

Computer Assisted Abdominal Surgery and NOTES

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In the past ...



IRCAD Strasbourg + Taiwan



More than 3.000 surgeons trained per year, 300 for robotics

eats

ircad

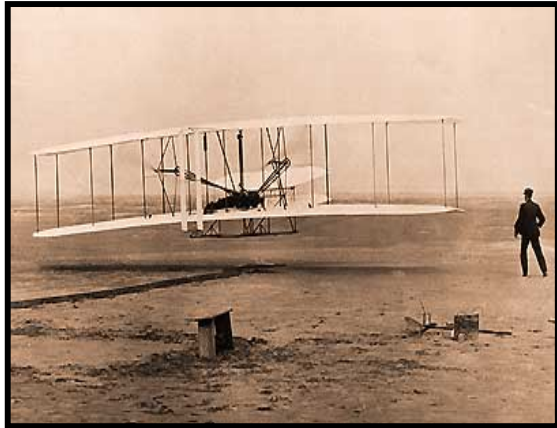
eits

From OP-Room to WebSurg

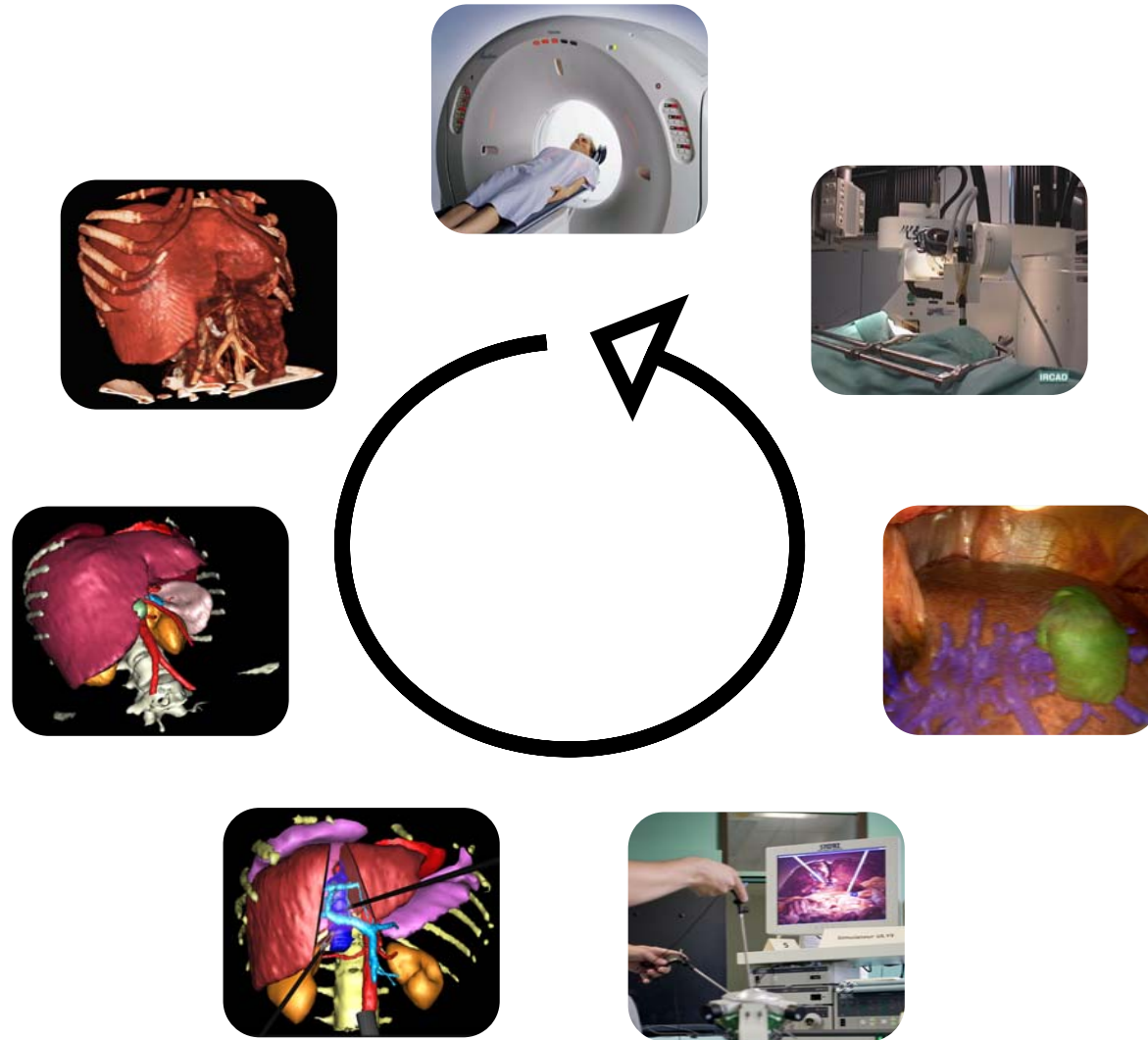


WebSurg : FREE ➔ www.websurg.com

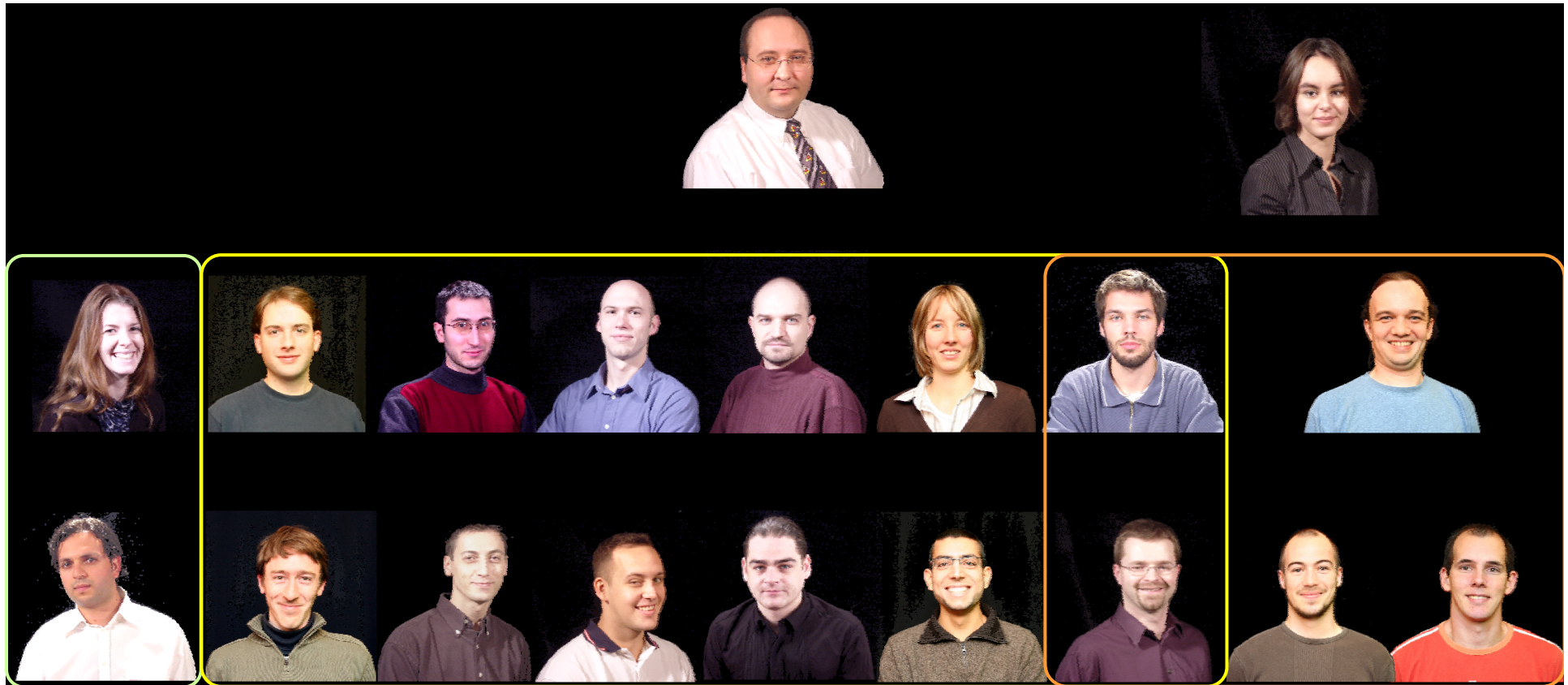
Future based onto known success



Computer Assisted Surgery



IRCAD R&D team



Ratdiology / R&D / Network IRCAD's team, December 2008

2009/2010 : 2 post-doctoral position (1500€/month)

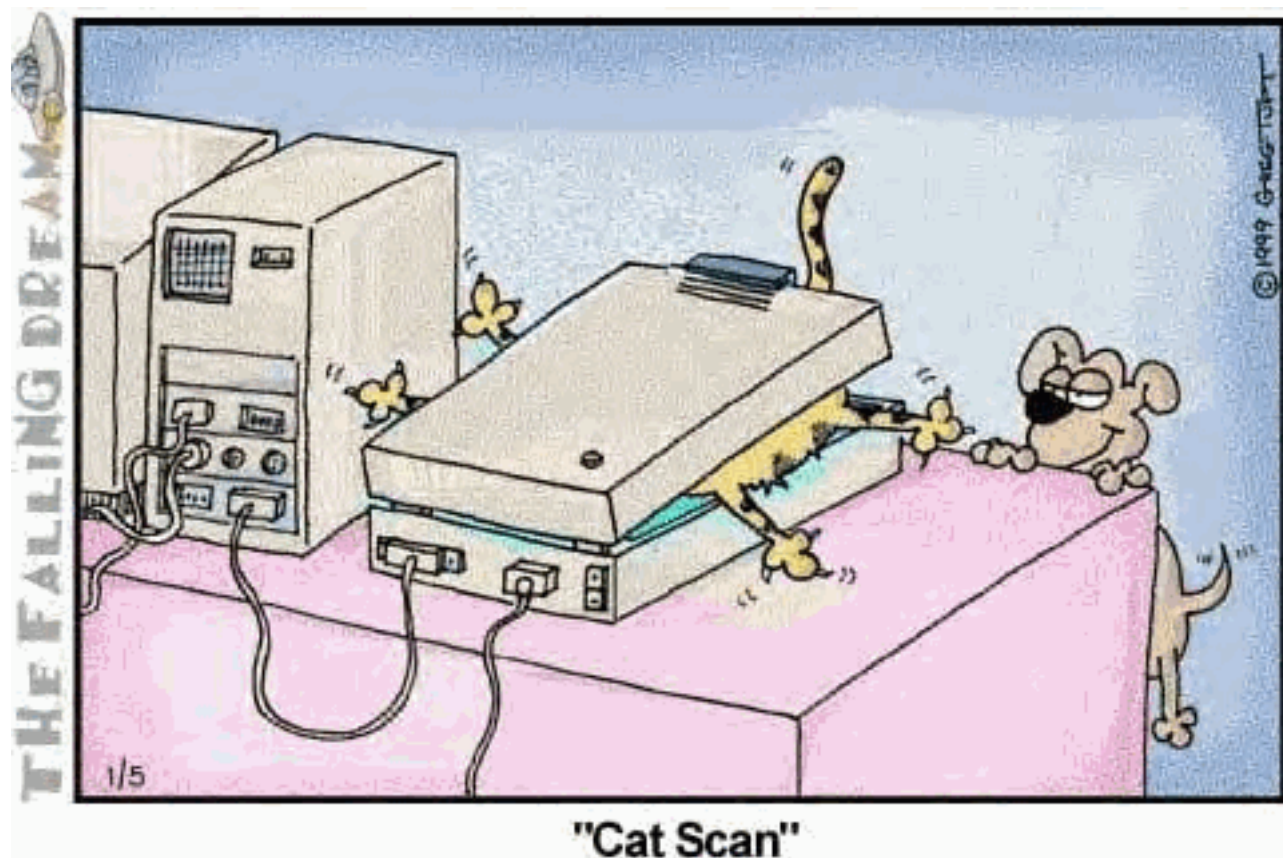
Step 0: Medical Image





Medical Imaging system

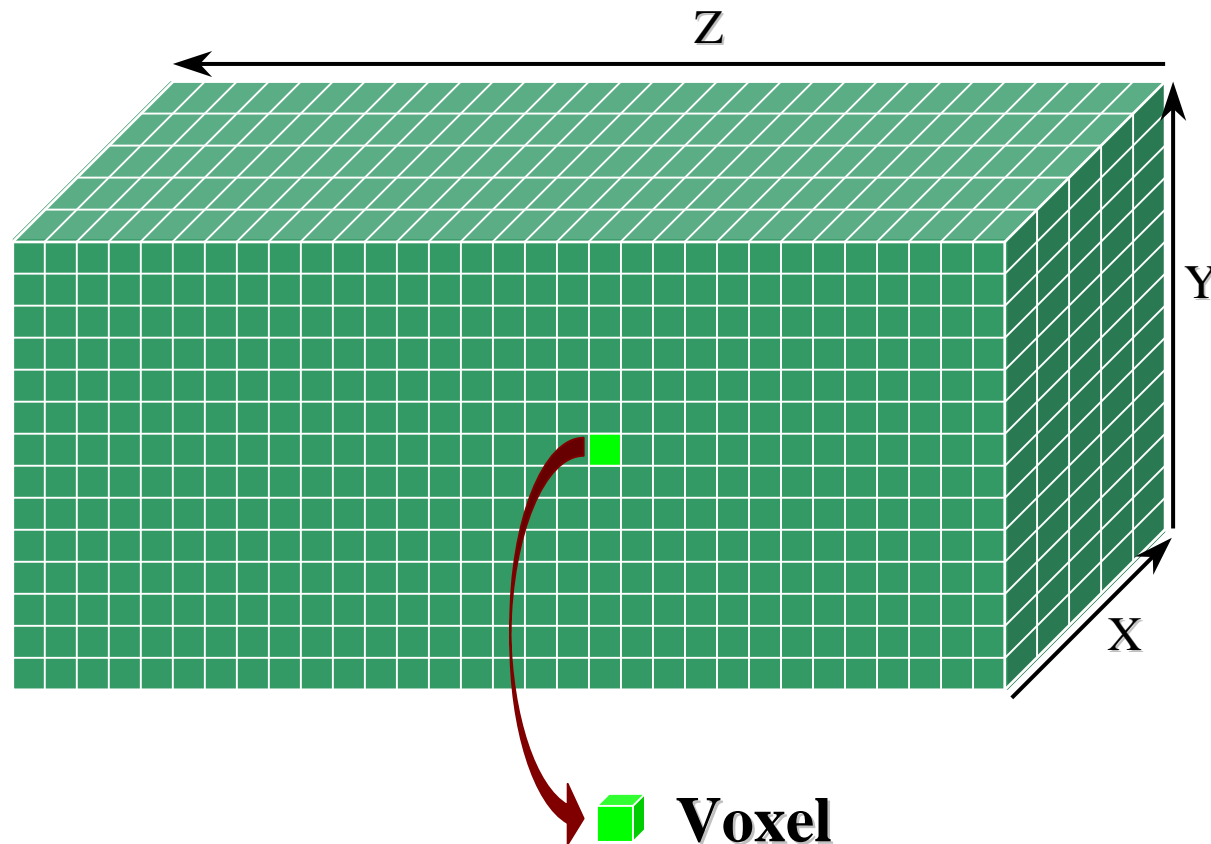
DICOM Image → « Normalized »
Numerical Format



