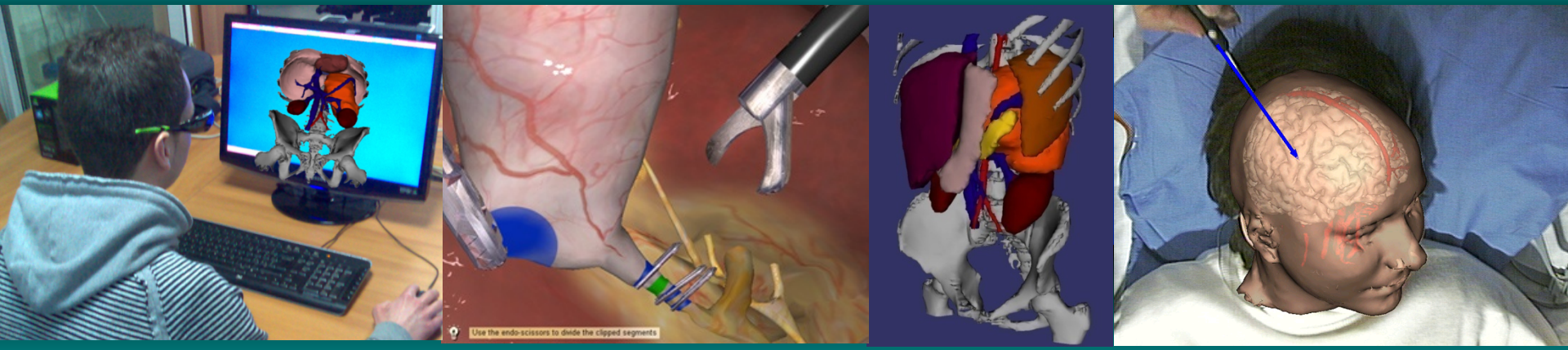
Department of Engineering for Innovation
University of Salento
Lecce, Italy



Virtual and Augmented Reality Applications in Medicine and Cultural Hertage

Lucio Tommaso De Paolis

Augmented and Virtual Reality Laboratory (AVR Lab)

Salento and Lecce

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

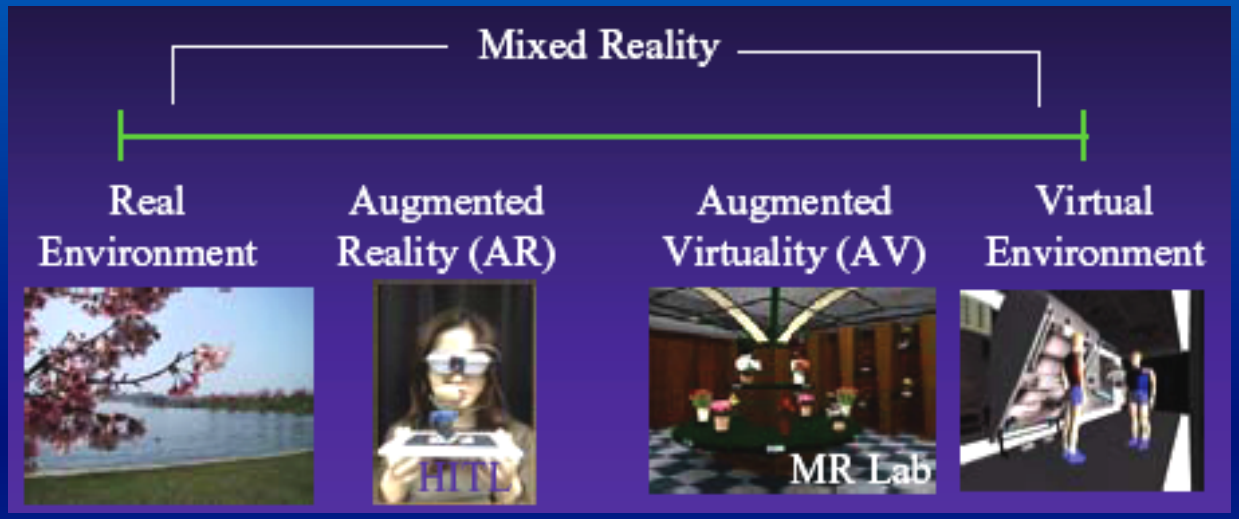
Augmented and Virtual Reality Lab
(AVR Lab)
www.avr.unisalento.it

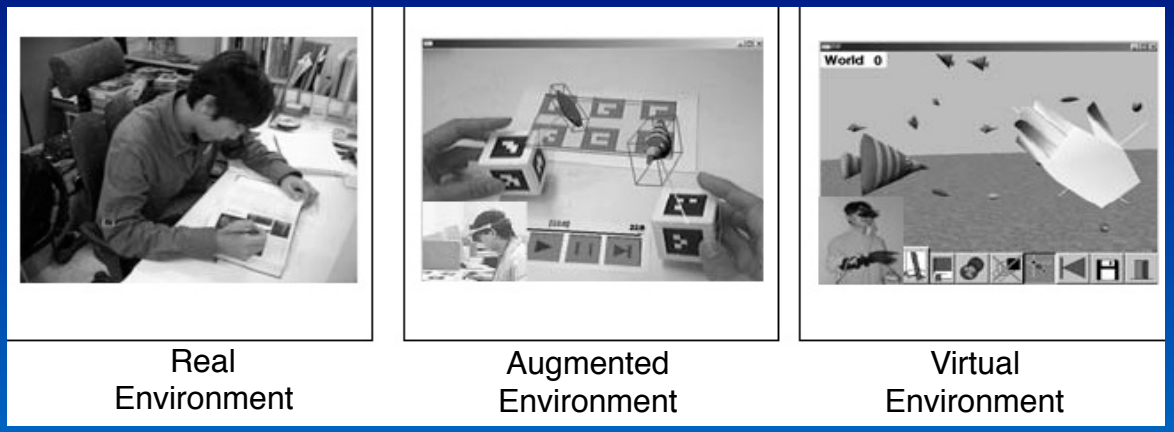
Virtual and Augmented Reality in Medicine and Surgery

Headlines

- Virtual and Augmented Reality in Medicine and Surgery
- Virtual and Augmented Reality in Cultural Heritage
- visualization and interaction systems

Virtual and Augmented Reality





AR/VR Research Lab

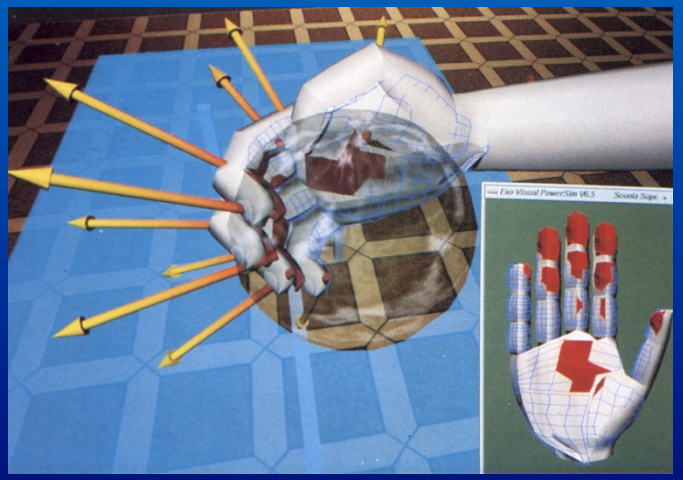
AR/VR Research Lab

Virtual Reality in Medicine and Surgery

Interactions in the Virtual Environment

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:

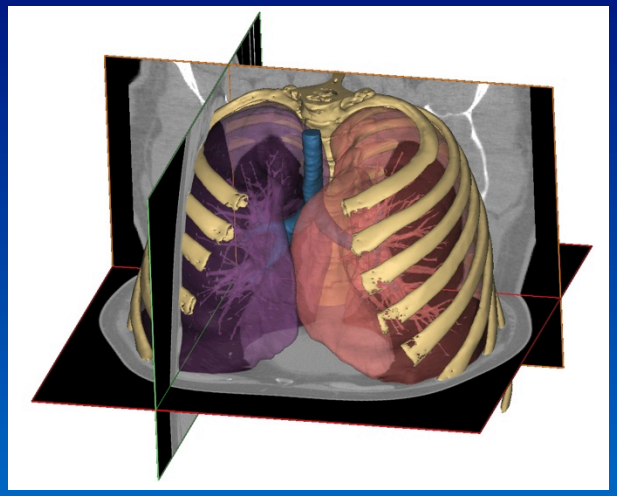
- to replicate the user's movements in the virtual environment
- to reproduce the sensations associated with the interactions in the virtual environment

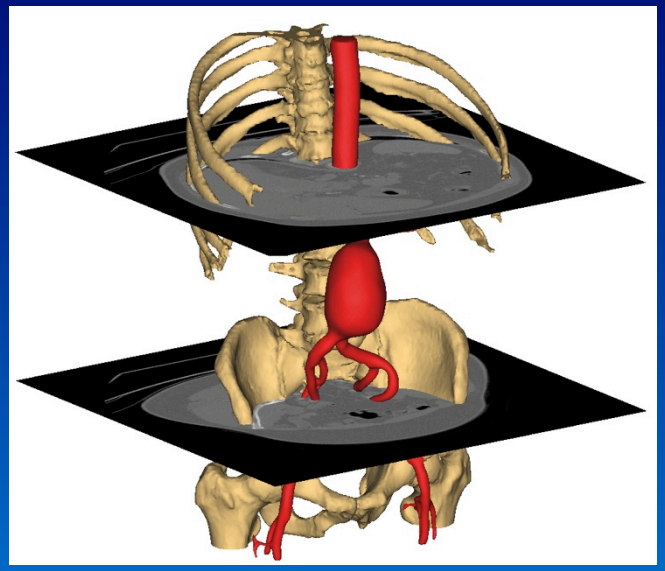
The user feels the forces generated in the virtual environment in response to the forces he applies

