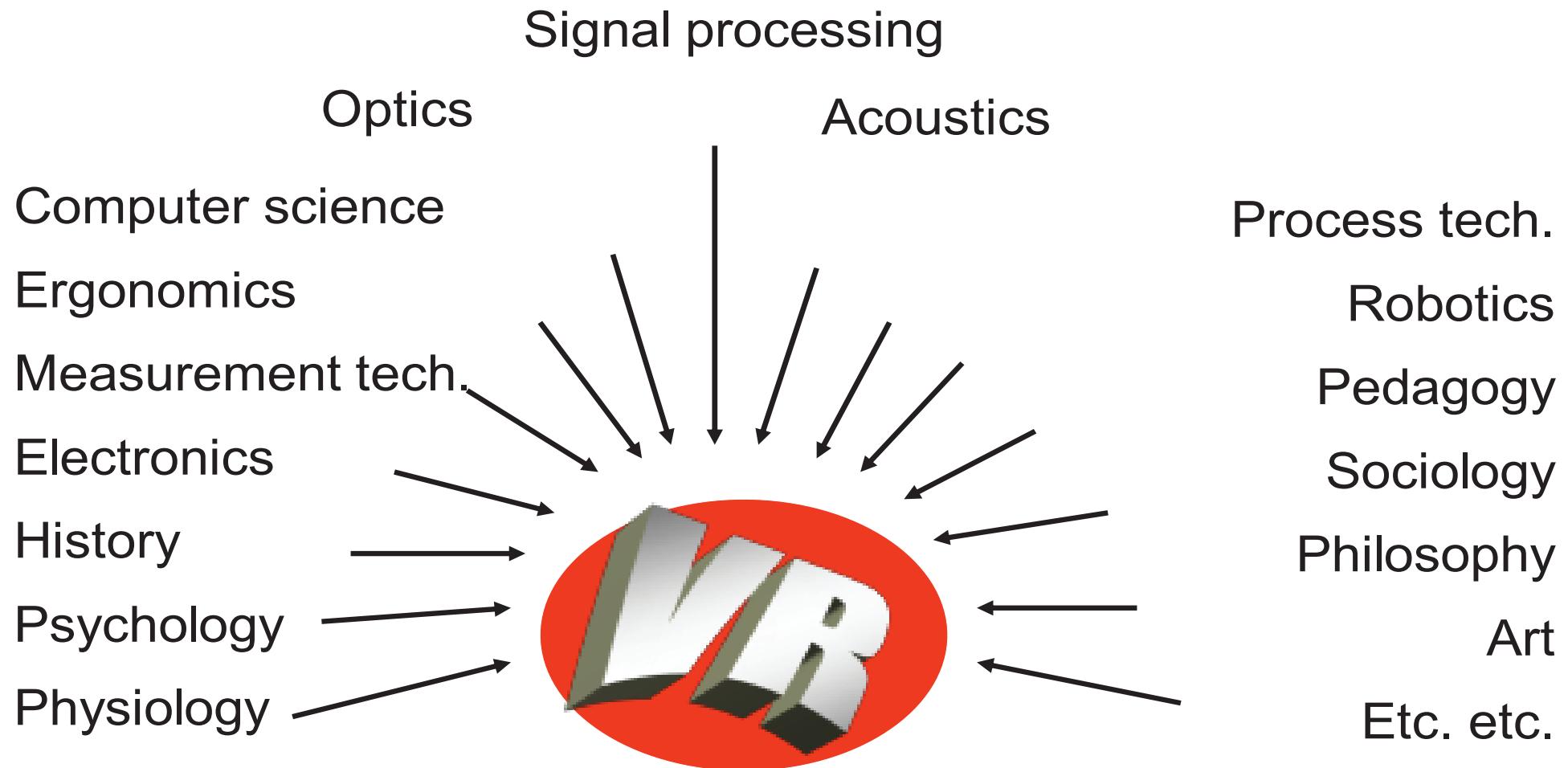
VR research areas

- A lot to develop and apply
- Realism
- The goal: perfect illusion
- Real time, < 20 ms
- Tracking accuracy and latency
- Tracking range
- Full field of view, resolution
- Audio channel and resolution
- Proprietary hardware
- Faster graphics
- Parallel computing