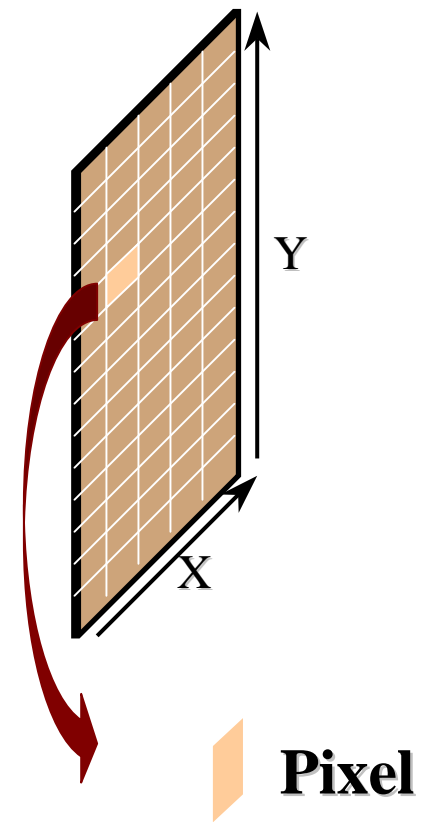


Definition

3D Imaging

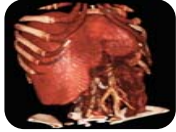


2D Imaging



Step 1: 3D Direct Visualisation





VR-Render : Direct visualisation

The screenshot shows the IRCAD France website for VR-Render. At the top, the IRCAD France logo is displayed with the tagline "There is no better way to learn : IRCAD, the vision of excellence !". Below the logo are links for "Software", "Download", "Documentation", and "Links". The main heading is "VR-Render 2D and 3D images Viewer!". A row of five small images shows various 3D medical visualizations: a head, a chest, a heart, a liver, and a brain. Below this, a text block states "VR-Render is a free IRCAD DICOM Viewer Software." followed by a bulleted list of features and awards. A framed certificate from the "Best Biomedical Visualization" contest is also shown. At the bottom, there are sections for "Photos" and "Video" with corresponding images, and buttons for "Download VR-Render" and "Getting Started & User manual". A "Contact us" link is at the very bottom.

ircad France *There is no better way to learn : IRCAD, the vision of excellence !*

Software Download Documentation Links

VR-Render 2D and 3D images Viewer!

VR-Render is a free IRCAD DICOM Viewer Software.

- VR-Render is a free IRCAD Image Viewer Software working on Windows, Linux and MacOS
- It allows to visualize DICOM, Jpeg, InrImage and Fits images in 2D slices (Frontal, Sagittal and Axial view) or in 3D thanks to Multiplanar Rendering, MIPS and Volume rendering.
- Like all volume rendering systems, it requires a transfer function allowing to parameterize the 3D view.
- Several automatic rendering functions have been incorporated for CT-scan images in order to simplify the software use.
- VR-Render wins the first prize at the Biomedical Visualization Contest (MICCAI 2008)

VR-Render has partly been developed in the PASSPORT project, eHealth project funded by the European Commission within the ICT-2007.5.3 research area.

Photos

Video

Use arrows to explore the gallery

Download VR-Render

Getting Started & User manual

Contact us

www.ircad.org

➤ 18.000 downloads

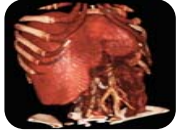
Since october 2008

Mac OS / Windows/ Linux

2D view of patient

Axial/Frontal/Sagittal

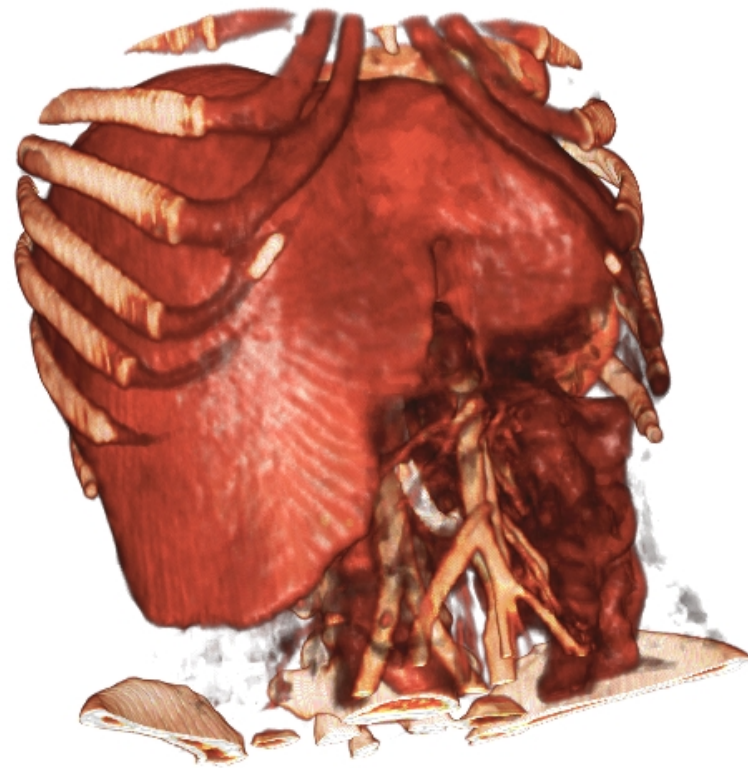
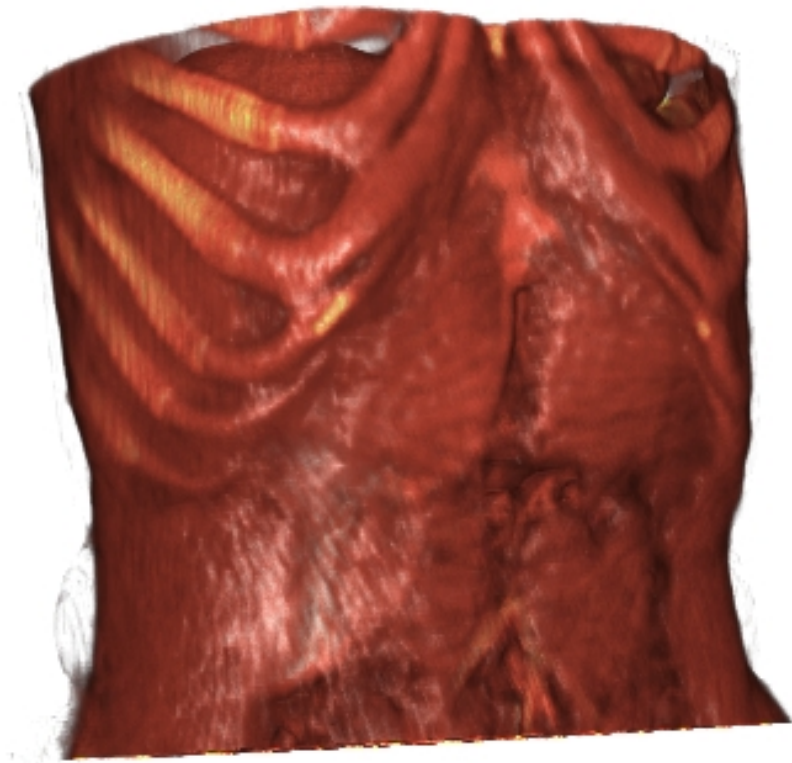
+ 3D volume rendering
FREE !!!



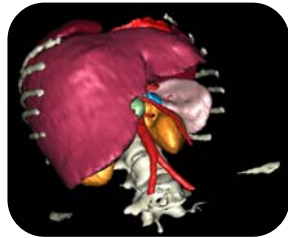
VR-Render : Direct visualisation

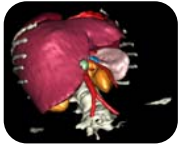
Sample of Direct Volume Rendering

VR-Render (IRCAD 2008)



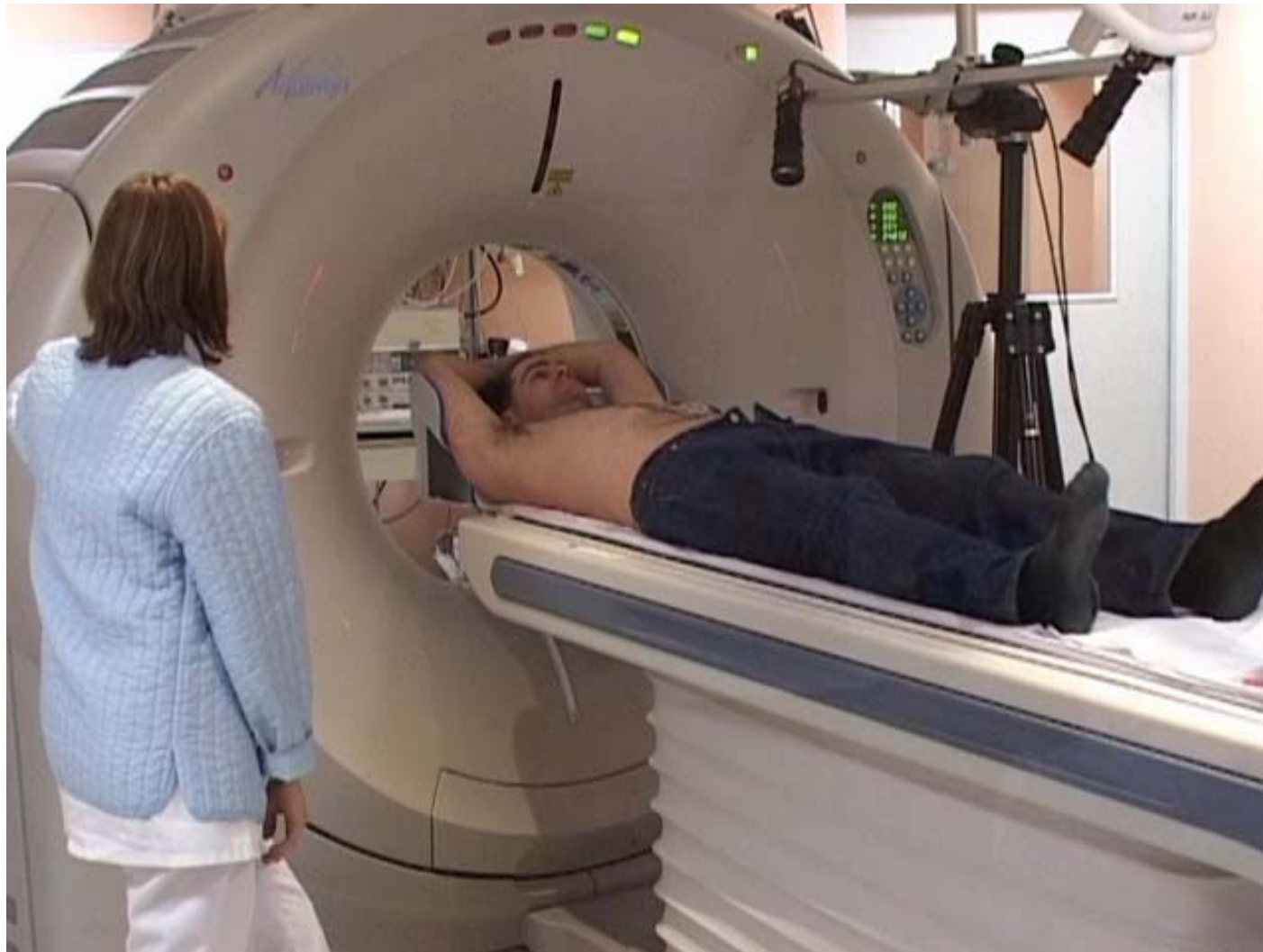
Step 2 : 3D Patient Modelling

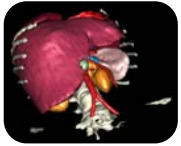




3D Modeling of Patients

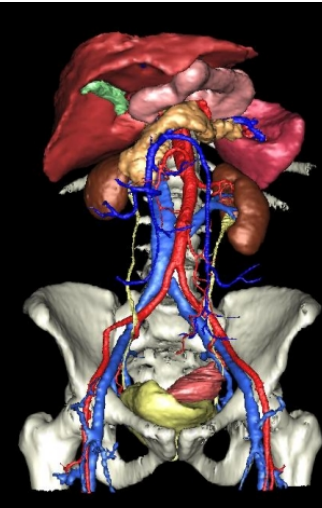
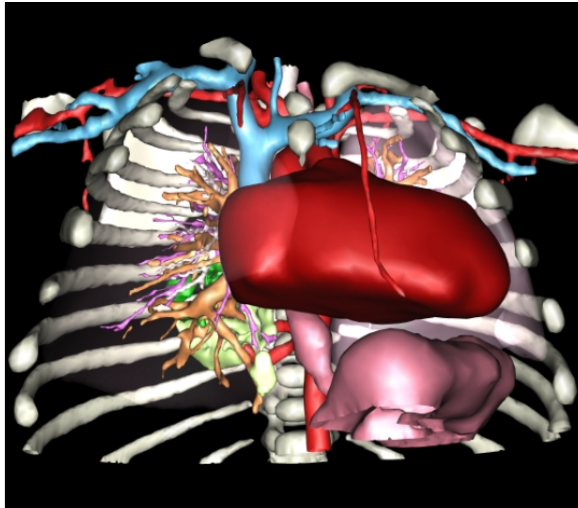
IRCAD R&D Modelling service