Building of the Virtual Environment

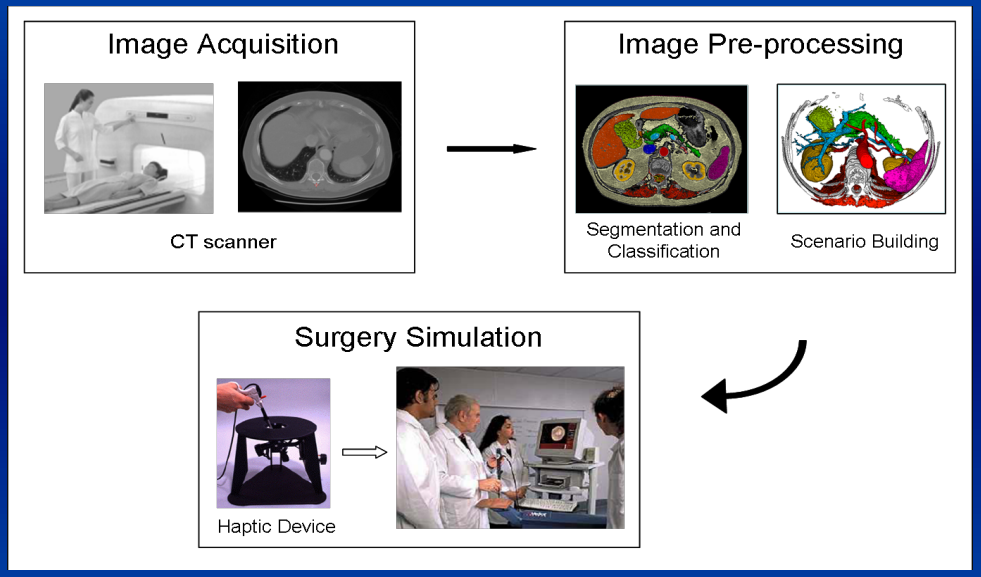
- the real patients' images are processed in order to distinguish the anatomical structures and to associate different chromatic scales to the organs

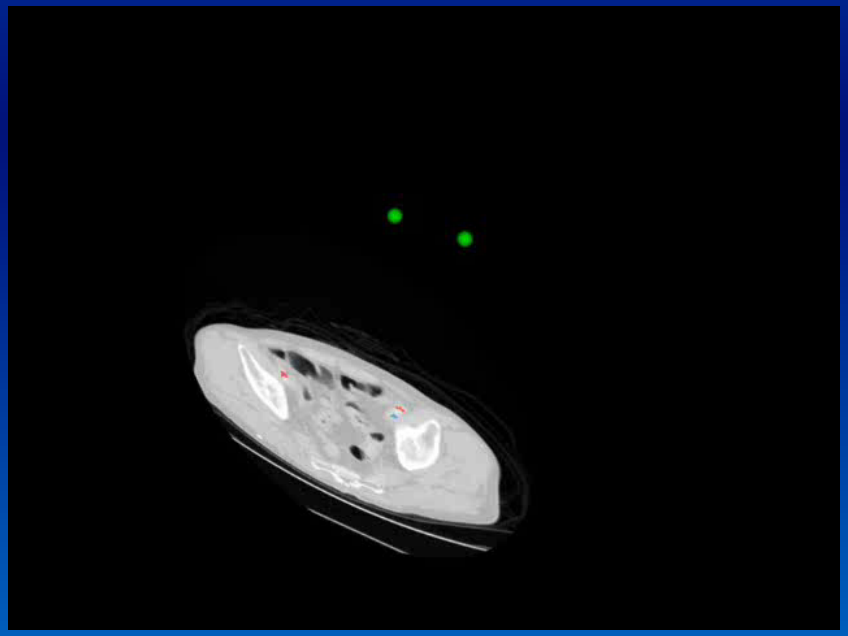
- the segmentation and classification phases are carried out in order to obtain information about the size and the shape of the organs



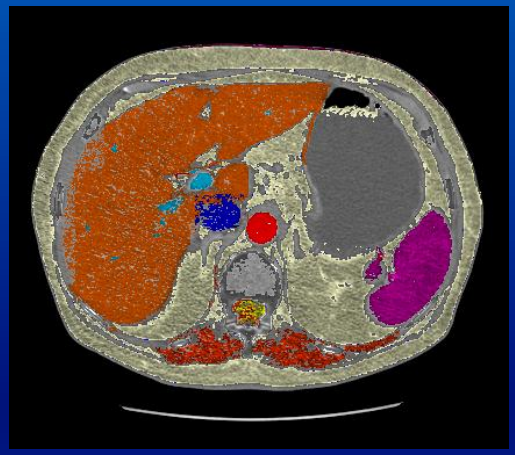


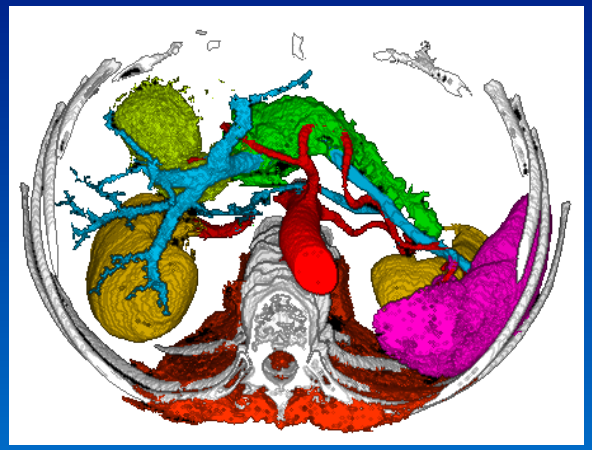
Building of the Virtual Environment



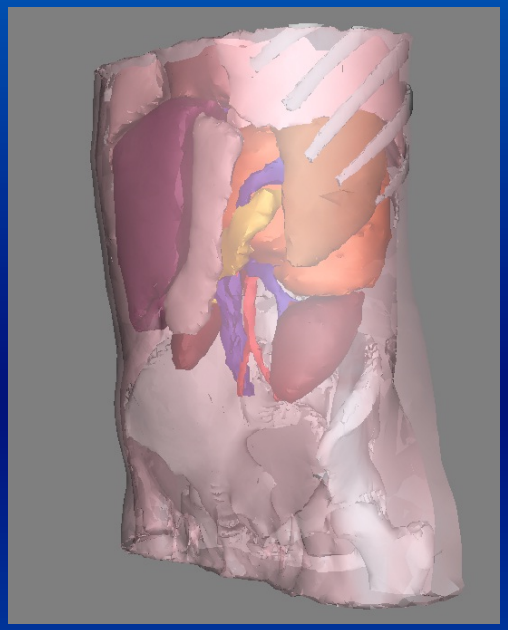


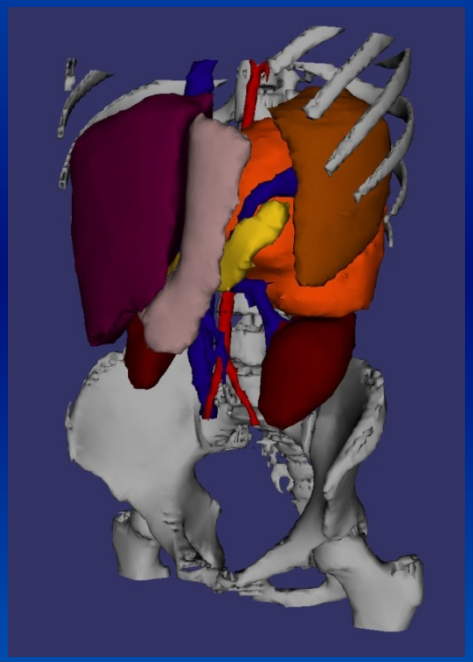
Building of the Virtual Environment

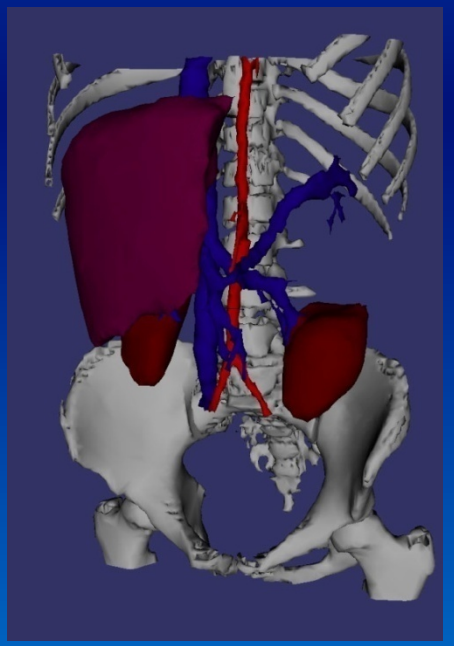




Building of the Virtual Environment

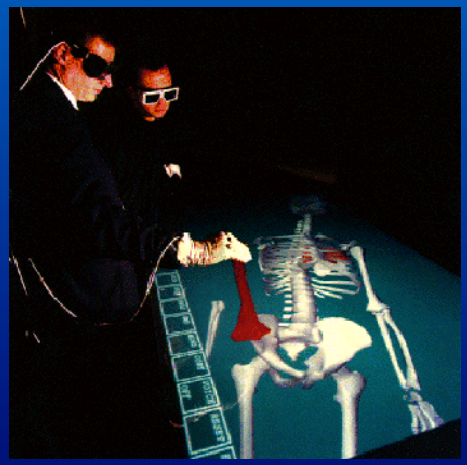






Virtual Reality in Medicine

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



Current Practice in 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

Current teaching practices have difficulty meeting the challenges of modern medicine

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

Why simulation?

