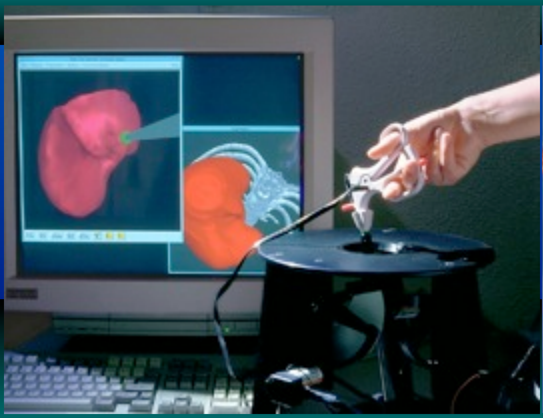
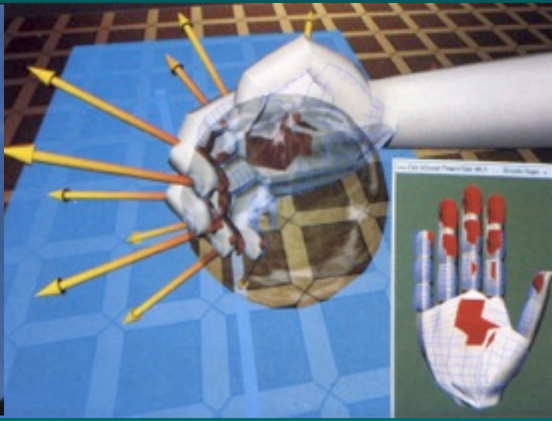
Department of Engineering for Innovation
University of Salento
Lecce, Italy

Augmented and Virtual Reality Laboratory
(AVR Lab)





Keynote Speech:

Virtual and Augmented Reality Applications

Lucio Tommaso De Paolis

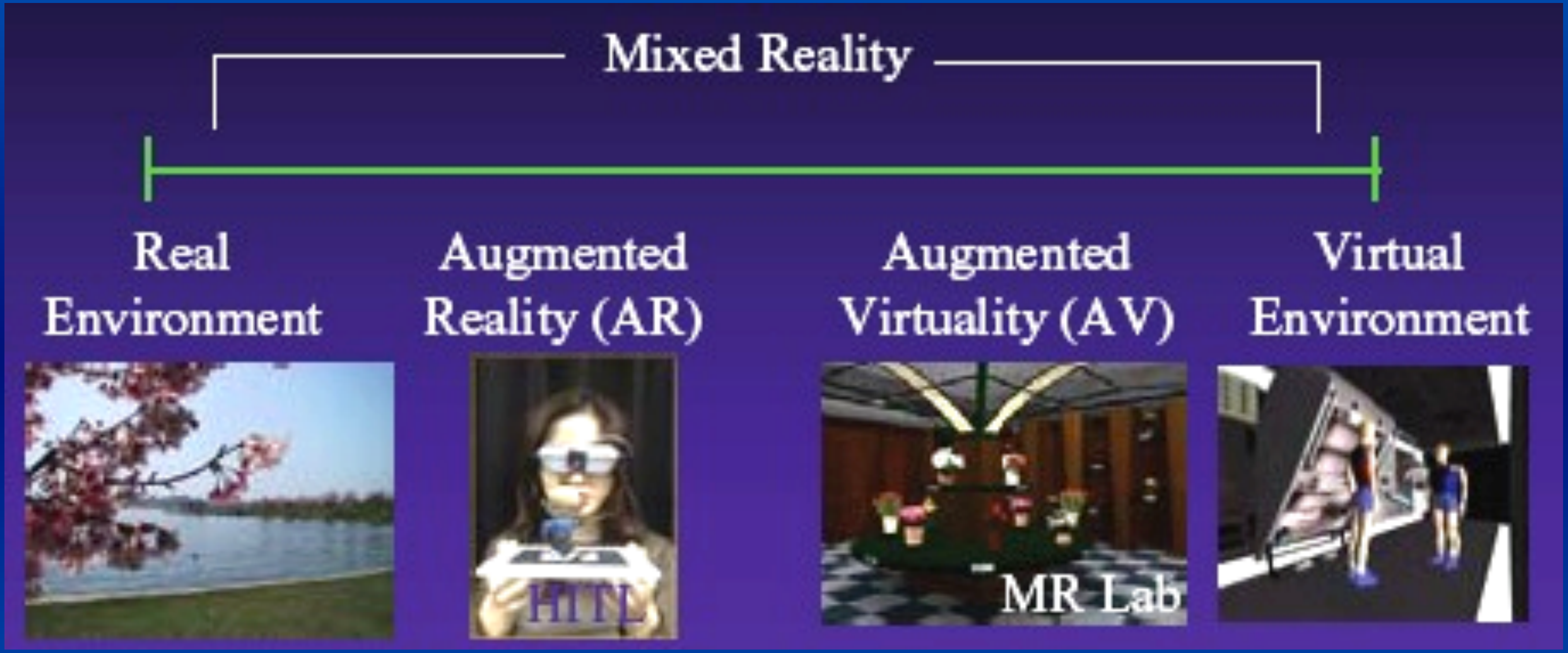
Augmented and Virtual Reality Laboratory (AVR Lab)

Keynote Speech:
Virtual and Augmented Reality Applications

Headlines

- Virtual and Augmented Reality Technologies
- Virtual and Augmented Reality in Medicine and Surgery
- Virtual and Augmented Reality in Cultural Heritage
- Virtual and Augmented Reality in Education

Virtual and Augmented Reality



Virtual Reality

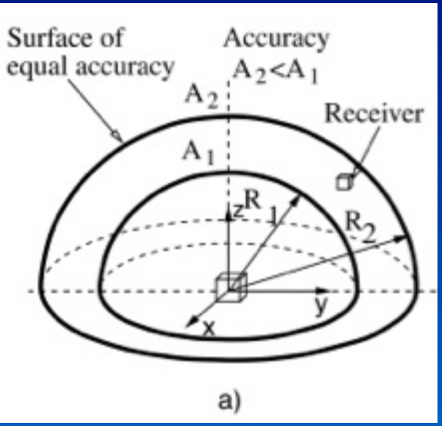
- textual VR (interaction, no immersion)
- desktop VR (interaction, immersion)
- immersive VR (interaction, high immersion)

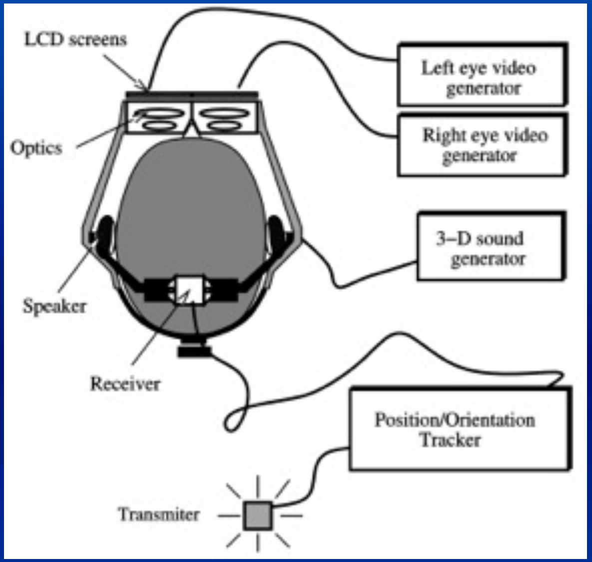
Input Devices

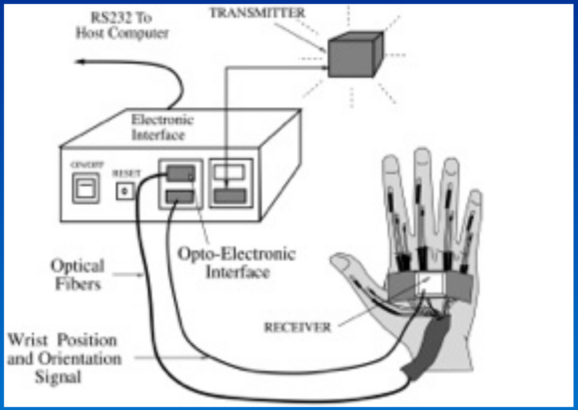
Trackers measure the motion of “objects” such as user’s wrist or his head vs. a fixed system of coordinates

Technologies to perform this task:

- ✓ Magnetic trackers
- ✓ Mechanical trackers
- ✓ Optical trackers



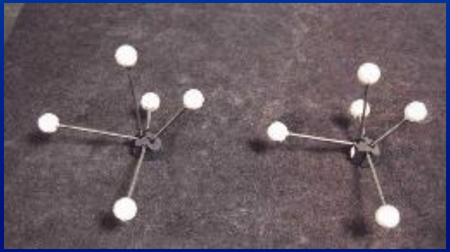




Input Devices

Optical Trackers

- passive
- active

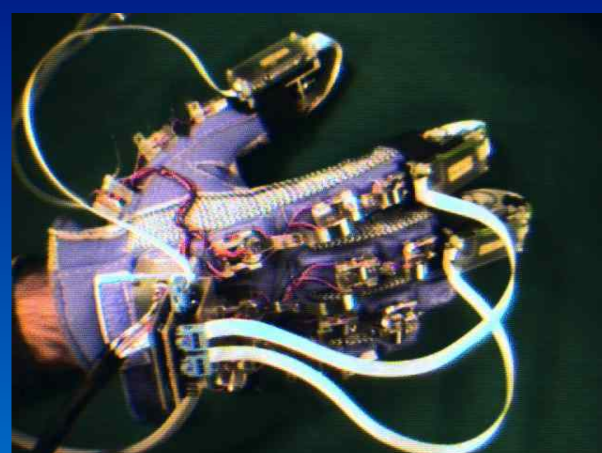


Input Devices

5DT Data Glove

The CyberGlove

PERCRO Glove



Output Devices

The human senses need specialized interfaces

- ✓ Graphics displays for visual feedback
- ✓ 3-D audio hardware for localized sound
- ✓ Haptic interfaces for force and touch feedback
- ✓ Low interest in smell feedback

Output Devices

Olympus Eye Trek Face Mounted Display Optics

Output Devices

Auto-stereoscopic 3-D Display

(courtesy of Dimension Technologies Co.)