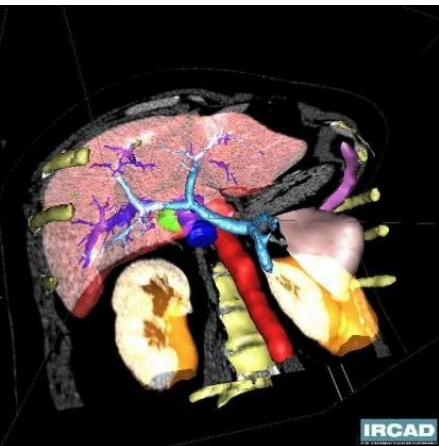
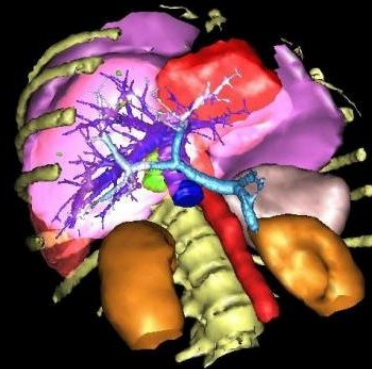
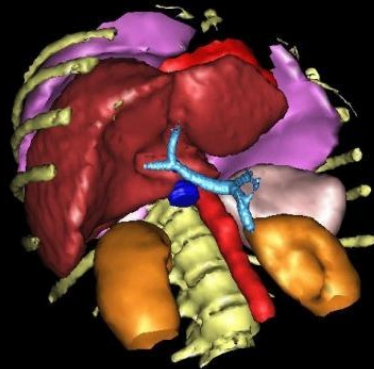


3D Modeling of Patients

IRCAD R&D Modelling service



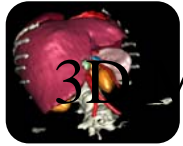
More than 600 patients from 7 hospitals since 2005



eats

ircad

eits



LIMITS

- Interactive = Time processing
- Automatic : Not enough robust
- Not yet all organs

But

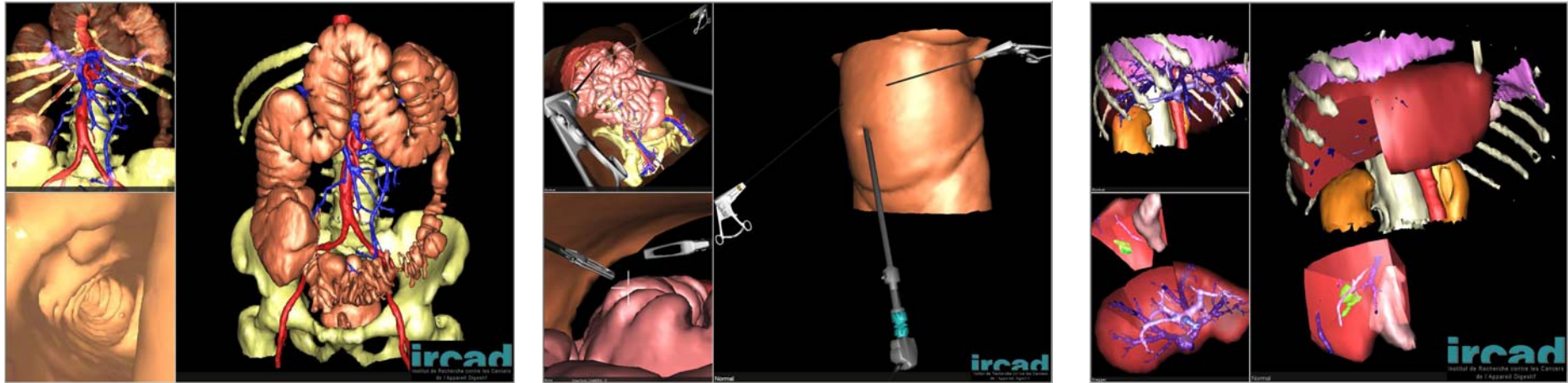
- All really efficient in routine
- Existing services such as Mevis Service

Step 3 : Surgical Planning





Surgical Planning



- Virtual navigation
- Virtual surgical tool positioning
- Virtual organ resection
- Volume computations

Step 4 : Surgical Simulation



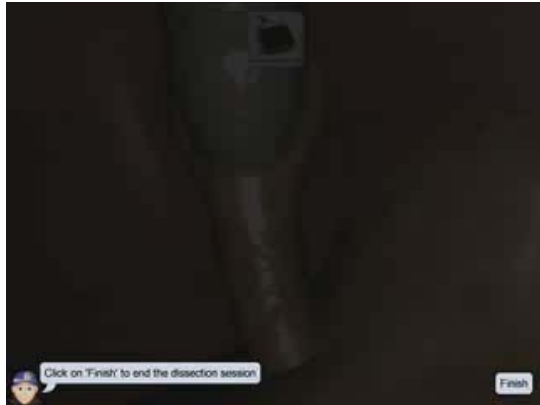


Existing Surgical Simulators

©Surgical Science

©SimSurgery

©Mimics

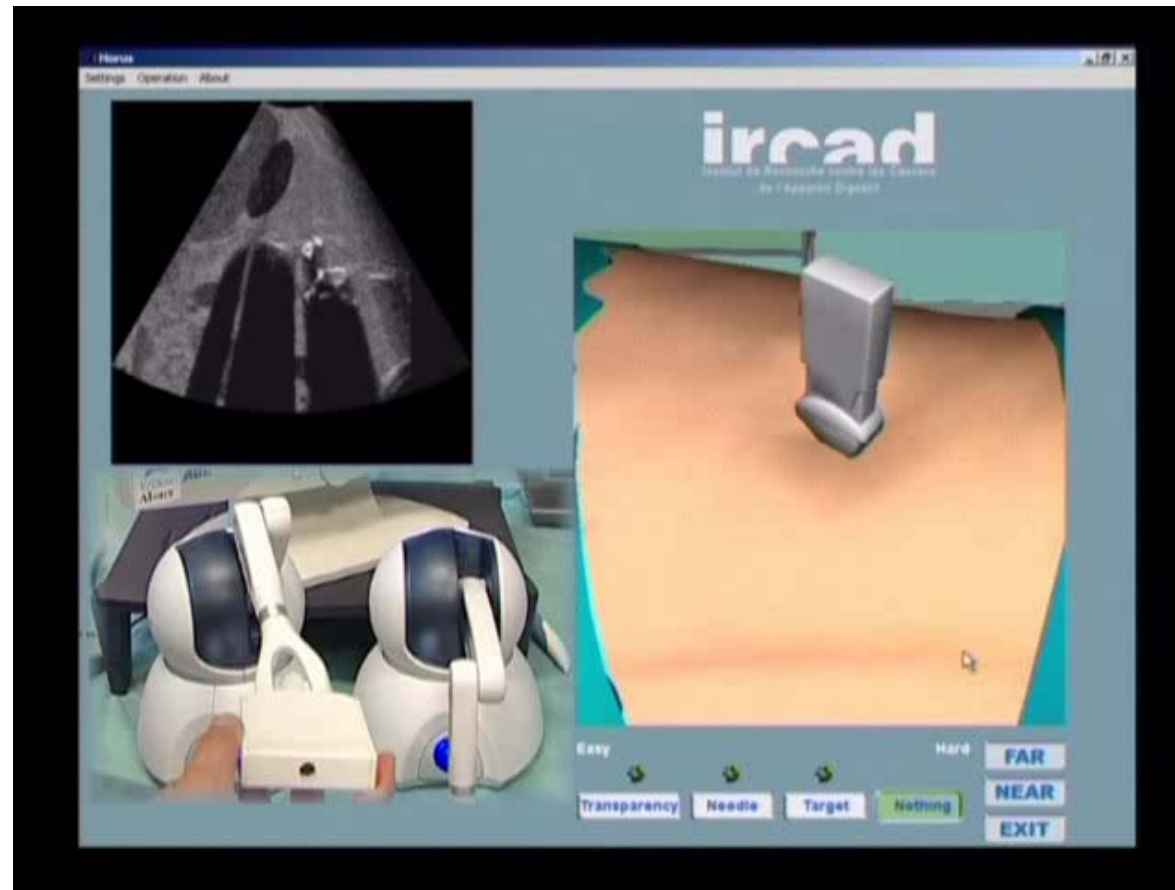


- Good but not realistic enough rendering
- Good variety of possible Surgical gestures
- Automatic evaluation