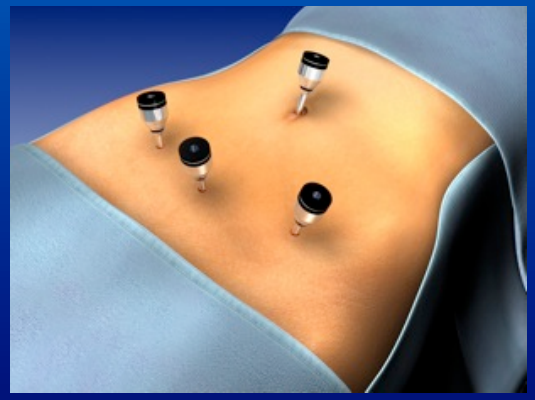
The training on virtual patients met the growing need for training in Minimally Invasive Surgery

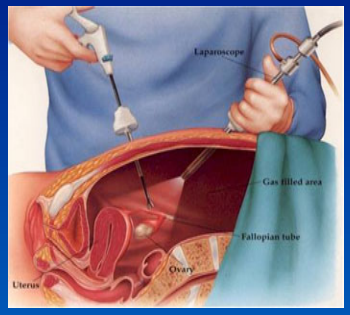
Many of these procedures need to be learned by repetition; new and unusual surgical procedures can be practiced in a safe manner

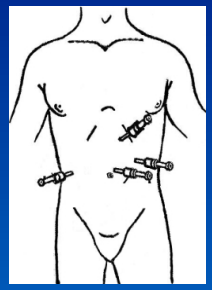
A simulator incorporates both realistic graphics and the sense of touch (force feedback)

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

Laparoscopic Surgery





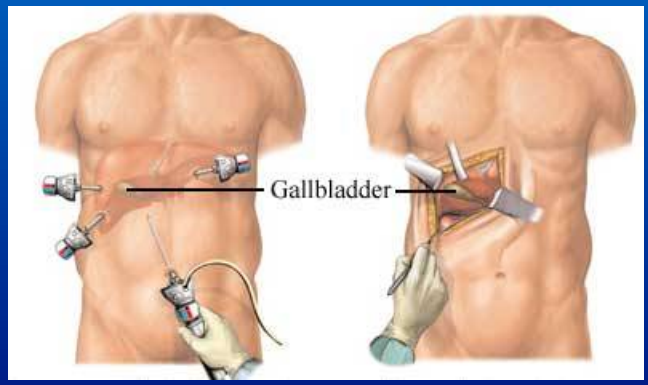


Laparoscopic Surgery

Minimally Invasive Surgery

advantages:

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

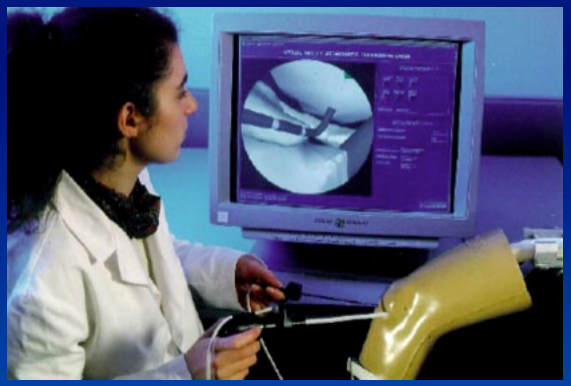


limitations:

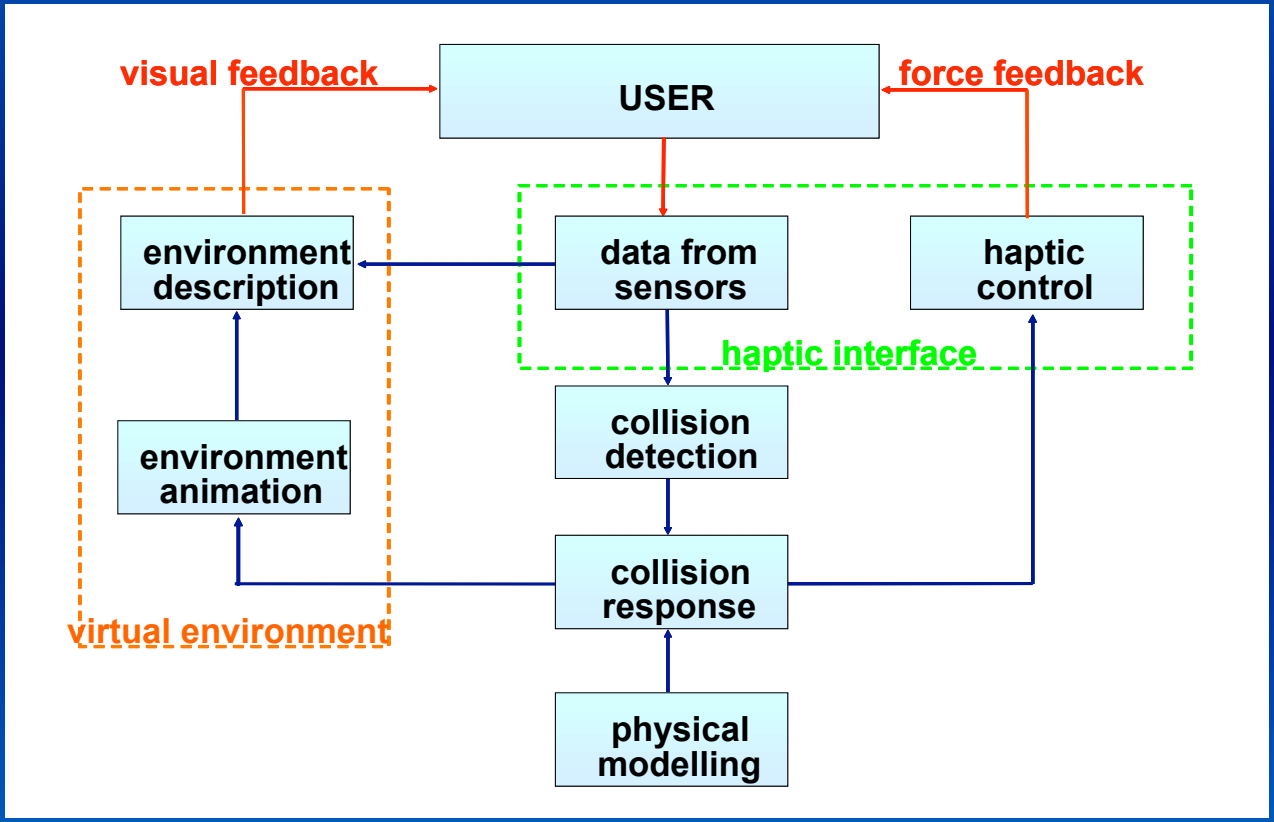
- the imagery is in 2D
- the surgeon can estimate the distance of anatomical structures only by moving the camera

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

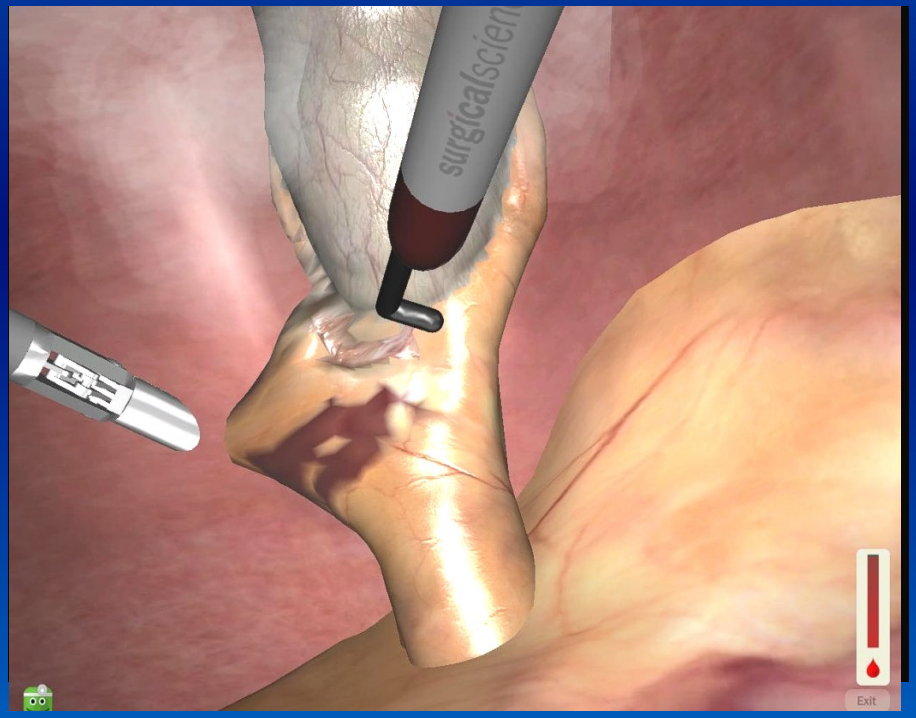
Laparoscopy Training Simulator

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

Dissection may be carried out using different instruments

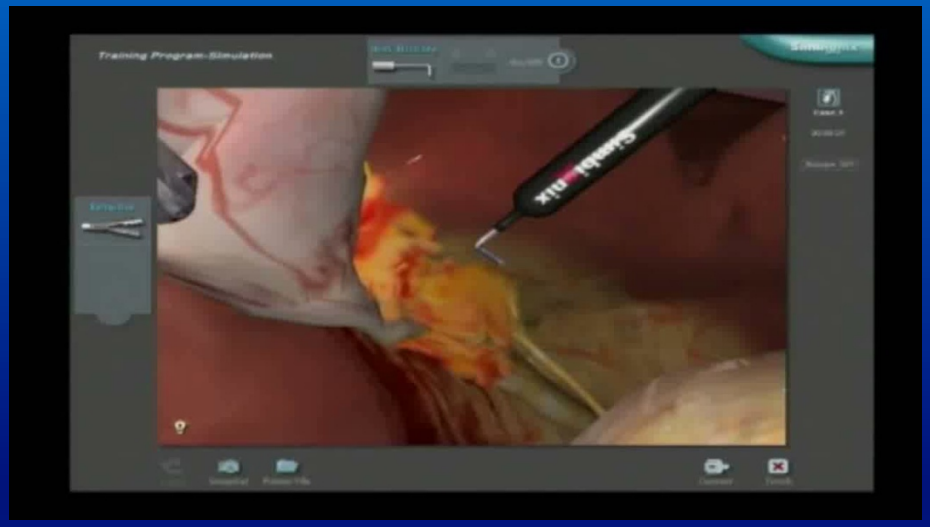
LapSim® System

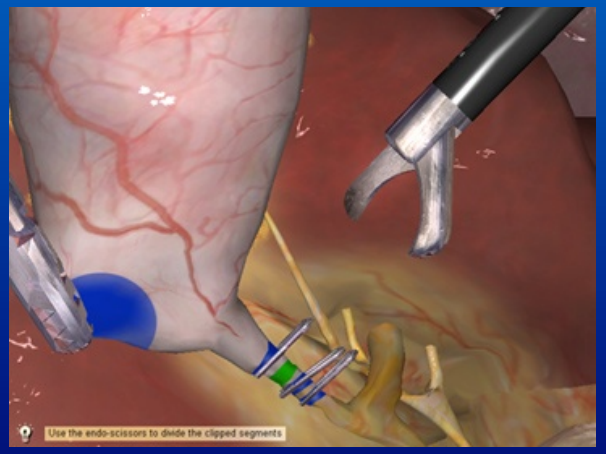
Surgical Science Ltd – Sweden
www.surgical-science.com