(courtesy of Dresden 3D Co.)

Output Devices

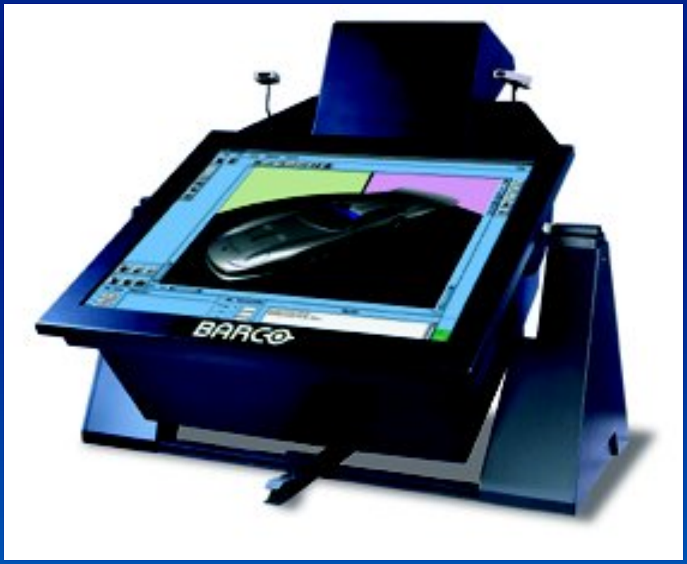
Active glasses

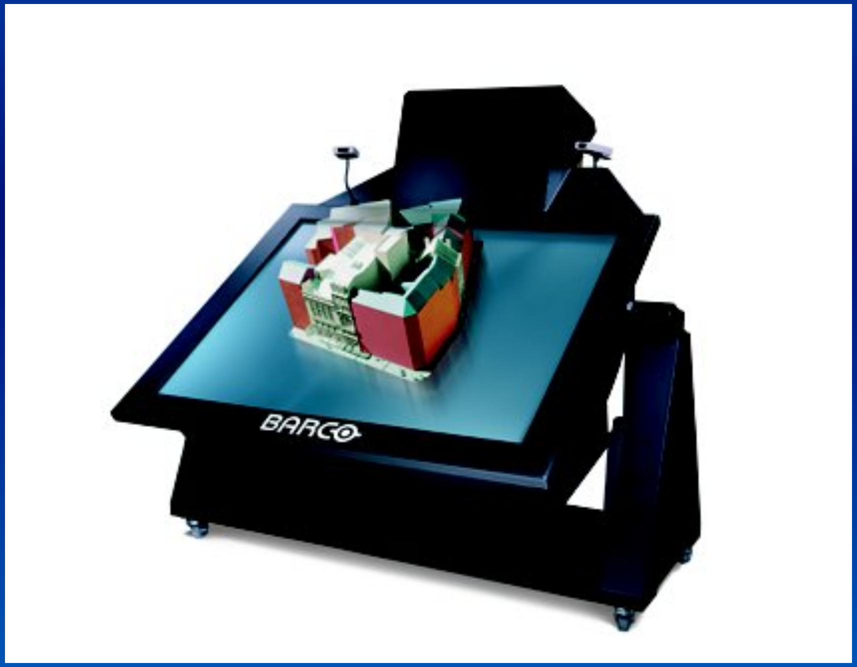
wireless

wired

Output Devices

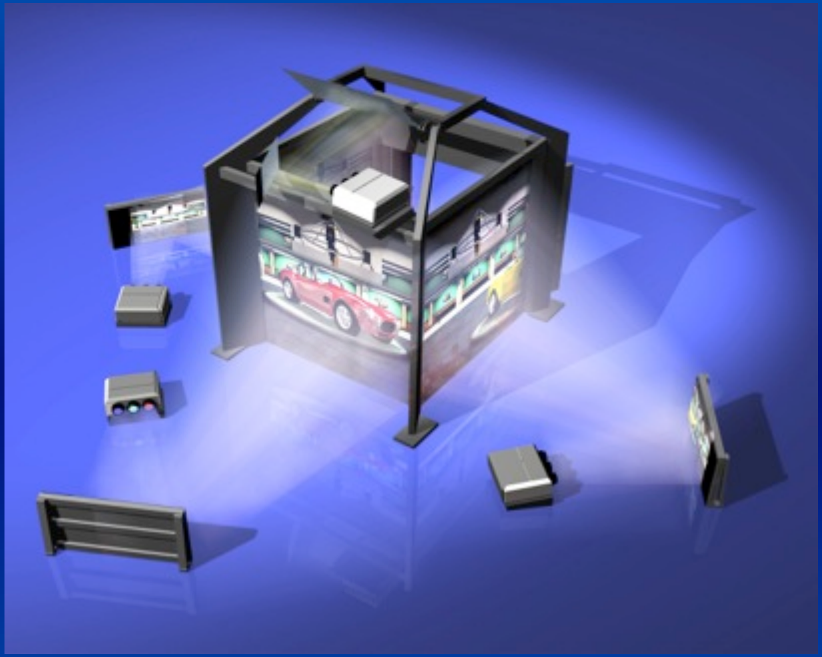
Projector-based Large-Volume Displays





Baron workbench (courtesy of BARCO Co.)

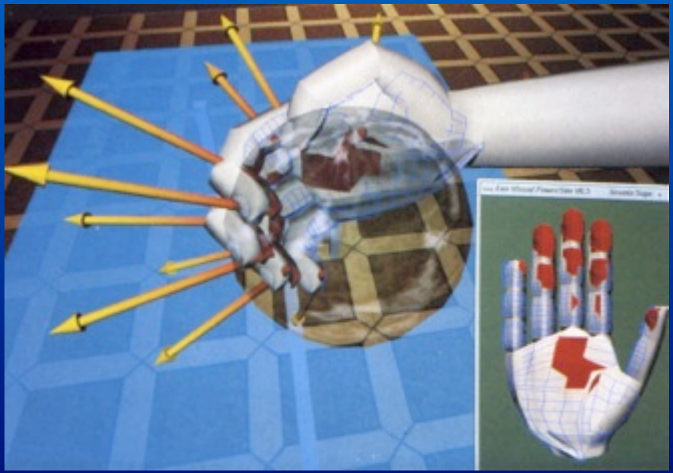
Output Devices



CAVE 3-D large volume display (courtesy of Fakespace Co.)

Interactions in the Virtual Environment

Force feedback, or haptic feedback, introduces the physical sensation into the virtual environment



In order to provide on the user's hand a force feedback it is necessity to use advanced human-machine interfaces (haptic interface) able:

- to replicate the user's movements in the virtual environment
- to reproduce the sensations associated with the interactions in the virtual environment

The user feels the forces generated in the virtual environment in response to the forces he applies

Output Devices

Haptic Interfaces

- ✓ Comes from Greek *Hapthai* meaning the sense of touch
- ✓ Groups touch feedback and force feedback

Touch Feedback

- ✓ Relies on sensors in and close to the skin
- ✓ Conveys information on contact surface geometry, roughness, slippage, temperature

Force Feedback

- ✓ Relies on sensors on muscle tendons and bones/joints proprioception
- ✓ Conveys information on contact surface compliance, object weight, inertia

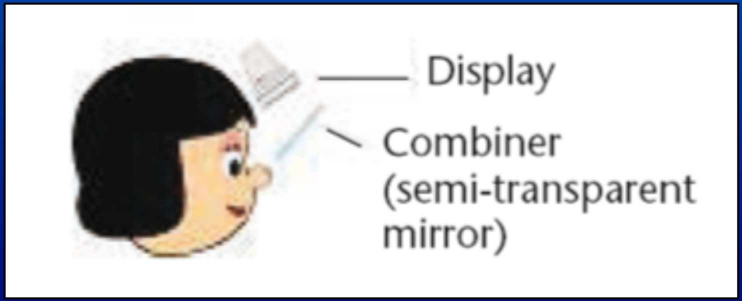
Haptic Interfaces

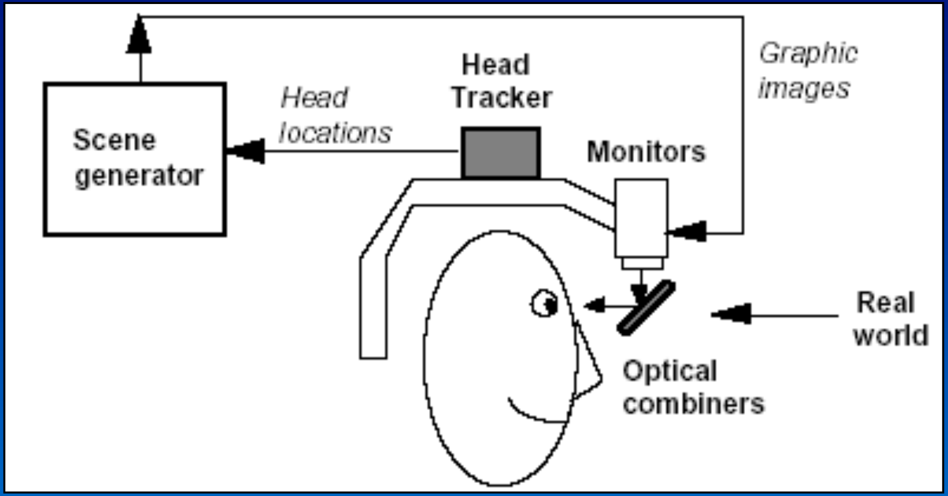
CyberTouch Glove (Virtex)