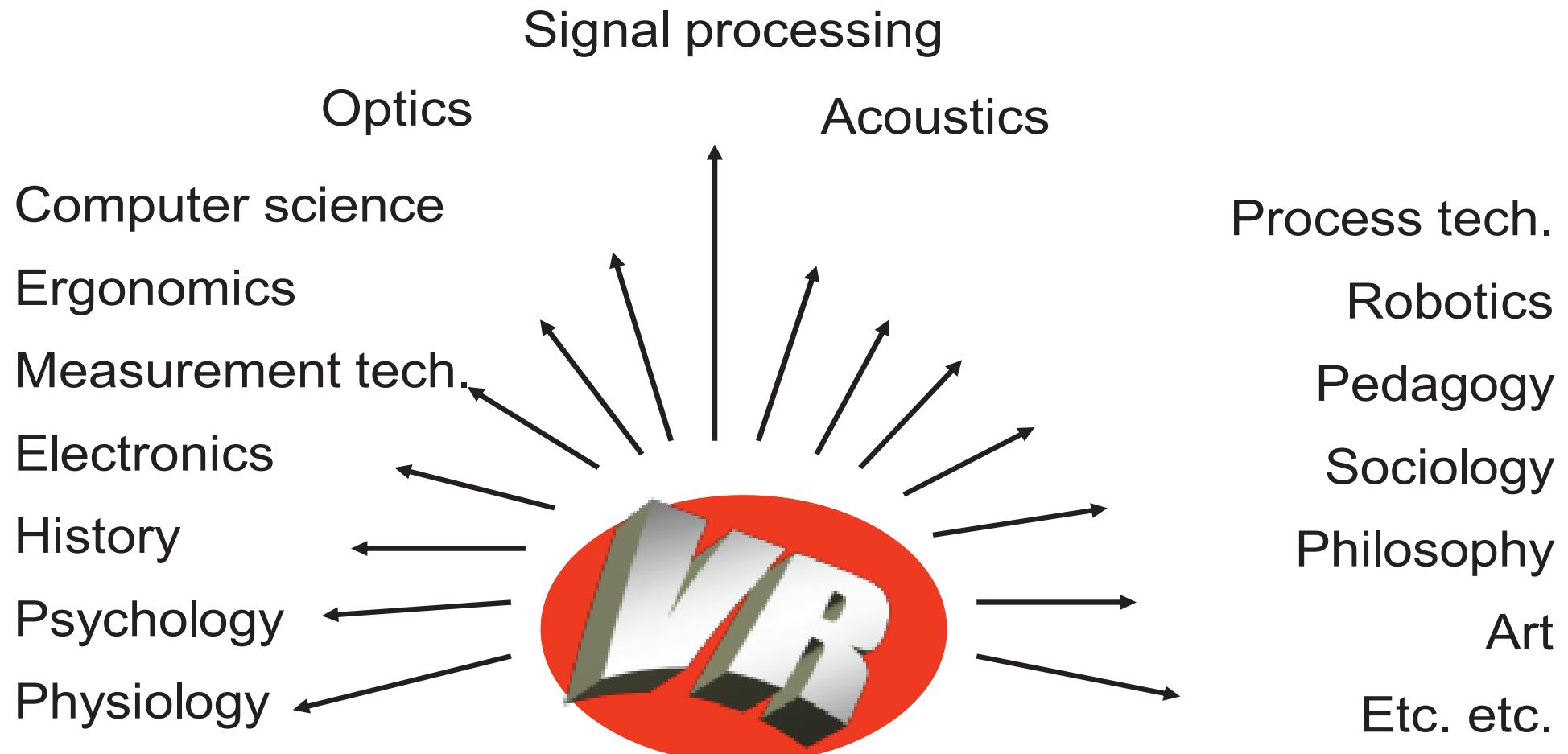
Research areas, continued

- Networked, shared VR
- Algorithms
- Incompatibilities
- Multimedia
- Augmented reality
- Web3D
- 3D and novel user interfaces
- Haptics
- Etc., etc.

VR technology needs numerous fields of science



VR can cater to many interdisciplinary applications



VR applications

- Can save money, time, lives!
- Training, simulators
 - Flight, cars, military, surgery, etc.
- CAD / prototypes / visualization
 - Useful when designing many kinds of products
 - Architecture, oil exploration, Boeing 777
 - Marketing
- Entertainment, casinos, games
- In the future, VR may have a big impact on novel user interfaces

Games as VR

- Earlier, computer games were quite simple and graphics were not realistic
 - Only 2D graphics at first, or even no graphics at all (text only)
 - Many limitations in graphics chips
 - Slow processor
 - Small amount of memory
 - The games could still be mentally very immersive
- VR was developed somewhere else
 - Special very expensive hardware was used
 - Special workstations (like Silicon Graphics)
 - HMD's, data gloves, etc.

