



Department of Engineering for Innovation
University of Salento
Lecce, Italy



Virtual and Augmented Reality Applications

Lucio Tommaso De Paolis

Augmented and Virtual Reality Laboratory (AVR Lab)

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Dept. of Engineering for Innovation
University of Salento
Lecce, Italy

Augmented and Virtual Reality Lab
AVR Lab
www.avr.unisalento.it

Course Headlines

Virtual and Augmented Reality Applications

- Virtual Reality technology
- Augmented Reality technology
- VR and AR applications in medicine and surgery
- VR and AR applications in cultural heritage
- VR and AR applications in education and games
- human-computer interfaces
- visualization and interaction systems

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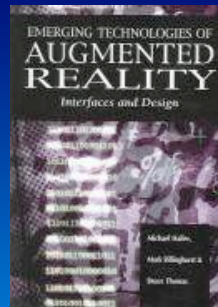
Virtual Reality Technology



Burdea Grigore C. and Coiffet Philippe
Virtual Reality Technology
2nd edition
John Wiley & Sons, 2003

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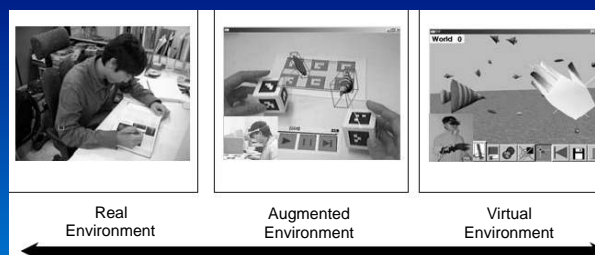
Augmented Reality Technology



M. Haller, M. Billinghurst and B. Thomas
**Emerging Technologies of Augmented Reality:
 Interfaces and Design**
 Idea Group Publishing, 2007

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Virtual and Augmented Reality

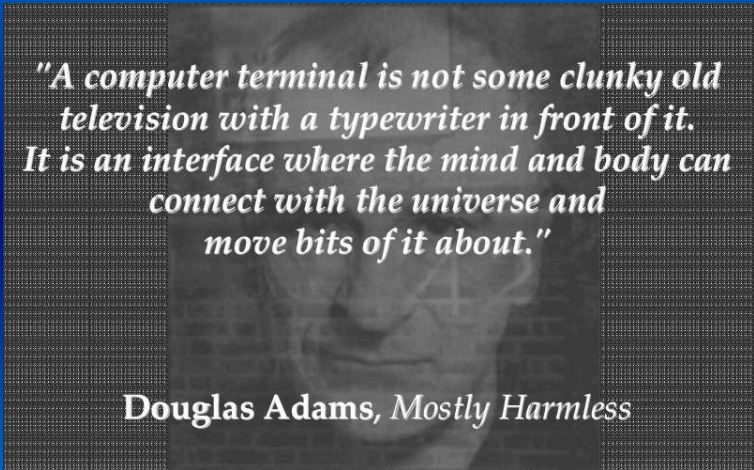


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Introduction to Virtual Reality

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Introduction



"A computer terminal is not some clunky old television with a typewriter in front of it. It is an interface where the mind and body can connect with the universe and move bits of it about."

Douglas Adams, Mostly Harmless

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Introduction

What is Virtual Reality?

“A high-end user interface that involves real-time simulation and interaction through multiple sensorial channels
(vision, sound, touch, smell, taste)”

“A computer-generated, immersive, multi-sensory information program which tracks a user in real time”

