Information age & surgery : from pre-operative simulation to remote surgery

Pr. Luc Soler, Pr. Jacques Marescaux

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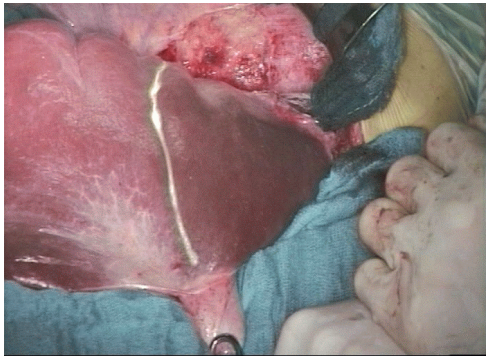
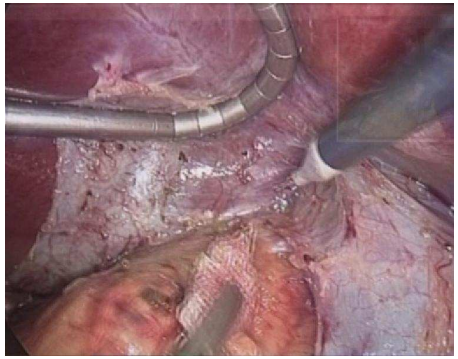
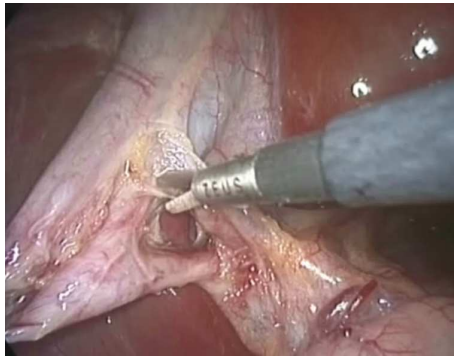
20th century Surgical Evolution

Open → Laparoscopy → Robotics



Evolution of surgery

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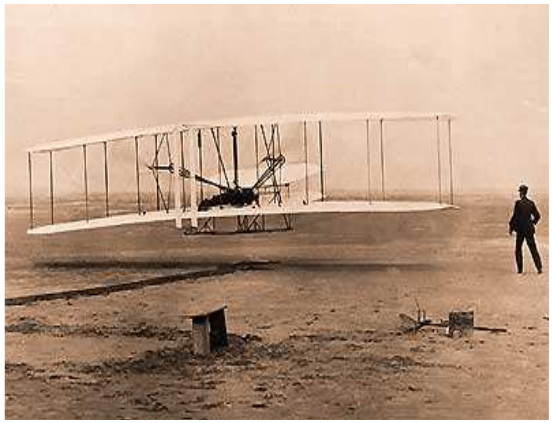
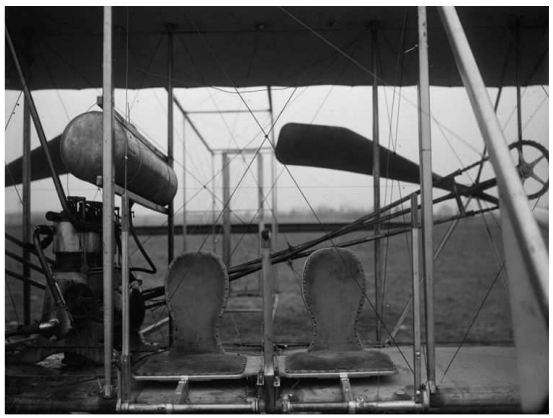
Another XXth century revolution





State of surgery today

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And tomorrow ?…

What we hope for surgery tomorrow

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WebSurg : Continuous education

Totally FREE !...

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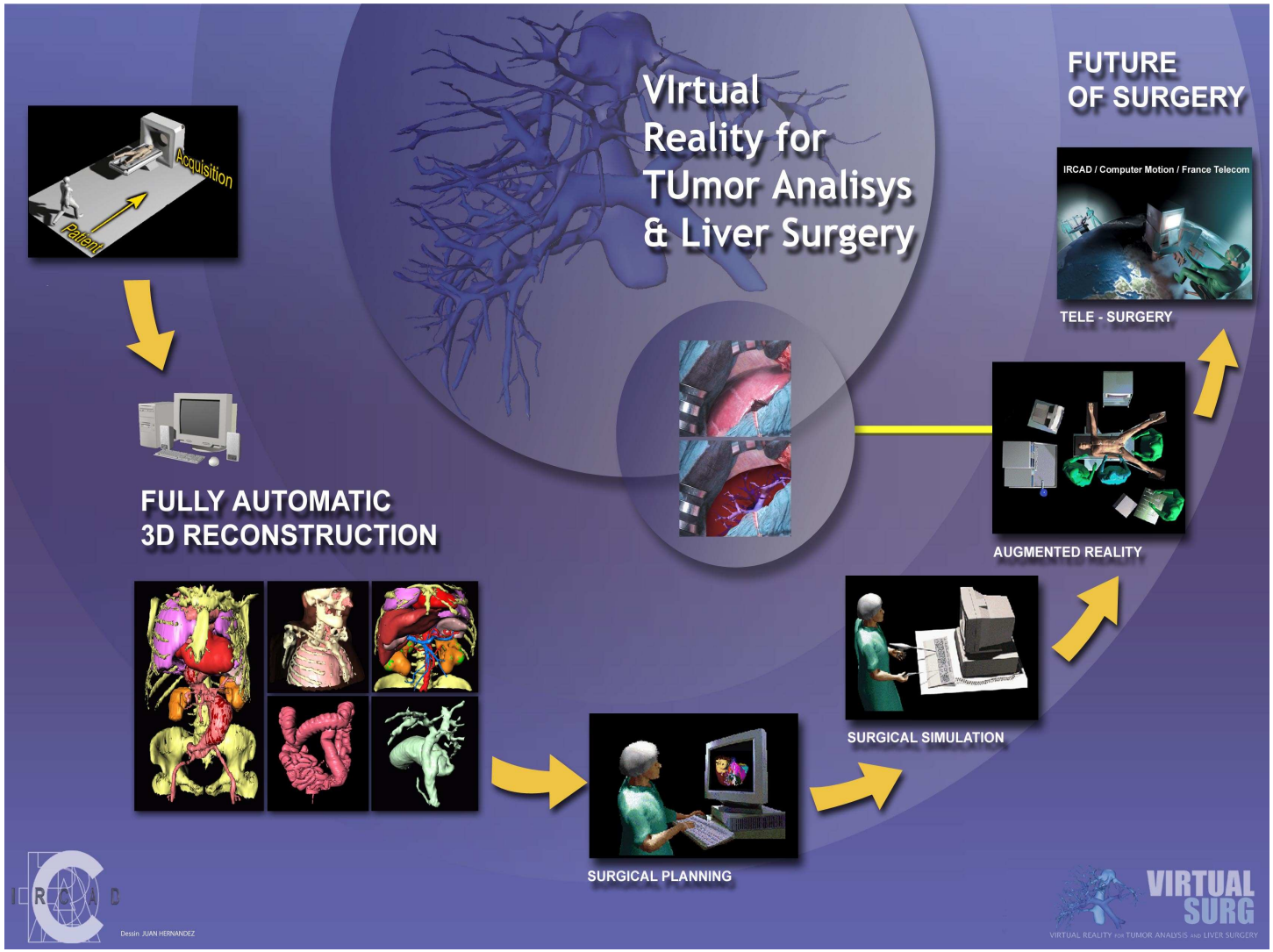
A global approach



From Image to Computer assisted Surgery

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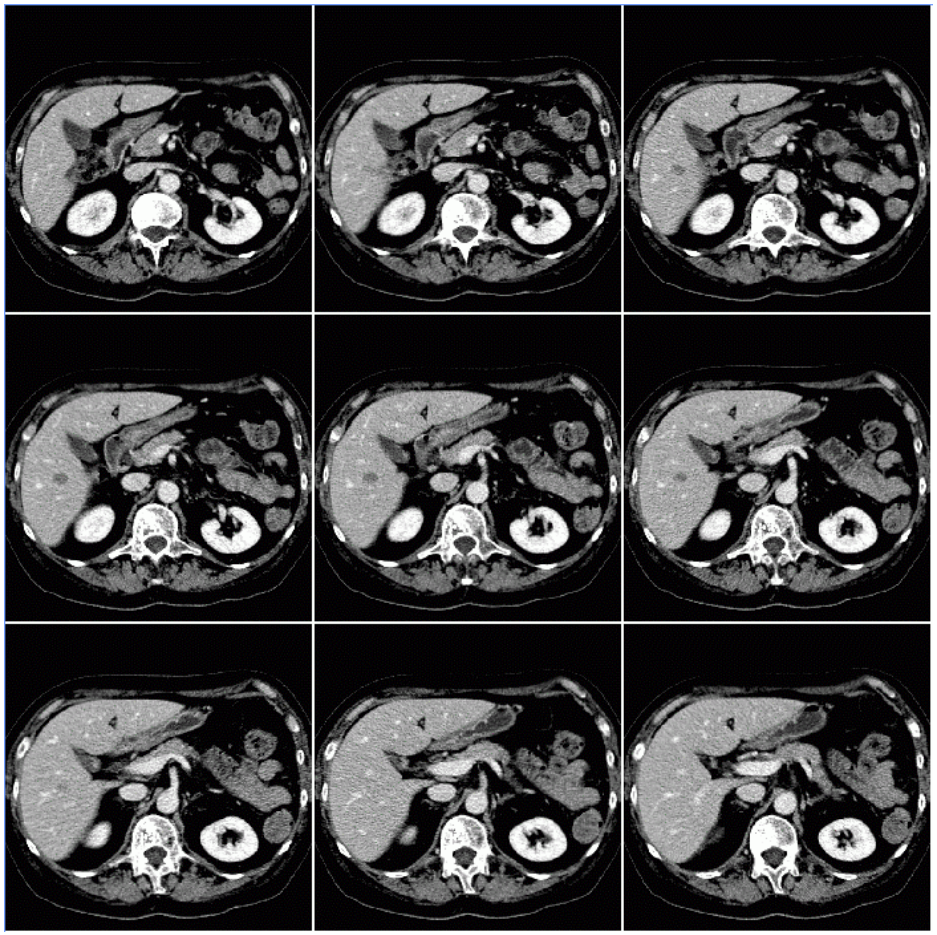
First Step : 3D Modeling of patient

From CT-scan or MRI of a patient



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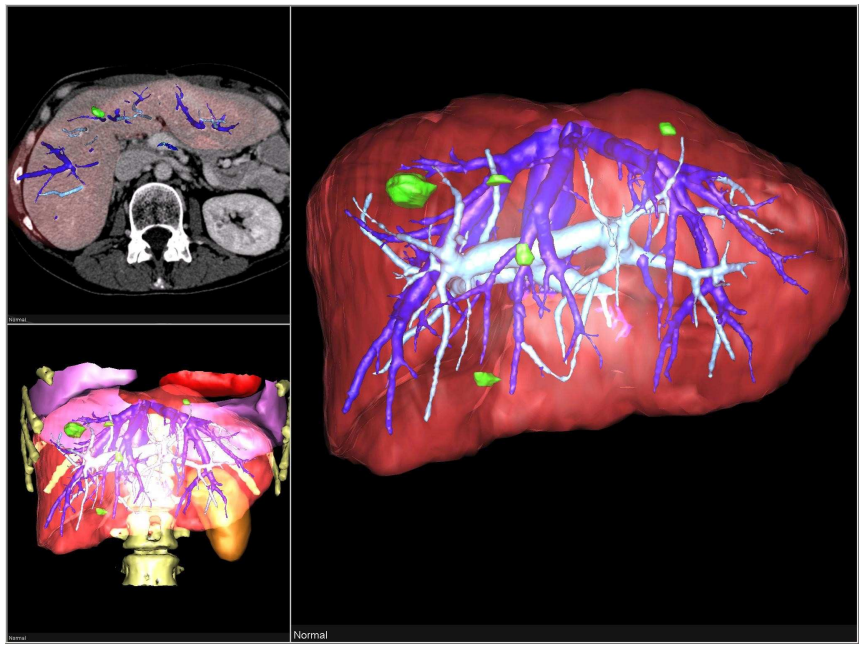
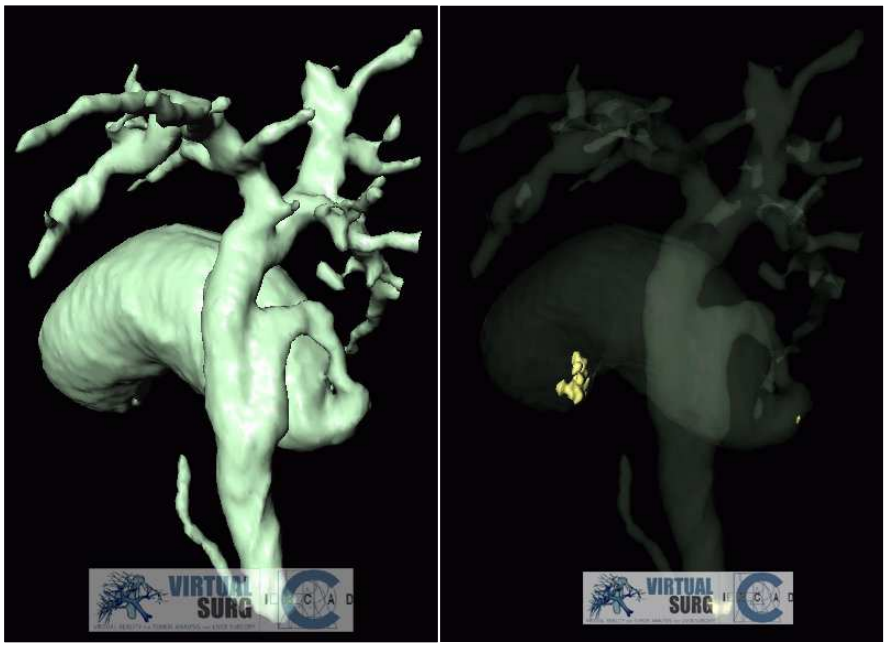
First Step : 3D Modeling of patient