Training, recruiting



"The simulator is an entry point for students to learn the latest in 4D-modeling techniques for virtual reality, real-time systems and control, animation tools, user interfaces, and sensory feedback"

- McMaster University, USA, 2006

Games as VR

- Computing resources of PC increased dramatically
 - Processing power
 - Memory + storage capacity
 - Complicated simulations became possible
- New graphics cards had much processing power
 - Hardware support for many complex graphical operations
 - OpenGL, DirectX
 - NVidia, ATI, Intel
- New games utilized this processing power
 - Many games became more and more realistic virtual simulations
 - Many people around the world can play together over the Internet in same virtual world

The history of immersion

- People used their own imagination
 - Dreams, daydreaming
- Stories
 - At first stories were told -> books, literature
- Theater, music
 - The first audiovisual experiences
 - Viewer's imagination complements strongly
- Illusionists
 - The magic tricks got better and better
 - Psychology and suggestion is an essential part!
- Imagination and mental immersion is the most important also in VR experiences, not the technical hi-fi

Image art

- First: ancient cave wall drawings
- Medieval times: ordinary people could see images only in cathedrals and churches
- Later: almost photographic paintings, also abstract art, photography, moving pictures, TV, cell phones, 3D displays
- Nowadays churches are often refuges of our visual culture, with flashy images and ads surrounding and attacking us everywhere