➔ BUT : Not Patient specific



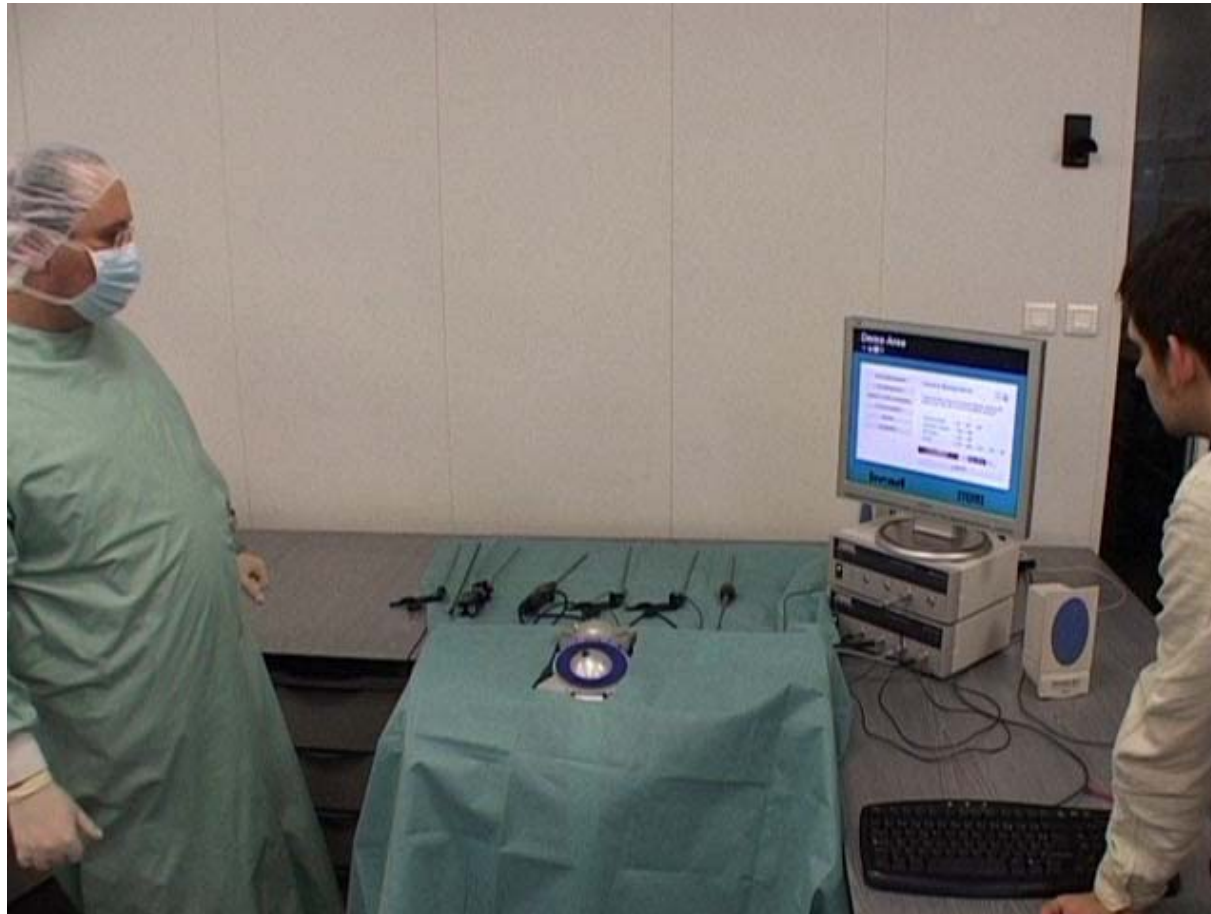
HORUS : Ultrasonography simulator



Ultrasonographic guided procedure
from patient CT-Scan



ULIS : Laparoscopic Simulator



IRCAD's Spin-off : Digital Trainers



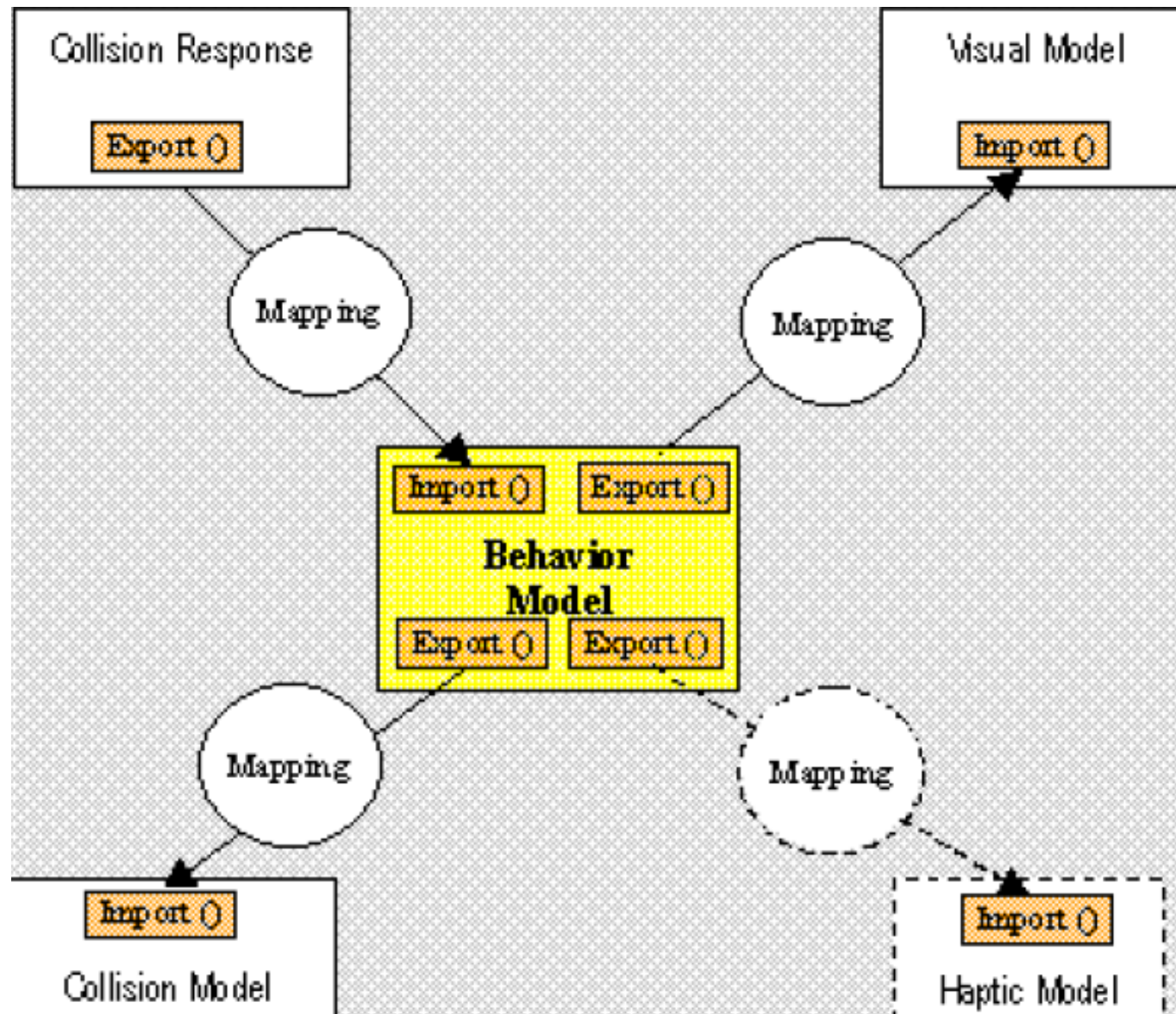
Educative Surgical Simulators



Patient-specific laparoscopic simulator



SOFA : www.sofa-framework.org





Patient Specific Simulators

LIMITS

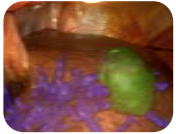
- Patient specific only in Morphology
- Do not include interstitial tissue or nerves
- Not mechanically patient specific

But

- Already interesting for basic training
- Elastography : next step of patient specific

Step 5 : Augmented Reality





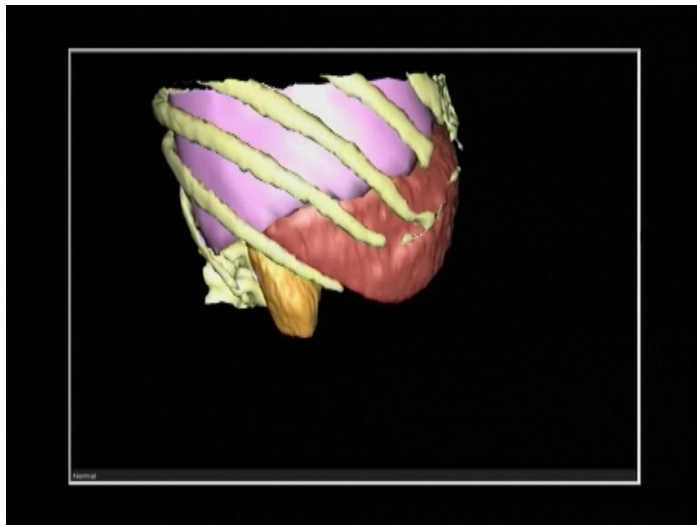
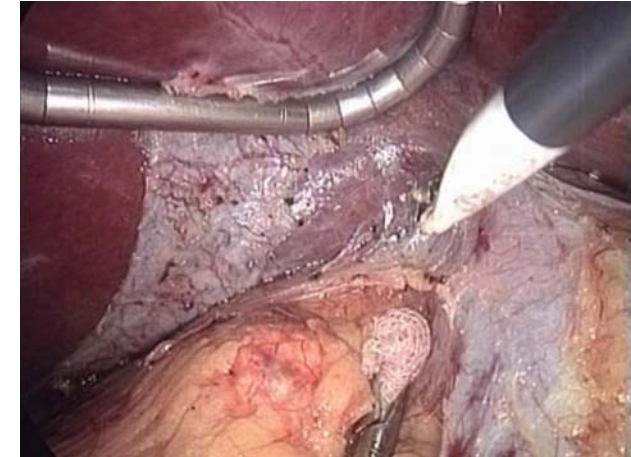
Augmented Reality