Automated delineation (15mn)

Liver area, colon, biliary tract, adrenal…





from CT-Scan ***or*** ***from MRI***

realized with 3D VPM ©ircad 2007

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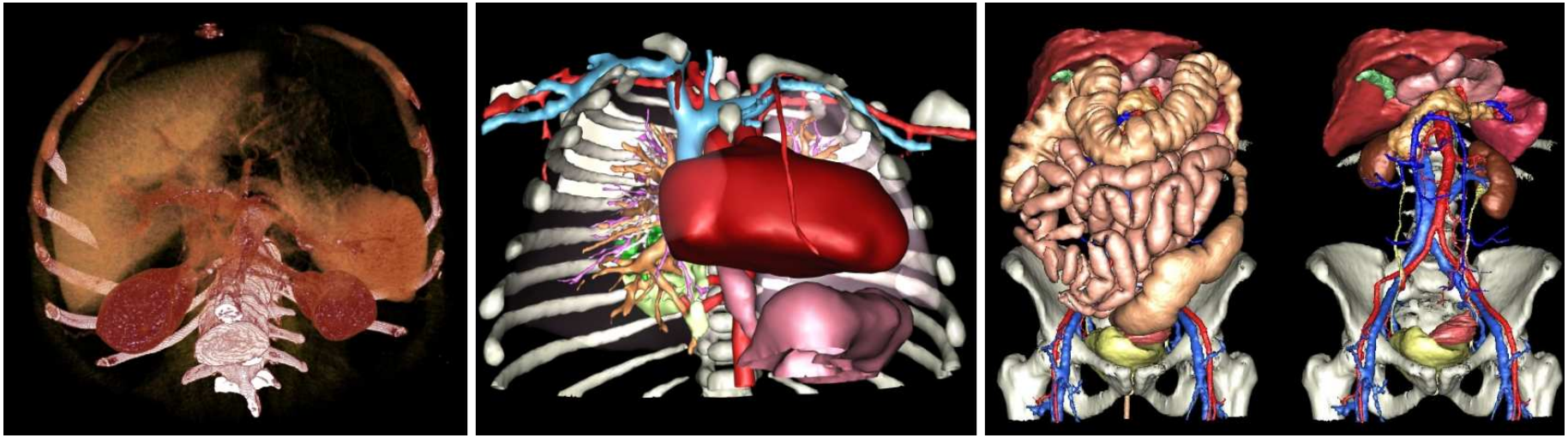
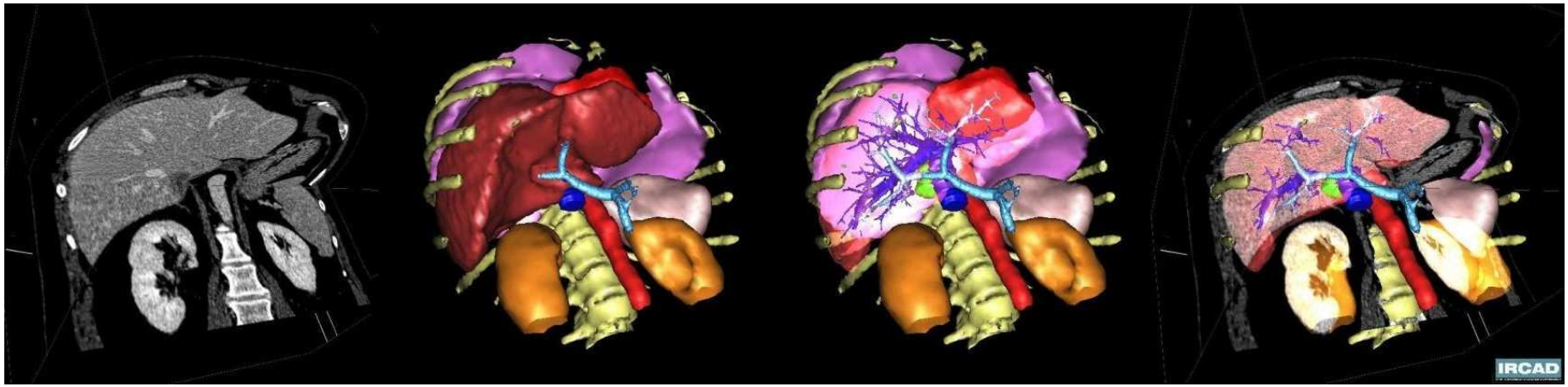
First Step : 3D Modeling of patient





realized with 3D VPM ©ircad 2007

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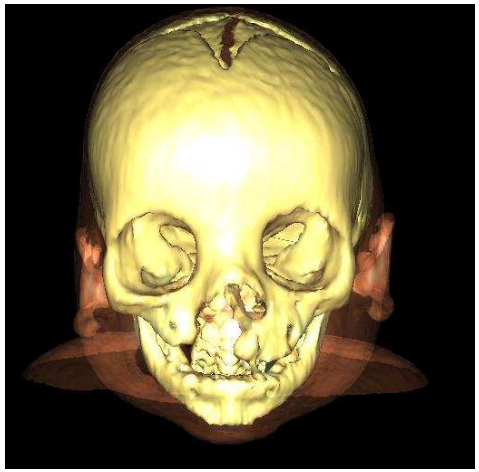
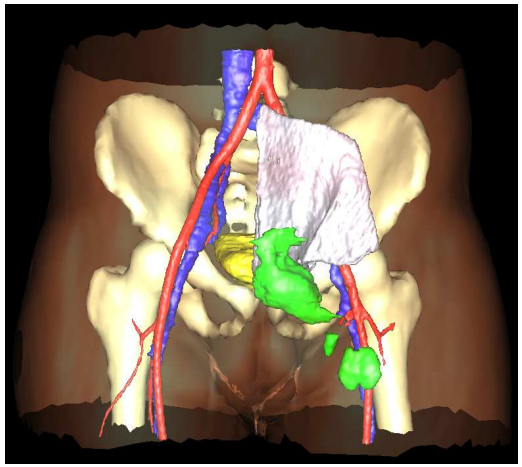
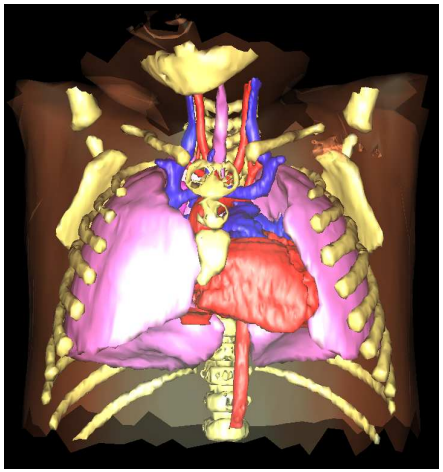
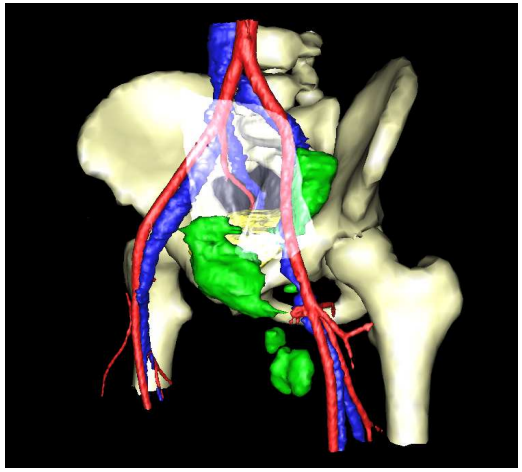
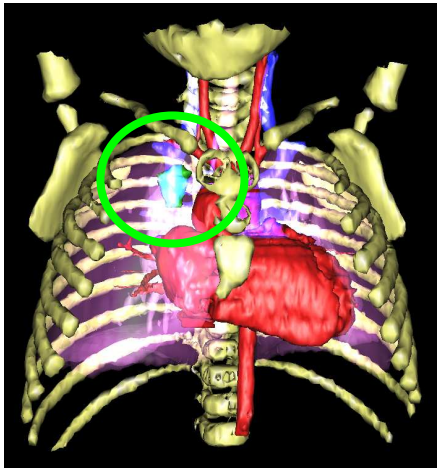
First Step : 3D Modeling of patient

Used for paediatric surgery

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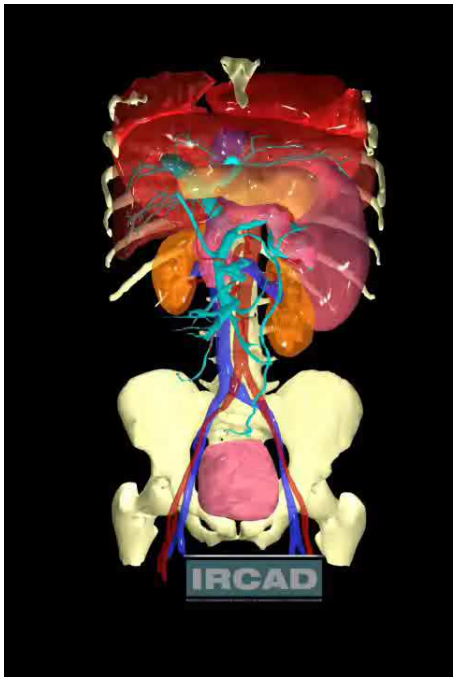
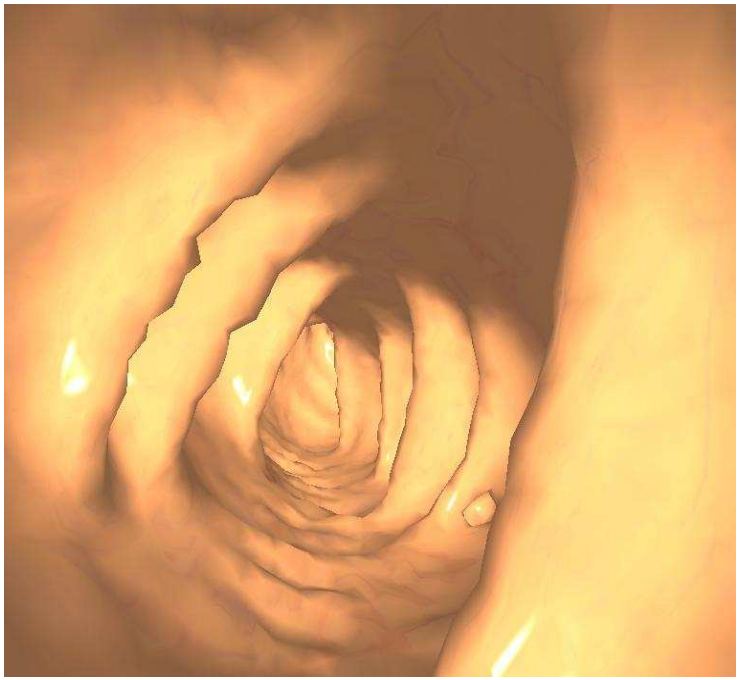
Surface Rendering visualisation