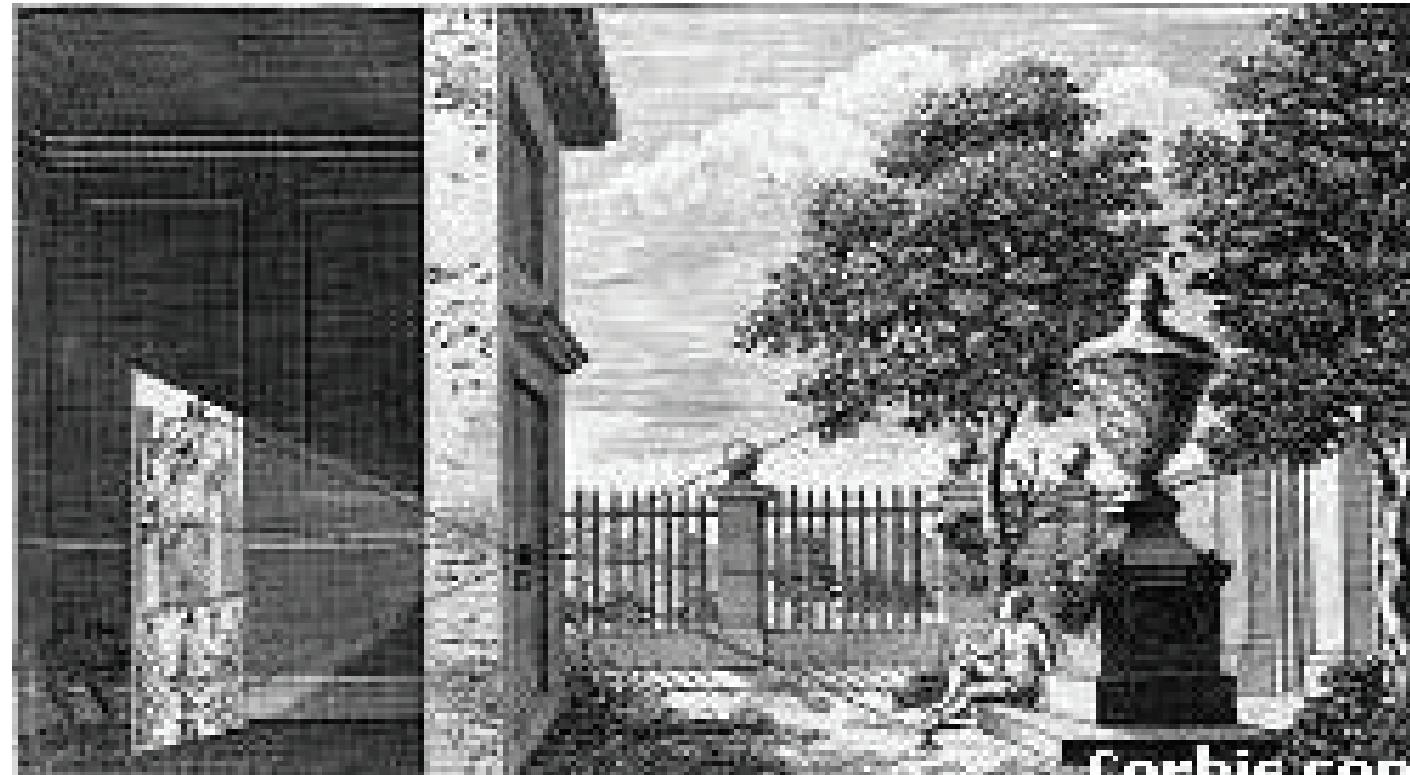
Anamorphic illusions

- Everything isn't what it looks like in images
 - <http://users.skynet.be/J.Bever/pave.htm>



Photography

- Camera obscura, 1515 (Leonardo da Vinci)
 - Not actually a real camera, but a tool to help drawing

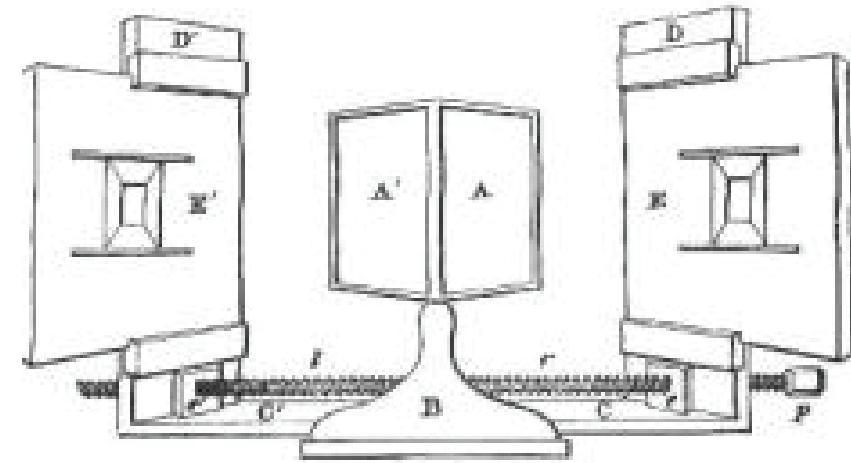


Photography

- The first picture was produced in 1827 by Niépce, using material that hardened on exposure to light
 - The picture required an exposure of eight hours
- Daguerre: photograph 1839
 - Discovered a way of developing photographic plates, a process which greatly reduced the exposure time to half an hour
 - Also discovered that an image could be made permanent by immersing it in salt

Stereoscope

- The first patented stereo viewer was Sir Charles Wheatstone's reflecting stereoscope in 1838
 - a bulky and complicated contraption that utilized a system of mirrors to view a series of pairs of crude drawings
- Improved designs in late 1800's became popular
- View-master™ 1939