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Virtual Reality

Environment

Computer

Senses

User



Simulation

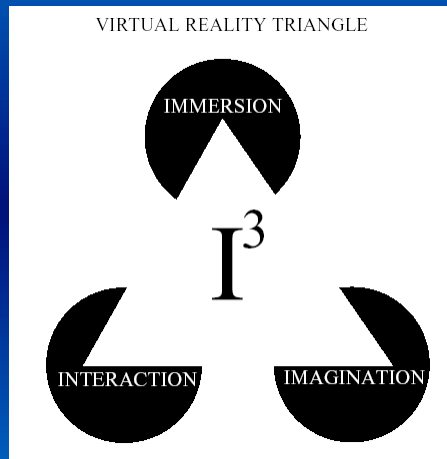
Interaction

Immersion

Presence

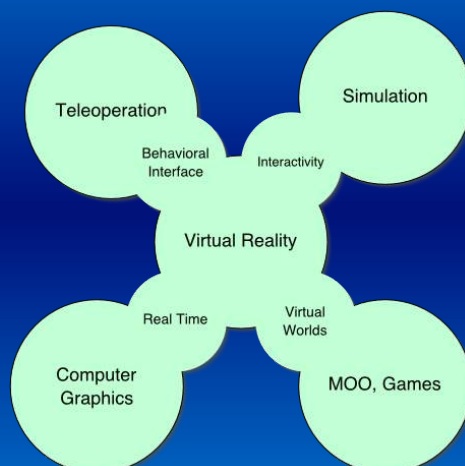
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Introduction



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Introduction



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Virtual Environment (VE)

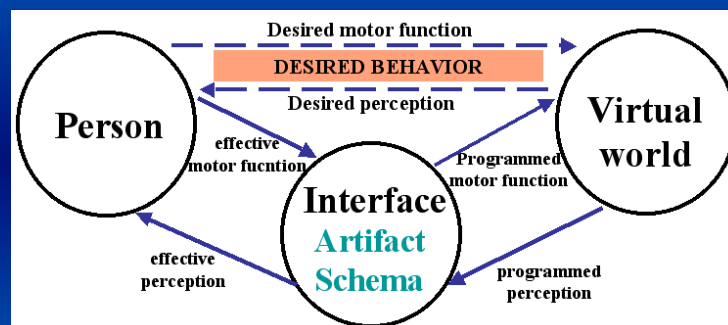
A computer generated world with which the user can interact

Interaction can vary from looking around to interactively modifying the world



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Introduction



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Introduction



Sensorama Simulator, US Patent #3,050,870, 1962

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VR Short History

- 1963: Ivan Sutherland's doctoral theses:
SKETCHPAD: stereo HMD, position tracking, and graphics engine
- 1966: Tom Furness: display systems for pilots
- 1967: Brooks developed force feedback GROPE system
- 1977: Sandin and Sayre invent a bend-sensing glove
- 1979: Raab et al: Polhemus tracking system
- 1989: Jaron Lanier (VPL) coins the term "Virtual Reality"
- 1994: VR Society formed

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VR Short History

Year	Person(s) Responsible	Why it was important
1965	Ivan Sutherland	The beginnings of VR
1977	Dan Sandin, Richard Sayre and Thomas Defanti	Interaction through body movement
1983	Myron Krueger	First virtual environment
1984	William Gibson	The term 'Cyberspace'
1987	Michael Piller (writer)	The Holodeck, idea of immersive VR
1992	Stephen King	A look at the possible negative side of VR
1995	Silicon Graphics	Virtual Reality Modeling Language
1999	Larry and Andy Wachowski	Virtual Reality movie grosses \$750M worldwide

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VR Short History

The term **Virtual Reality** born in 1989, in an interview with Jaron Lanier "A Portrait of the Young Visionary"

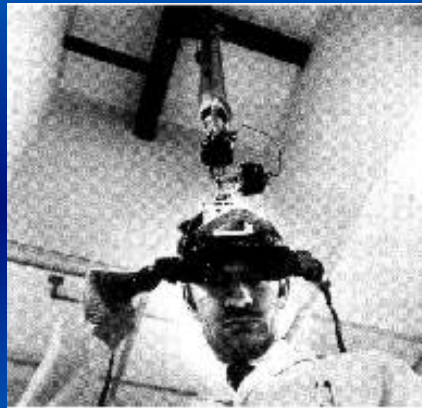
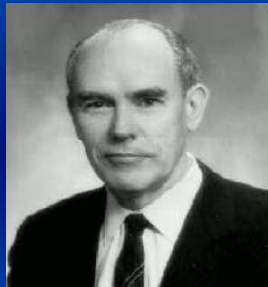


"We are speaking about a technology that uses computerized clothing to synthesize shared reality. It recreates our relationship with the physical world in a new plane, no more, no less. It doesn't affect the subjective world; it doesn't have anything to do directly with what's going on inside your brain. It only has to do with what your sense organs perceive.