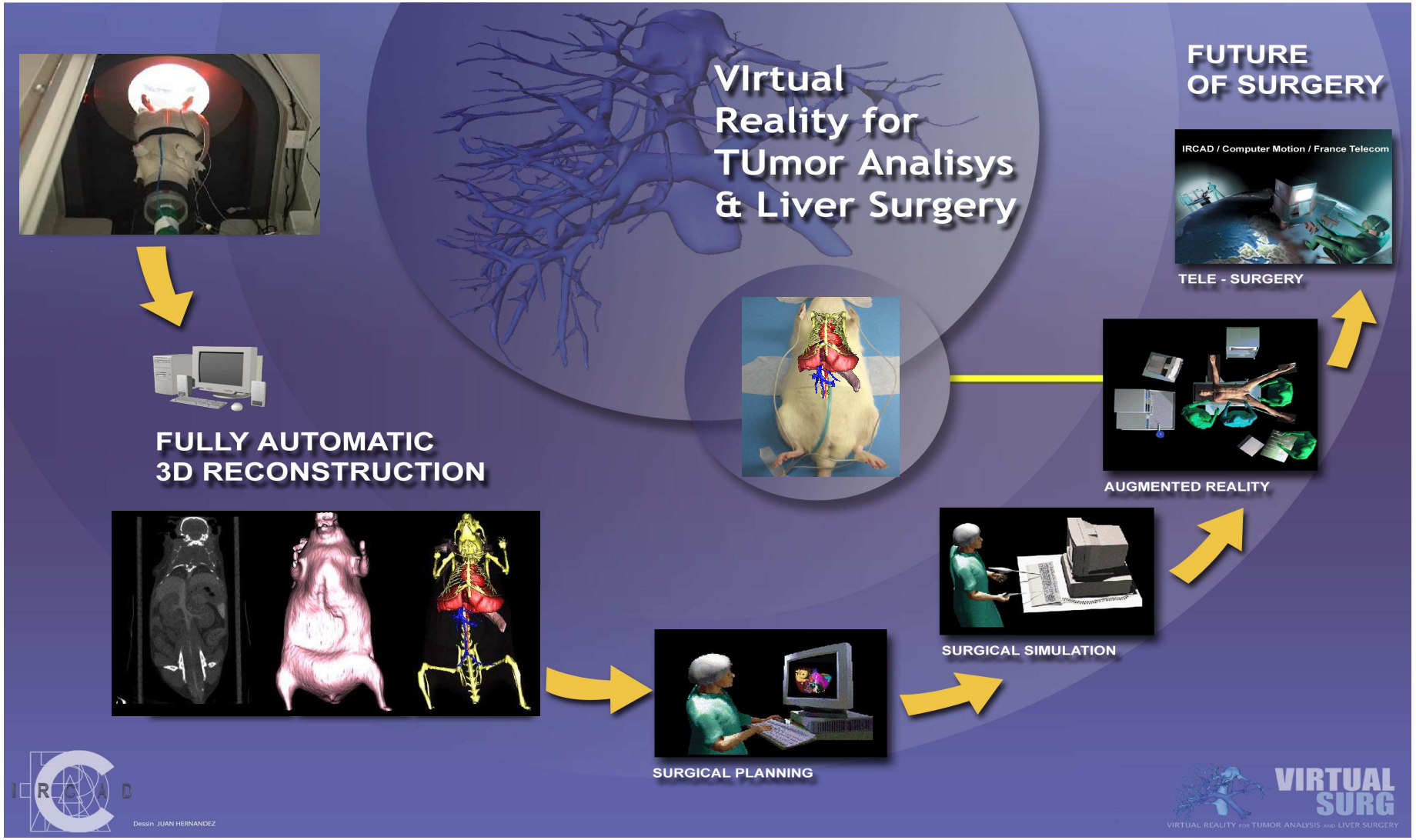
Can be visualized with any Internet Explorer
On any kind of computer






Texture make image more realistic

Preclinical Virtual Reality & Robotics



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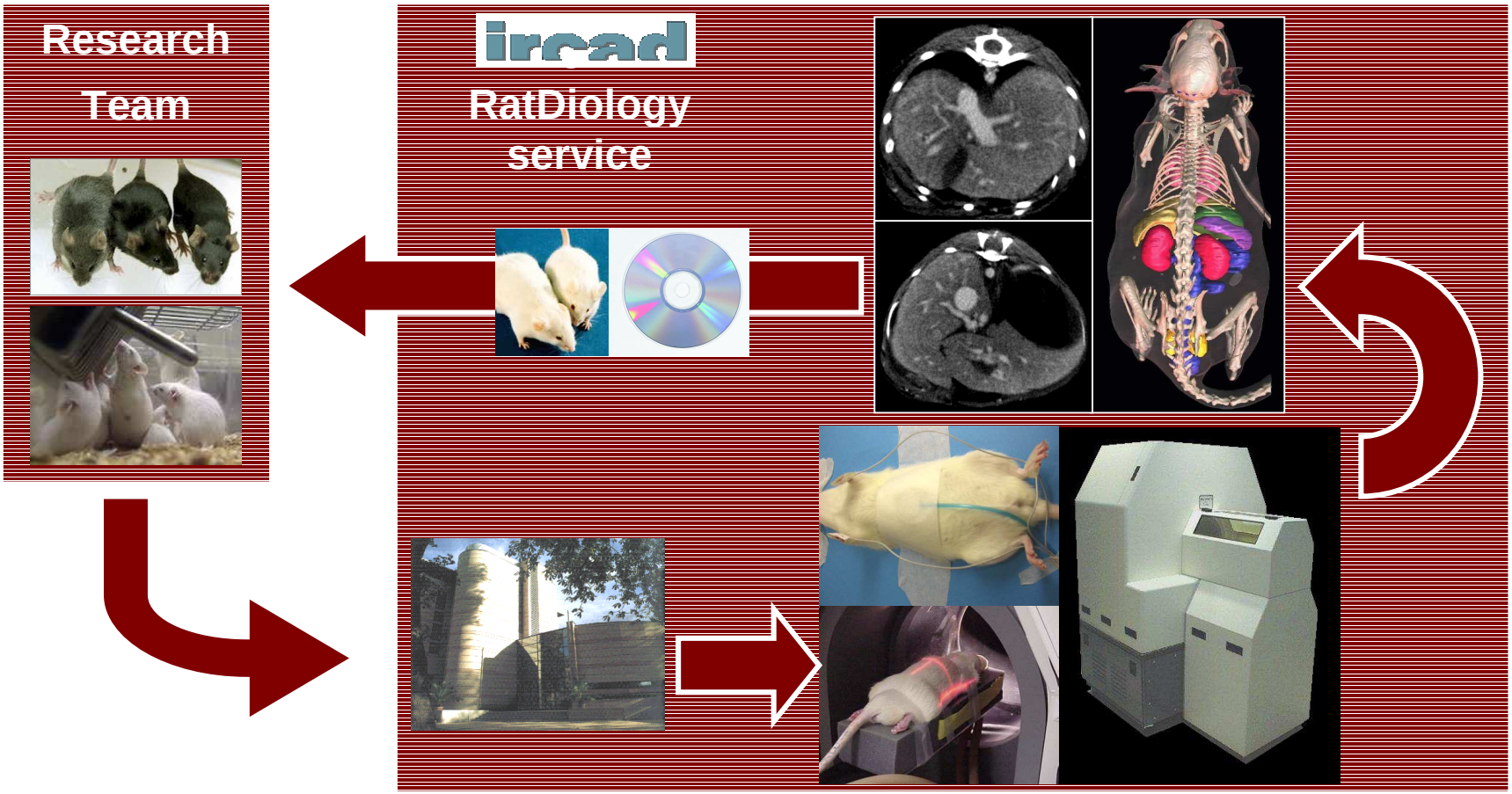
New tool for fundamental research

Provide a CT-scan imaging service for mice and rats including 3D modelling



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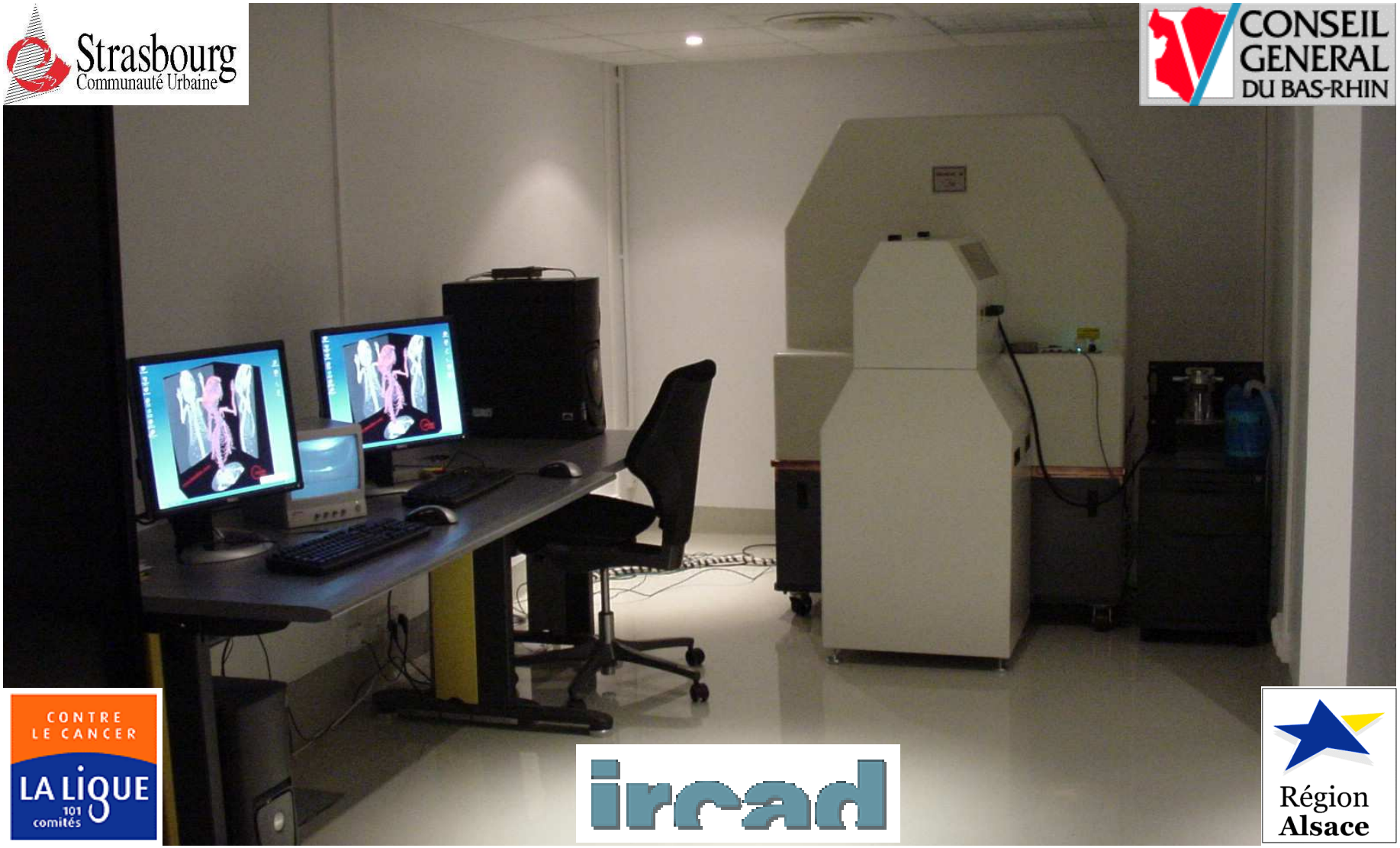
IRCAD's Micro CT-scanner



Région Alsace, Département Bas-Rhin, Ville de Strasbourg,
Ligne Nationale contre le cancer