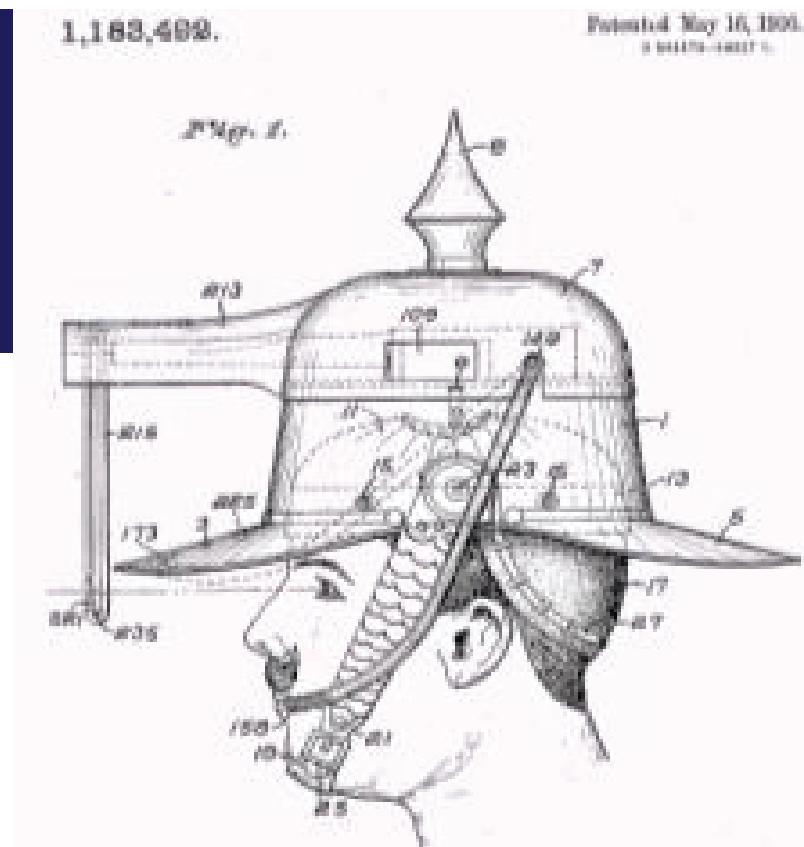


The Wheatstone stereoscope used angled mirrors (A) to reflect the stereoscopic drawings (E) toward the viewer's eyes.

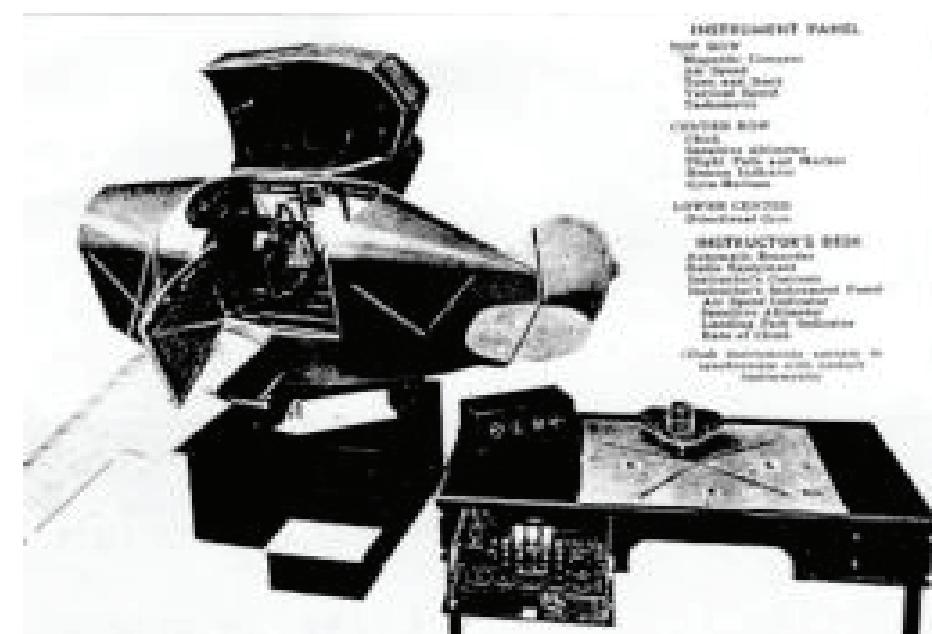


Towards Virtual Reality

- Head-mounted periscope display
1916



- First flight simulator 1929
 - Link Company
 - Simple and mechanical device for instrument flight training
 - Some 10,000 Link Trainers were used in the 1939-45



Moving pictures

- Zoetrope 1834
- Praxinoscope 1877
 - offered a clearer, brighter image to viewers than the zoetrope could
- G. Eastman: foldable film 1889
- Lumière: Moving pictures 1895
- 3D movie “L’arrivée du train” in 1903 by the Lumière brothers
- TV
 - Baird 1925 (30 lines)
 - NTSC 480, PAL 576
 - Ultra HiVision 4320 lines



Sensorama

- "Virtual reality workstation"
- Invented by M. Heilig 1962
- Simulation of a motorcycle ride, no computers used!
- Stereo movie
- Sound
- Smell
- Wind
- Vibras



Introducing . . .