By courtesy of Surgical Science Ltd

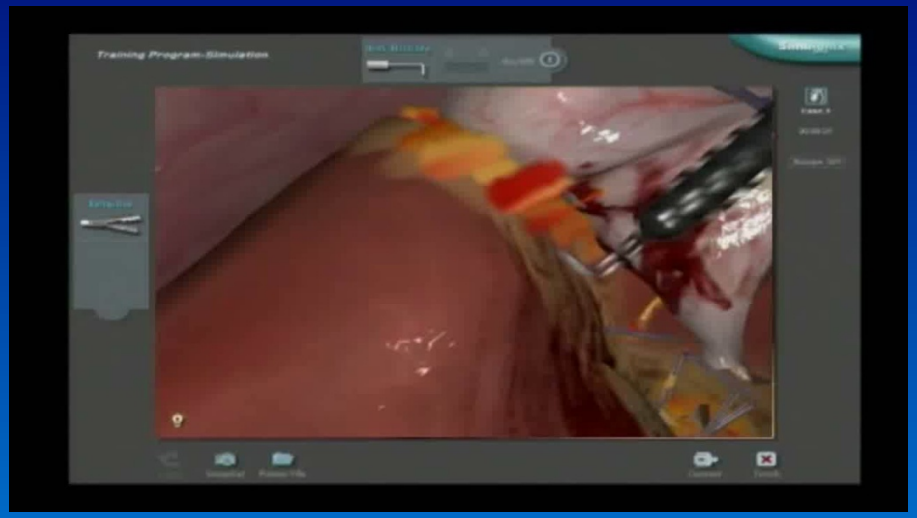
Laparoscopy Training Simulator





LAP Mentor II

Simbionix USA Corp.
www.simbionix.com



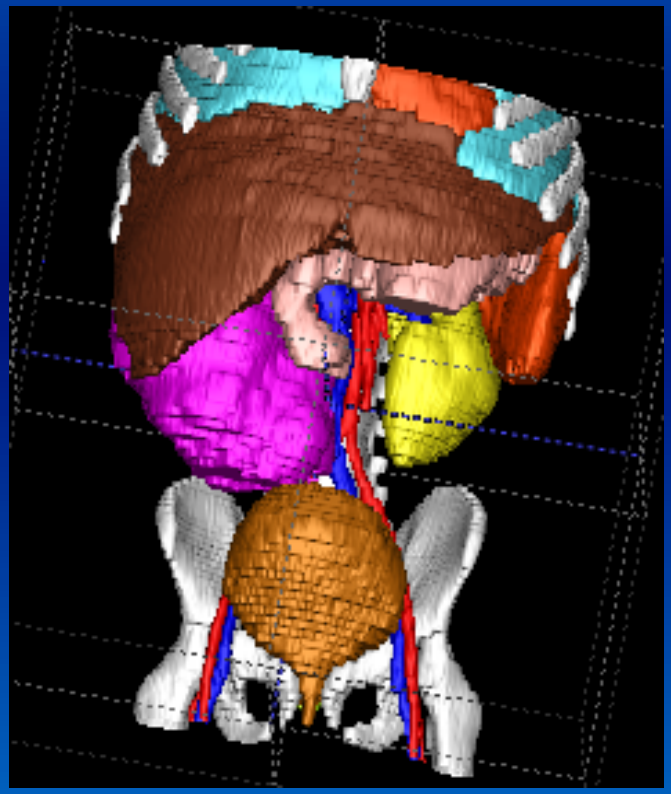
ARPED Project

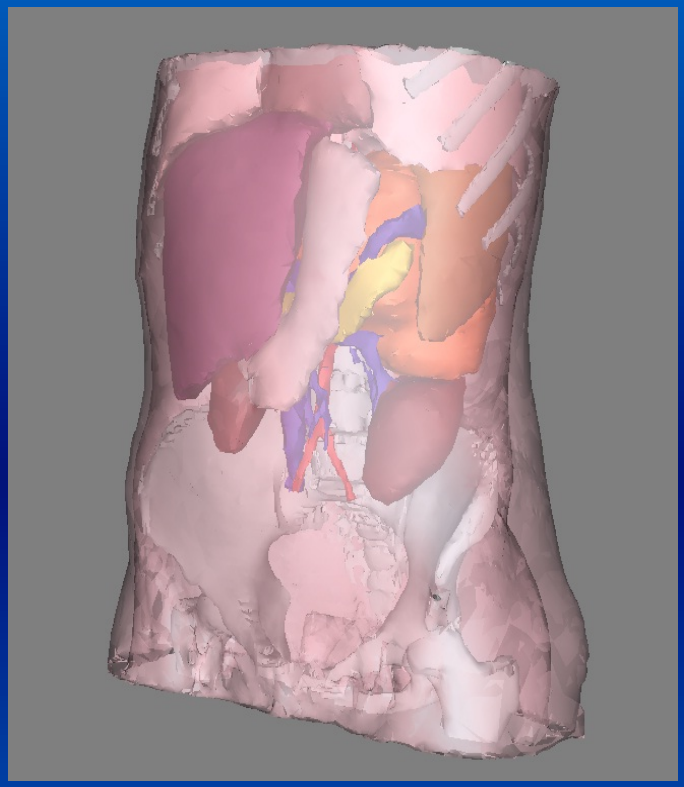
ARPED - Augmented Reality Application in Pediatric Minimally Invasive Surgery

- building the 3D model from the patient's medical images
- to identify the points of the trocar insertion
- simulate the use of laparoscopic instrumentation
- measuring distances
- AR to augment the real scene

ARPED Project

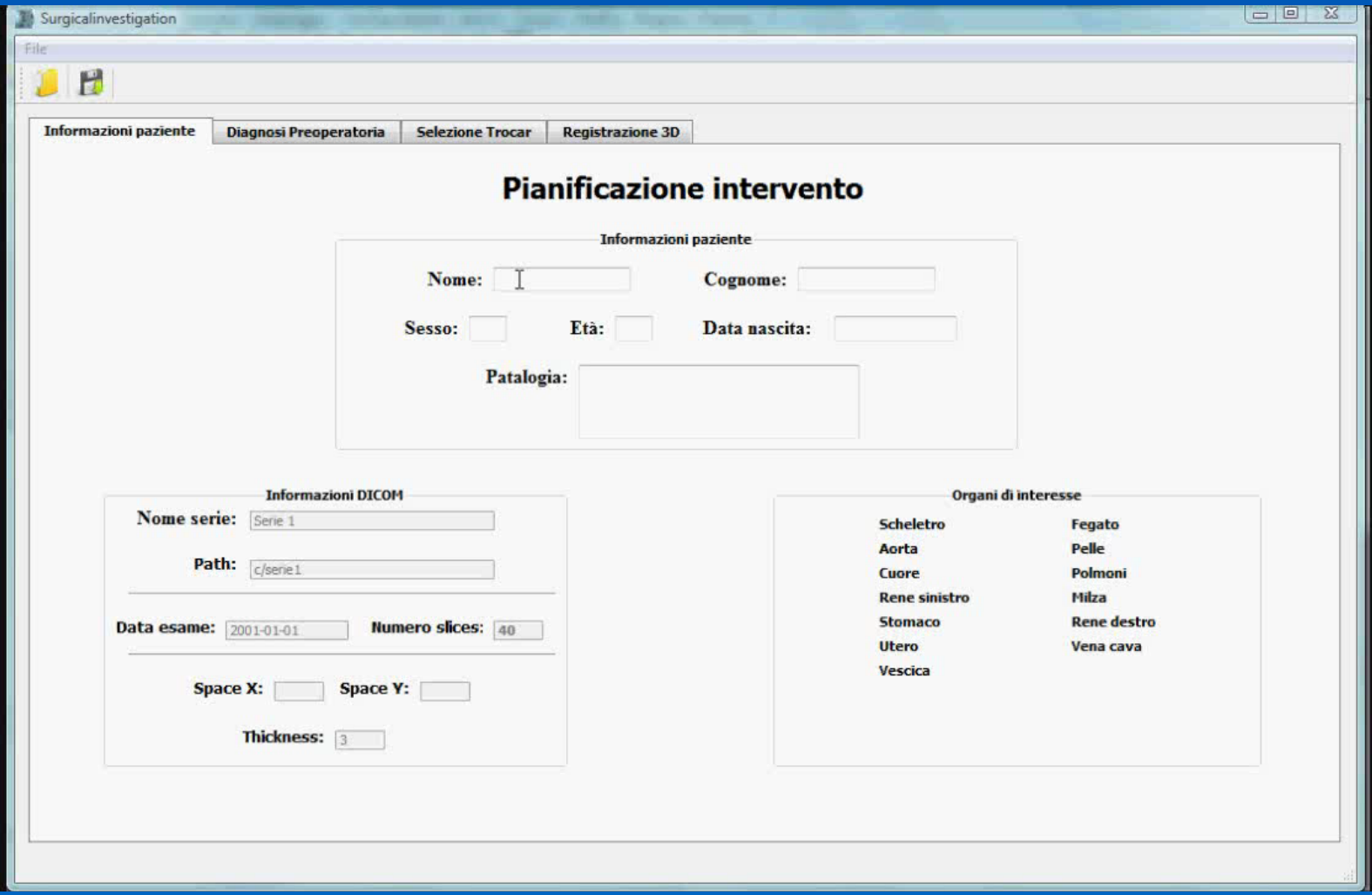
1° case:
child with the Wilms tumor





2° case:
child with a tumor of the peripheral nervous system (ganglioneuroma)