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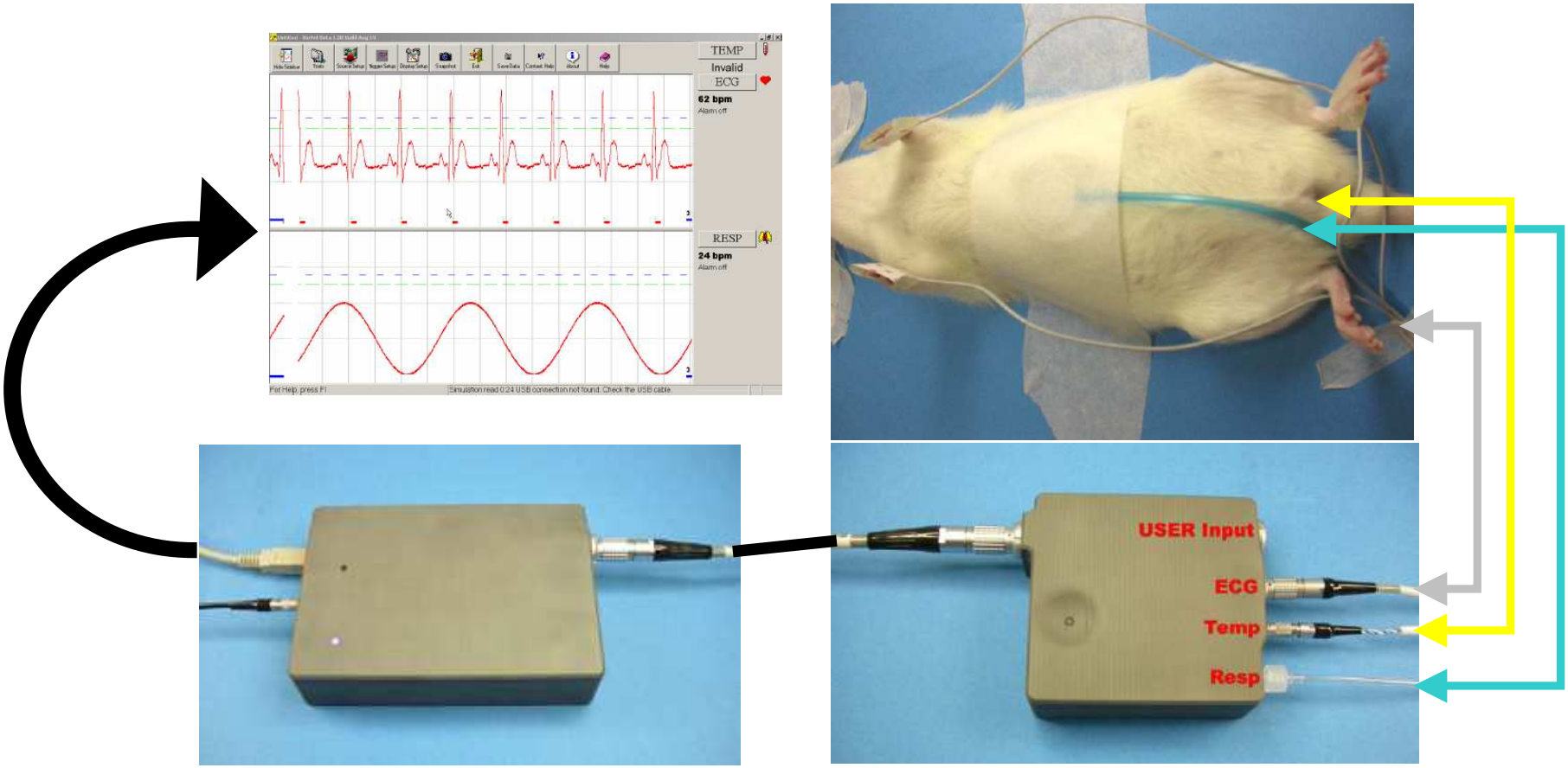
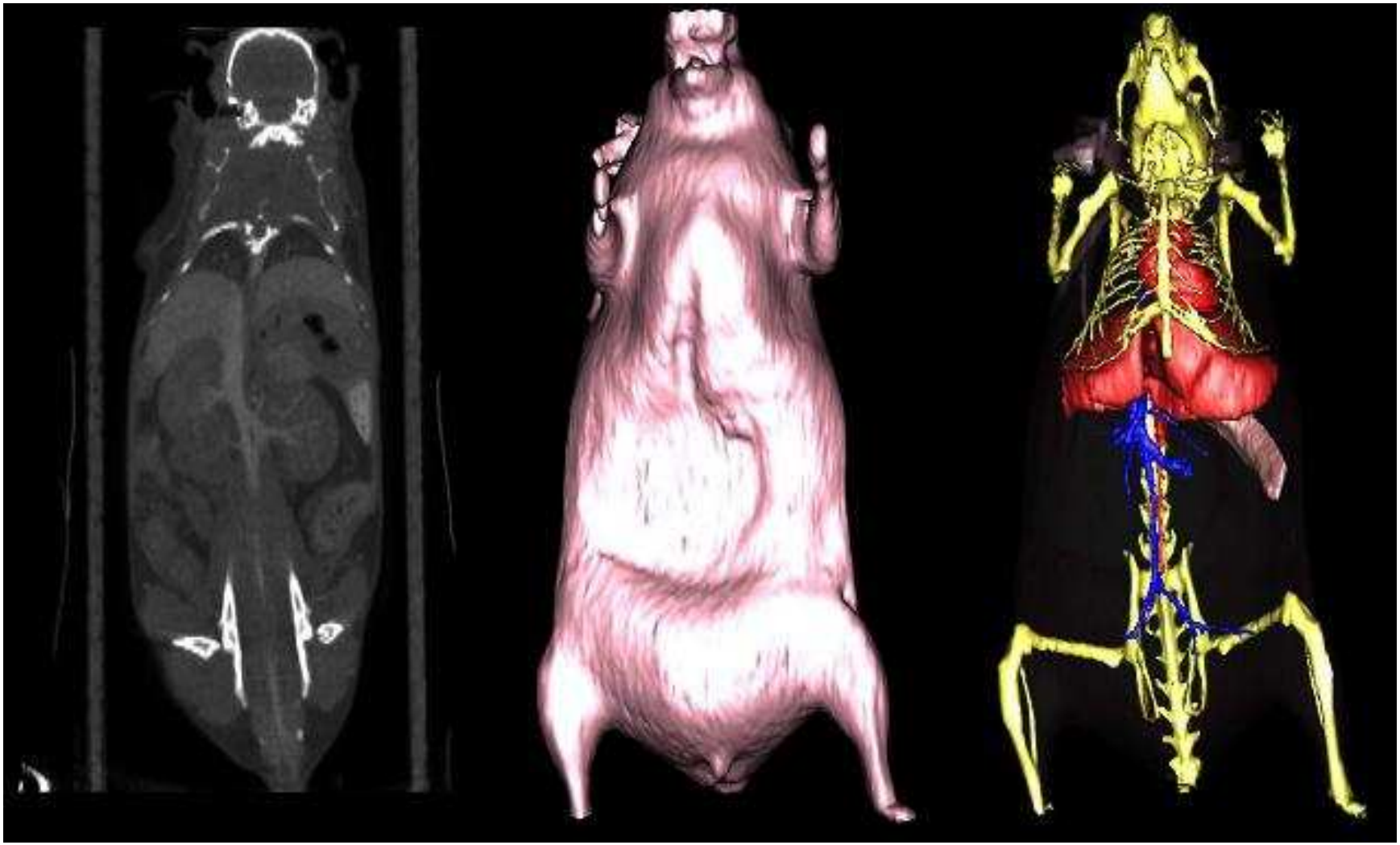
In vivo Micro scanner X

Automatic Synchronisation



3D modelling of small animals



Intravenous Fenestra LC + Fenestra VC

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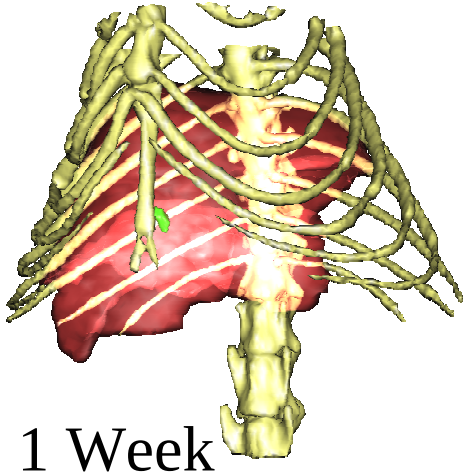
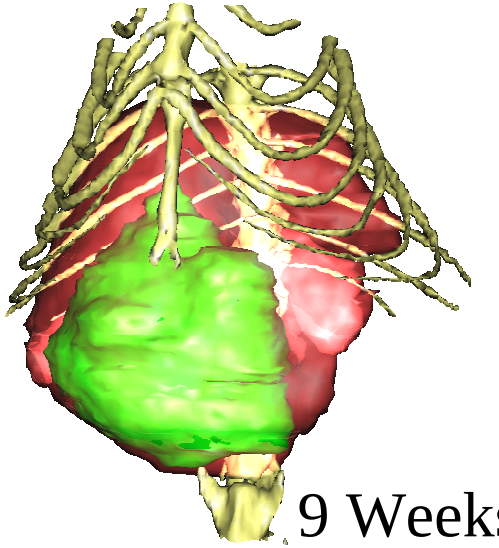
4D Comparison

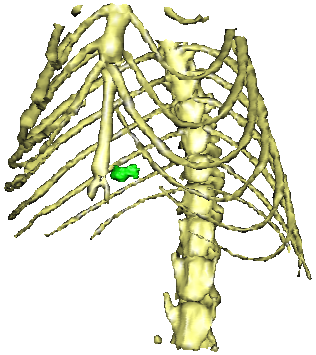
Liver tumor evolution



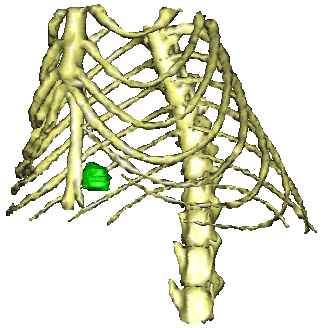
1 Week



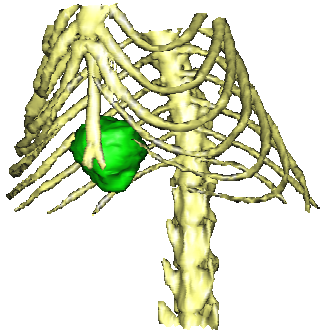
9 Weeks



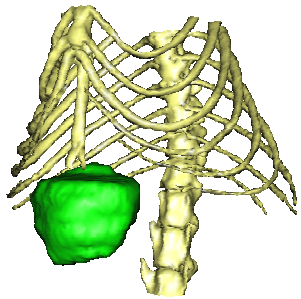
2 Weeks



4 Weeks



6 Weeks



8 Weeks

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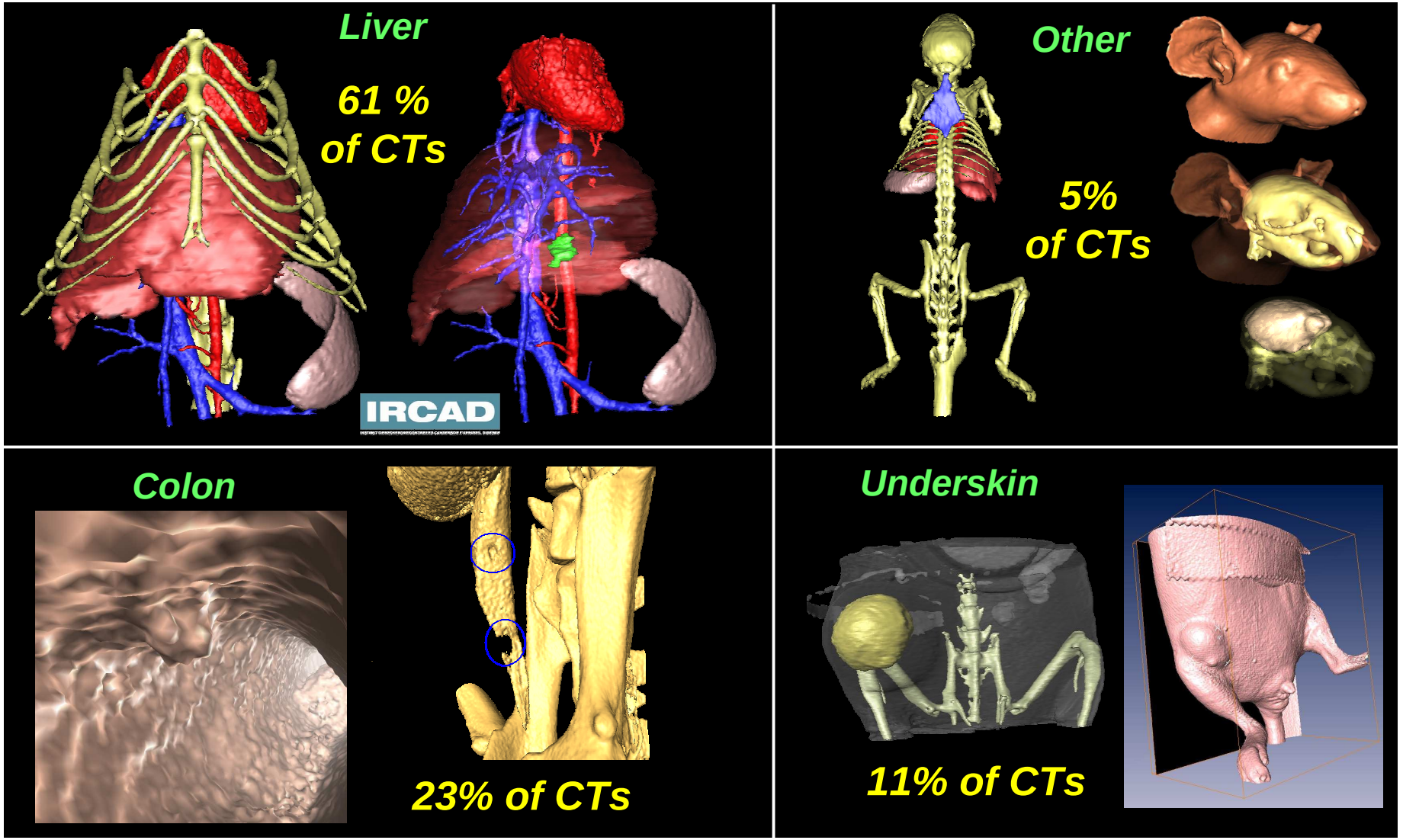
Ratdiology Project