Real
Views

Out

In

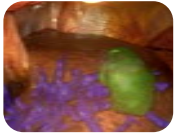


Virtual
Views

Out

In

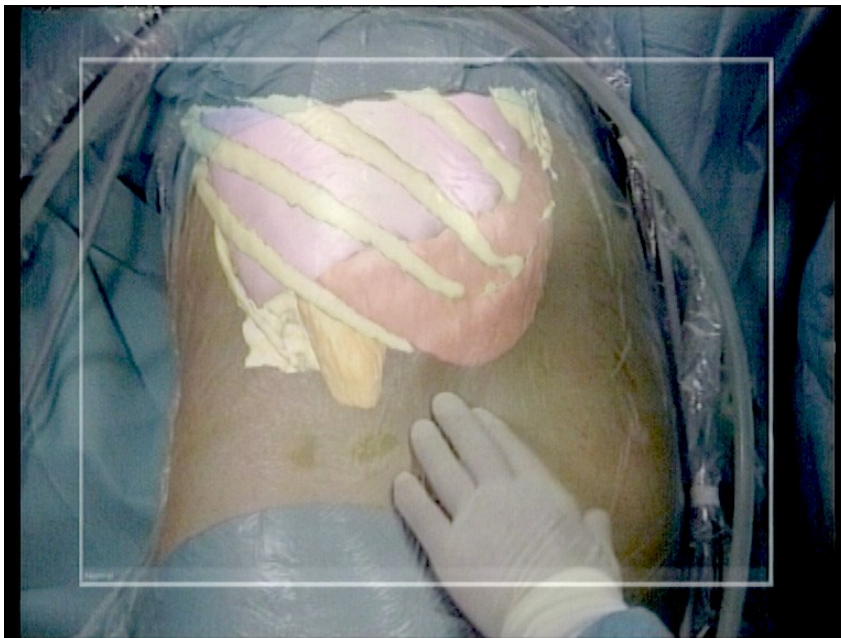




Augmented Reality

Augmented Reality Views

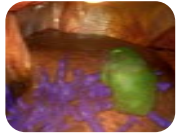
Out



In

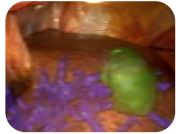


Data Fusion



Interactive Augmented Reality

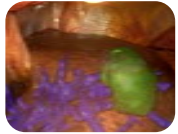




Interactive Augmented Reality



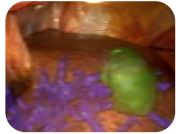
Adrenal Surgery : JAMA November 2004



Interactive Augmented Reality



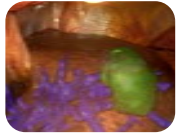
Liver Surgery, IRCAD 2008



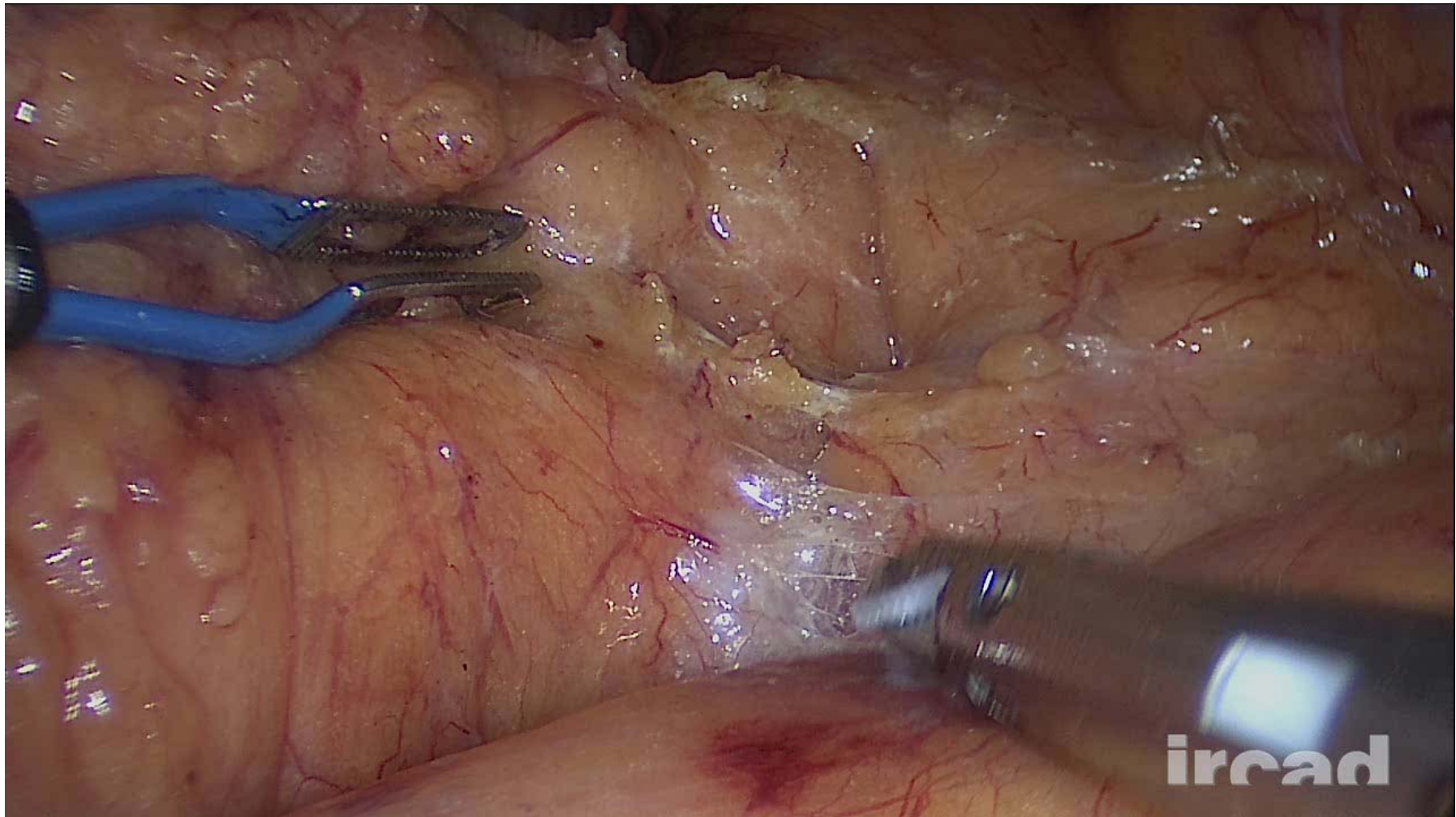
Interactive Augmented Reality



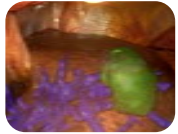
Cirrhotic Liver Surgery, IRCAD 2009



Interactive Augmented Reality



Pancreas Surgery, IRCAD 2008



Interactive Augmented Reality

LIMITS

User dependent system

No reproducibility

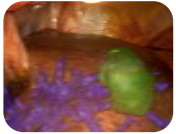
No secured accuracy

Rigid registration for deformable organs

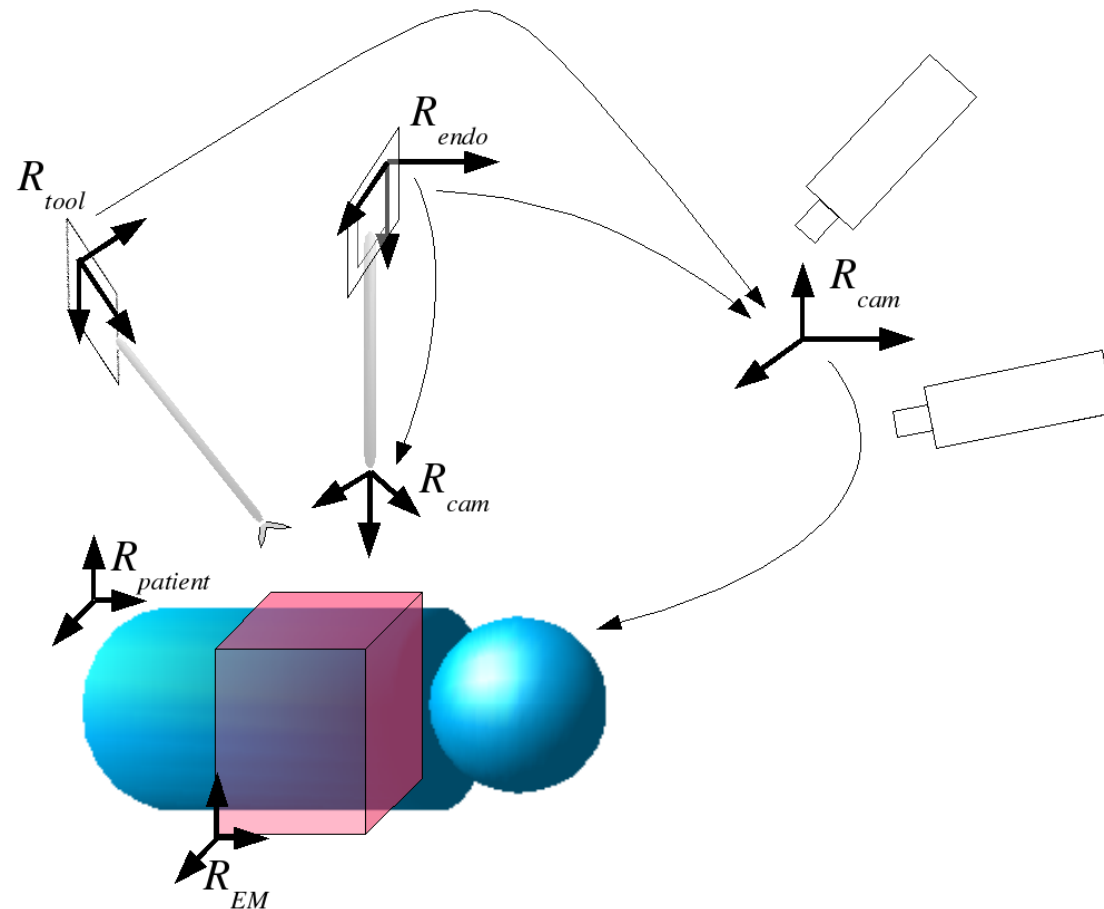
But

Really efficient with expert user

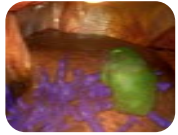
A first answer to surgeons request



Automated Augmented Reality

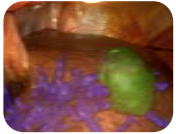


2 axes → Calibration & Registration

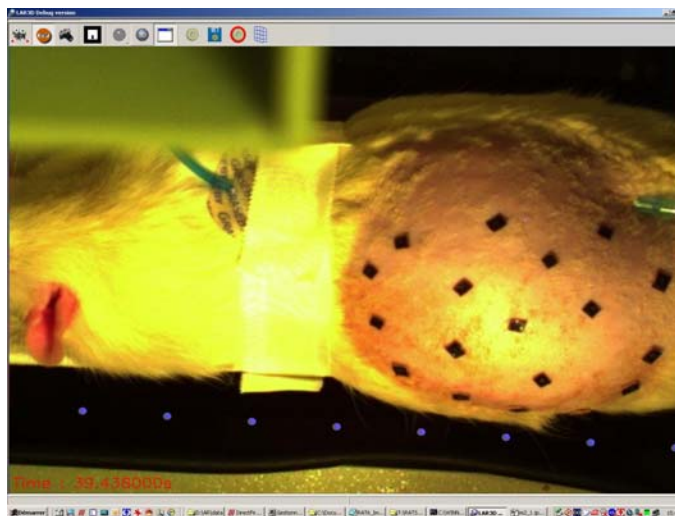
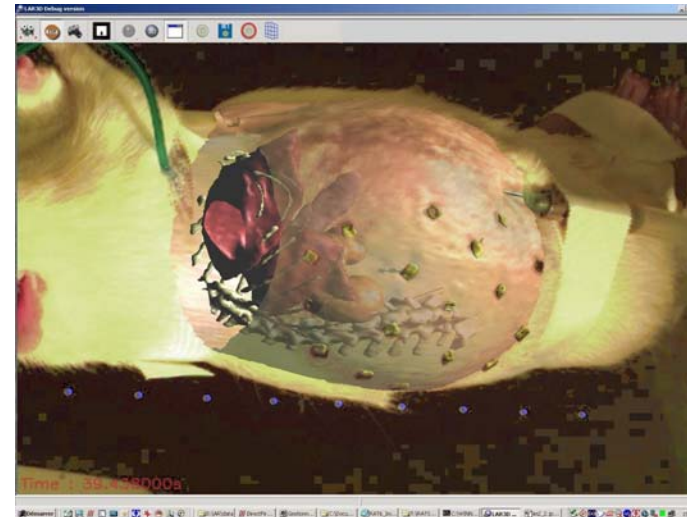
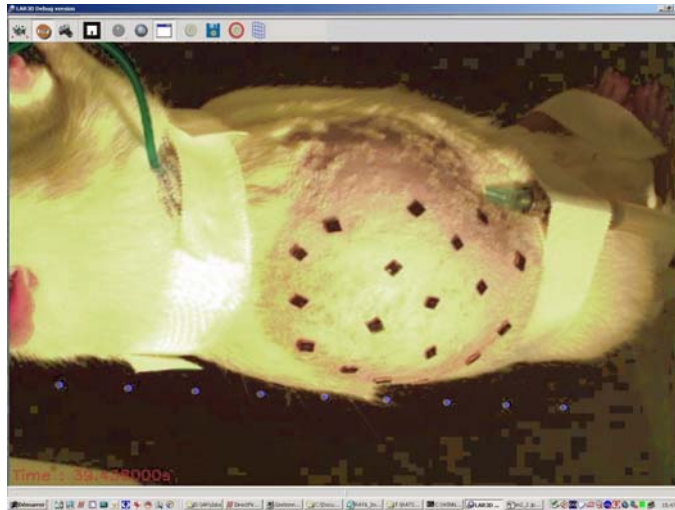


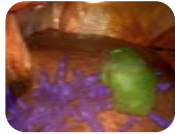
Automatic Augmented Reality



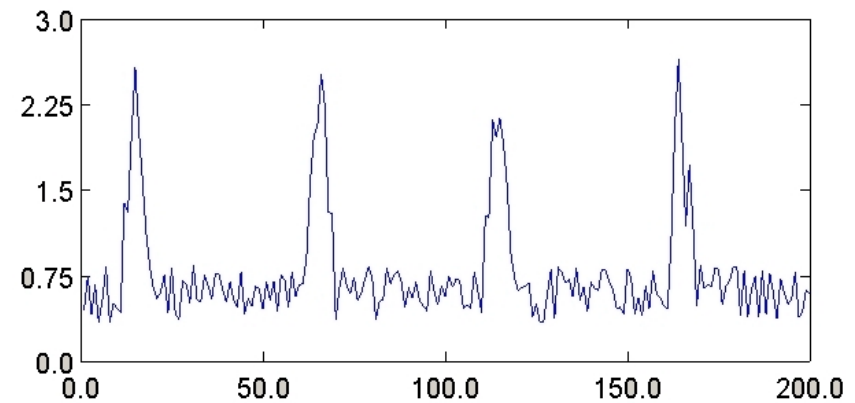
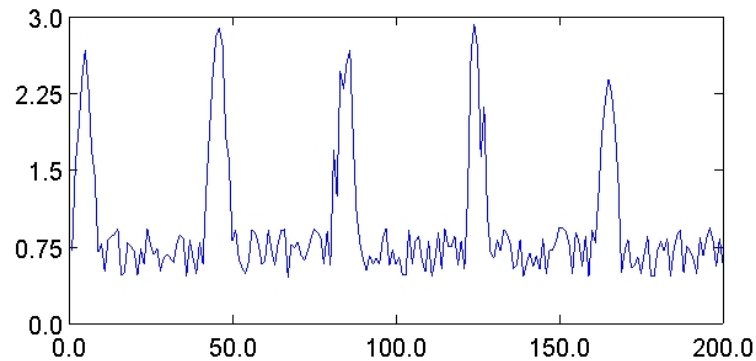


Automatic Augmented Reality



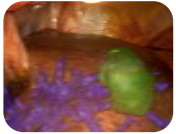


Automatic Augmented Reality

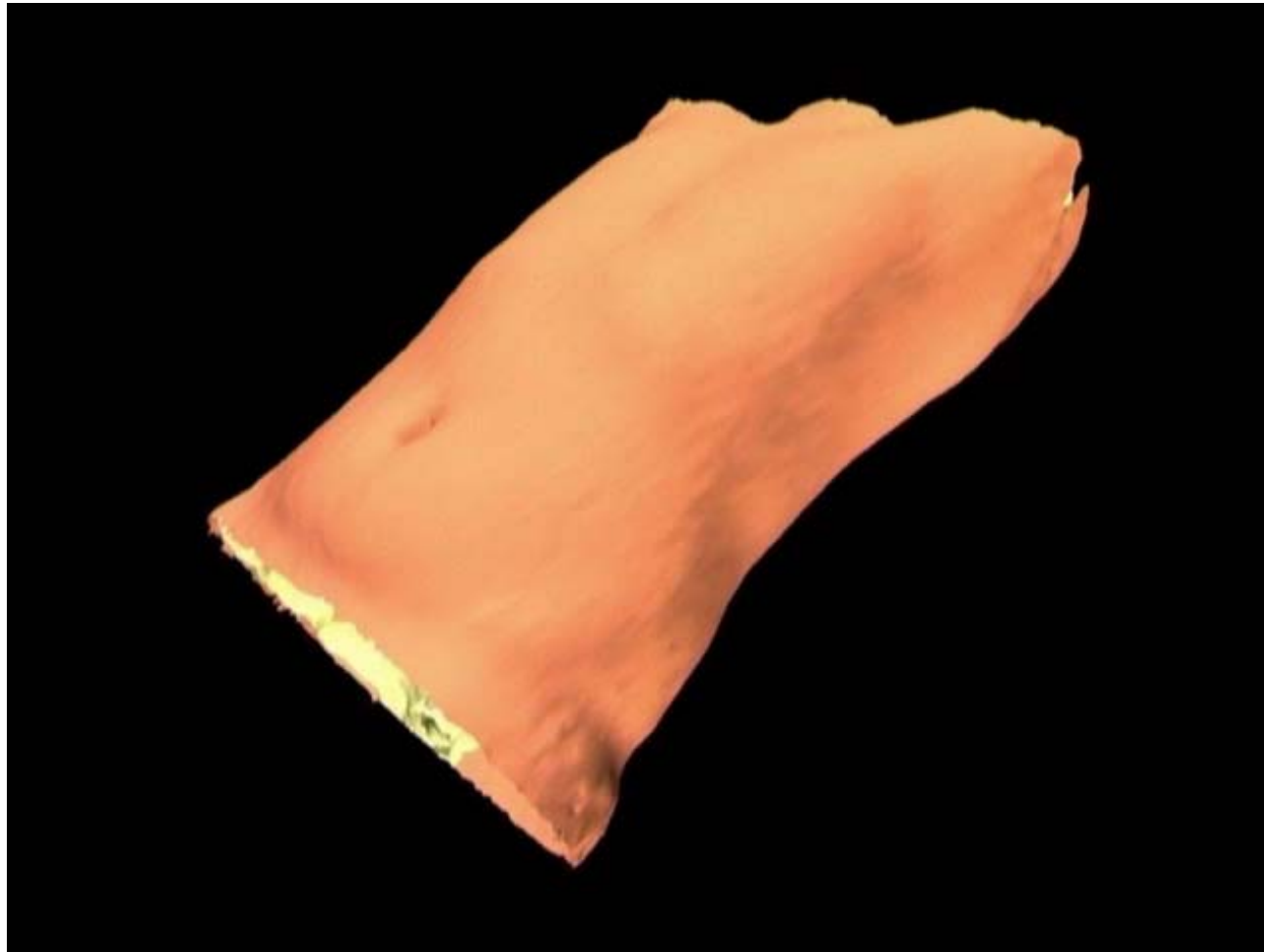


Rat number	1	2	3	4	5
System error (mm)	0.76 ± 0.06	0.85 ± 0.05	0.63 ± 0.04	0.82 ± 0.04	0.68 ± 0.05

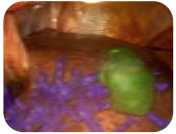
Average system error of 0.75 mm



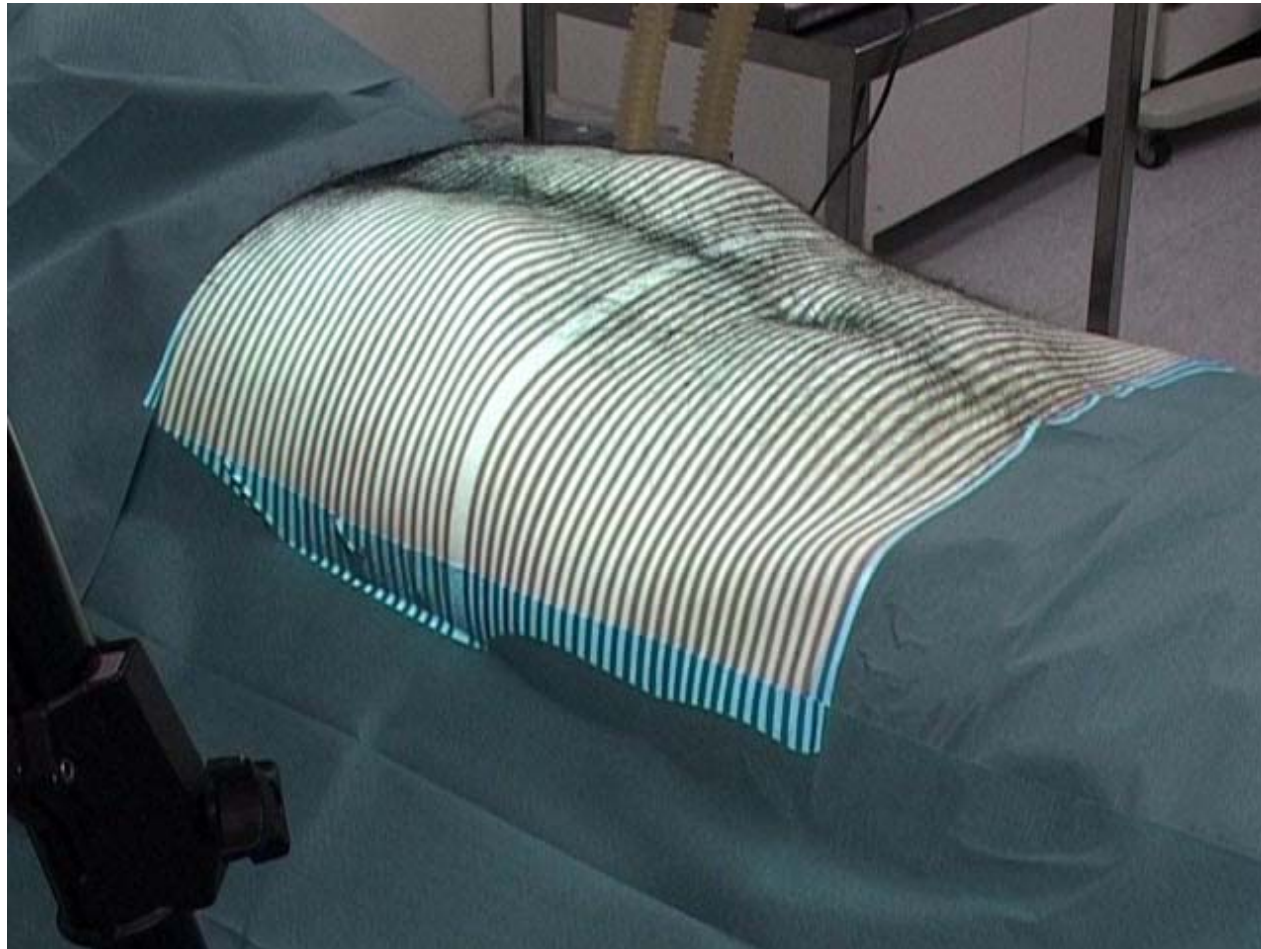
Breath movement simulation



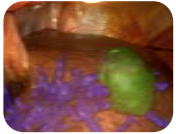
Patient-specific organ motion simulation