Augmented Reality Technology

Augmented Reality Technology

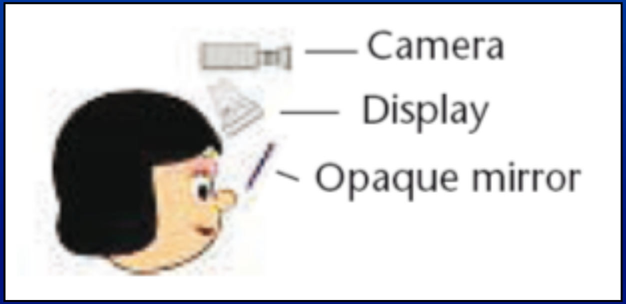
optical see-through

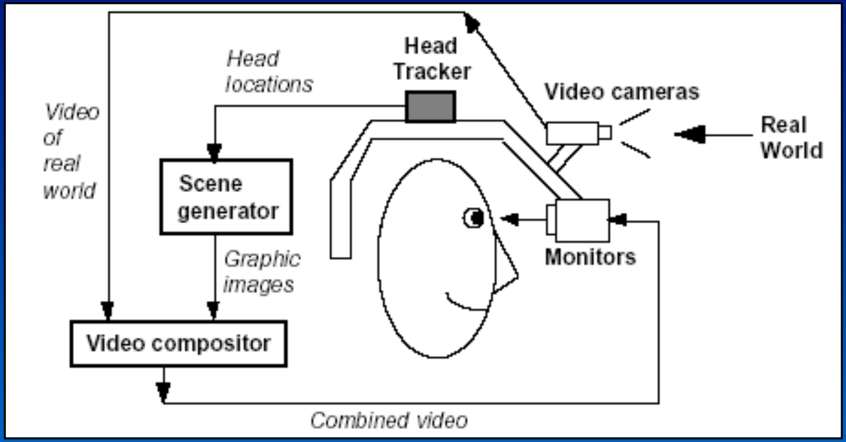




Augmented Reality Technology

video see-through





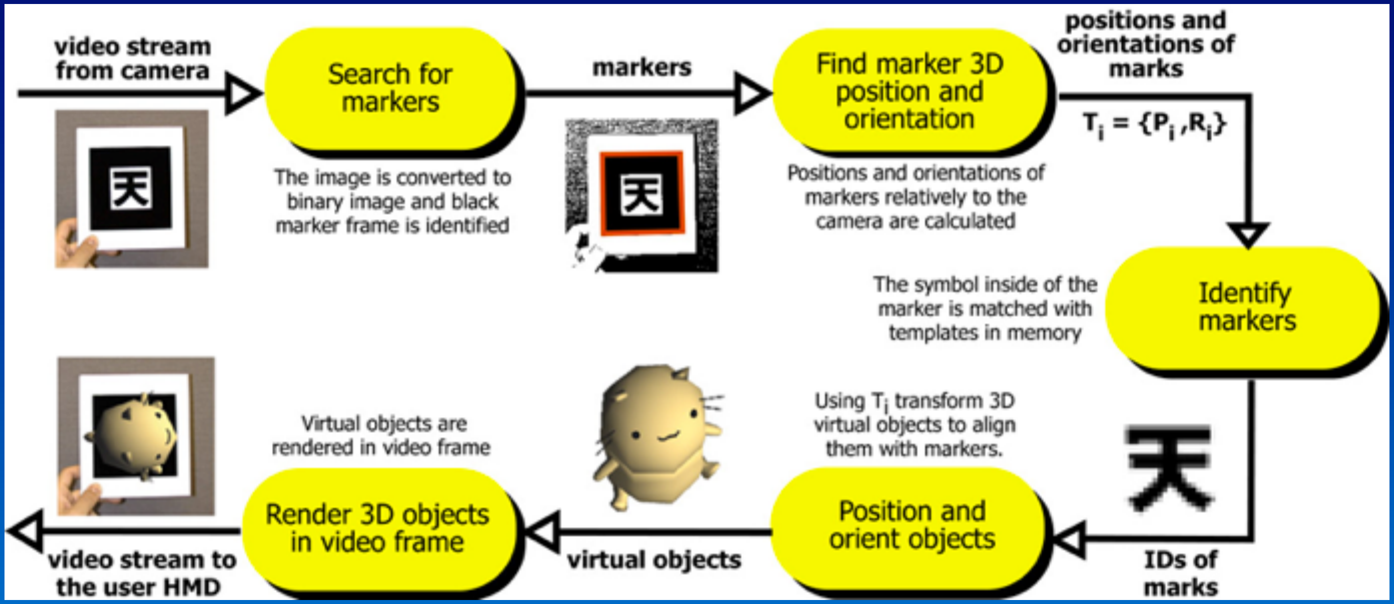
Augmented Reality Technology

retinal display

AR Toolkit

- Library for the building of AR applications
- Use of computer vision algorithms based on marker:
  - ✓ Marker: pattern of black squares

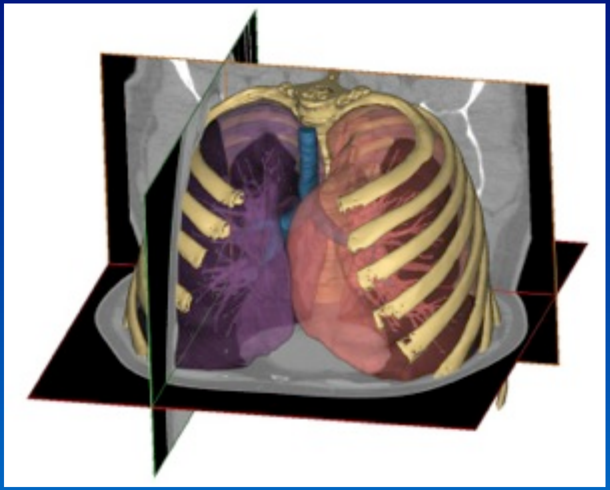
http://www.hitl.washington.edu/artoolkit/

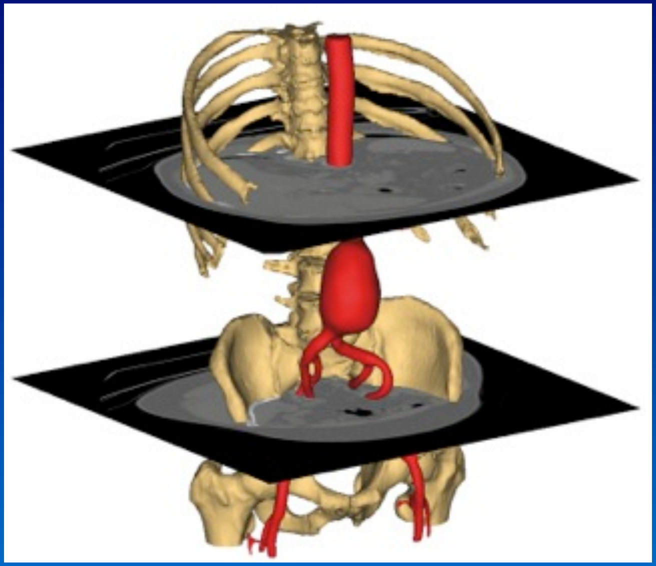


Virtual Reality
in Medicine and Surgery

Building of the Virtual Environment

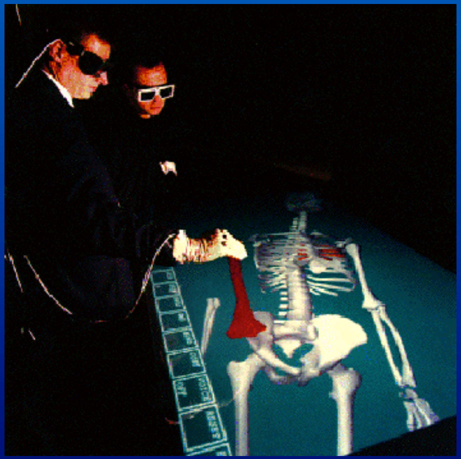
- the real patients' images are processed in order to distinguish the anatomical structures and to associate different chromatic scales to the organs
- the segmentation and classification phases are carried out in order to obtain information about the size and the shape of the organs





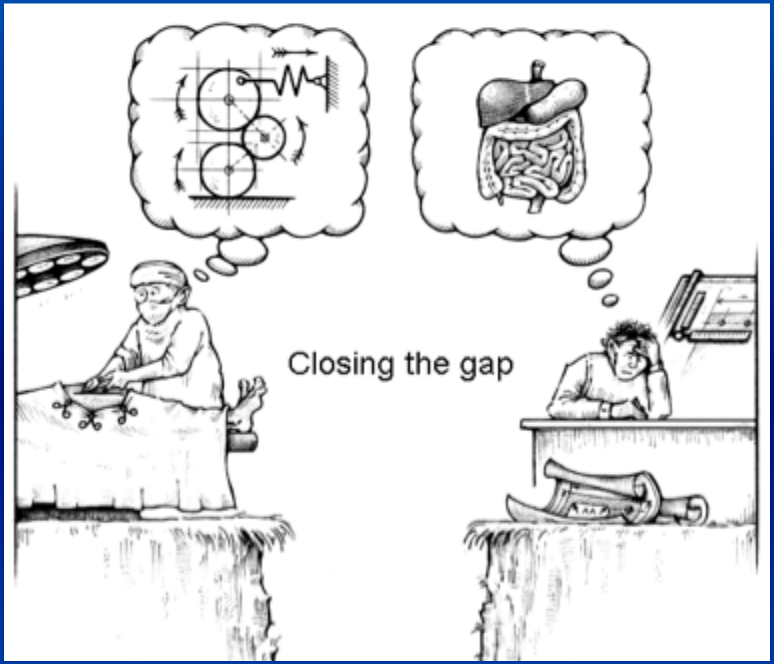
Virtual Reality in Medicine

- Computer Aided Surgery
- Diagnosis
- Pre-operative Planning
- Training
- Telesurgery
- Rehabilitation



Virtual Surgical Training

The outcome of a surgical procedure is closely related to the skills of the surgeon



- animals: different anatomy
- cadavers: different physiology
- patients: risks to patient safety

For the surgeons to reach and to remain at a high level of technical skills are required new and alternative ways of performing surgical training

Medicine Meets Virtual Reality

Virtual Reality and Robotics had a big impact on health care in the next decade

Clinically validated, powerful medical simulators are now available and in use across the world

The simulators offer an interesting way to provide adequate training without any risks for the patients

Current teaching practices have difficulty meeting the challenges of modern medicine

Why simulation?