Sensorama

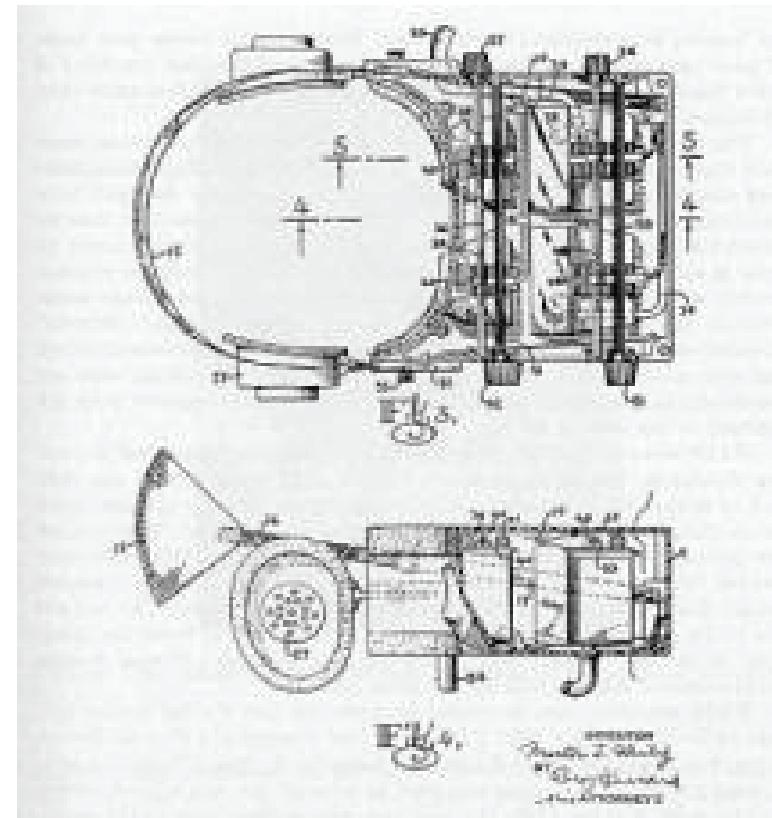
The Revolutionary Motion Picture System
that takes you into another world
with

- 3-D
- WIDE VISION
- MOTION
- COLOR
- STEREO-SOUND
- AROMAS
- WIND
- VIBRATIONS



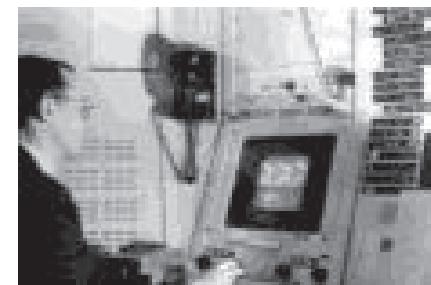
Early head-mounted displays

- Heilig's Head Mounted Display 1960
 - Used wide field-of-view optics to view 3D photographic slides
 - Had stereo sound
 - Had also an "odor generator"
- Head-Mounted Display 1961
 - Philco Corp.
 - Tracking of head orientation
 - Tele-operation of a remote camera



Sutherland's inventions

- Sketchpad by Ivan Sutherland 1963
 - First interactive computer graphics
 - A Man-machine Graphical Communications System
 - A light pen to perform selection and drawing interaction
 - The computer, TX-2 was a giant machine by the standards of the day



Sutherland's inventions

- The Ultimate Display 1965-68
 - A window to virtual world
 - Head-Mounted Display
 - Tracking of head
 - Control of a remote camera
 - Synthetic 3D graphics
 - “It is a looking glass into mathematical wonderland”
 - Includes kinesthetic (haptic) as well as visual stimuli



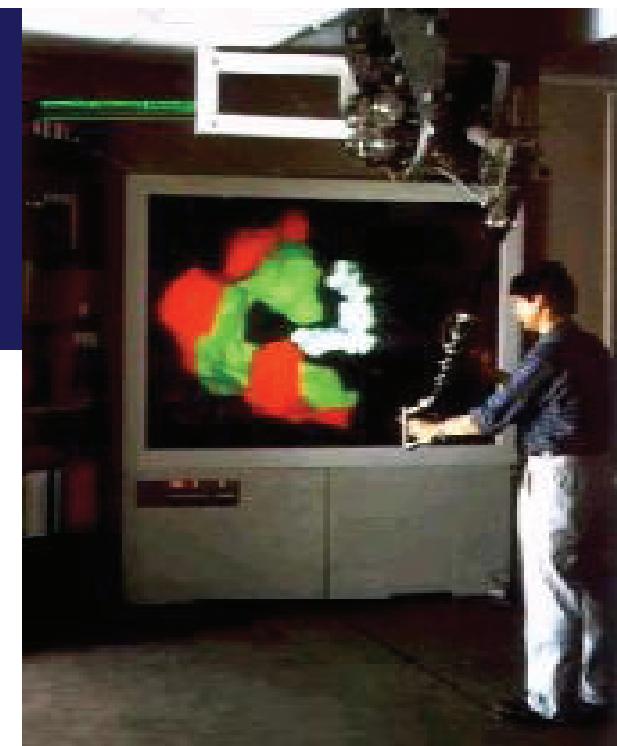
Aspen Movie Map

- Was created at MIT in 1977
- A crude virtual simulation of Aspen, Colorado in which users could wander the streets in one of three modes
 - summer, winter, and polygons
- The first two were based on photographs
 - The researchers actually photographed every possible movement
- The third was a basic 3D model of the city