2005 : 501 CT / 2006 : >700 CT

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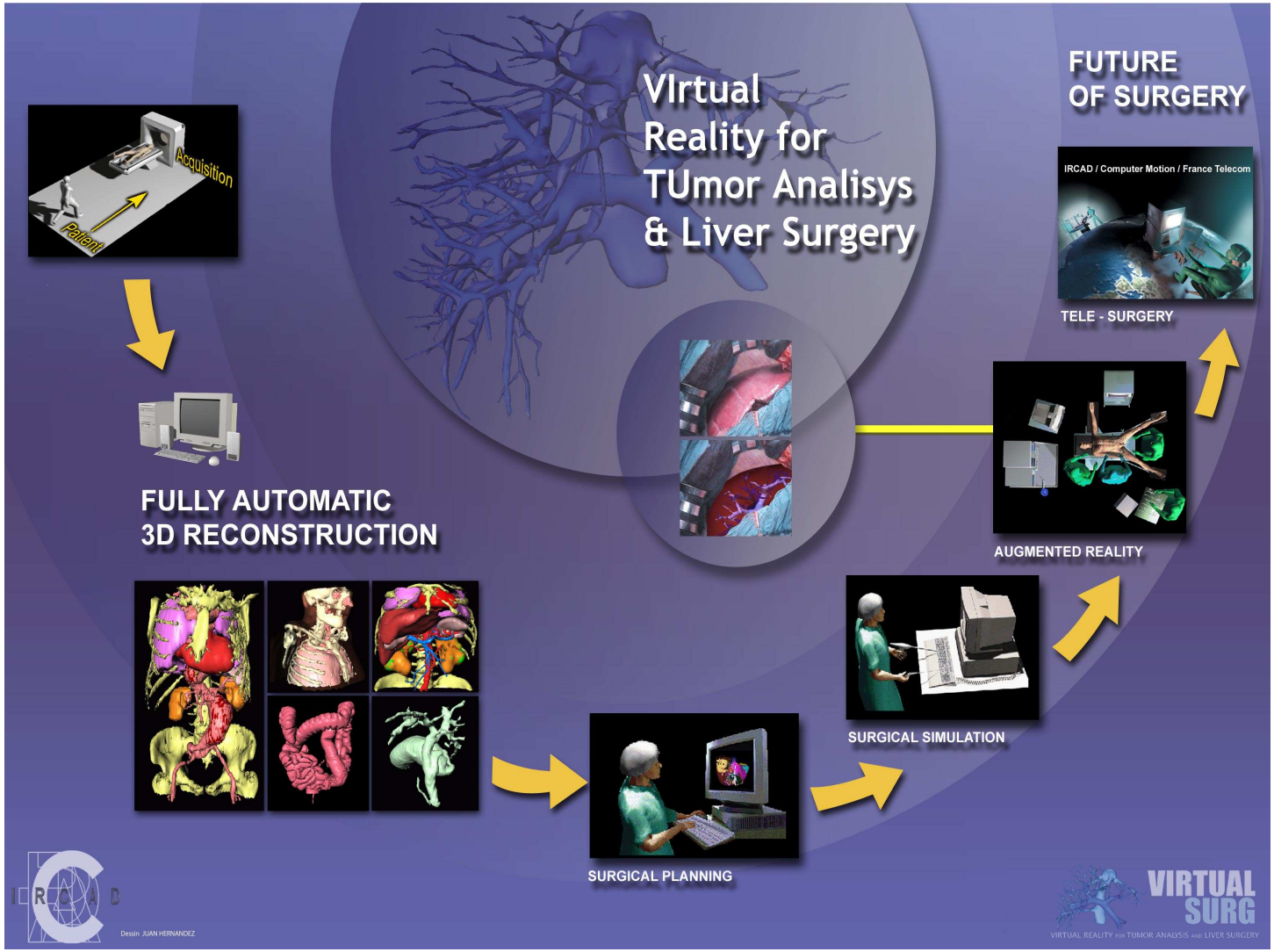
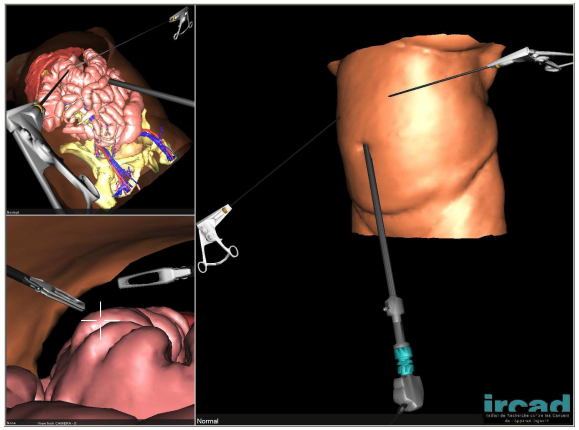
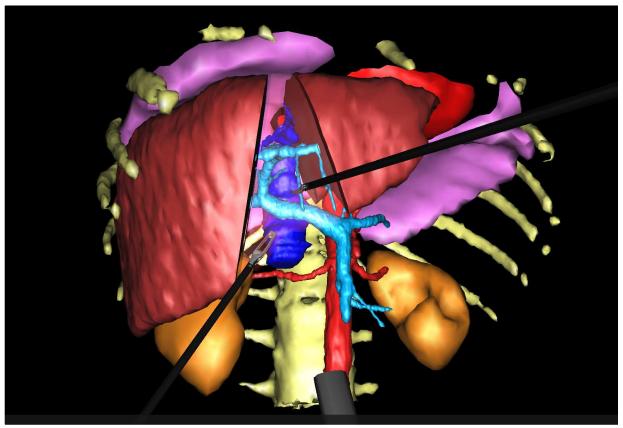
Surgical Planning

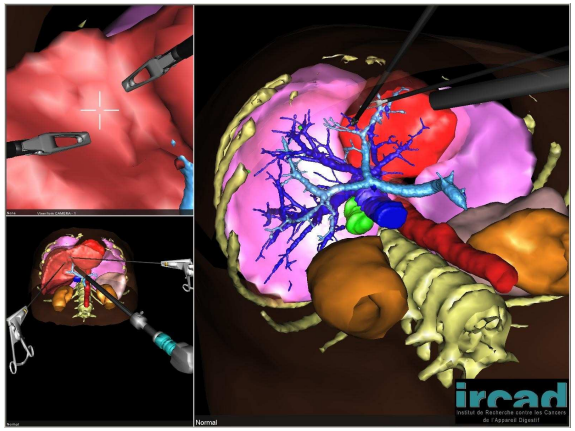


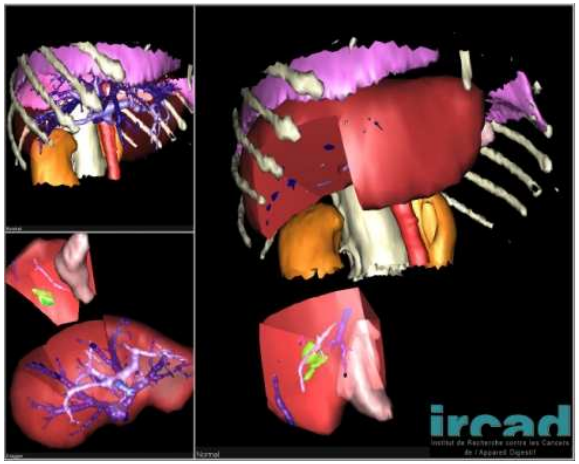
Second step : Surgical planning

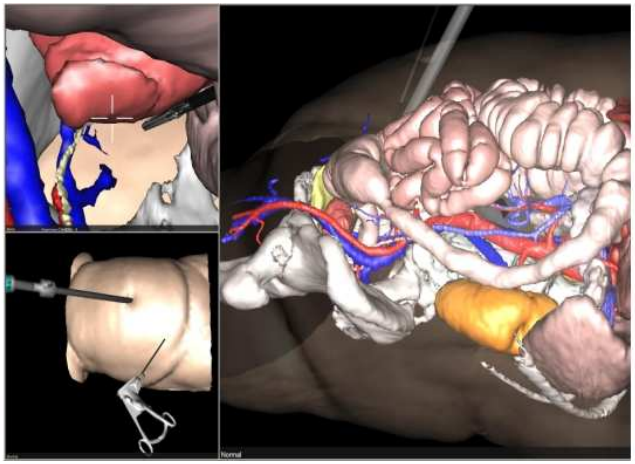
3D VSP ©ircad 2002











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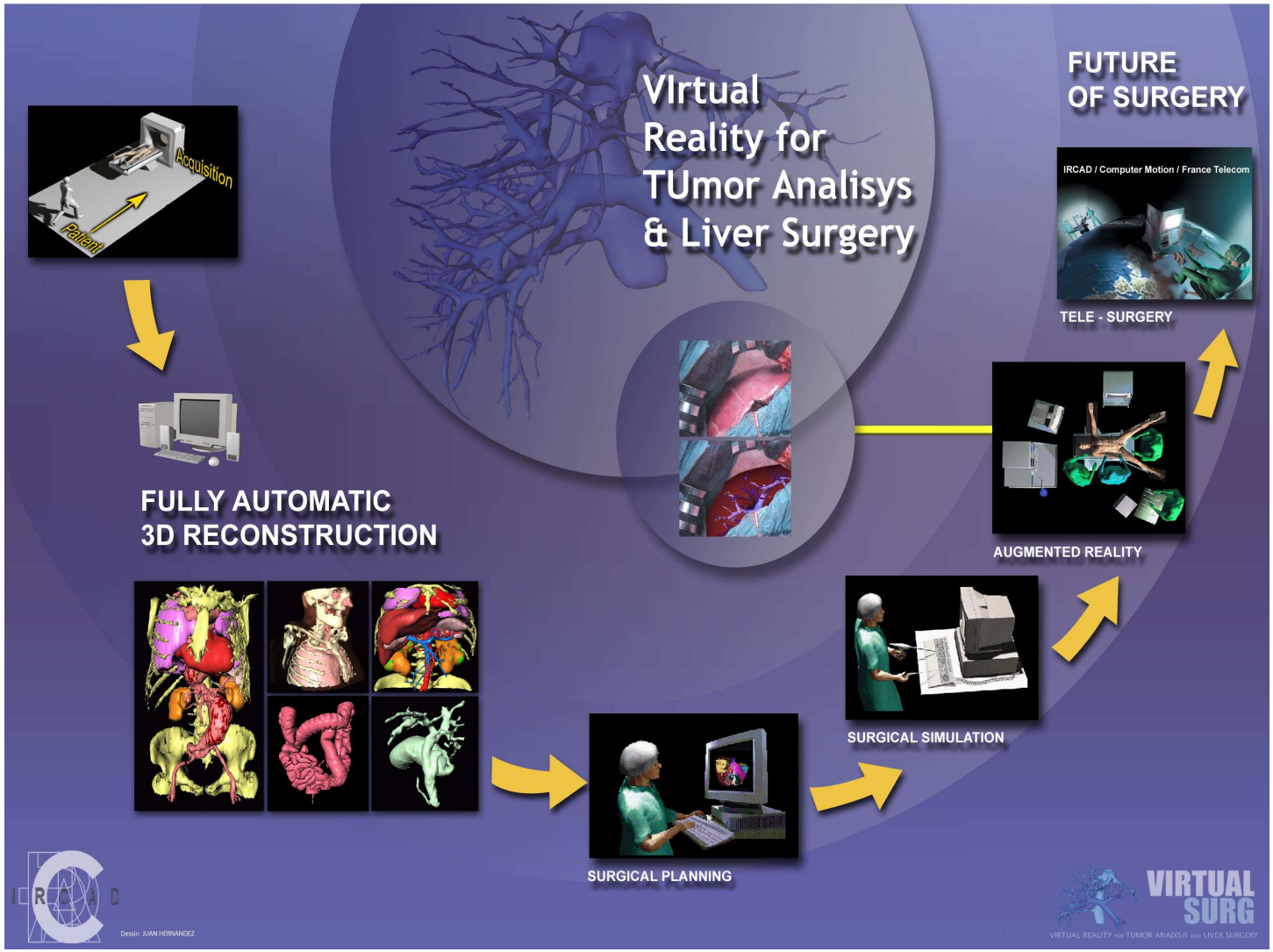
Third Step : Surgical Simulation



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Current laparoscopic simulators

©Surgical Science *©Simbionix* *©SimSurgery*

- Realistic rendering
- Large set of possible training (suture, clip applying, etc…)
- Automated evaluation

Current laparoscopic simulators

BUT : based on non real patient

➔ limited database

Objective :

Develop pre-operative simulator allowing a real preoperative training on virtual copy of patient

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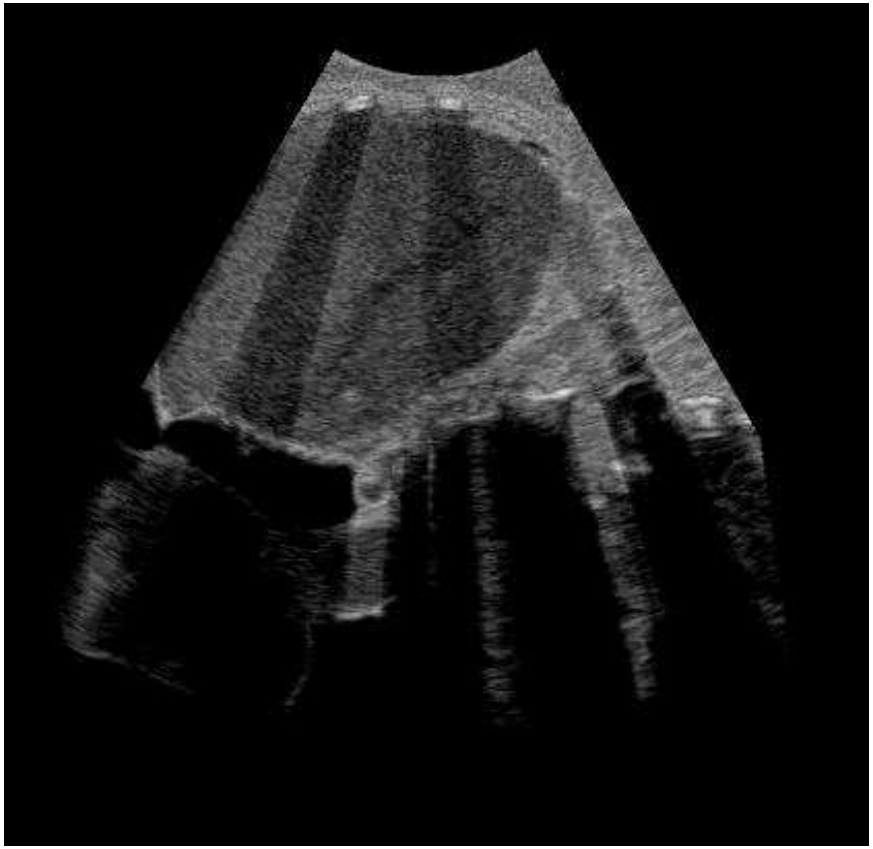
Third Step : Surgical Simulation