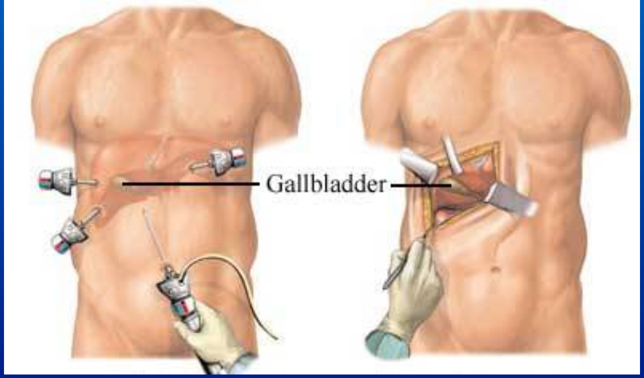
The training on virtual patients met the growing need for training in Minimally Invasive Surgery

Many of these procedures need to be learned by repetition; new and unusual surgical procedures can be practiced in a safe manner

A simulator incorporates both realistic graphics and the sense of touch (force feedback)

- to increase experience
- to increase patient safety
- to practice medical skills
- to plan the operative strategy

Minimally Invasive Surgery

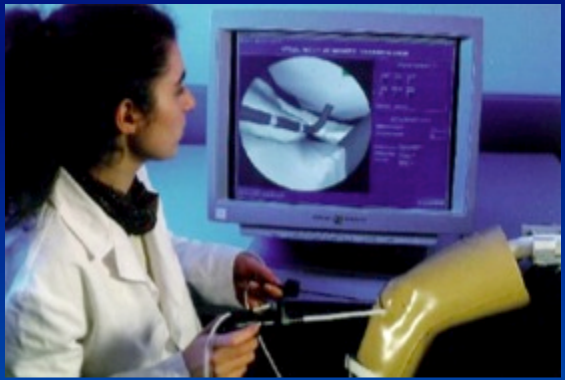


advantages:
- shorter hospitalizations
- faster bowel function return
- fewer wound-related complications
- a more rapid return to normal activities

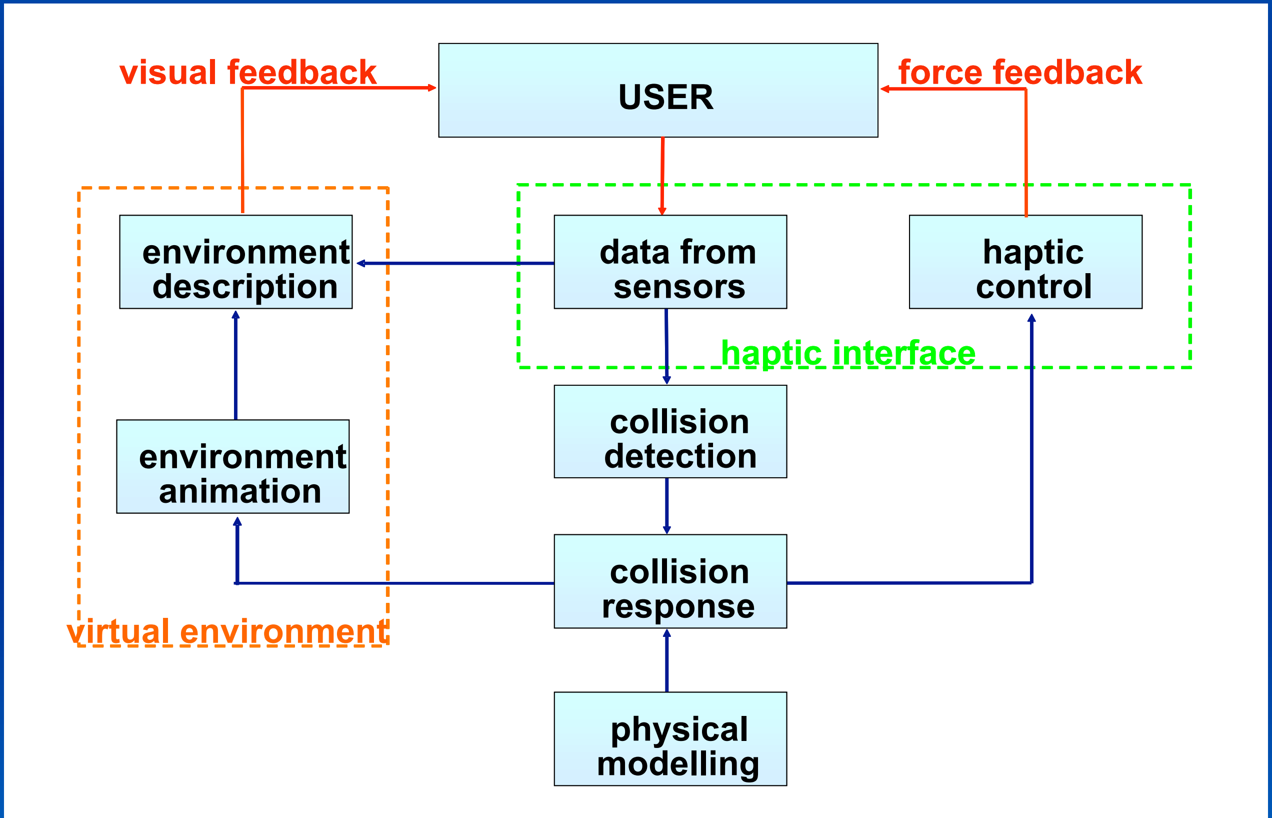
limitations:
- the imagery is in 2D
- the surgeon can estimate the distance of anatomical structures only by moving the camera

Simulators for Surgical Training

A surgery simulator requires the calculation of the real-time force feedback sensation and also the modelling of the organs behaviour, its deformations and cutting in tissue



Surgical Simulator



Laparoscopy Training Simulator

VEST System One (VSOne)

The "Virtual Endoscopic Surgery Training" (VEST) system was developed within the framework of the partners Forschungszentrum Karlsruhe - Institut für Angewandte Informatik and the company Select IT VEST Systems AG – Bremen

Karlsruhe Virtual Endoscopic Surgery Trainer (VEST)

www-kismet.iai.fzk.de

Origin: Forschungszentrum Karlsruhe

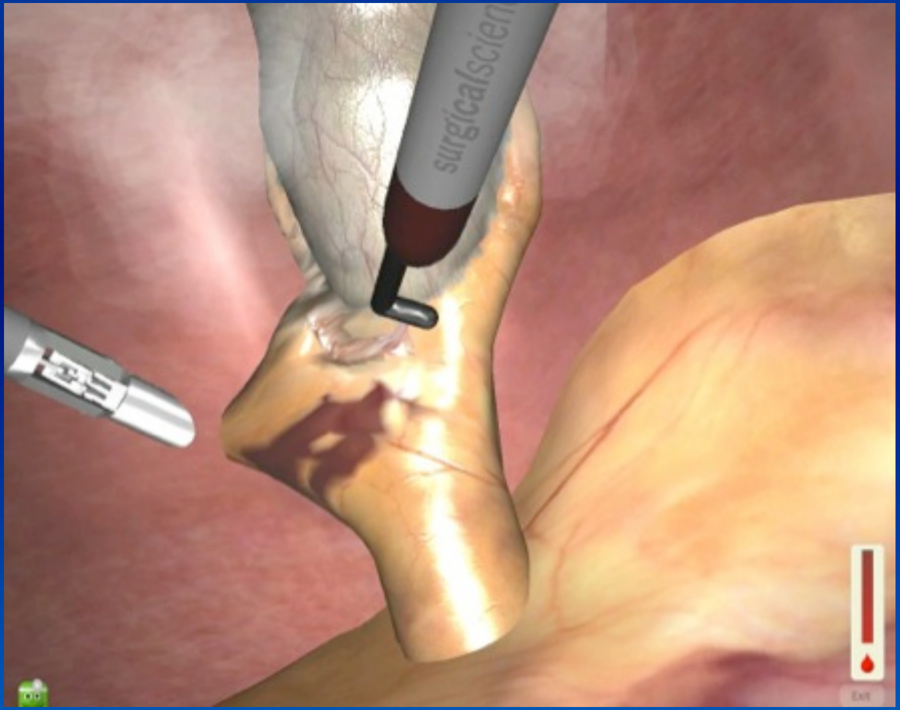
Laparoscopy Training Simulator

The simulated tissue in LapSim dissection reacts realistically to the user's manipulations