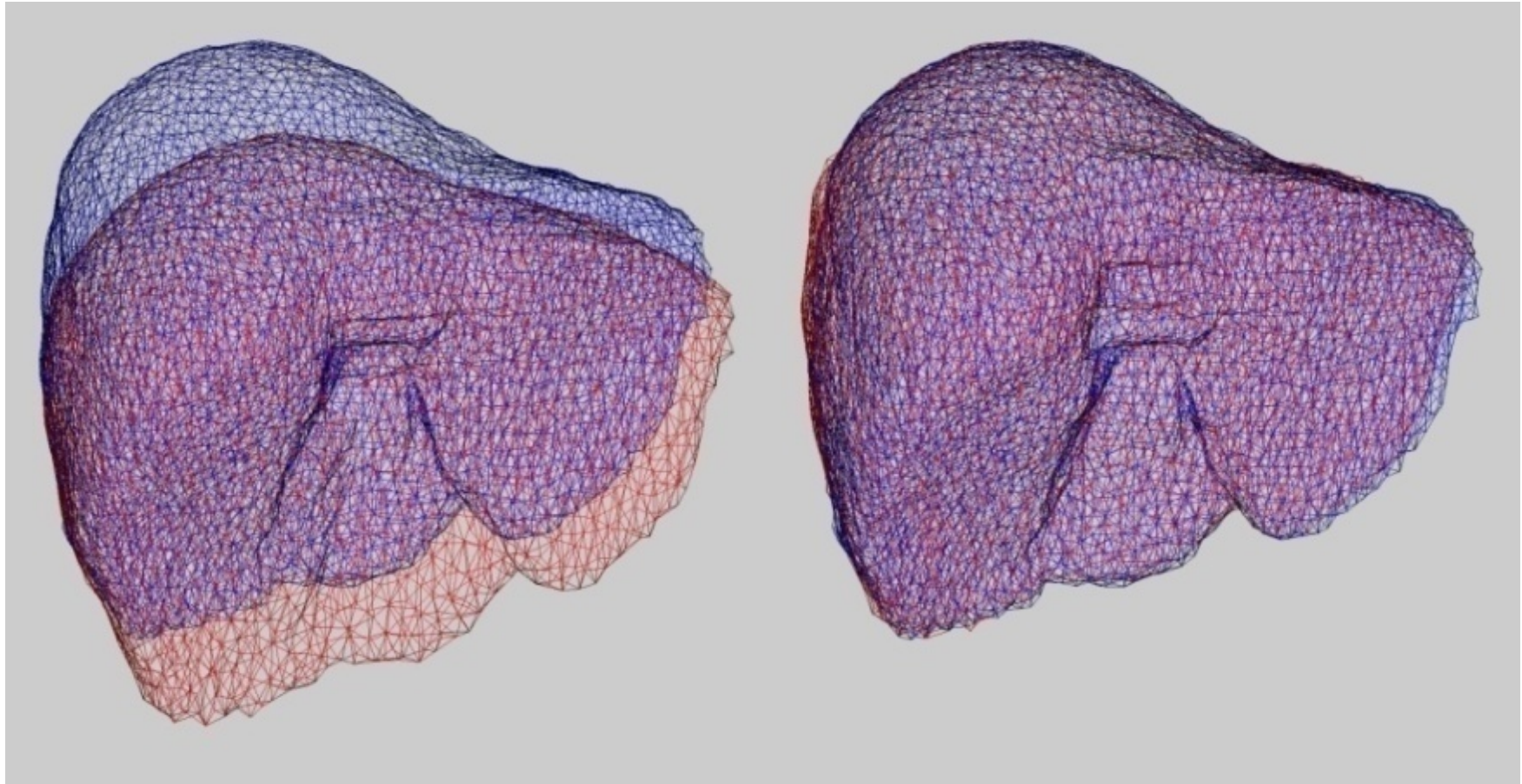
Automatic Augmented Reality



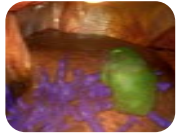
Predictive simulation



Breath simulation



Accuracy = 2 mm for liver (1.3 for kidneys)



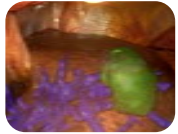
Automated Augmented reality

LIMITS

- Not yet sufficient for abdominal organs
- Time process too long for tracking and analysis of organs movements

But

- Current system efficient for Radiotherapy and interventional radiology
- Next step : add better mechanical modelling and intraoperative image analysis



Automated Augmented Reality

Future Works

Real-time tracking of organ deformation

Use of U.S. / MRI / Structured light / ...