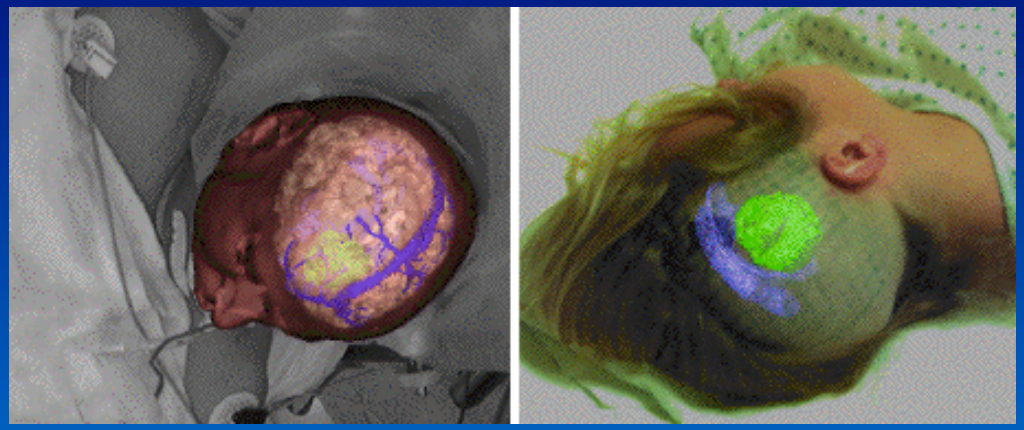
ARPED Project

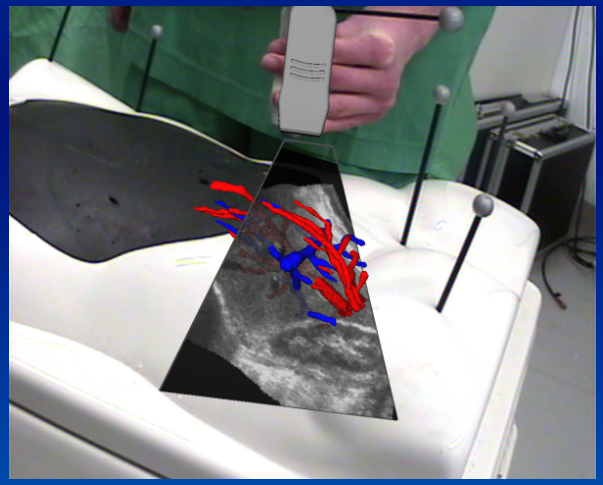


Augmented Reality in Medicine and Surgery

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



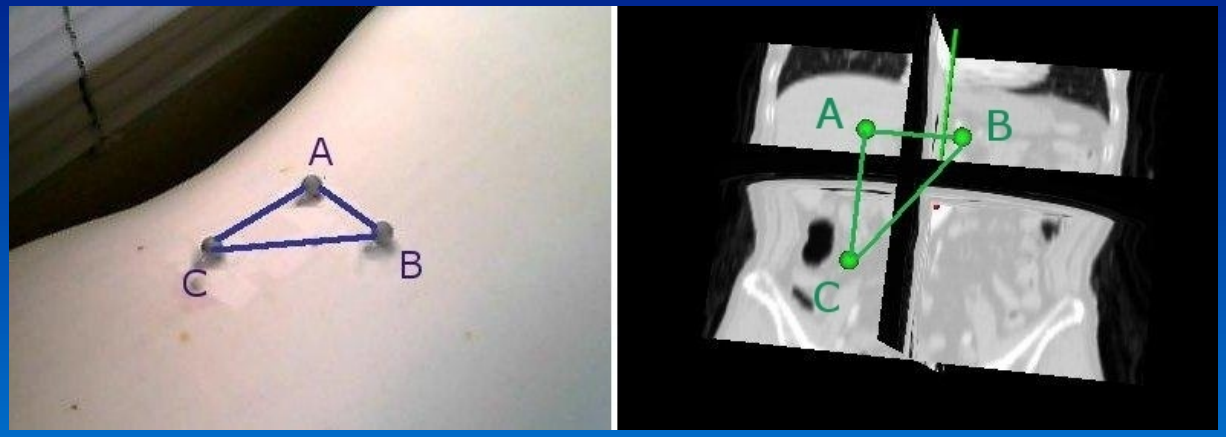


Augmented Reality in Surgery

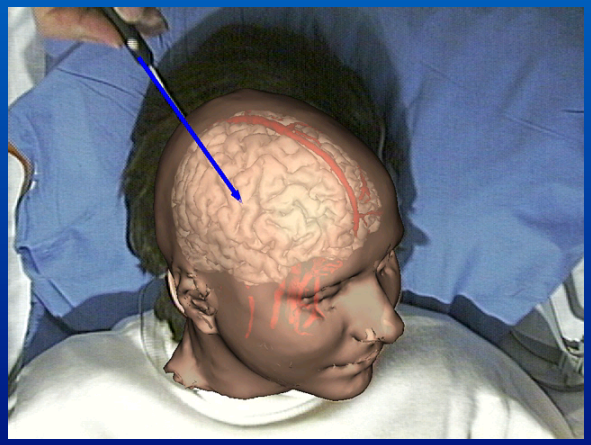
In order to have a perfect correspondence between virtual and real organs it is necessary to carry out an accurate registration phase that provides as result the overlapping of the virtual 3D model of the organs on the real patient

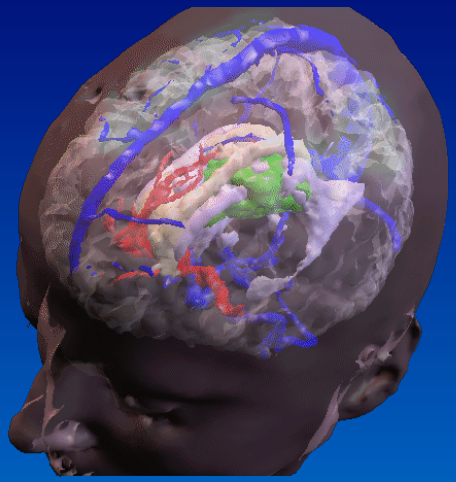
The registration phase is carried out just once at the beginning of the surgical procedure

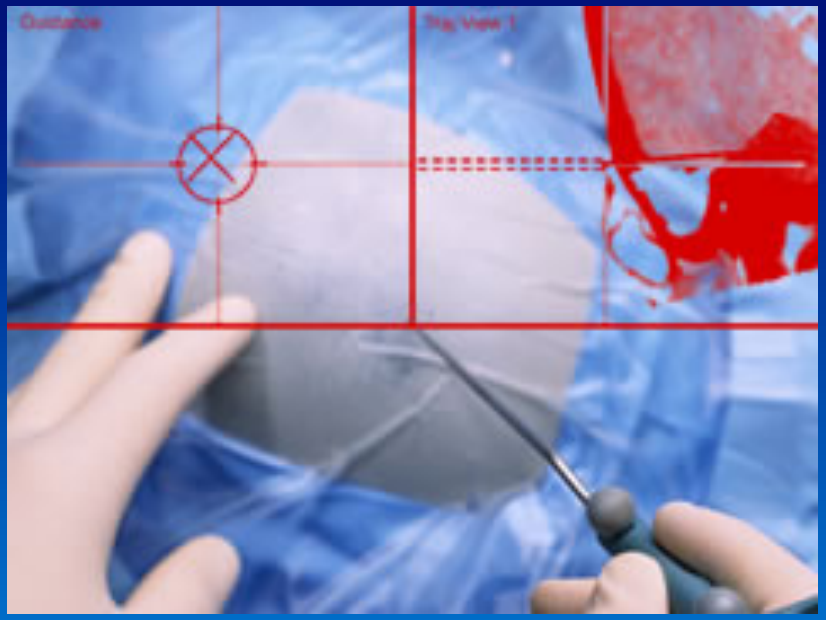
the registration algorithm is based fiducial points