Dissection may be carried out using different instruments

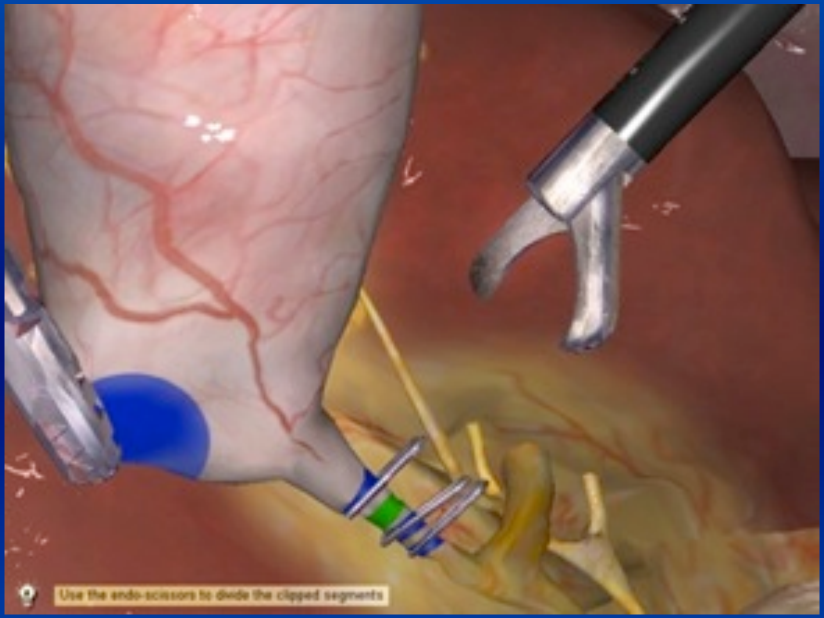
LapSim® System

Surgical Science Ltd – Sweden
www.surgical-science.com



By courtesy of Surgical Science Ltd

Laparoscopy Training Simulator



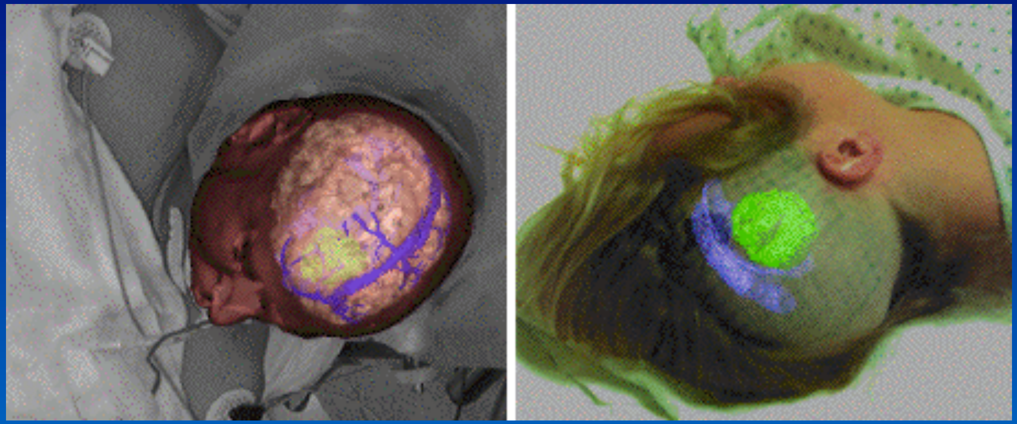
LAP Mentor II

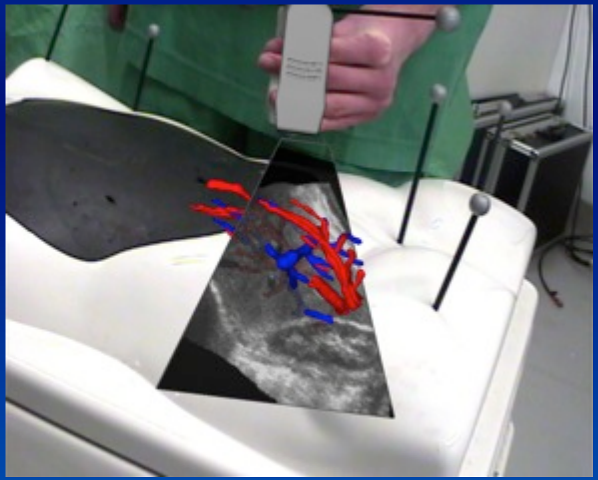
Simbionix USA Corp.
www.simbionix.com

Augmented Reality in Medicine and Surgery

Augmented Reality in Surgery

- Augmented Reality blends virtual and real in the real environment
- the basic idea is to provide a “X-ray vision“
- to use the high accuracy of medical images not only for diagnostics, but for the operation itself overlaying an image to the surgical field



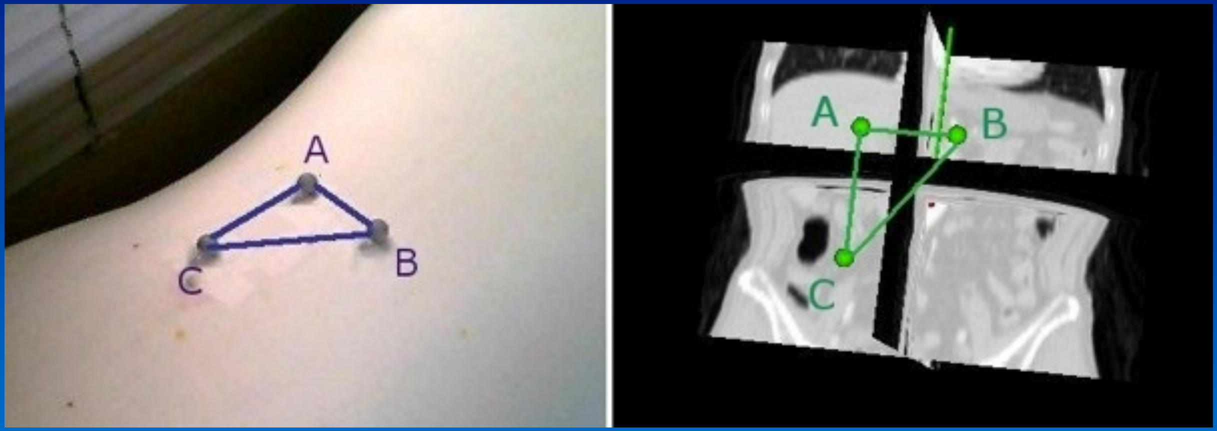


Augmented Reality in Surgery

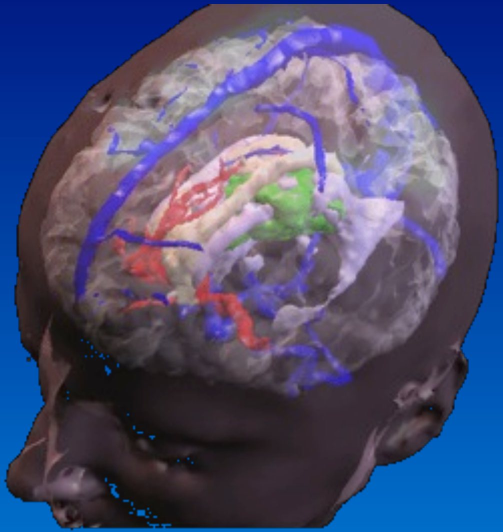
In order to have a perfect correspondence between virtual and real organs it is necessary to carry out an accurate registration phase that provides as result the overlapping of the virtual 3D model of the organs on the real patient

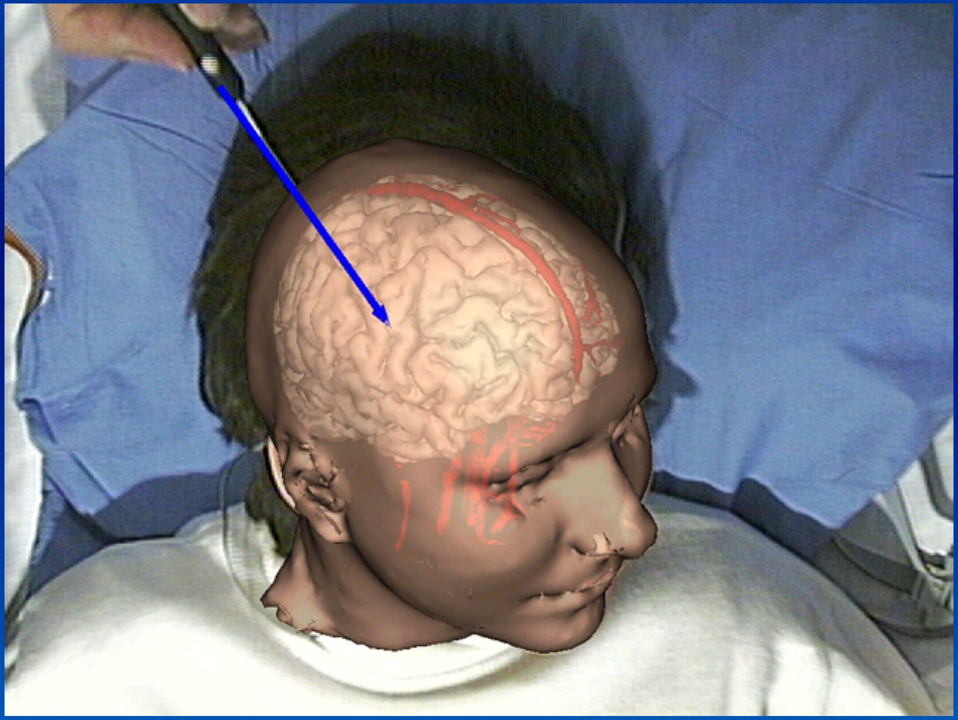
The registration phase is carried out just once at the beginning of the surgical procedure