The physical world, the thing on the other side of your sense organs, is received through these five holes, the eyes, and the ears, and the nose, and the mouth, and the skin. They're not holes, actually, and there are many more senses than five but that's the old model, so we'll just stick with it for now."

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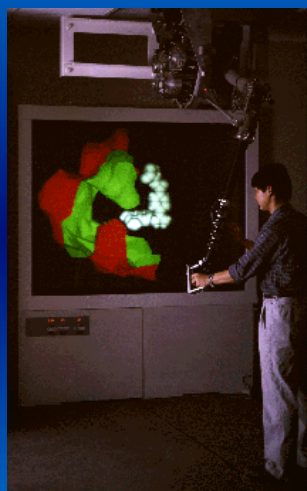
VR Short History



Ivan Sutherland's HMD (1966)

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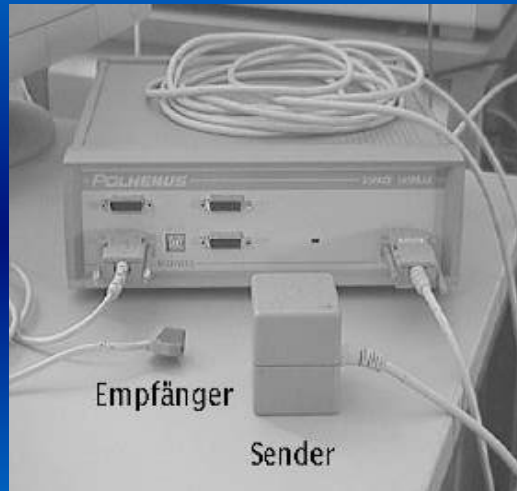
VR Short History



Brooks's Grope Project (1977)

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VR Short History



Polhemus 3D (1979)

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VR Short History

NASA ... a pioneer in VR

- the first complete system was developed by NASA "Virtual Visual Environmental Display" (VIVED) early 80s
- they prototyped the LCD HMD
- became "Virtual Interface Environment Workstation" (VIEW) in 1989
 - large simulation
 - training needs
 - relatively small budgets

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VR Short History



NASA VIEW system (1989)

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VR Short History



NASA VIEW system (1992)

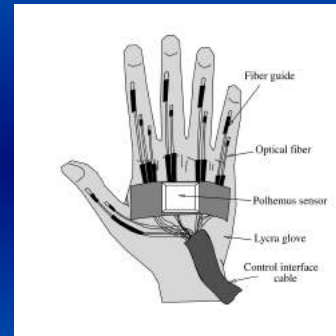
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VR Short History

Towards commercialization...

The first commercial VR systems appeared in the late 80s produced by VPL Co. (California):

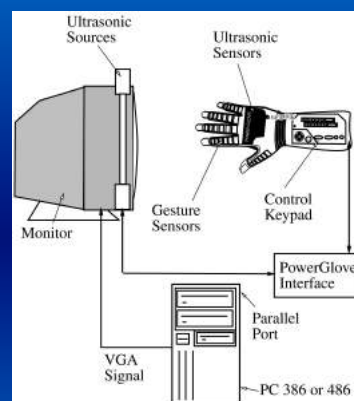
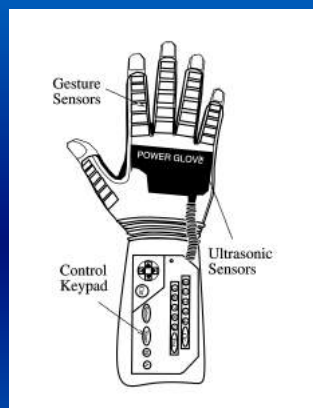
- VPL "Data Glove"
- VPL "Eye Phone" HMD



The VPL DataGlove (1987)

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VR Short History

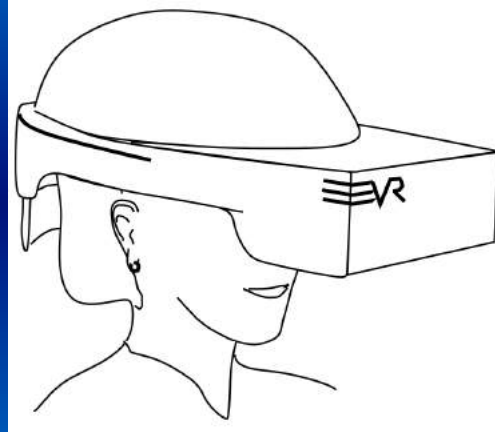


The first commercial VR glove for entertainment

Mattel Power Glove \$50 (1989)

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VR Short History



The Flight Helmet (ca. 1990) weighs 5 lbs

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VR Short History

Virtual Reality in the early 90s....