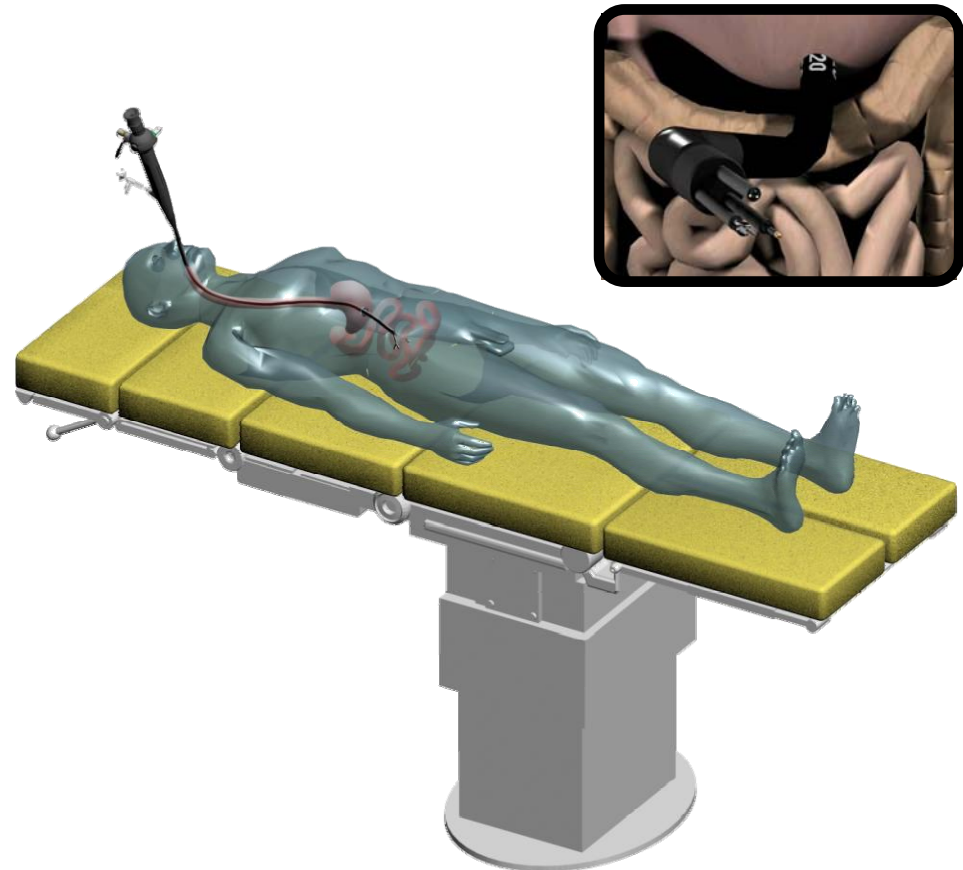
Use new flexible tracking systems

Patient-specific deformation

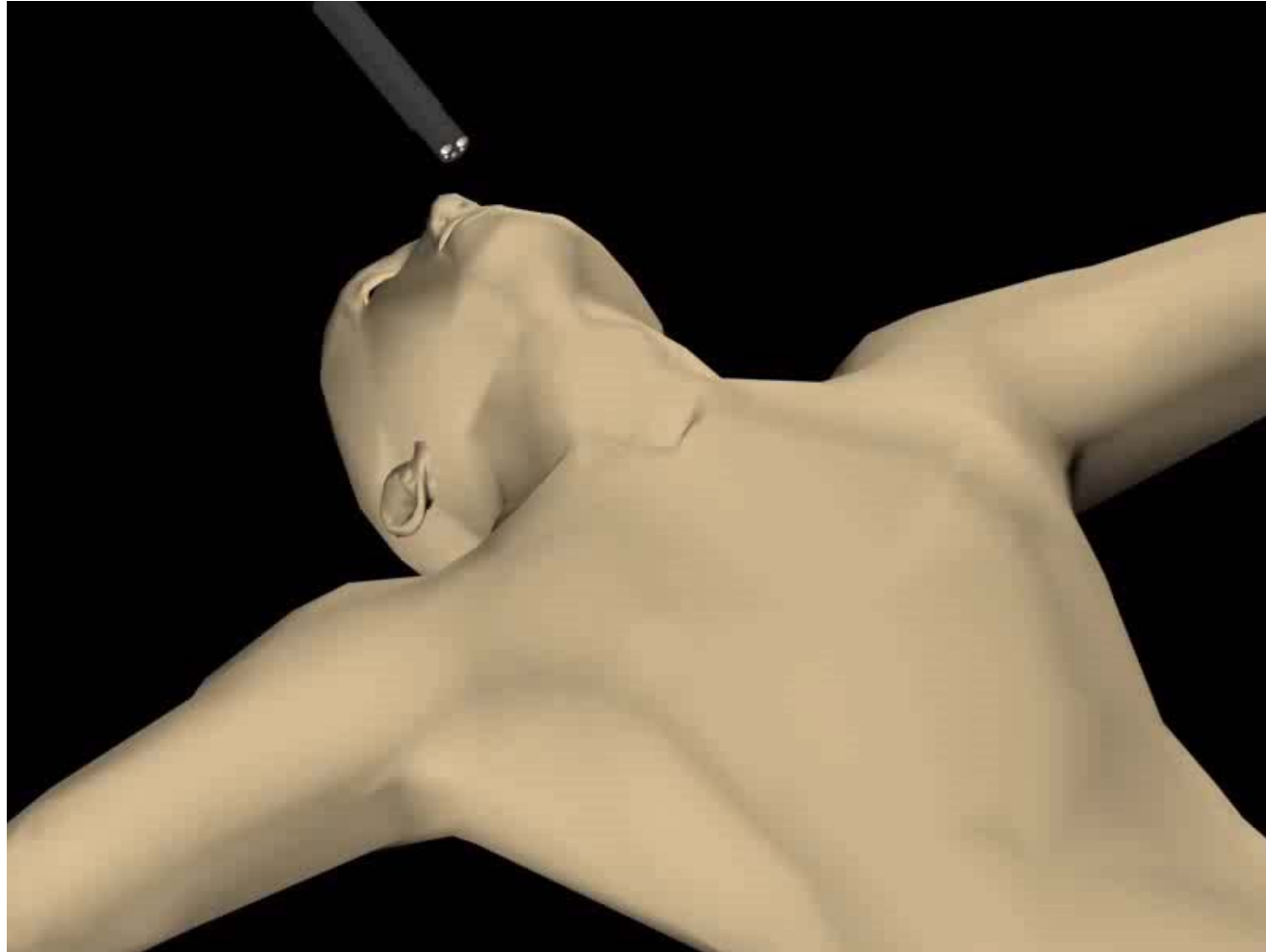
Automated Accuracy control

VR, AR & Robotics applied to NOTES

ANUBIS Project : 2005-2008



Natural Orifice Transluminale Endoscopic Surgery



No scar Surgery

First Human Transluminal Surgery

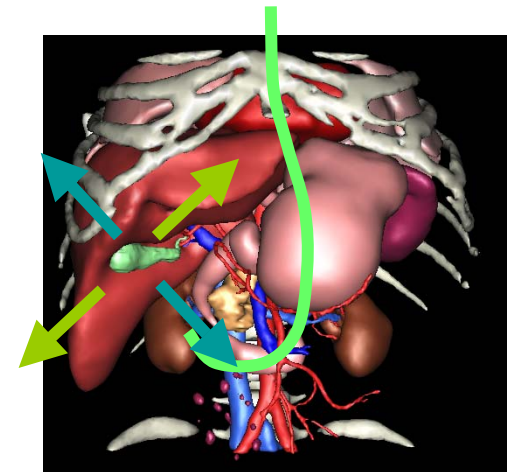
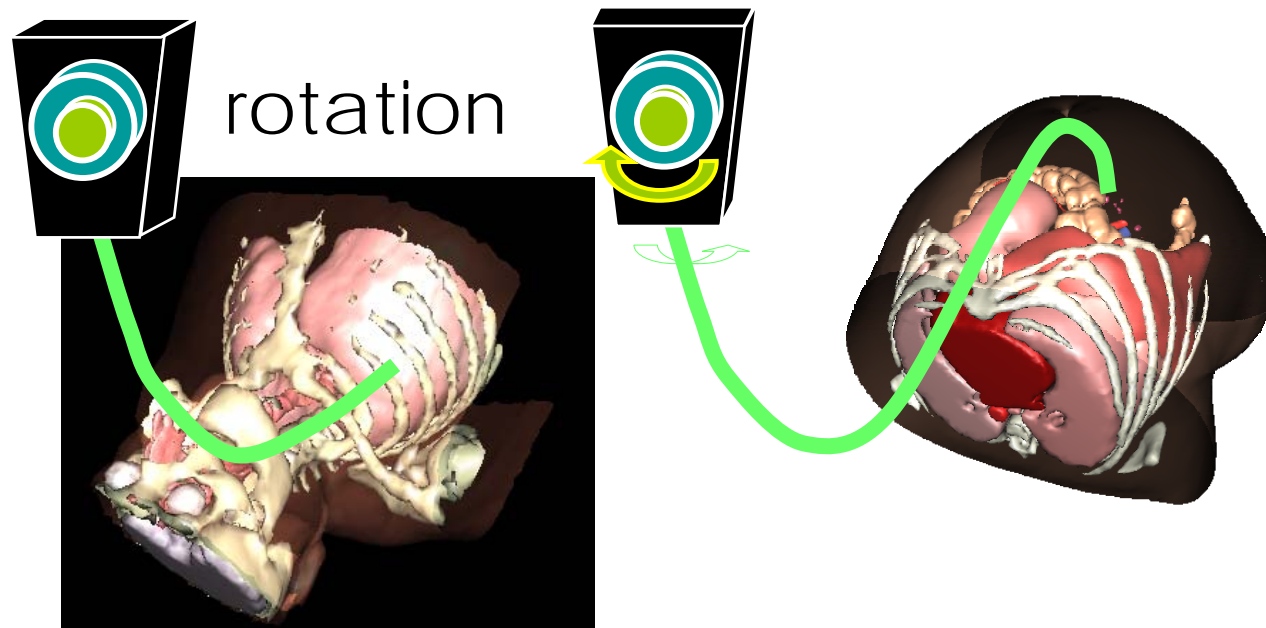
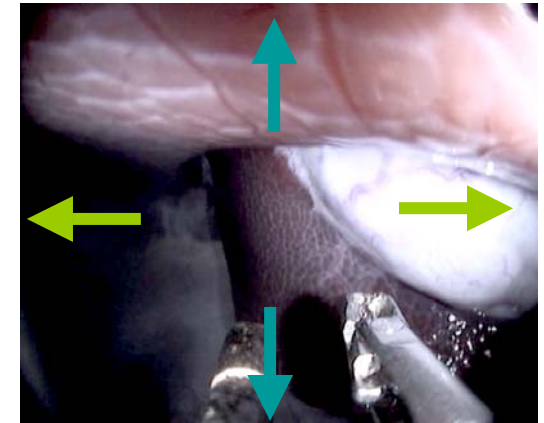
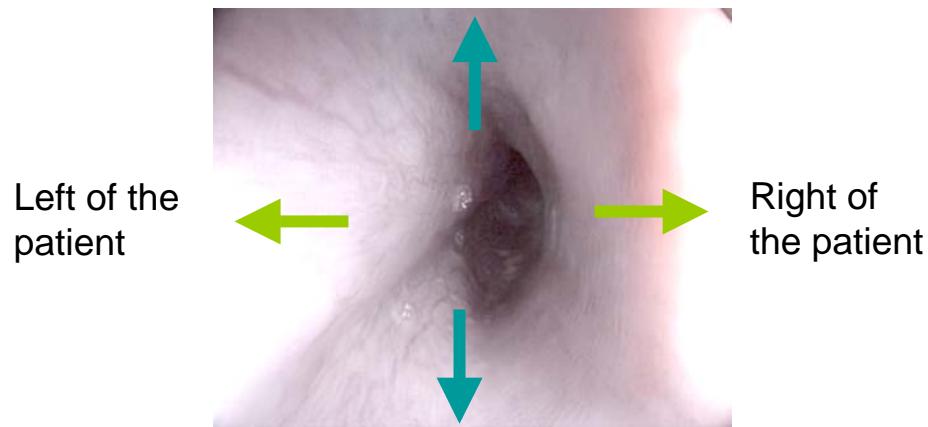


April 2007: Transvaginal Cholecystectomy

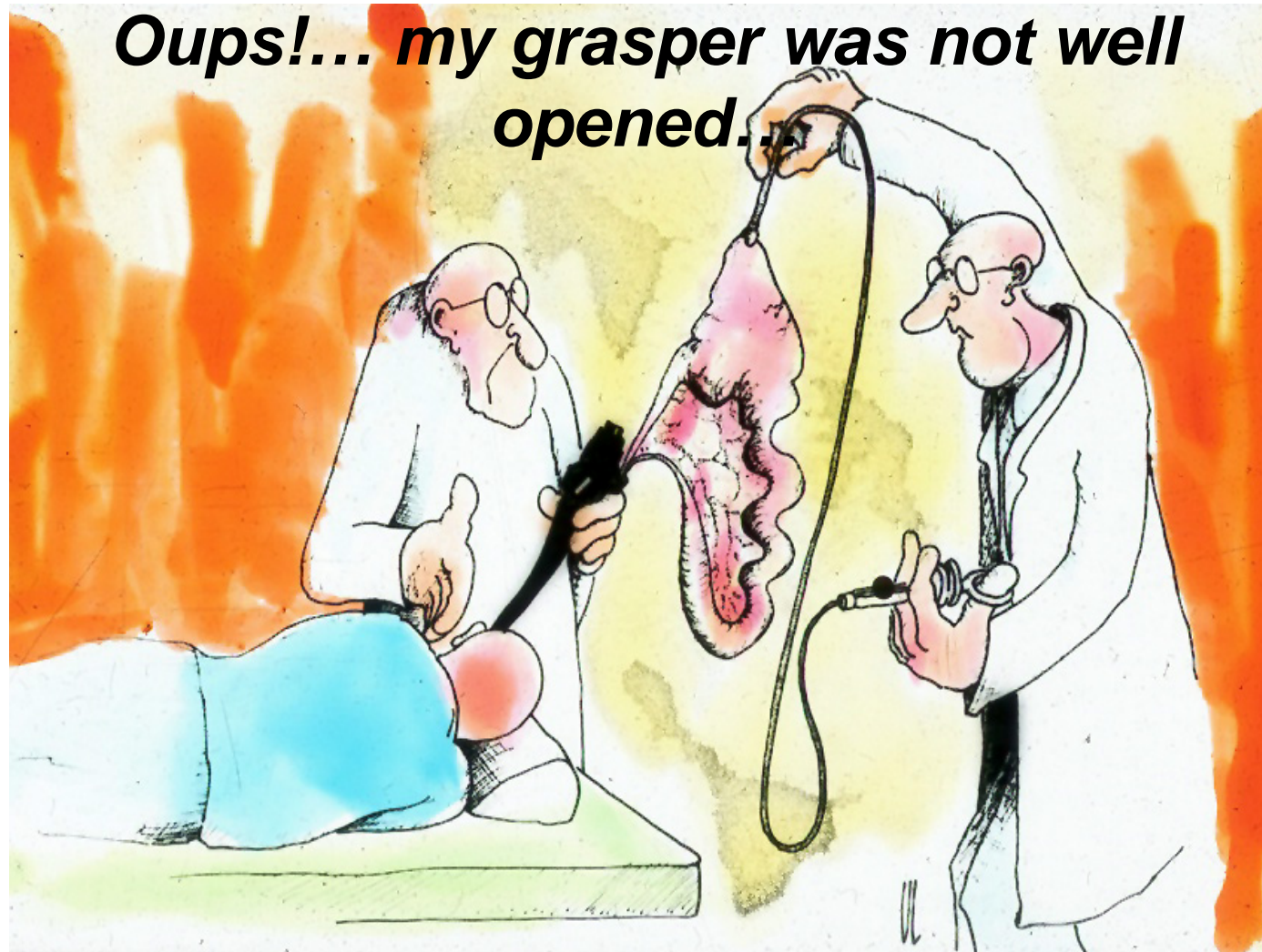
Aim : Improve instruments & control



Why is it difficult to control endoscope?



Aim : Improve instruments & control



Aim : Improve instruments & control

Before ...



Now ...



Aim : Improve instruments & control

Before ...

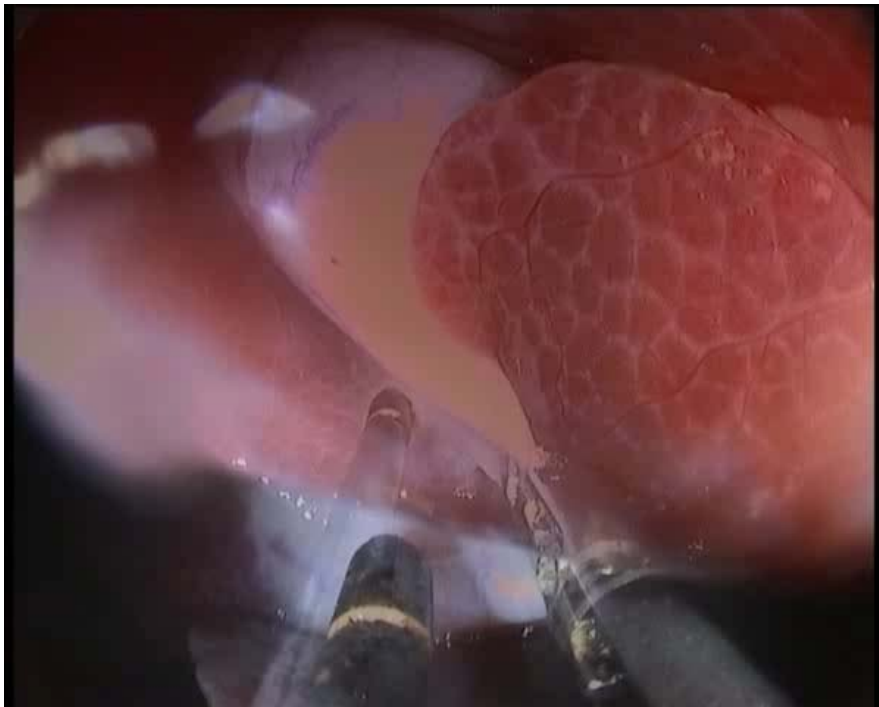


Now ...

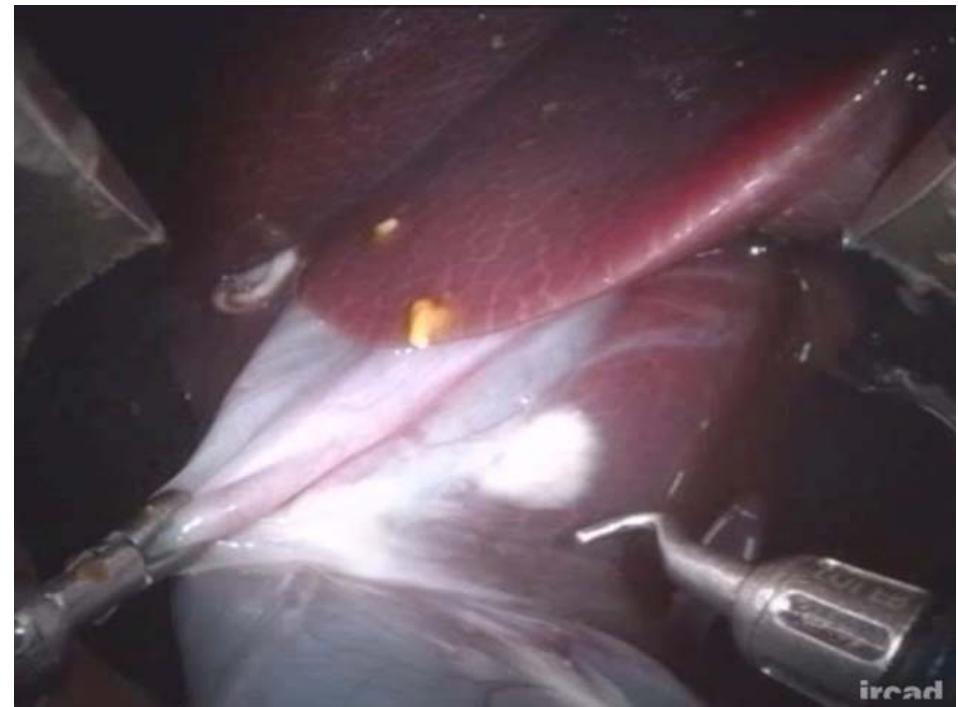


Aim : Improve instruments & control

Before ...

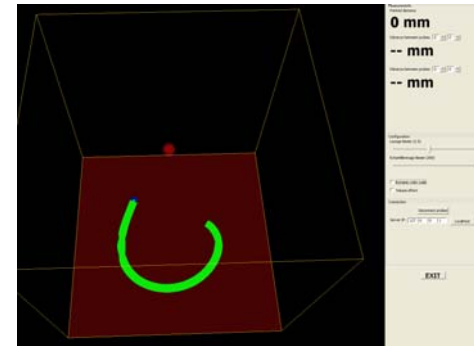


Now ...