the registration algorithm is based fiducial points

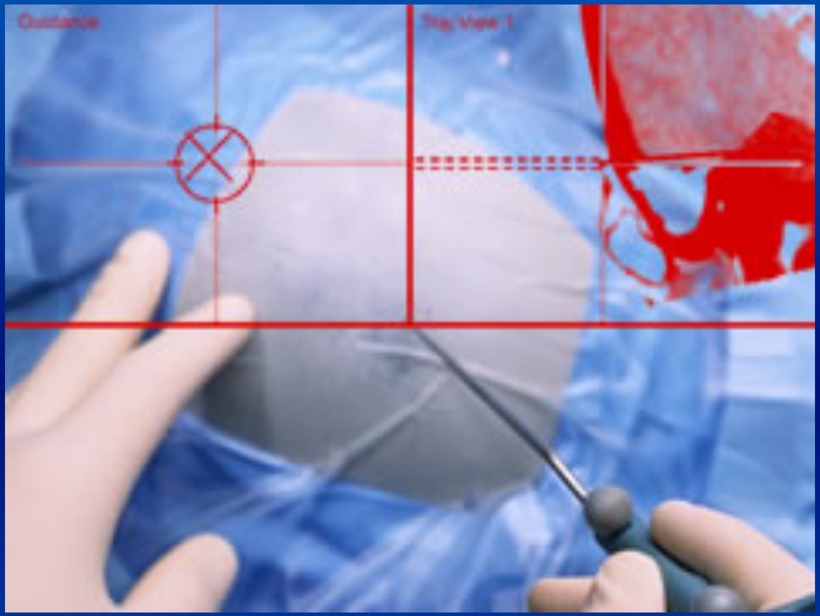


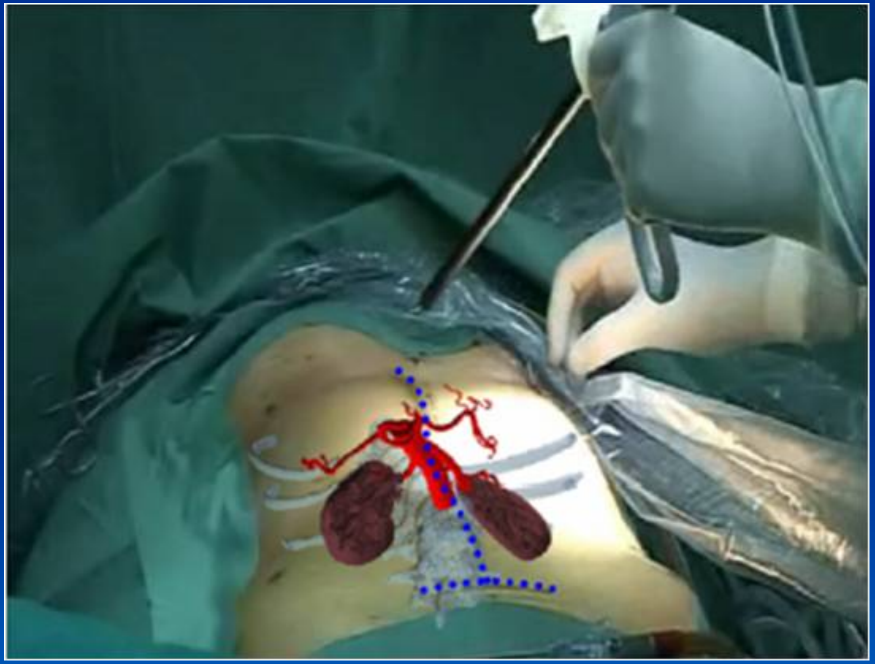
Augmented Reality in Surgery



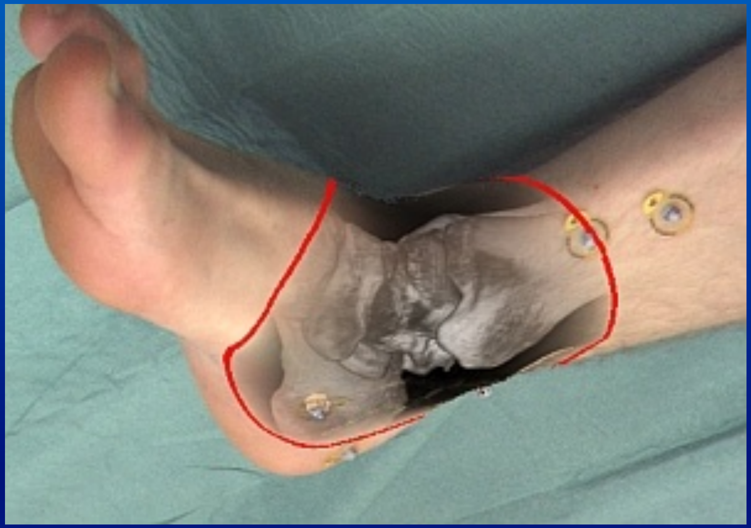


Augmented Reality in Surgery





Augmented Reality in Surgery



AR applications in Orthopedy

RFA Ablation of the Liver Tumours

RFA Ablation of the Liver Tumours

Hepatic cancer is one of the most common solid cancers in the world

Today surgery is the best approach to avoid the death of the patient and the reversion of hepatic cancer (only from 5 to 15 per cent)

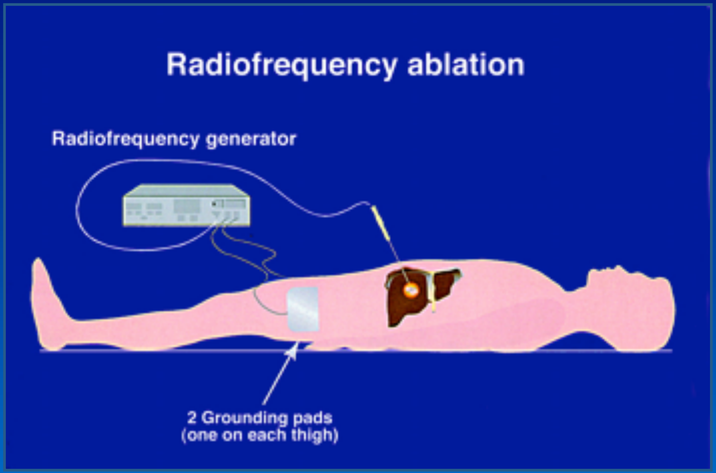
Patients with confined disease of the liver could not be candidates to resection because of multifocal disease (proximity of tumor to vascular keys or biliary structures)

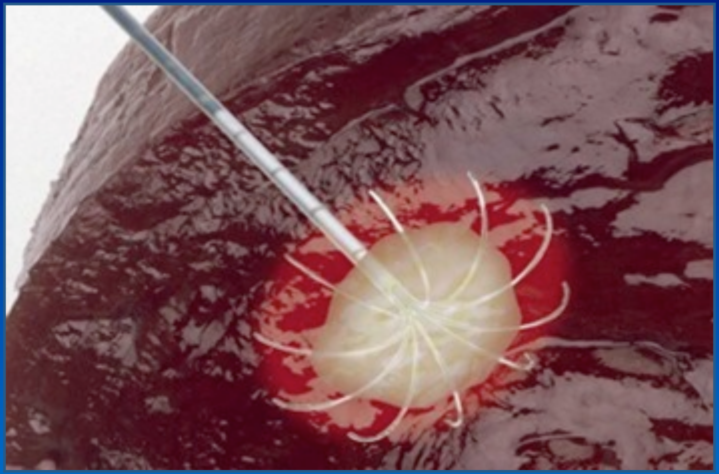
Liver transplant can’t be always used

RFA Ablation of the Liver Tumours

The Liver Radiofrequency Ablation (RFA) consists in the placement of a needle inside the liver parenchyma to reach the centre of the tumour

One problem in using RFA is the correct placement of the needle because the use of these two-dimensional images makes the procedure very difficult and requires sometimes more than one insertion

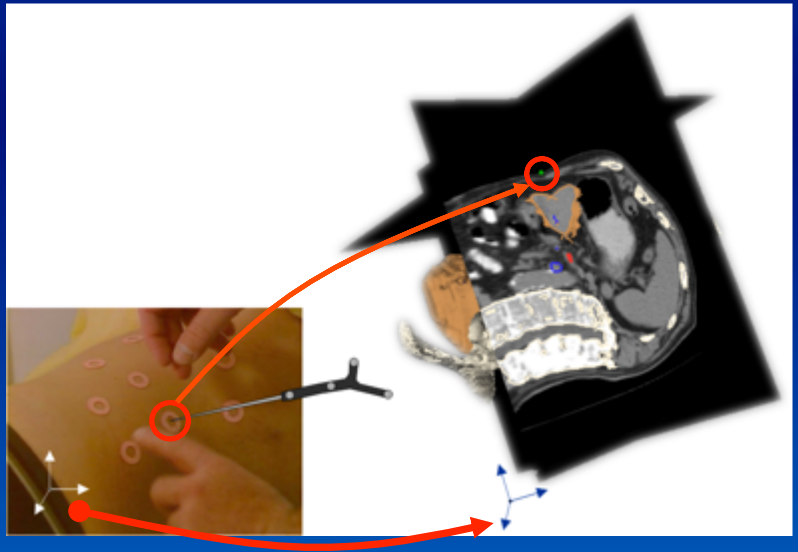


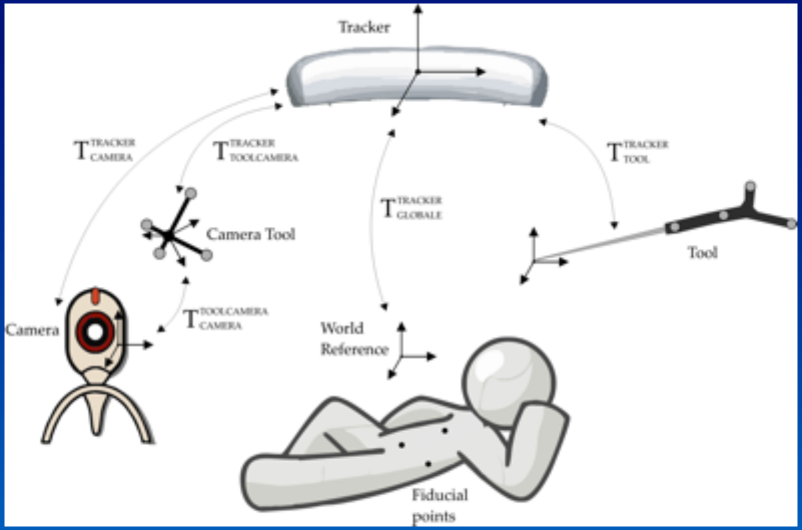


AR in RFA Ablation of the Liver Tumour

In order to have a perfect correspondence between virtual and real organs it is necessary to carry out an accurate registration phase

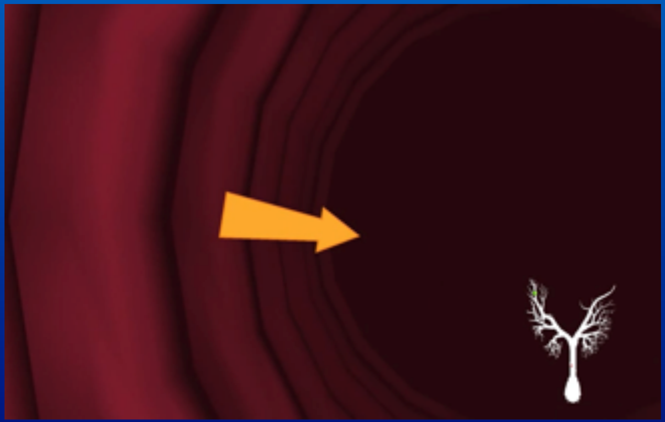
The registration algorithm is based fiducial points