Ultrasonographic Simulator



From CT-scan of the patient

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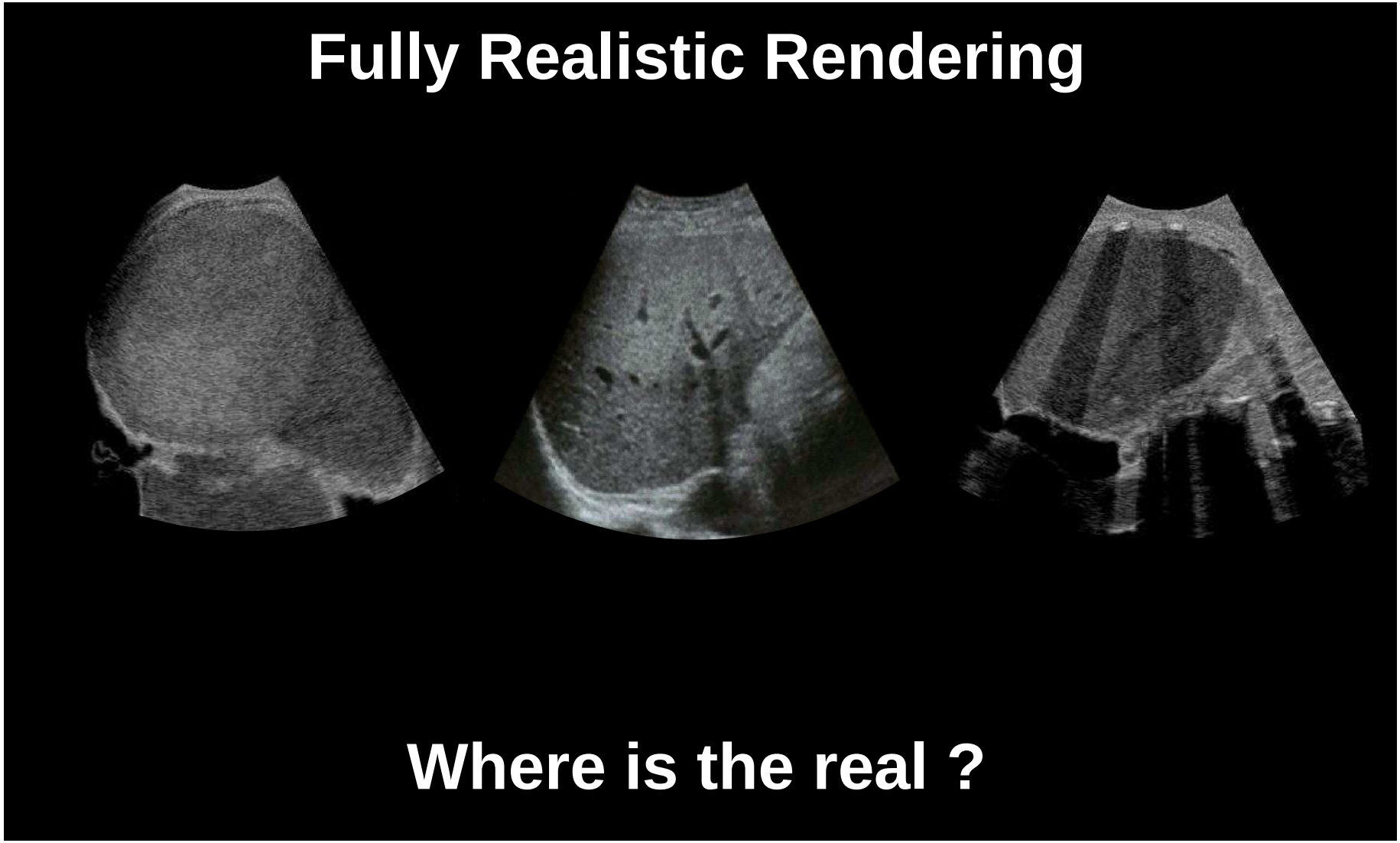
Third Step : Surgical Simulation



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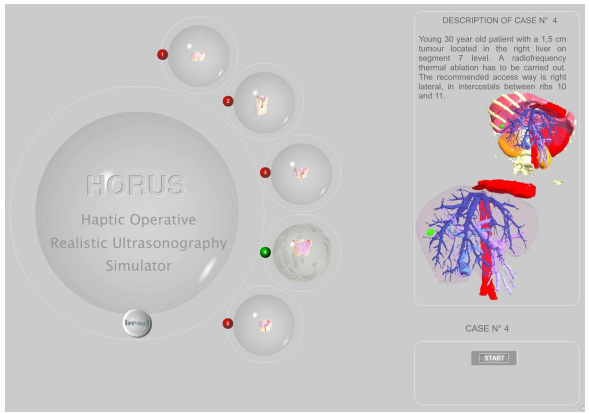
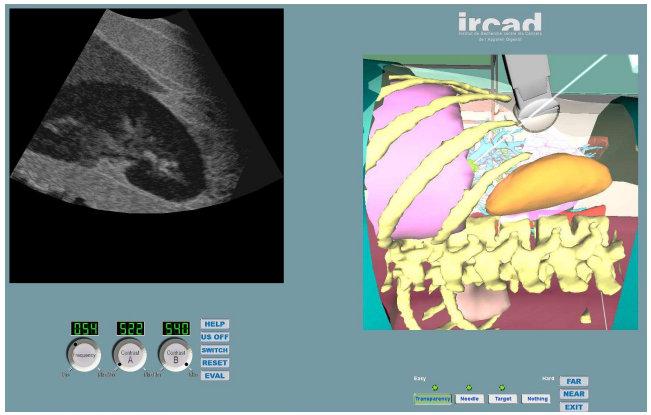
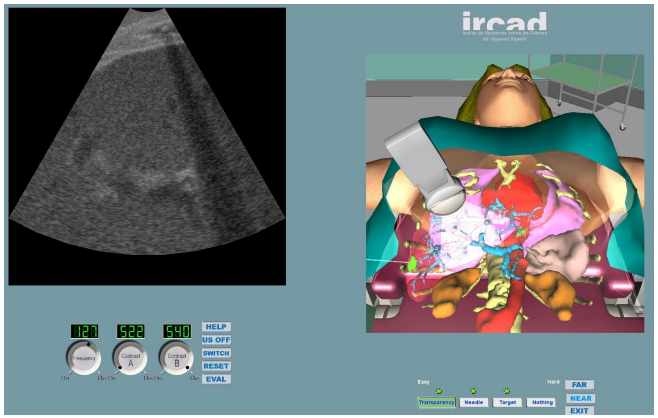
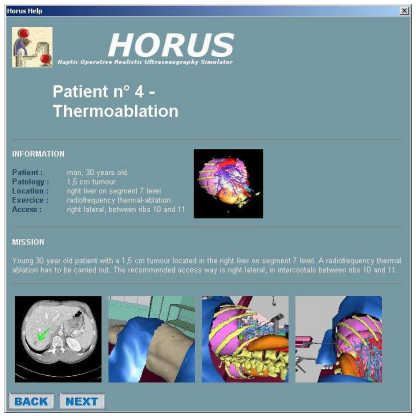
Third Step : Surgical Simulation

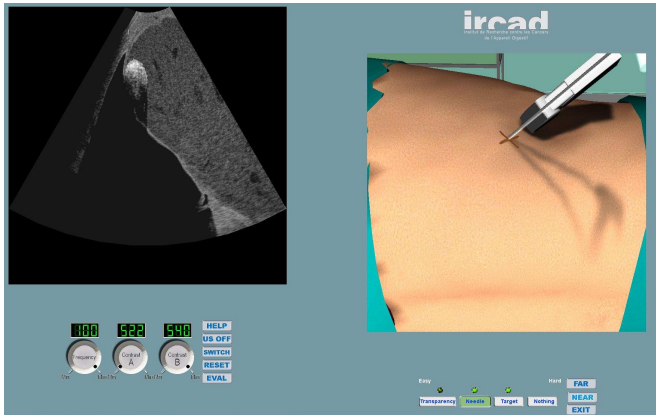
ultrasonographic percutaneous needle insertion Simulator

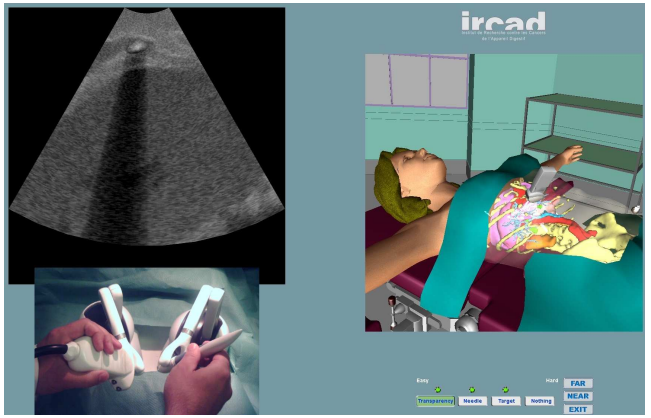












HORUS ©ircad 2005

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Third Step : Surgical Simulation

Real-time Force Feed-Back simulation

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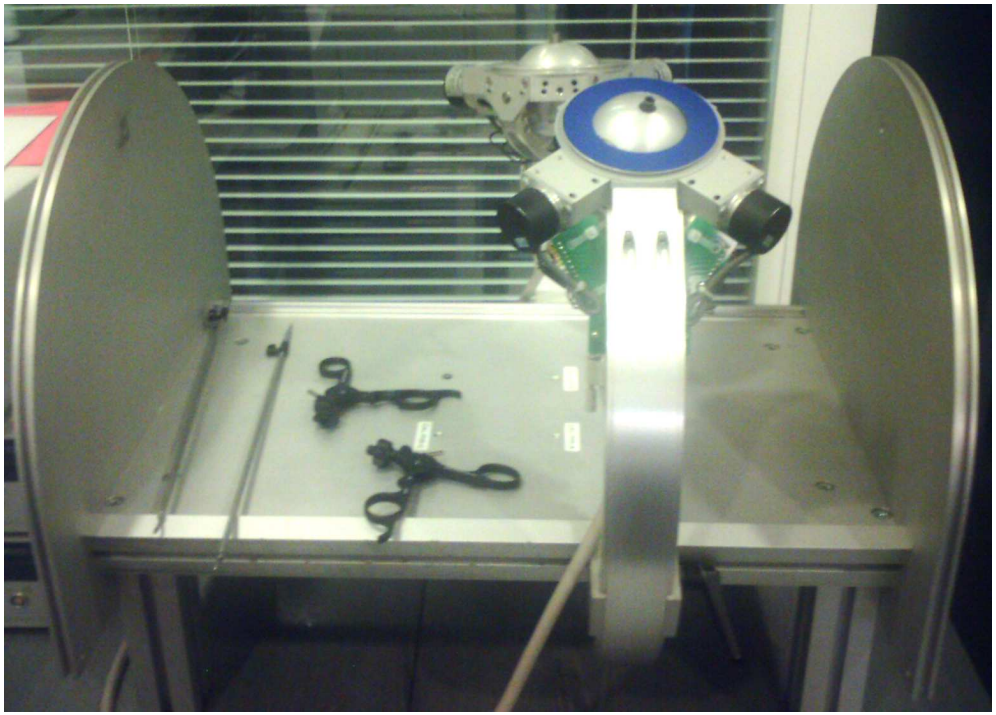
Third Step : Surgical Simulation

Develop a Force Feed-Back simulator using the Karl Storz FFB system



Eurêka "ODYSSEUS" Project

STORZ
KARL STORZ — ENDOSKOPE

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Third Step : Surgical Simulation

ULIS ©ircad 2007

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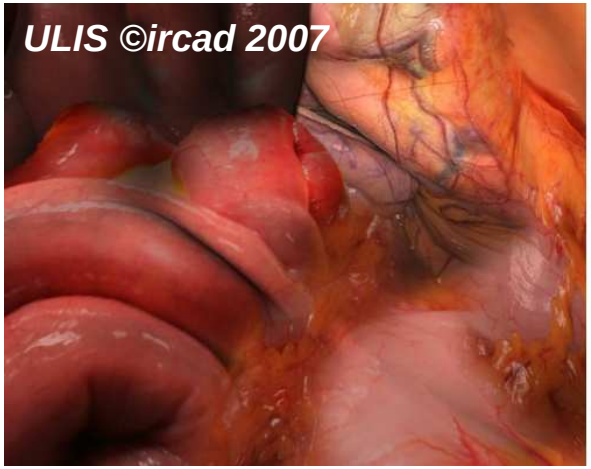
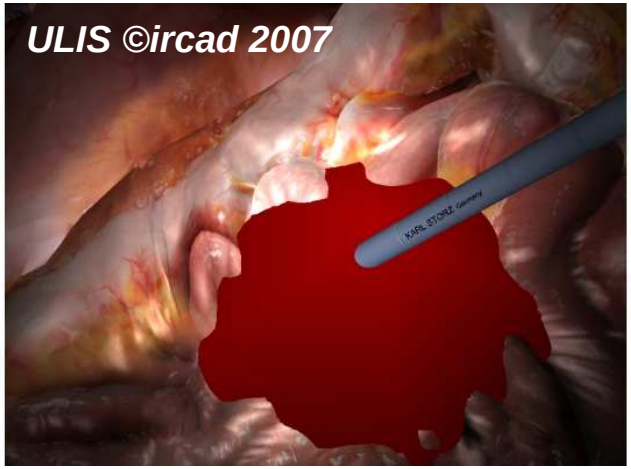
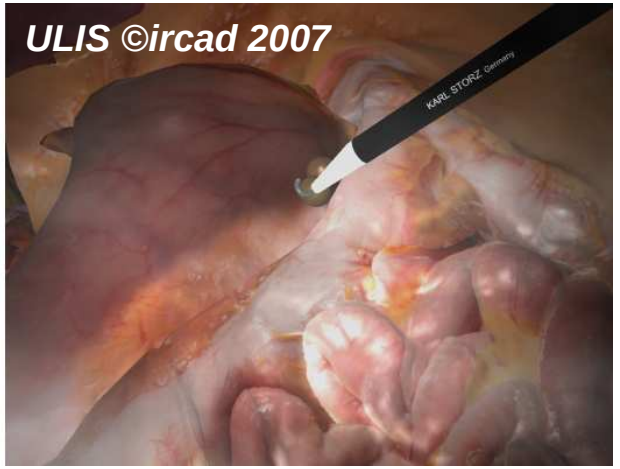
Third Step : Surgical Simulation