More history

- UNC: GROPE I-III
 - Force feedback 1967-88
- Flight simulators etc.
 - DC-9 in 1970's, night visual
- ACM Siggraph founded 1969, conf. 1974
- Knowlton: virtual keyboard 1975
- Engelbart: mouse, hyperlink 1968
- Wide field-of-view optics LEEP 1975
 - Large Expanse, Extra Perspective



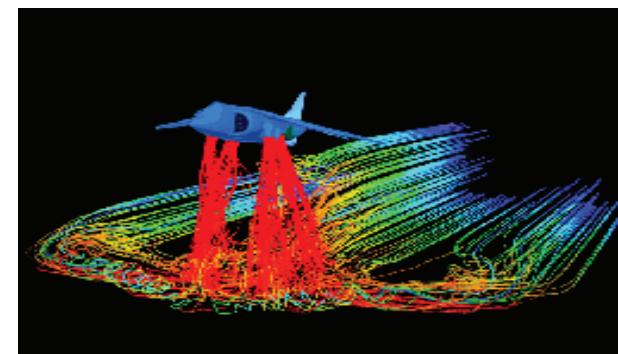
More history

- Krueger: VideoPlace 1975-
- MIT: Put That There 1980
- SGI 1984
- Dataglove 1985
- Eyephone HMD 1988
- Fakespace BOOM 1989
- Division: integrated VR workstation 1991



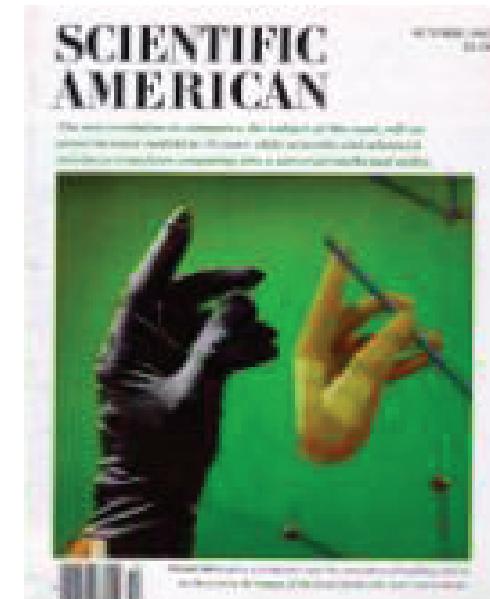
More history

- NASA Ames Research Center 1981-
 - HMD, VIEW, Virtual Wind Tunnel etc.
- Univ. of Illinois, Chicago: CAVE 1992
- ImmersaDesk 1996
- Augmented Reality (AR) 1990's
- 3D graphics has become ubiquitous
 - PC, mobile phone 3D graphics!
 - Game consoles
- VR hardware has improved
- Advanced professional applications
- Still very little mass markets
 - May become consumer products



Virtual reality in the media

- Gibson: "Cyberspace" 1984
- Scientific American 1987 (& 2001)
- "Virtual reality" was coined by Jaron Lanier in 1989
 - One of the pioneers in the field, founding VPL Research Inc., which built some of the first systems in the 1980s
- The related term artificial reality has been in use since the 1970s and cyberspace dates to 1984
- Overwhelming expectations, hype
- Bust
- VR-related Movies
 - Tron 1982 (3D CG), Lawnmower man, Minority report, Matrix, etc. 3D graphics has become standard in movies