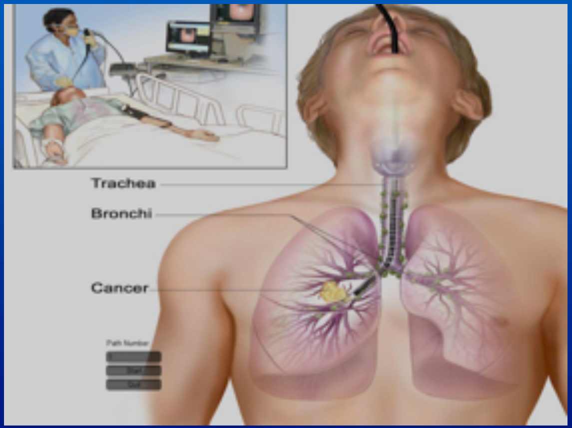


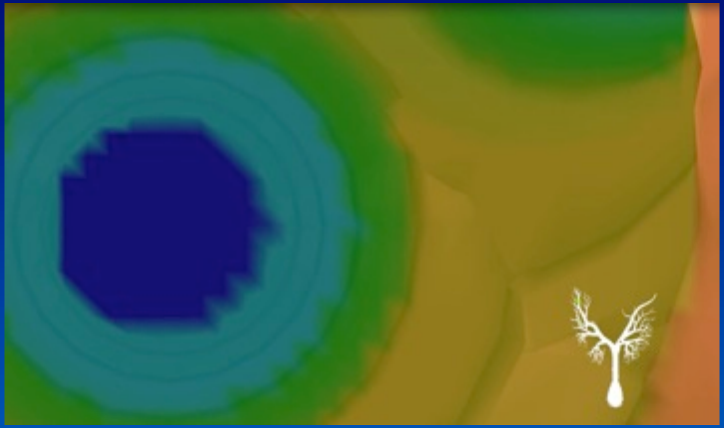


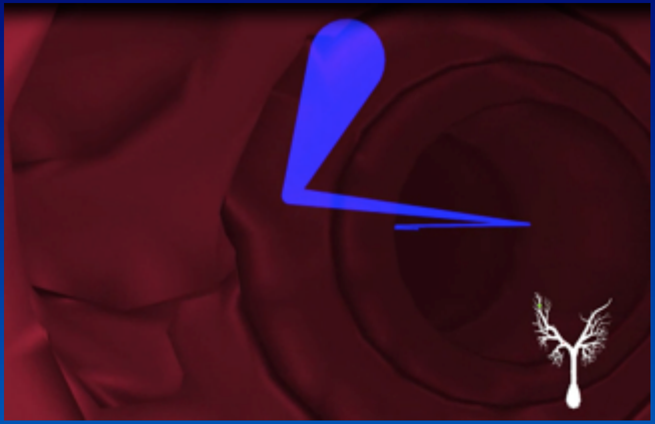
Virtual Broncoscopy

Virtual Broncoscopy (AR)



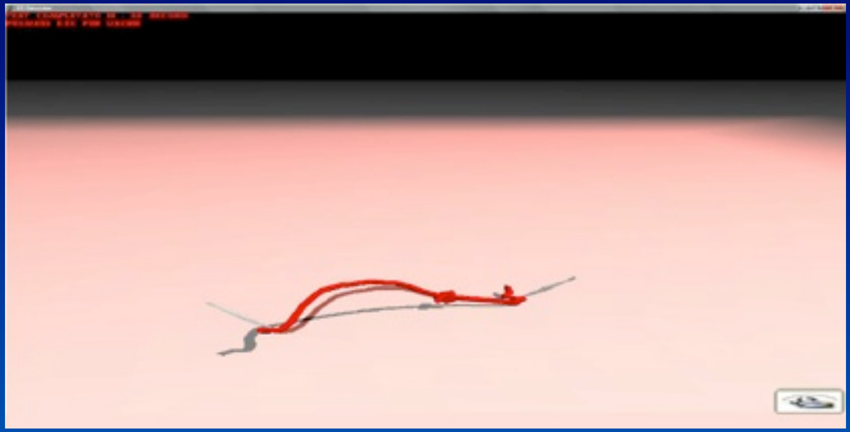






Serious Games in Surgery

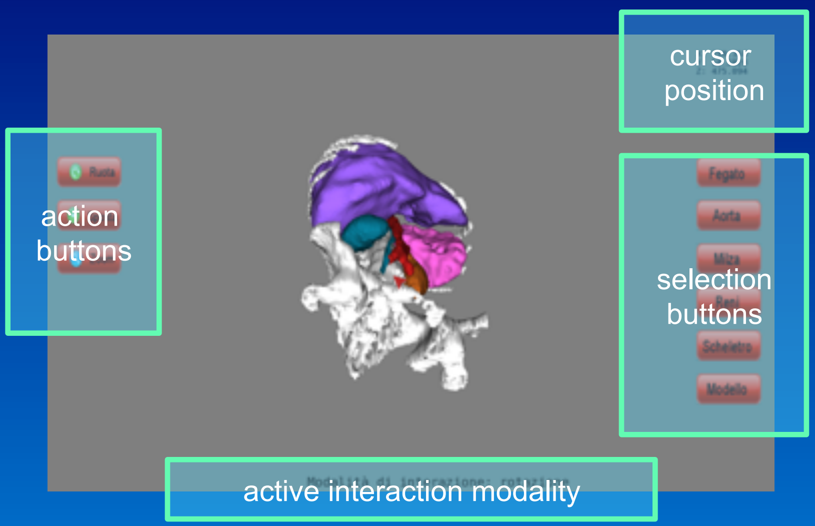
Serious game in laparoscopic suturing



Visualization and Interaction

Virtual Interface

- first prototype designed to avoid contact with the computer
- interactions in real-time
- the virtual interface appears as a touch-screen suspended in free space
- the interaction happens by pressing the buttons located in the interface



Gestural Interface

Bacterial Contamination of Computer Keyboards in a Teaching Hospital

Maureen Schultz, MSN, CIC; Janet Gill, BSN, CIC; Sabiha Zubairi, MT; Ruth Huber, MS, CIC; Fred Gordin, MD

ABSTRACT

We tested 100 keyboards in 29 clinical areas for bacterial contamination. Ninety five were positive for microorganisms. *Clostridium perfringens*, *Enterococcus* (including one

COMPUTER KEYBOARD AND MOUSE AS A RESERVOIR OF PATHOGENS IN AN INTENSIVE CARE UNIT

Bernd Hartmann, Dr med.,[1] Matthias Benson, Dr med.,[1] Axel Junger, Dr med. habil,[1] Lorenzo Quinzio,[1] Rainer Röhrig, Dr med.,[1] Bernhard Fengler,[1] Udo W. Färber, Dr rer. nat.,[2] Burkhard Wille, Prof Dr med.,[2] and Gunter Hempelmann, Prof Dr med. Dr h.c.

Hartmann B, Benson M, Junger A, Quinzio L, Röhrig R, Fengler B, Färber UW, Wille B, Hempelmann G. Computer keyboard and mouse as a reservoir of pathogens in an intensive care unit.
J Clin Monit 2004; 18: 7–12

ABSTRACT. Objective. User interfaces of patient data management systems (PDMS) in intensive care units (ICU), like computer keyboard and mouse, may serve as reservoirs for the transmission of microorganisms. Pathogens may be transferred via the hands of personnel to the patient causing nosocomial infections. The purpose of this study was to

Gestural Interface

Gestural Interface

VR in Cultural Heritage

MediaEvo Project

- Development of a multi-channel and multi-sensory platform for the edutainment in cultural heritage
- Loyal representation of the possible scenarios (environments, characters and social roles) in an historic-geographical context of Otranto and its surroundings during the XIII century
- Testing of data processing technologies for the realization of a digital didactic game oriented to the knowledge of medieval history and society

MediaEvo Project

Otranto as an example town

It played an important role in the Middle Ages from a political and cultural point of view

Due to its geographical position Otranto was like a bridge between East and West

We focused on the Swabian Age (XIII century)

MediaEvo Project

- Geographical context
- Socio-cultural analysis
- Historical analysis
- Narrative analysis

- Learning by doing
- Collaborative learning
- Education & entertainment

- Multi-channels and multi-sensory platforms
- Scenario’ s modelling with CAD and game engine