METRIS

8 x 5 DOF Electromagnetic sensor coils
in a flexible tube of max 2.5 mm Ø

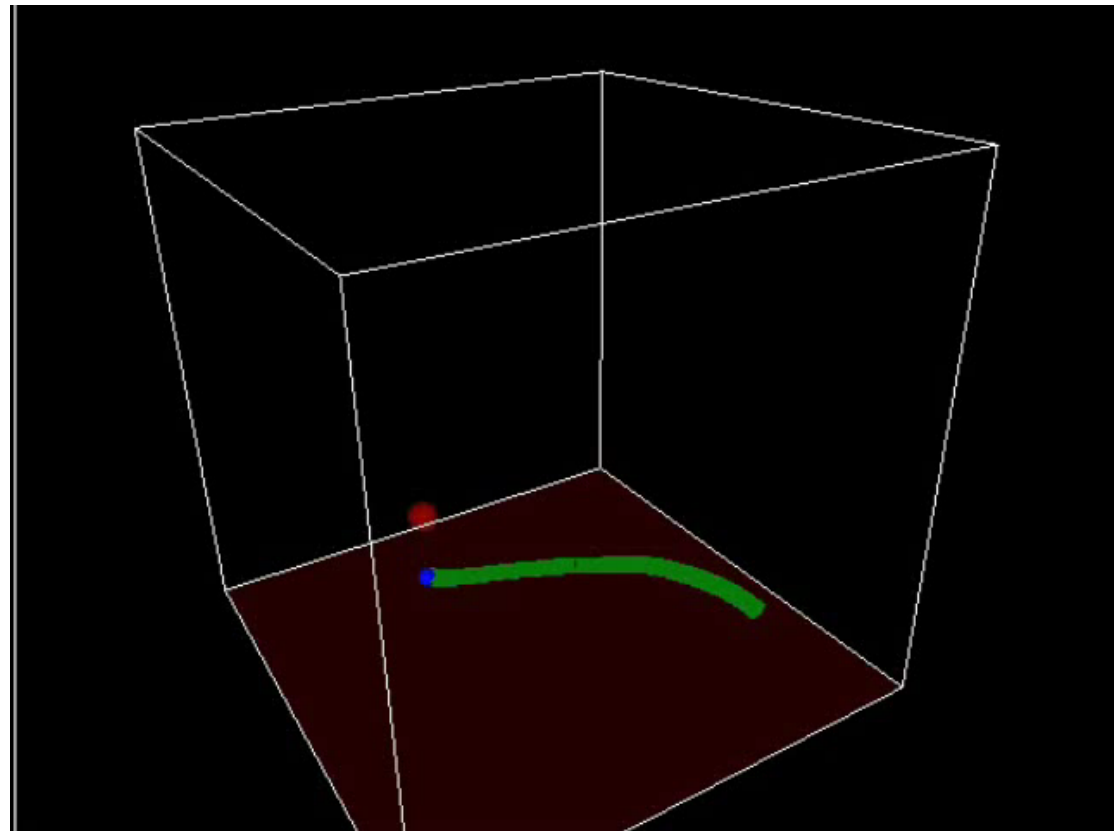
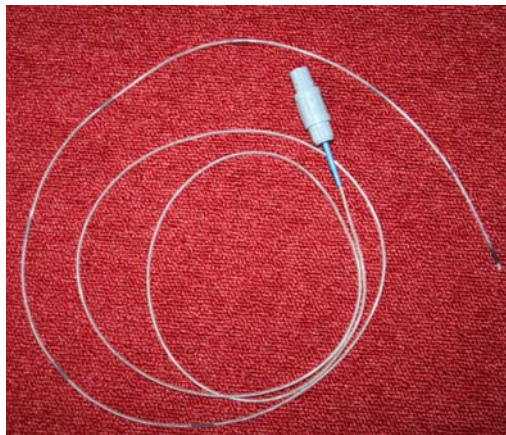


The system provides :

- Distance between 2 selected positions
- 3D Shape of the flexible tube in real-time

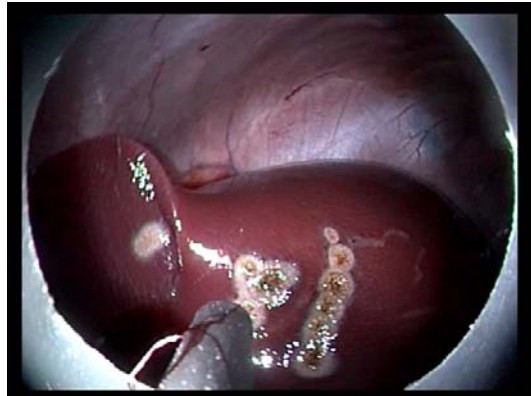
VR & AR : Simplest instrument control

3D View of the flexible endoscope



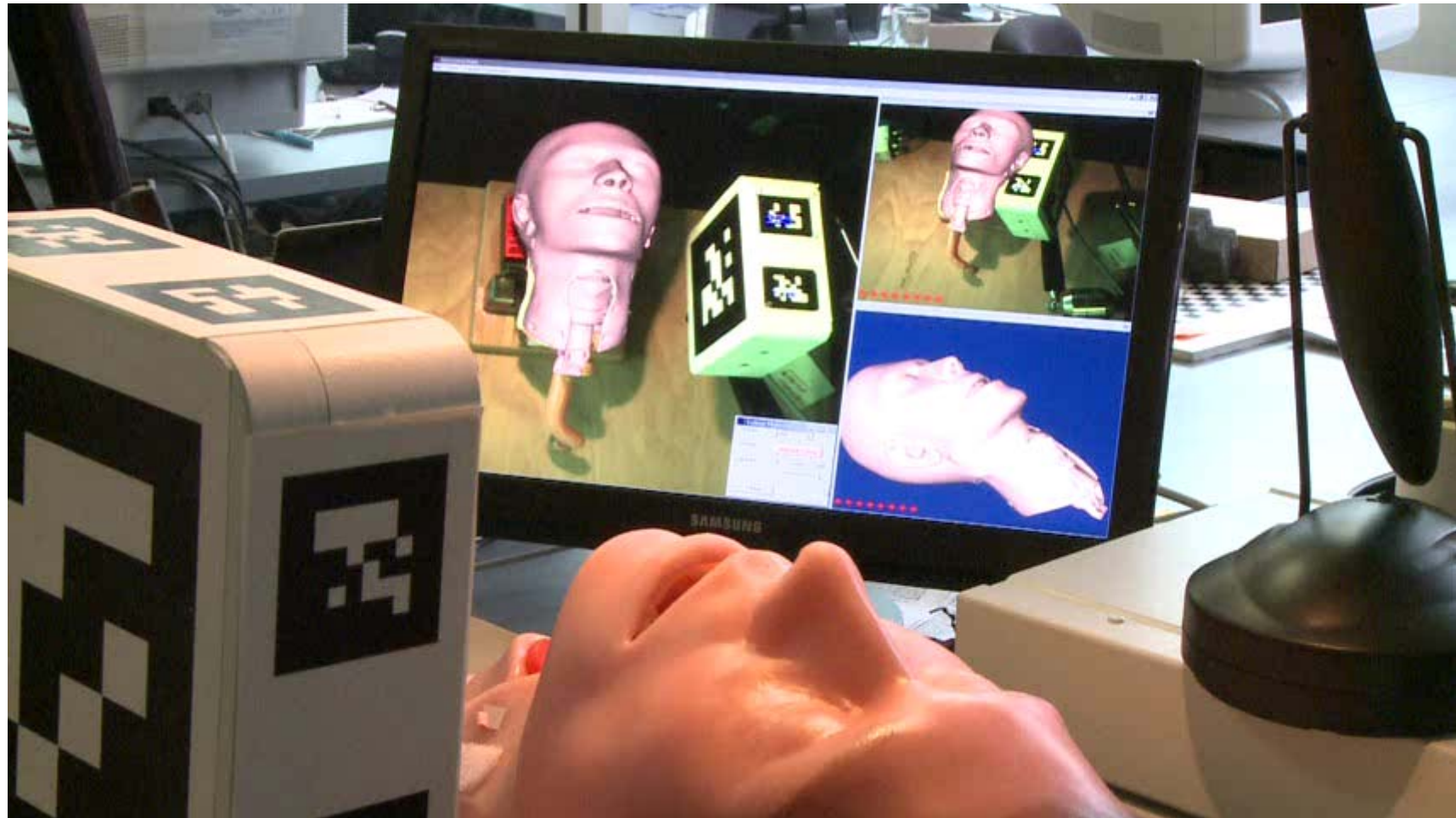
METRIS → 1mm of precision

In vivo evaluation of measure precision



<i>en mm</i>	METRIS 1	REGLE 1	METRIS 2	REGLE 2
MARQUE 1	7.1	8	5.2	6
MARQUE 2	15.2	16	13.4	14.3

VR & AR : Simplest instrument control



VR & AR : Simplest instrument control



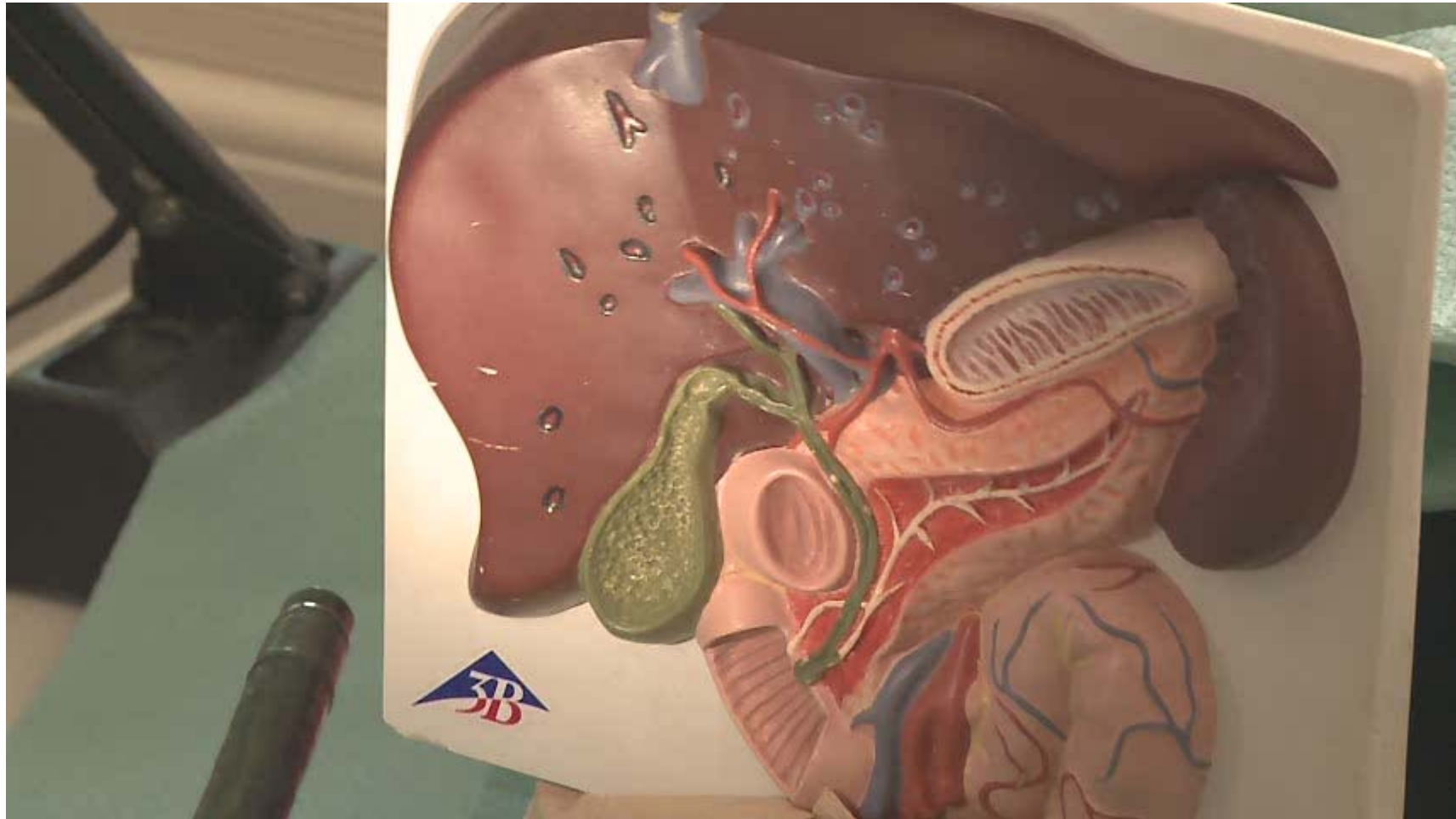
Robotics : Simplest instrument control

Easy interactive flexible endoscope control



Robotics : Automatic instrument control

Easy Automated flexible endoscope control



Robotics : Automatic instrument control

WITHOUT Automatic Flexible endoscope control



Gastroscope



Laparoscope

Robotics : Automatic instrument control

WITH Automatic Flexible endoscope control



Gastroscope



Laparoscope

External Motors : Endoscope Robot

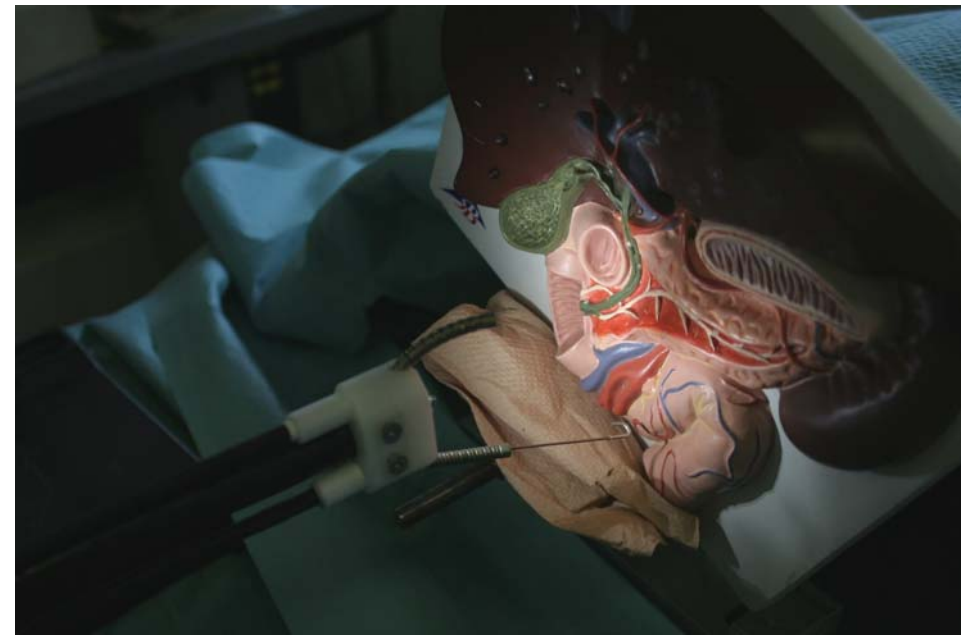
Single user Master Slaves NOTES Robot



LSiIT Robotic team of Michel de Mathelin, IRCAD/ Strasbourg university

External Motors : Endoscope Robot

Single user Master Slaves NOTES Robot



LSiIT Robotic team of Michel de Mathelin, IRCAD/ Strasbourg university

Conclusion



"Have Fun"
Russel Taylor
Winter School MRCIIS 2009



Thanks for your attention



**Don't worry, I have experience. I'm not a surgeon
but I work for one since 10 years**