Emergence of first commercial Toolkits:

- ✓ WorldToolKit (Sense8 Co., now Engineering Animation Inc.)
- ✓ VCToolkit (Division Ltd., UK)
- ✓ Virtual Reality Toolkit VRT3 (Dimension Ltd./Superscape, UK)
- ✓ Cyberspace Developer Kit (Autodesk)

Emergence of first non-commercial toolkit:

- ✓ Rend386
- ✓ Virtual Reality Modeling Language (VRML 1.0)
- ✓ Java and Java 3D

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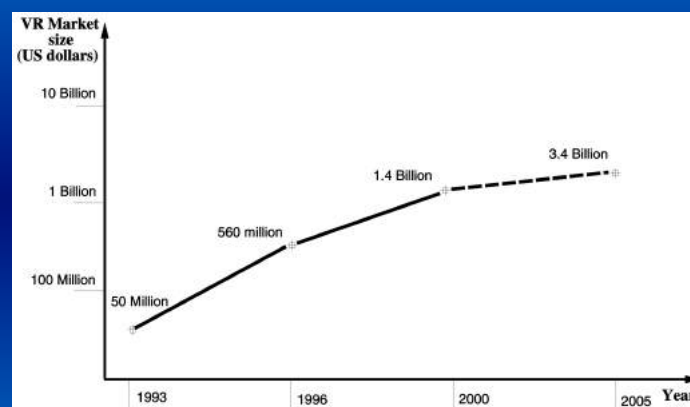
VR Short History

Virtual Reality in the early 90s....

- ✓ PC boards still very slow (7,000 – 35,000 polygons/sec);
- ✓ First turnkey VR system – Provision 100 (Division Ltd.)
- ✓ Emergence of faster graphics rendering architectures at UNC

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VR Short History



VR market growth

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VR and Cinema



THE LAWNMOWER MAN (1992, Brett Leonard)

[Video](#)

A simple man is turned into a genius through the application of computer science

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VR and Cinema



NIRVANA (1997, Gabriele Salvatores)



MATRIX (1999, Andy and Larry Wachowski)

The film depicts a future in which reality as perceived by most humans is actually a simulated reality or cyberspace created by sentient machines to subdue the human population, while their bodies' heat and electrical activity are used as an energy source

Types of VR



- textual VR (interaction, no immersion)
- desktop VR (interaction, immersion)
- immersive VR (interaction, high immersion)
- augmented VR (interaction, no immersion)

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Types of non-immersive VR

- **augmented VR**: the idea of taking what is real and adding to it in some way so that user obtains more information from their environment



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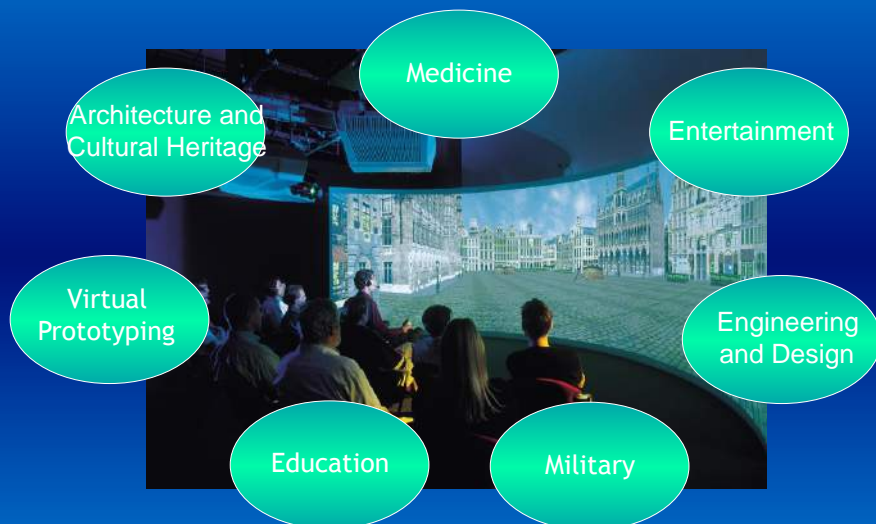
What is Immersive VR?