Historical and literary research experiences

Learning methods

High Technologies and ICT

Prototype of digital didactic game set in Middle Ages

Game

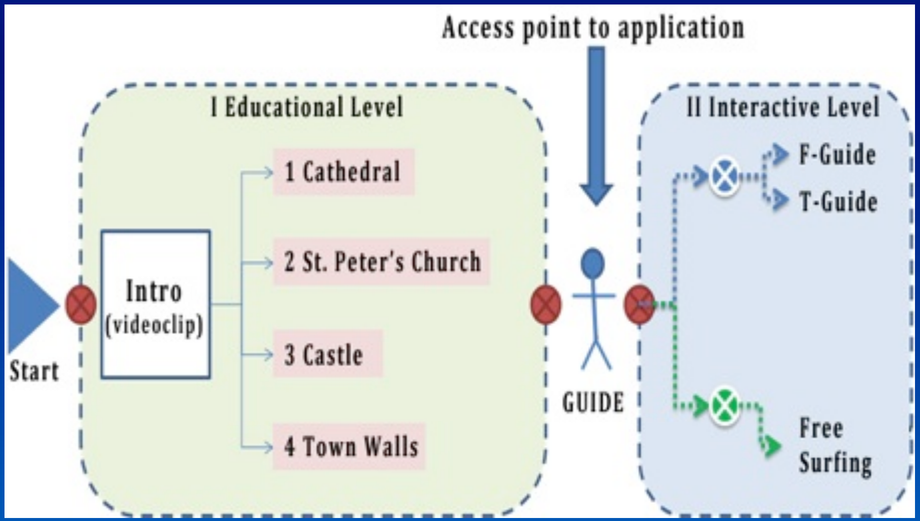
APPLICATIONS

Virtual Landscape

Paths and Interest Points

Navigation modes

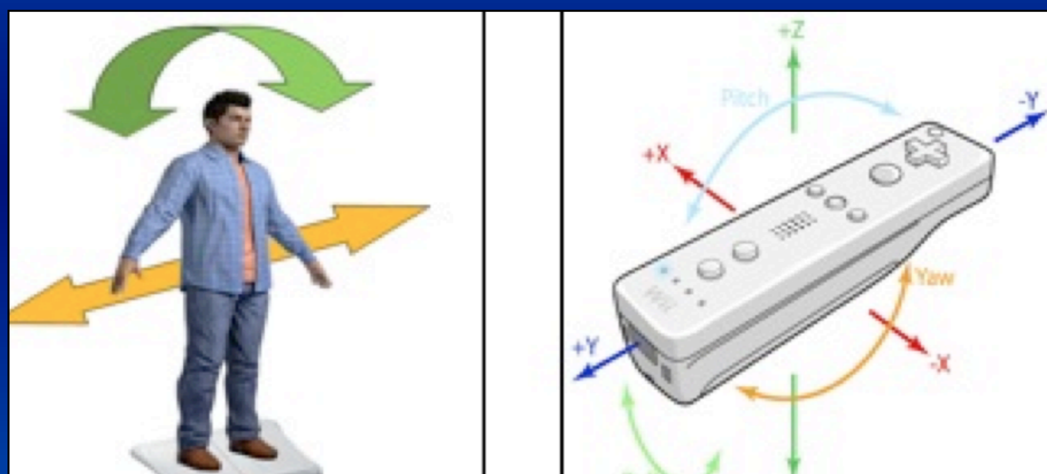
- Guided navigation (4 main paths)
- Free navigation



Navigation with WiiMote and Balance Board

The aim is to make the interaction easier for users without any experience of navigation in a virtual world and more efficient for trained users

We use some intuitive input devices that can increase the sense of immersion



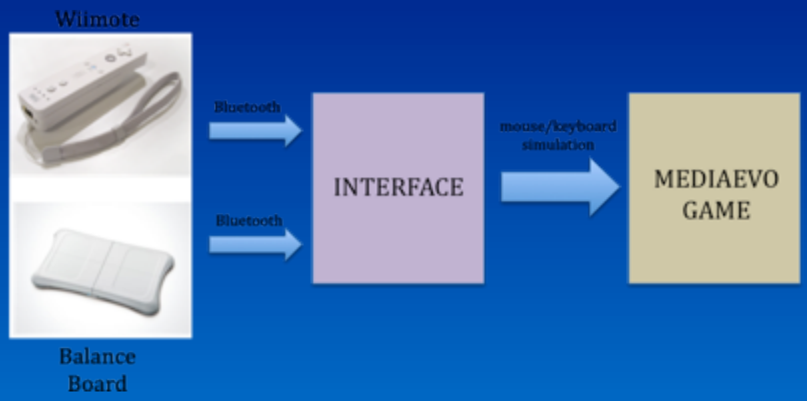
Since the frequency of communication between the Wii console and the Wiimote/ Balance Board are those of the standard Bluetooth, these devices can be used as tools to interact with any computer equipped with the same technology

Navigation with WiiMote and Balance Board

Because we walk on our feet, controlling walking in Virtual Reality could be felt as more natural when done with the feet than with other modes of input

The Nintendo Balance Board as input device for navigation that offers a new and accessible way to gain input

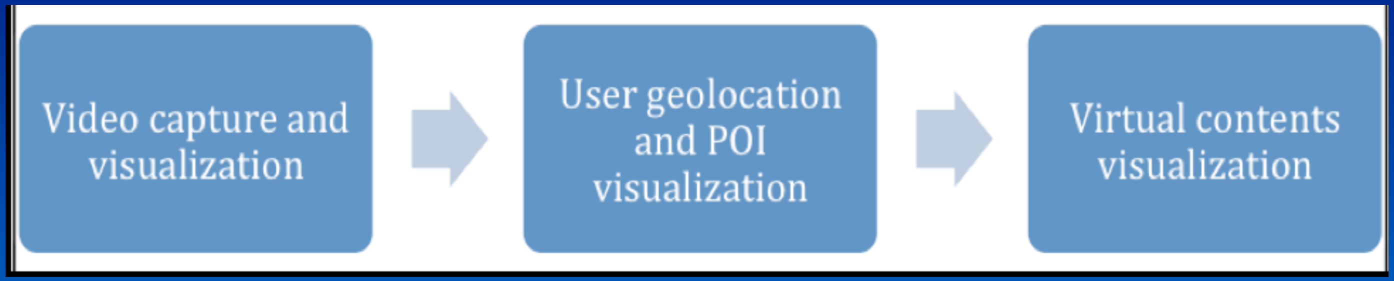
In addition, in order to implement the control of different views and to change the point of view of the user, we use the Nintendo Wiimote



Virtual Treasure Hunt

Within the MediaEvo Project it has been also developed a "virtual treasure hunt" using an iPhone as a device to find and read the clues of the game

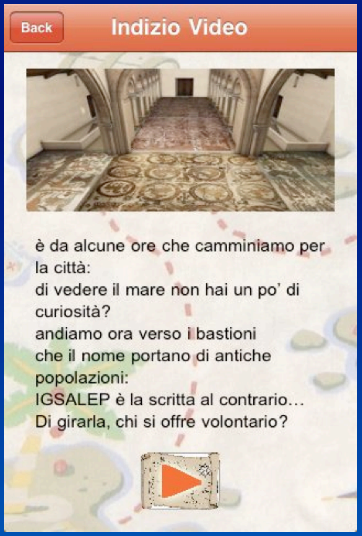
The Augmented Reality has been used for geolocating the points of interest (POI) and the visualization of useful and interesting data that are overlapped on the video stream of the iPhone camera



Virtual Treasure Hunt

Once the player is close to a POI, a marker that indicates the presence of a clue is visualized on the iPhone screen and superimposed on the images captured by the camera

Touching the marker in the screen, the description of the stage is shown

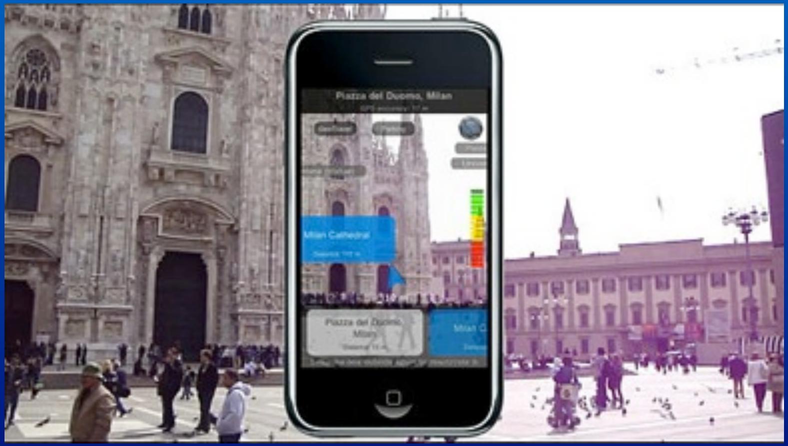


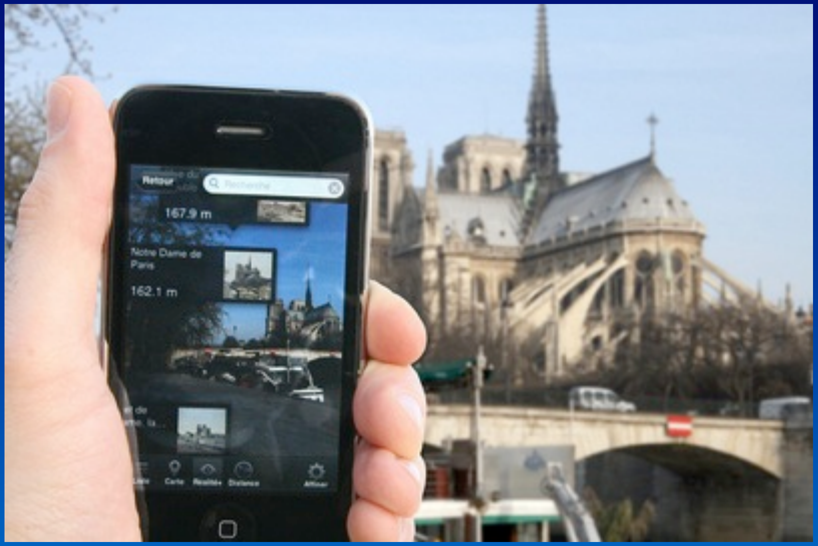
Augmented Reality Visualization

In order to have realistic 3D models, aerophotogrammetry and aerial photos of the town have been used; this has meant that not only the correct scale and correct proportions of the buildings have been obtained, but also the division of the land was acquired

Augmented Reality on mobile

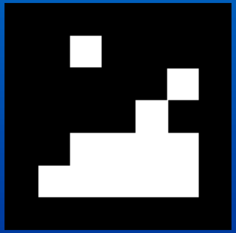
Augmented Reality Applications





Augmented Reality

- Marker detection



- Markerless detection

- GPS + compass

Tested algorithms

logo

acquired images

Department of Engineering for Innovation
University of Salento
Lecce, Italy

Augmented and Virtual Reality Laboratory
(AVR Lab)

Lucio Tommaso De Paolis

lucio.depaolis@unisalento.it

Augmented and Virtual Reality Laboratory (AVR Lab)
www.avr.unisalento.it