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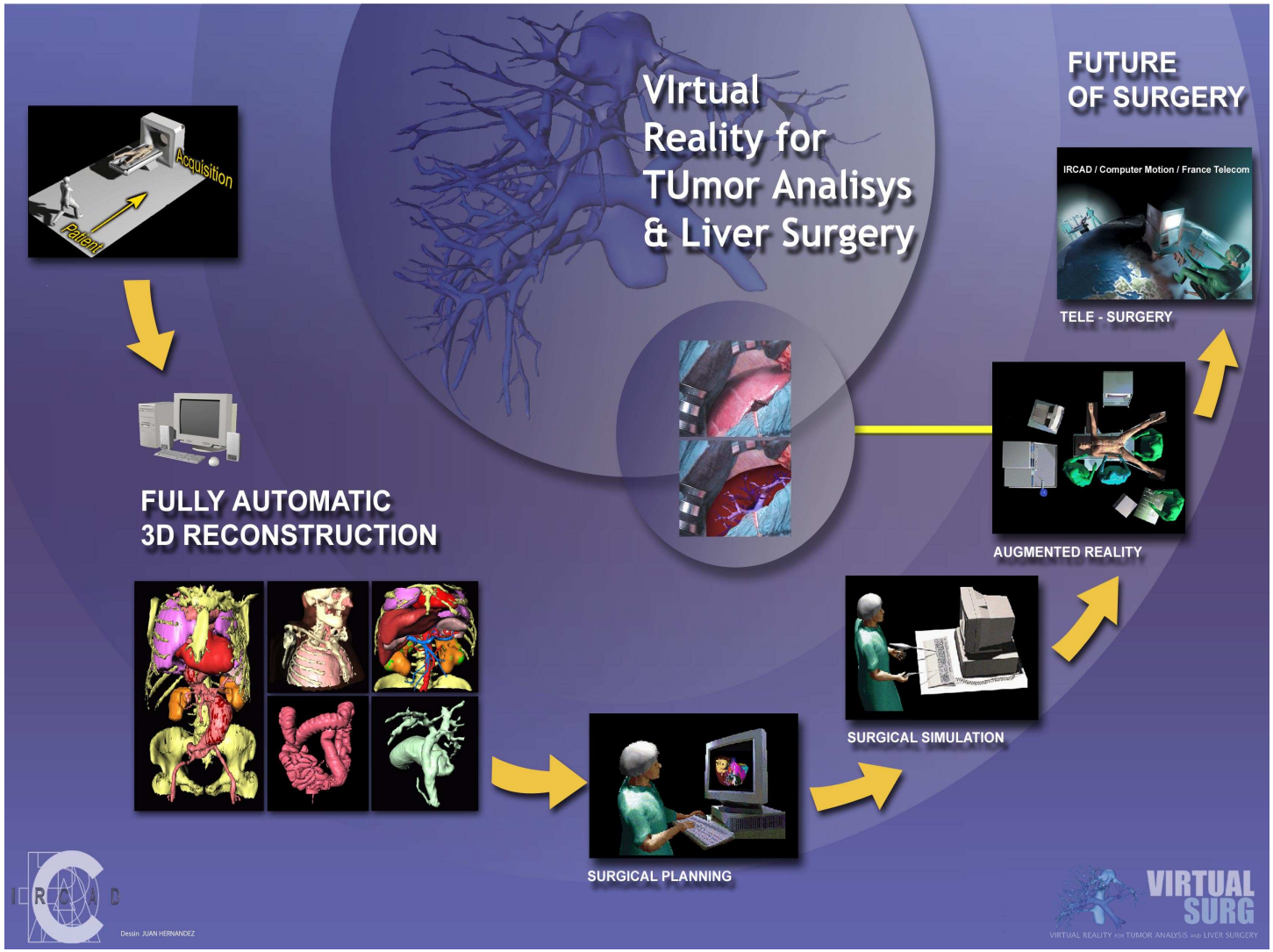
Intra-operative Use



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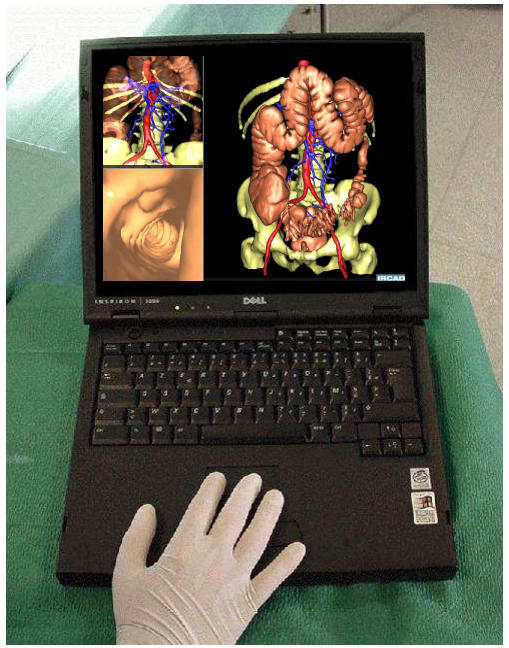
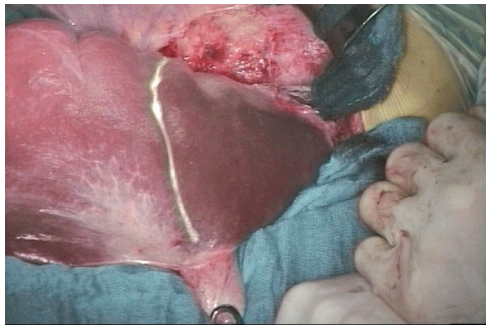
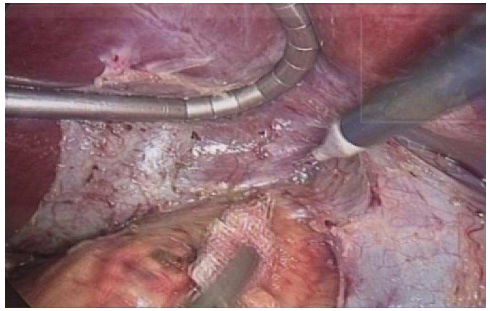
Surgical planning software

Open or laparoscopic Surgery







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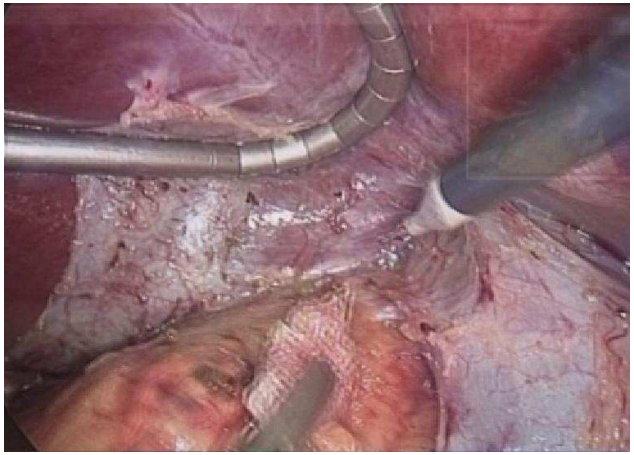
Forth Step : Intra-operative Use