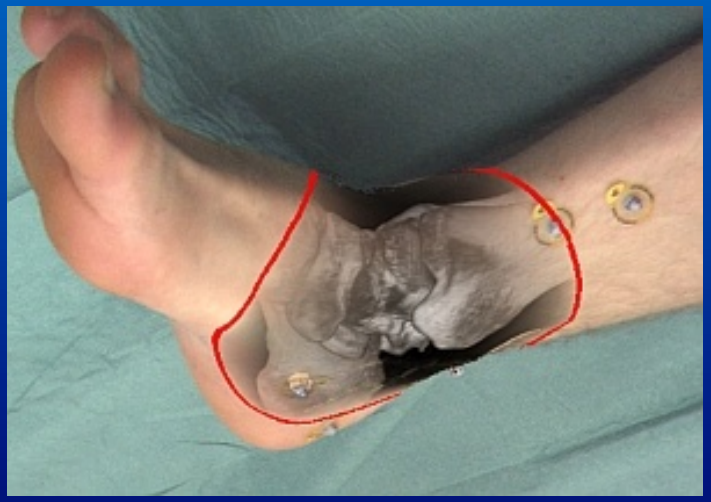
Augmented Reality in Surgery

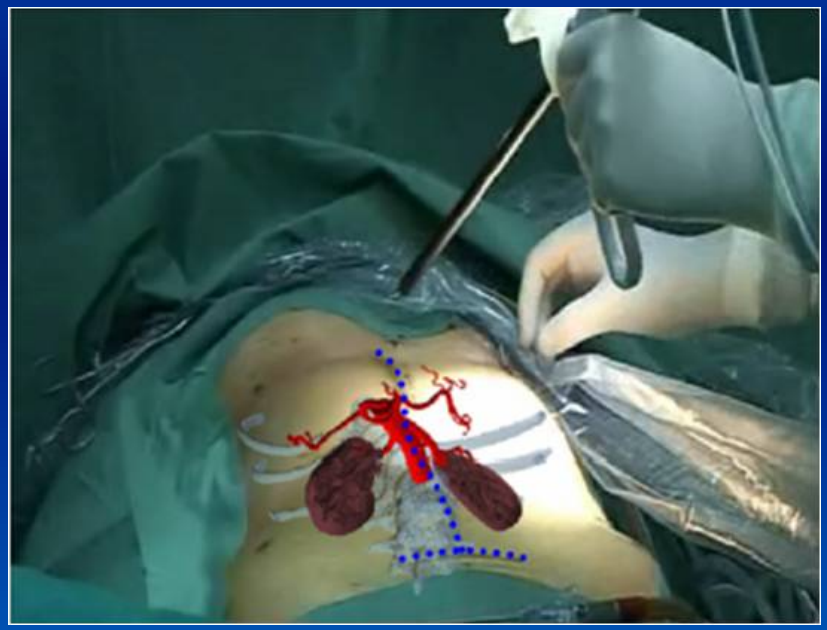






Augmented Reality in Surgery



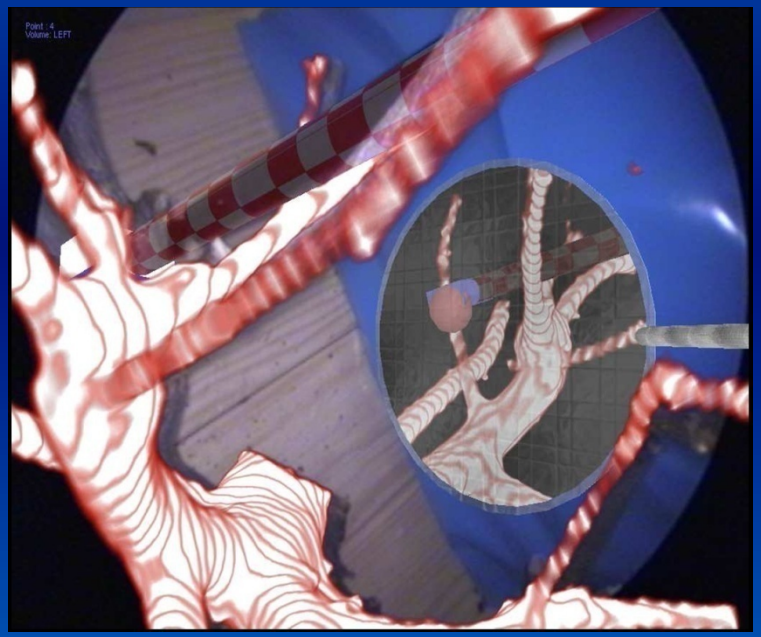


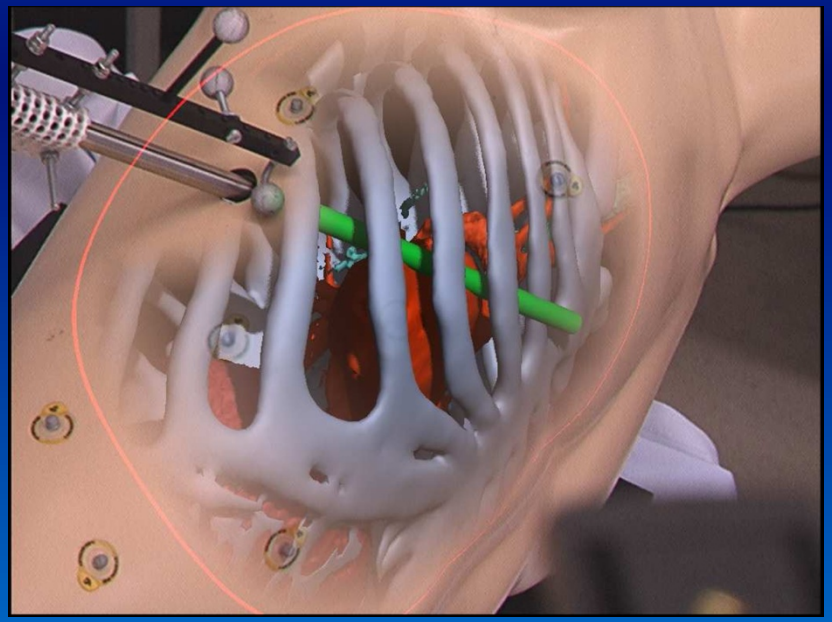
Augmented Reality in Surgery

Augmented Reality in Surgery

CAMP

(Computer Aided Medical Procedures) Munchen - Germany





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)

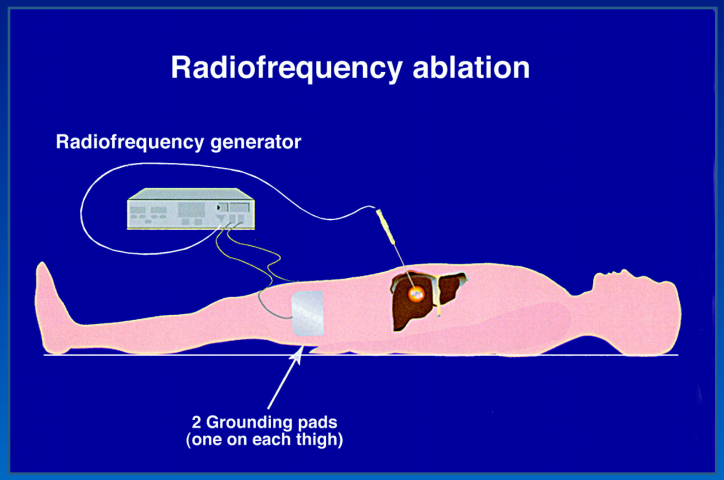
Patients with confined disease of the liver could not be candidates to resection because of multifocal disease (proximity of tumor to vascular key or biliary structures)

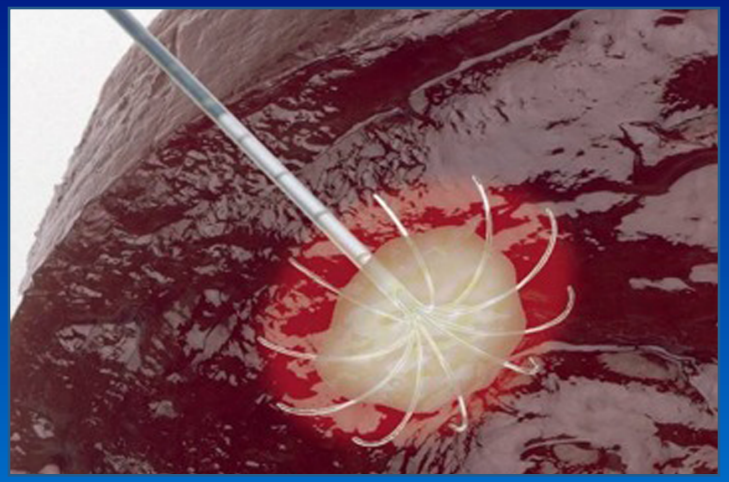
Liver transplant can't be always used

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

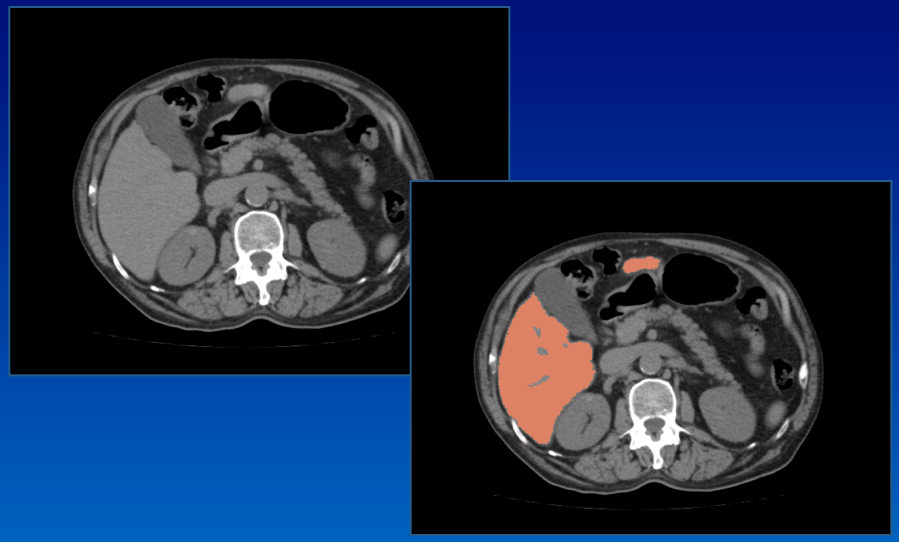


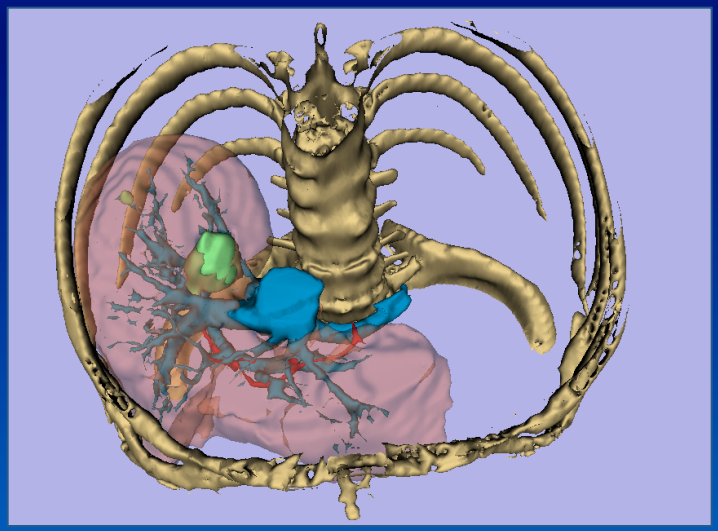


RFA Ablation of the Liver Tumour

With the superimposition of the virtual models of the patient's anatomy (liver, cancer, etc) exactly where are the real ones, it is possible to make the needle placement less difficult