- a type of VR in which the user becomes immersed (deeply involved) in a virtual world
- it is also a form of VR that uses computer-related components



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Applicazioni della Realtà Virtuale



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Architecture

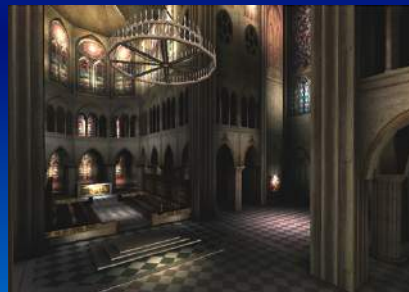
- an area in which virtual reality has tremendous potential is in architectural design
- already being created are architectural "walk-throughs" that allow designers and clients to examine homes and office buildings, inside and out, before they are built
- with virtual reality, designers can interactively test a building before construction begins



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Cultural Heritage

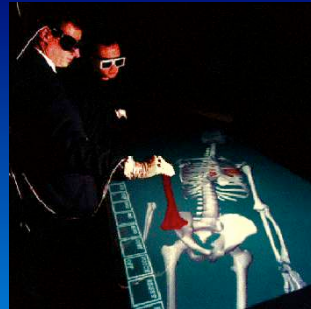
- digital preservation of cultural assets and digital restoration of their original appearance
- users virtually enter the virtual space and they get a feeling of being a part of the virtual environment
- to improve such a feeling, various navigation paradigms are applied



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Medicine

- the medical application of VR was stimulated initially by the need of medical staff to visualize complex medical data, particularly during surgery and for medical education and training
- researchers are using virtual reality technology to create 3D models of the organs to help doctors in diagnose, pre-operative planning and intra-operative treatments



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Military

- one of the first areas where virtual reality found practical application is in military training and operations
- three views of military applications of VR are:
 - as a simulation of reality
 - as an extension of human senses through telepresence
 - as an information enhancer through augmented reality



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Military - Flight trainers

- Virtual environment produces realistic readings on the instrument panel and the motion of the trainer on the pedestal combined to produce a sensation similar to actually flying on instruments at night
- the pilot could receive visual feedback both inside and outside the cockpit
- the SIMNET Project connects two or more simulators to produce a distributed simulation environment
- SIMNET can be used not only for training, but also to develop and test new combat strategy and tactics

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Military - Telepresence

Two rather obvious reasons why the military explore and utilize telepresence in their operations:

- reduce exposure to hazards
- to increase stealth

Smart weapons and remotely-piloted vehicles were developed because:

- many aspects of combat operations are very hazardous
- more risky if the combatant seeks to improve his performance

Some smart weapons are autonomous, others are remotely controlled after they are launched

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Entertainment

- applications that conceived virtual places as fantasy spaces, focusing on the activity of the subject rather than replication of some real environment
- the ability to manipulate virtual objects and not just see them is central to the presentation of compelling virtual worlds



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Education

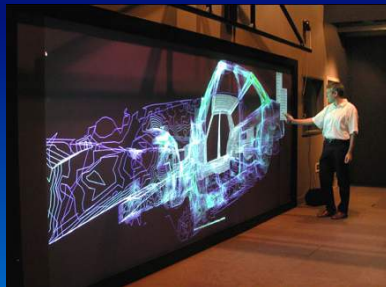
- using VR to enhance the learning process have become the recent idea in education
- VR environment is implemented for teaching aid such as in virtual classroom, virtual library and virtual lab
- the objective is to introduce students to experimentation, problem solving, data gathering, and scientific interpretation (Buffalo's Virtual Reality Laboratory)



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Virtual Prototyping

- Virtual Prototyping technique has been studied and implemented in recent years in engineering design
- Virtual Prototyping is a relatively new technology which involves the use of VR and other computer technologies to create digital prototypes
- in mechanical engineering, Virtual Prototyping is the idea to replace physical mock-ups by software prototypes



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Lucio Tommaso De Paolis

lucio.depaolis@unisalento.it

www.avr.unisalento.it