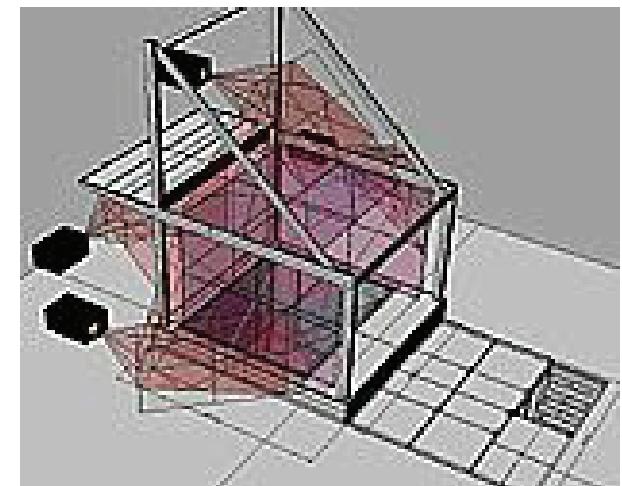


Research institutions

- HITLab (Washington Univ.)
- NASA Ames Research Center, JPL
- US Army (Naval Research Lab etc.)
- University of North Carolina at Chapel Hill
- Georgia Institute of Technology
- Columbia University
- Rutgers University
- Fraunhofer-IGD, GMD, Germany
- Tokyo & Nara Institutes of Technology, Japan
- KAIST, KIST, South Korea
- INRIA, France, Etc. etc.
- More VR companies and research:
 - <http://www.caip.rutgers.edu/vrtechnology/links.html>

VR Research in Finland

- Seinäjoki polytechnic + TUT in Seinäjoki
 - The best cave in Finland (5 screens)
 - Opened in 2005
- TUT
 - ELE, SGN, IHA, ROVir, etc.
 - Tampere VR Center (VRC) in 2000-2005
 - Was the best in Finland at the time, now closed
- HUT & CSC
 - TML (EVE environment), AKU
- Univ. of Oulu
- VTT various branches
 - Ship simulator Espoo, EXPO 2000
 - CyPhone Oulu
 - Automation and safety, Tampere



VR Research in Finland

- CSC (scientific visualization, EVE)
- Univ. Helsinki, Joensuu (forestry)
- Univ. of Art and Design, Lapland
- Univ. of Tampere
 - Haptic interfaces & human psychological research
 - Game research
- Lappeenranta Univ. of Tech., <http://www.lut.fi/kote/koal/>
- Univ. of Oulu / VTT / CCC Software
- Several colleges, Tampere polytechnic
- Simulations, simulators, visualizations
 - Forest machines etc.
- Companies: Delfoi, Instrumentointi, Bronto Skylift, Timberjack, NRC, PlusTech, Metso, Finnair, Elisa (Helsinki Arena 2000), Aamulehti (Nääsnetti 1997), MTV3, Army, Police, Senetrix, Mevea, 3D game and 3D hardware companies

VR related conferences etc.

Journals: Presence, IEEE CG&A

The Journal of Virtual Reality and Broadcasting

IEEE VR, Visualization, **MMVR**, Laval virtual

Siggraph, Web3D, I3DG

UIST, CHI, IUI, PUI

Eurographics, **EGVE**

ISMAR, ISAR => **ISMAR**

VRST, VSMM, IPT, ICAT

ISWC, UbiComp

SPIE, CVE, GI,

<http://confcal.vrvis.at/>

Some VR links:

<http://www.tml.tkk.fi/Opinnot/T-111.5400/2007/linkit.html>

<http://www.visgraf.imp.br/Projects/mcapture/hotlinks.html>

VR-related organisations in Finland

- VR-SIG Finland (discontinued)
 - Gathered people and organizations interested in VR in Finland
 - <http://www.cs.tut.fi/~ira/vr-sig/>
 - Mailing list, 7 VR seminars: over 100 participants
 - Replaced by ACM SIGGRAPH Finland
- ACM SIGGRAPH Finland
 - Special Interest Group on Computer Graphics (SIGGRAPH)
 - Promote an increased knowledge of and greater interest in the educational, artistic, and scientific aspects and applications of modern computing in computer graphics
 - Provide a means of communication between persons having an interest in computer graphics
 - Sponsoring conferences, symposia and workshops
 - <http://siggraph.fi/>

VR-related organisations in Finland

- SIGCHI Finland
 - *Finland Association for Computing Machinery Special Interest Group on Human-Computer Interaction*
 - <http://www.sigchi.fi>
 - Operates to promote increased knowledge of and greater interest in the science, design, development, and applications of modern computing in human-computer interaction (HCI)
- VR professor Randy Pausch's inspirational Last Lecture
 - "Achieving Your Childhood Dreams"
 - http://www.youtube.com/watch?v=ji5_MqicxSo
 - He had pancreatic cancer and died in August 2008