In this way the surgery patient's risks and the surgery time should be reduced

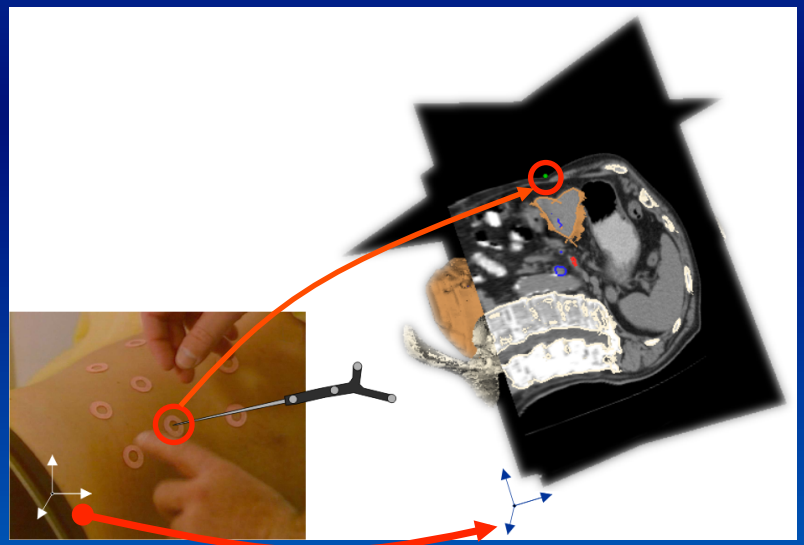


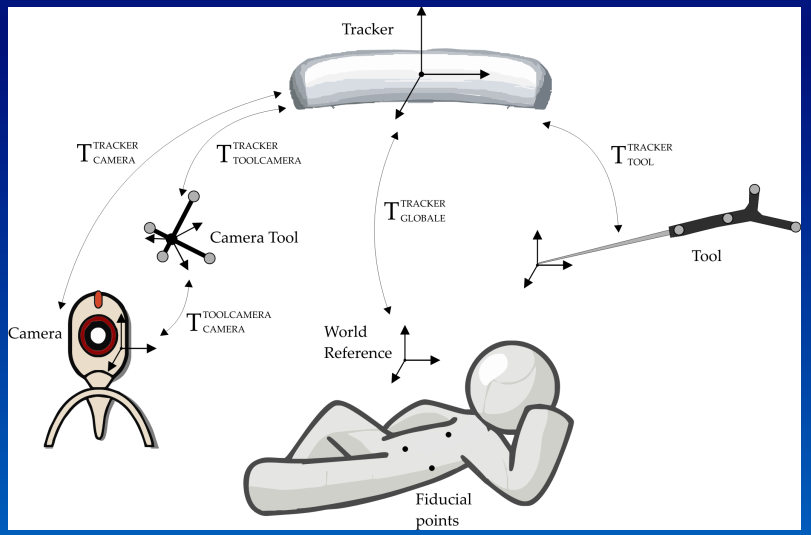


AR in RFA Ablation of the Liver Tumour

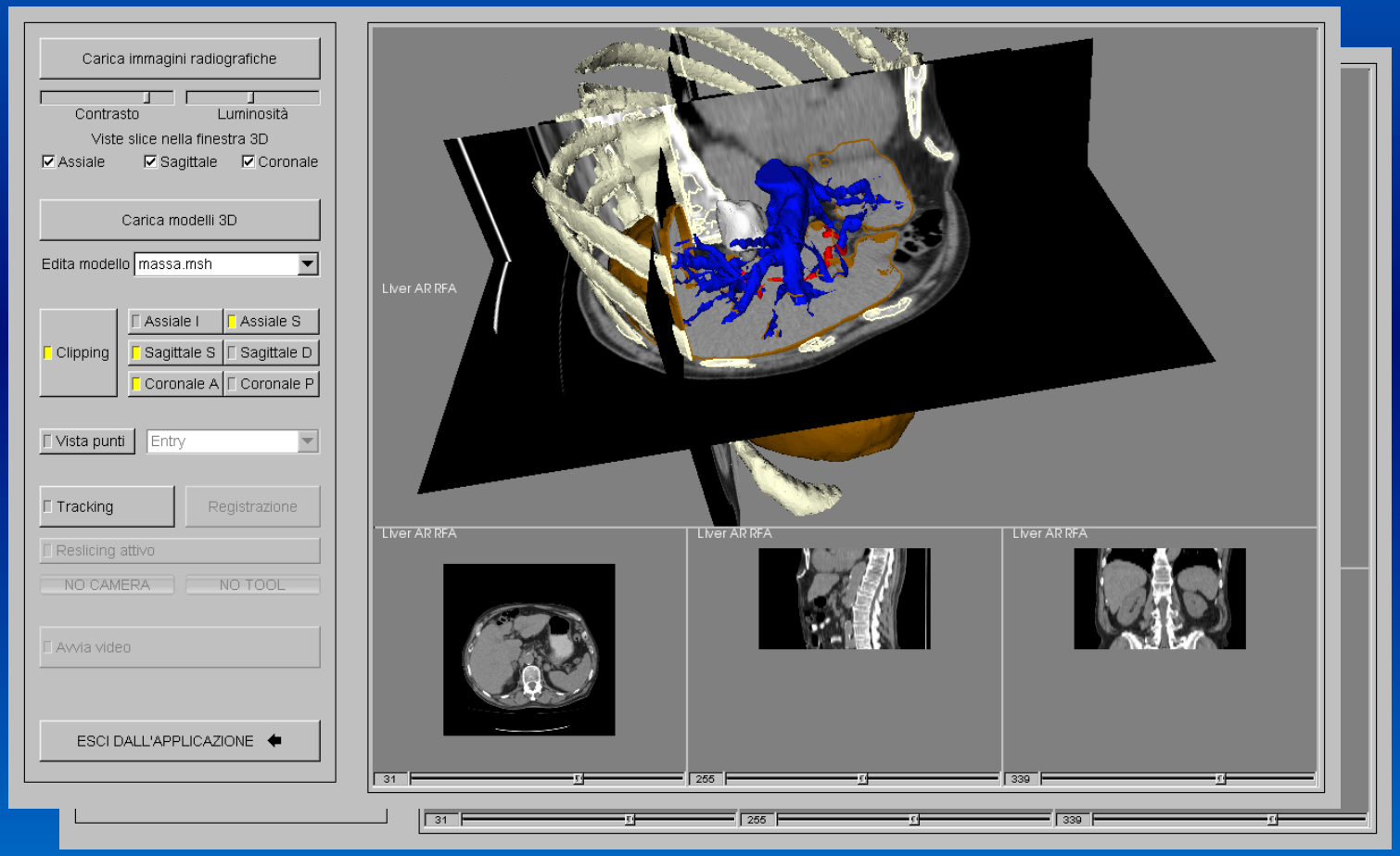
In order to have a perfect correspondence between virtual and real organs it is necessary to carry out an accurate registration phase

The registration algorithm is based fiducial points

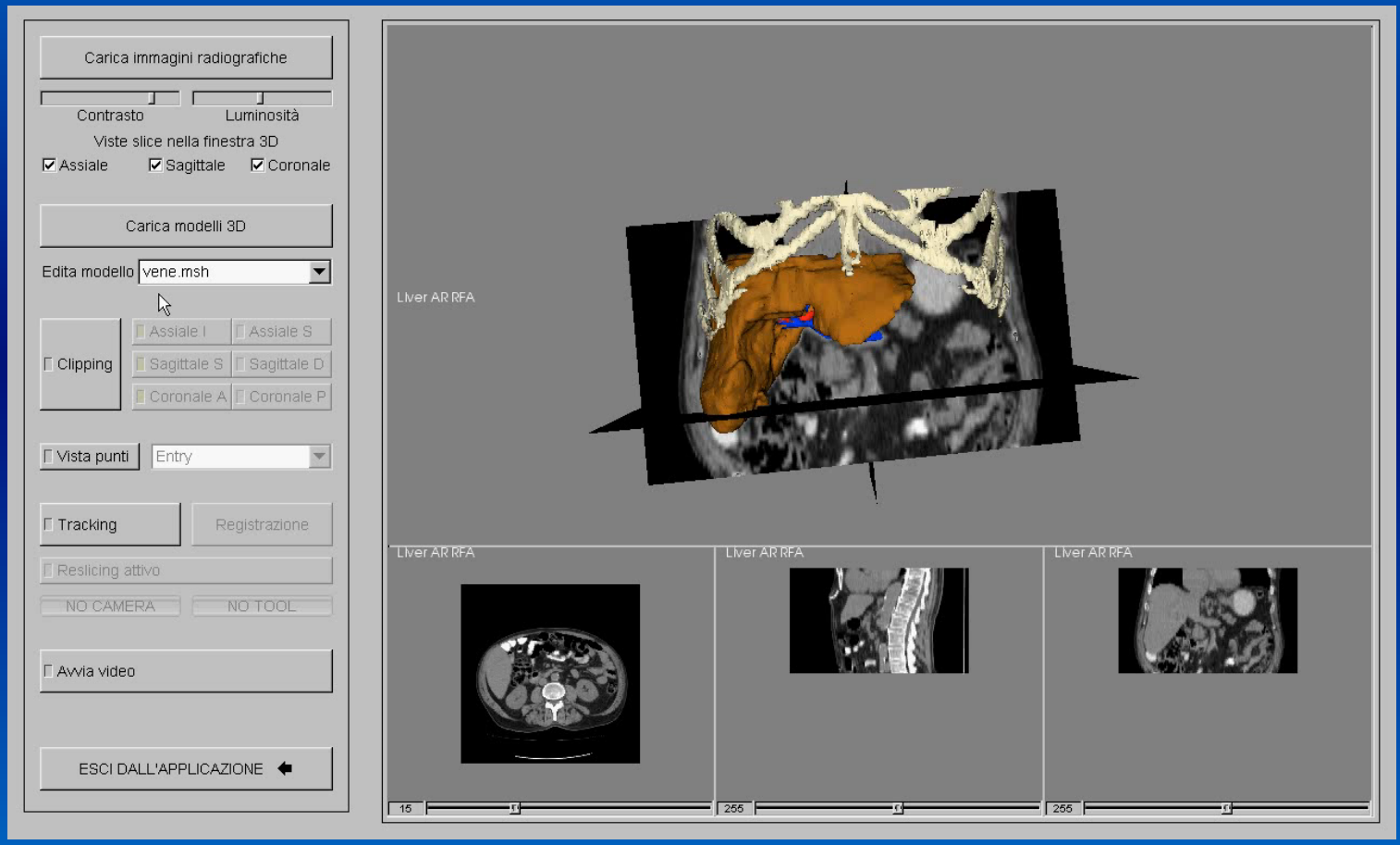




AR in RFA Ablation of the Liver Tumour

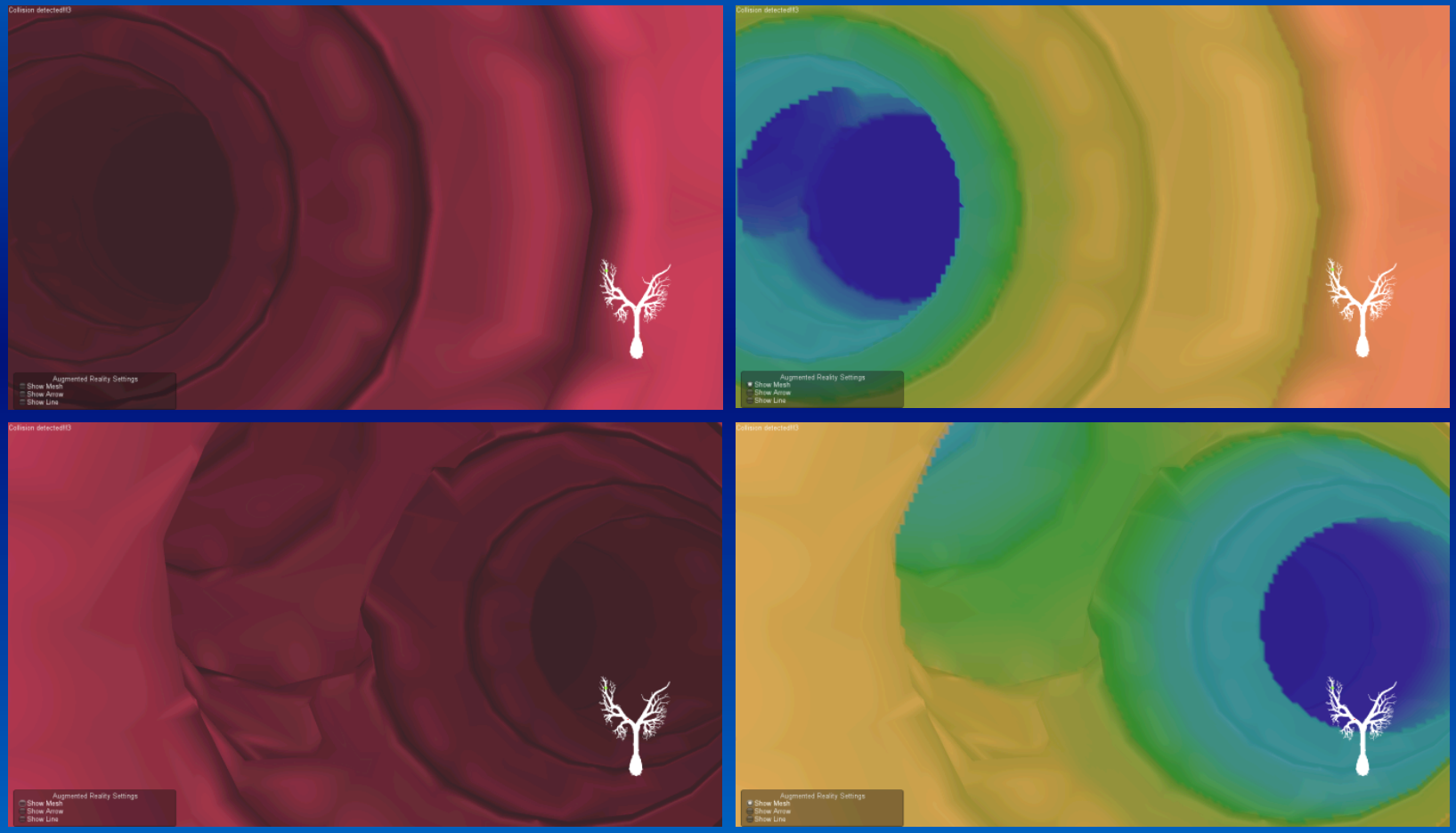


AR in RFA Ablation of the Liver Tumour

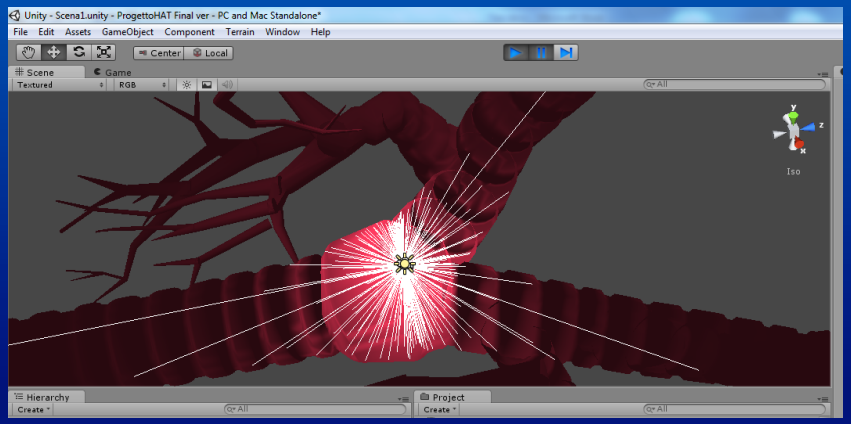


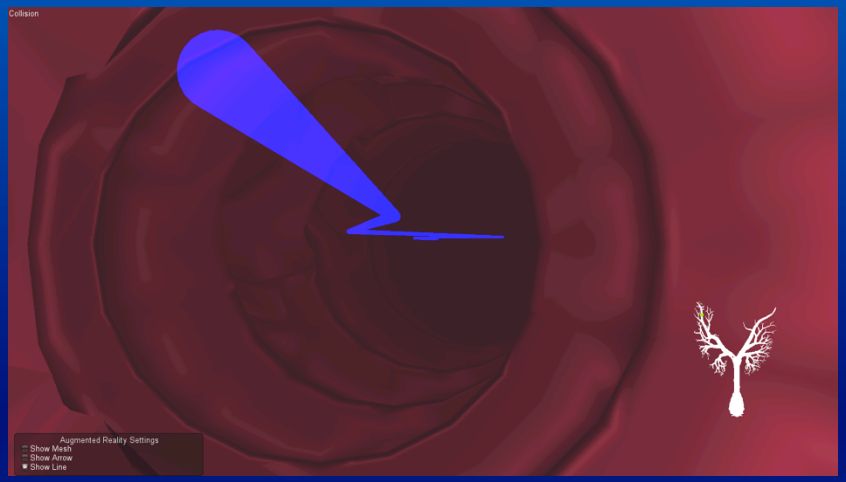
AR in RFA Ablation of the Liver Tumour

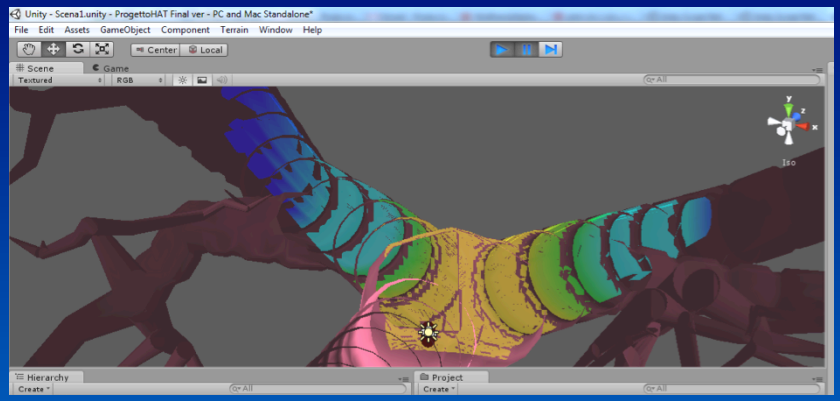
AR in Broncoscopy

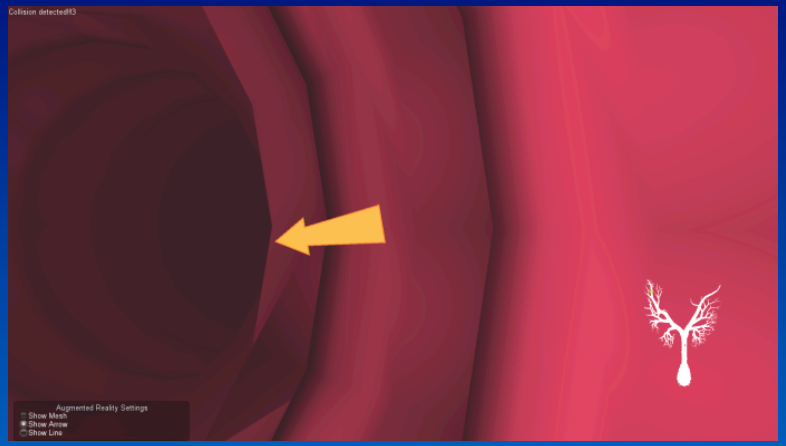


AR in Broncoscopy

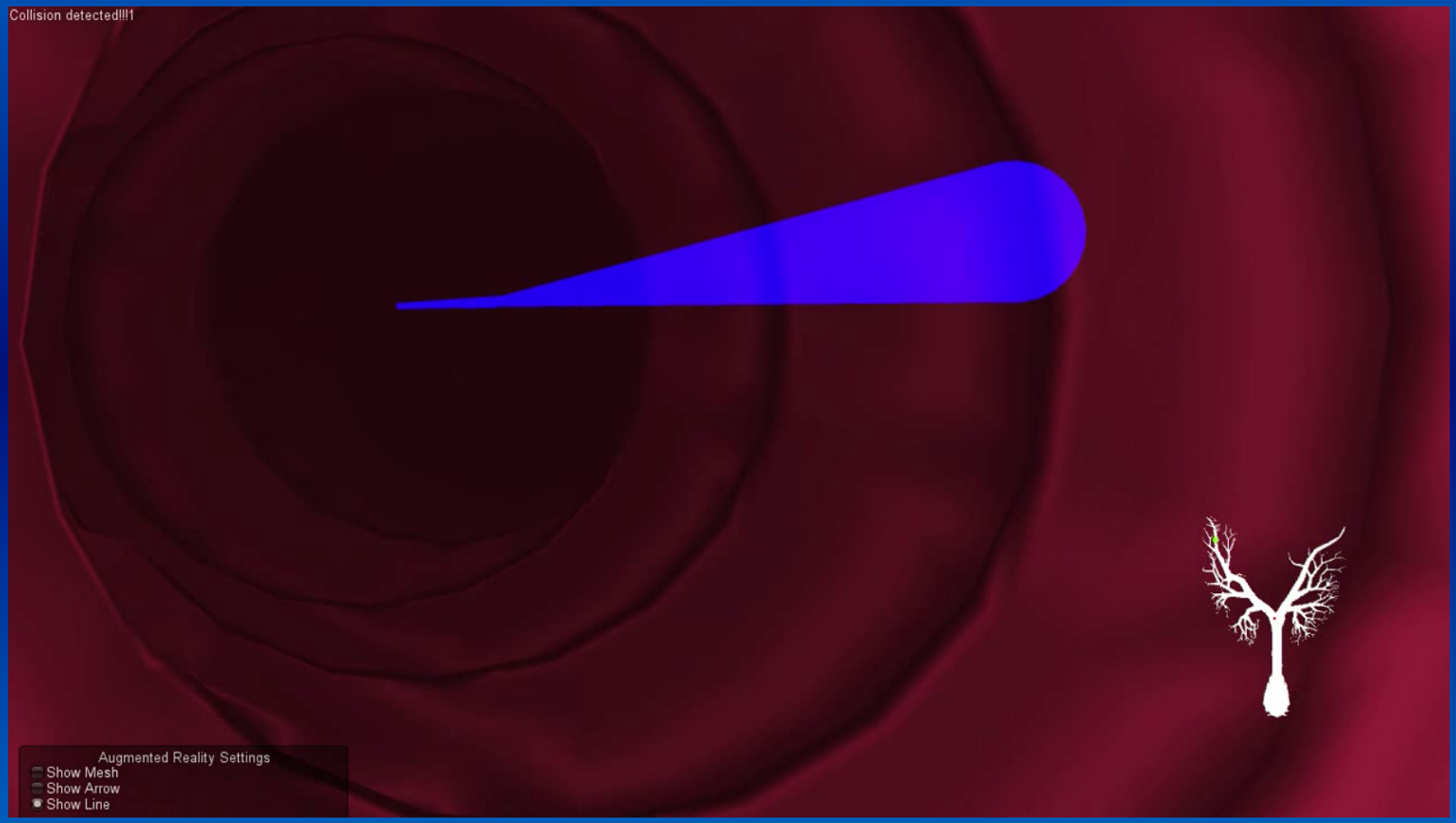








AR in Broncoscopy



Visualization and Interaction