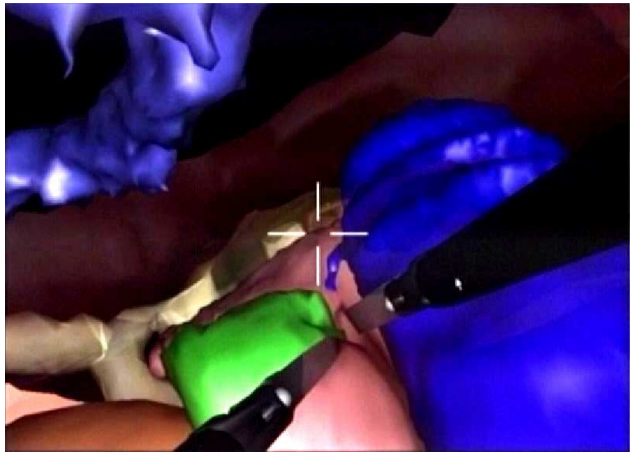
Surgical views

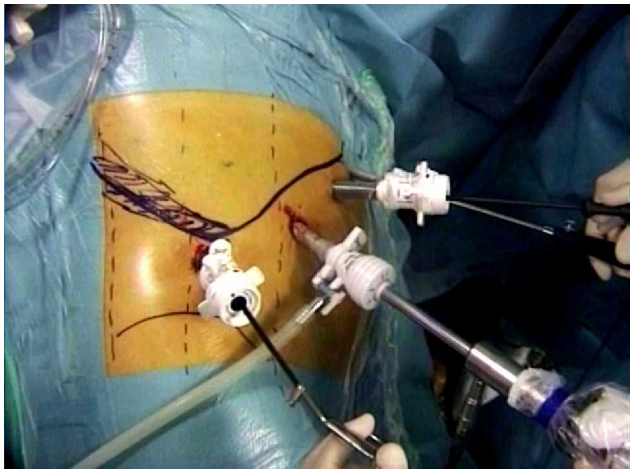
Laptop views



Internal view

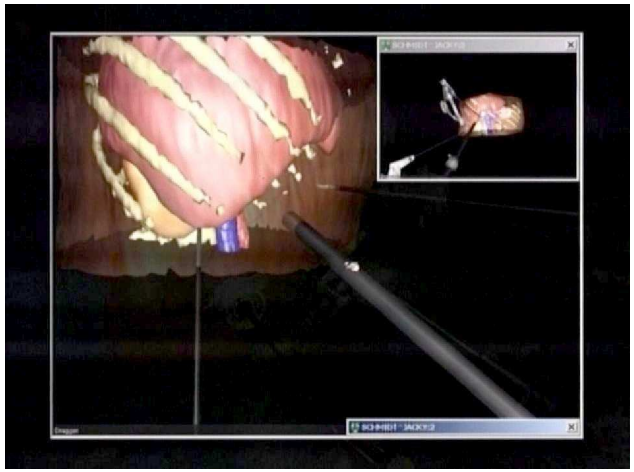
Real Virtual





External view

Real Virtual

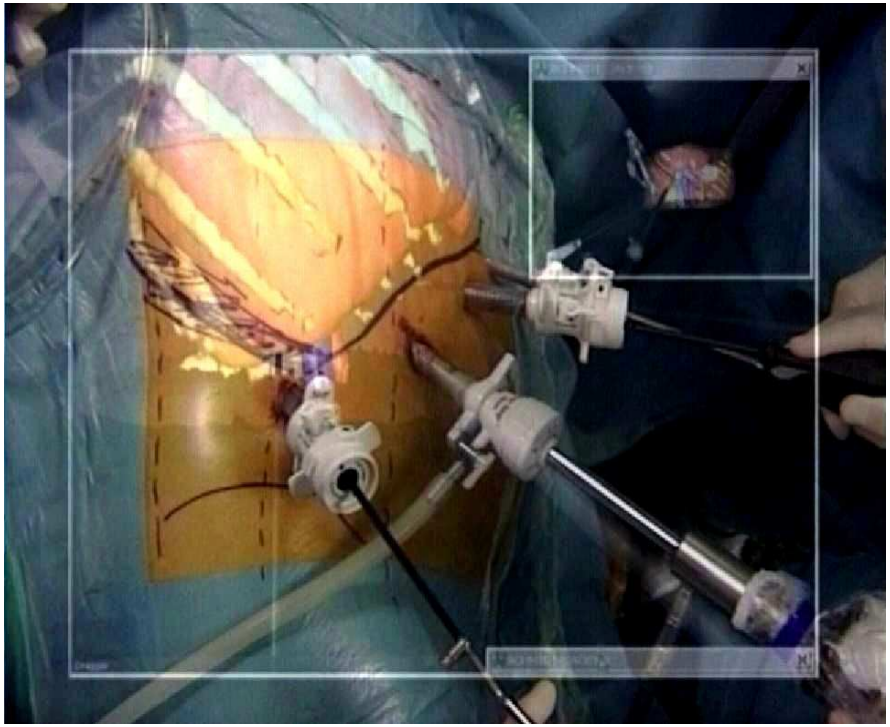


Forth Step : Intra-operative Use

Optimal use : Fuse real and virtual

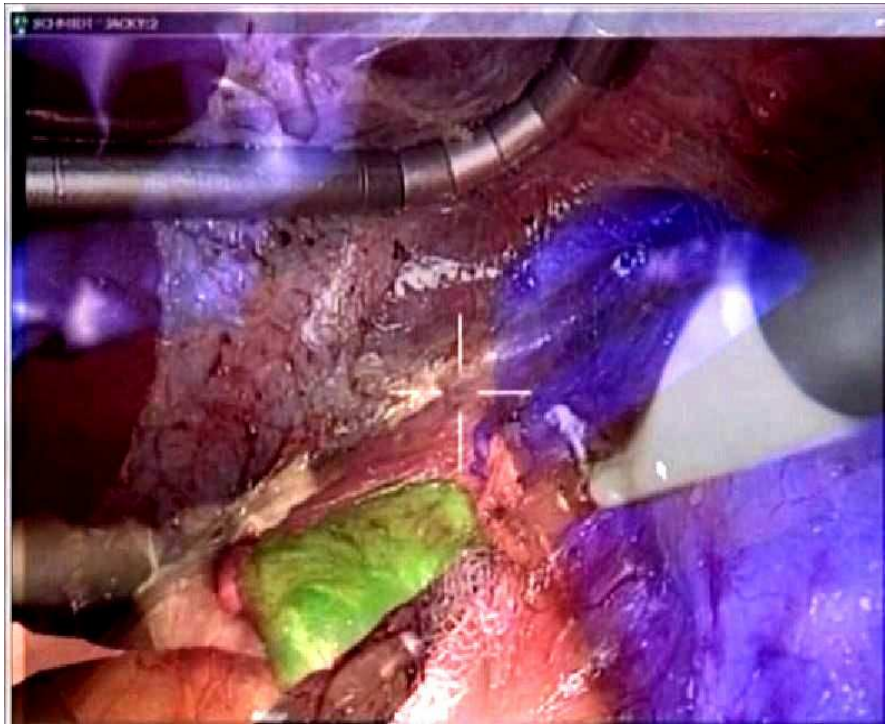
External view

Real + Virtual



Internal view

Real + Virtual



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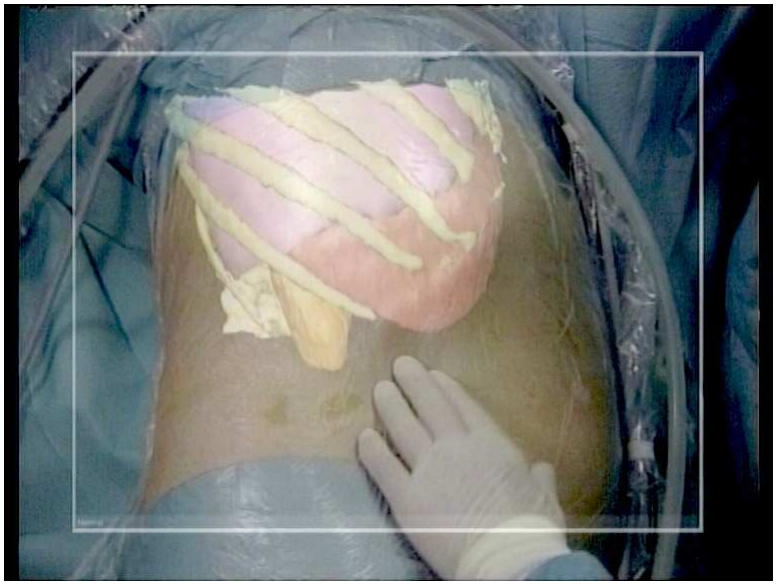
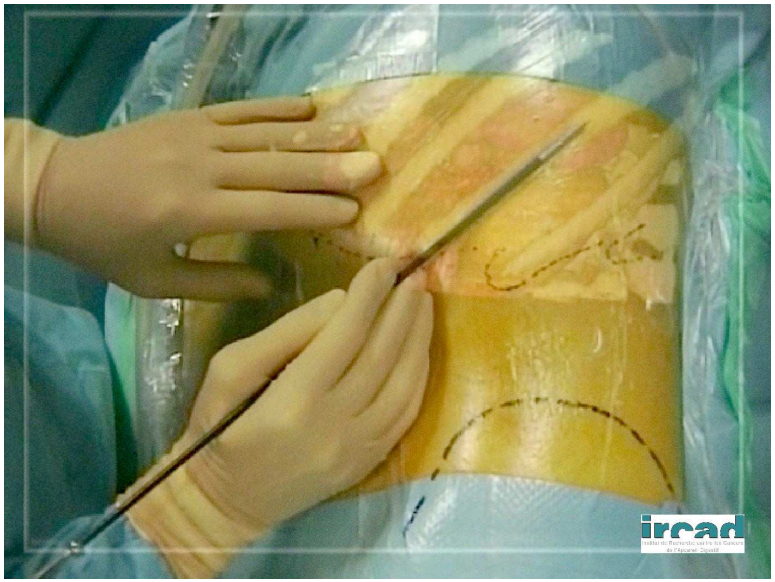
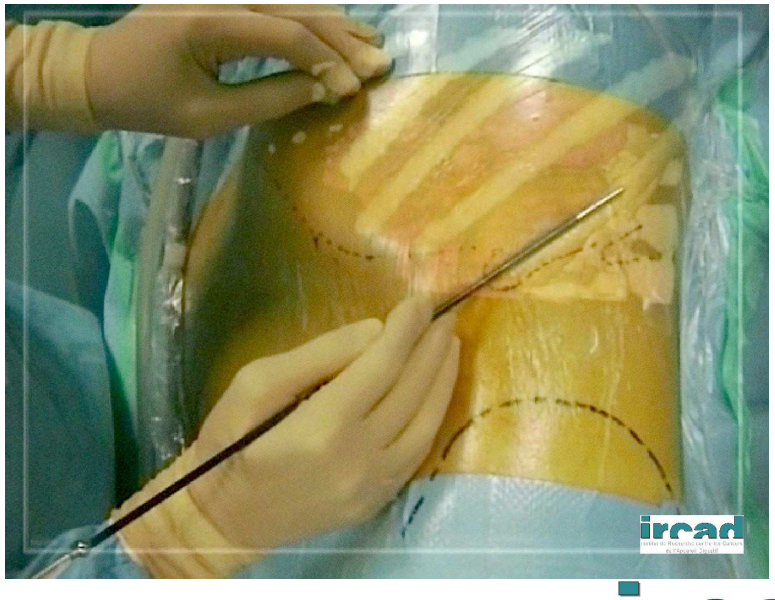
Interactive Augmented reality







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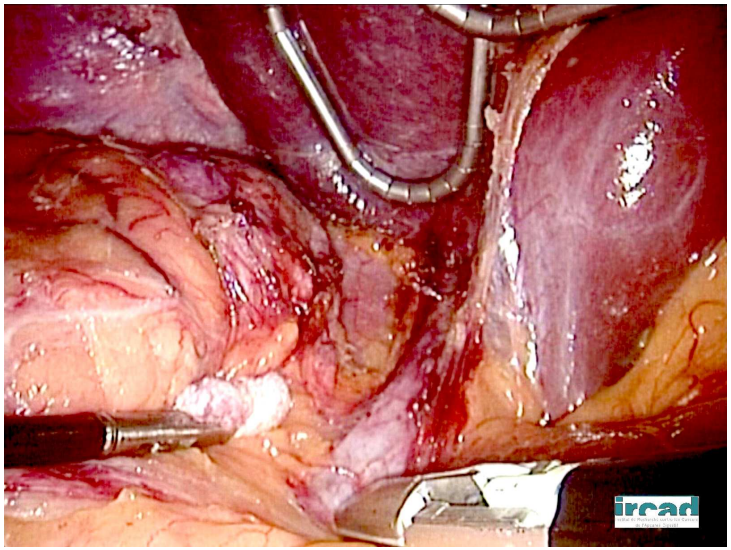
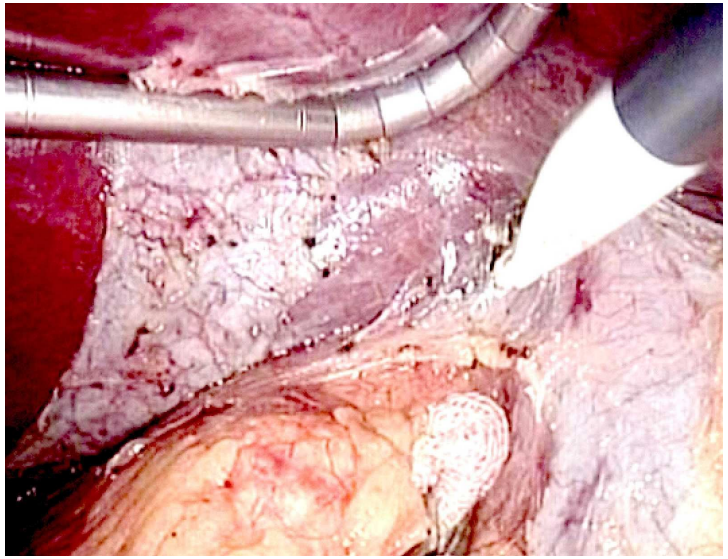
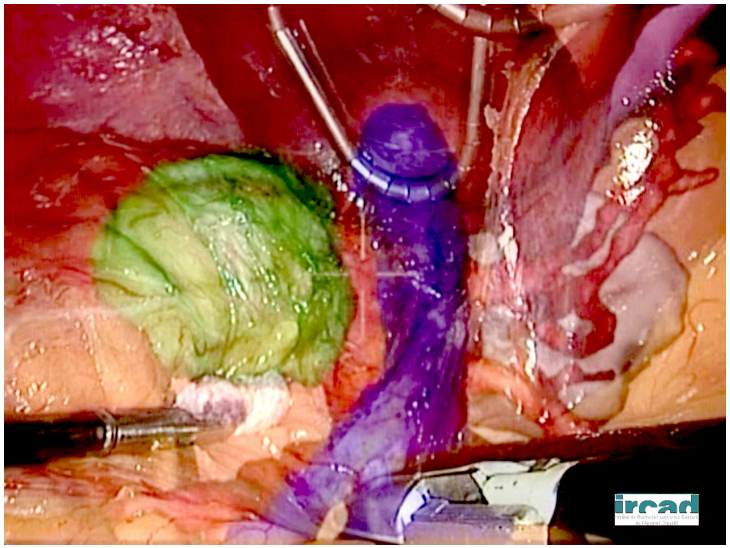
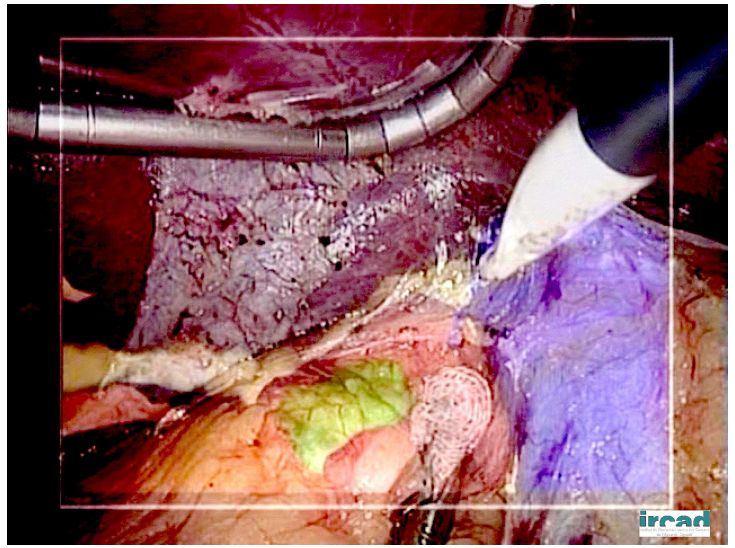
Interactive Augmented reality









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Interactive Augmented reality

LIMITS

- **Manual Registration of Virtual & Real**
- **Manual Tools Positioning & Tracking**
- **Manual Organs Tracking**
- **Impossible Virtual Organ Deformation**

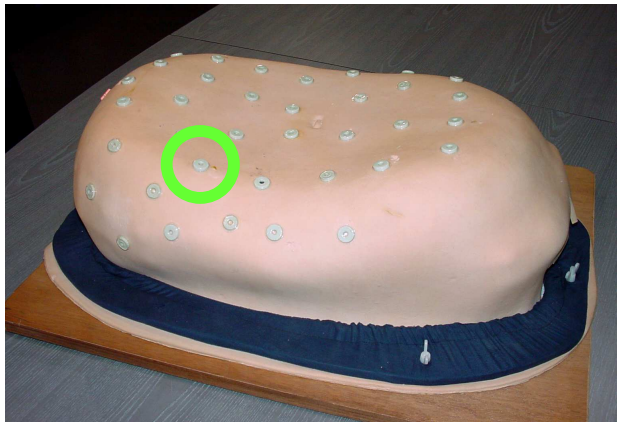
Interactive Augmented reality

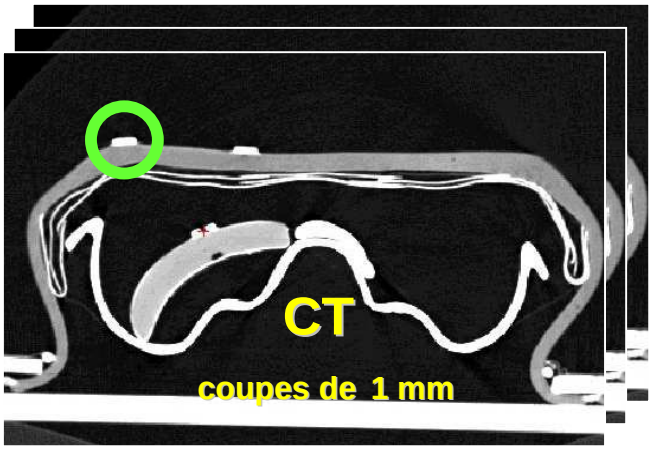
LIMITS

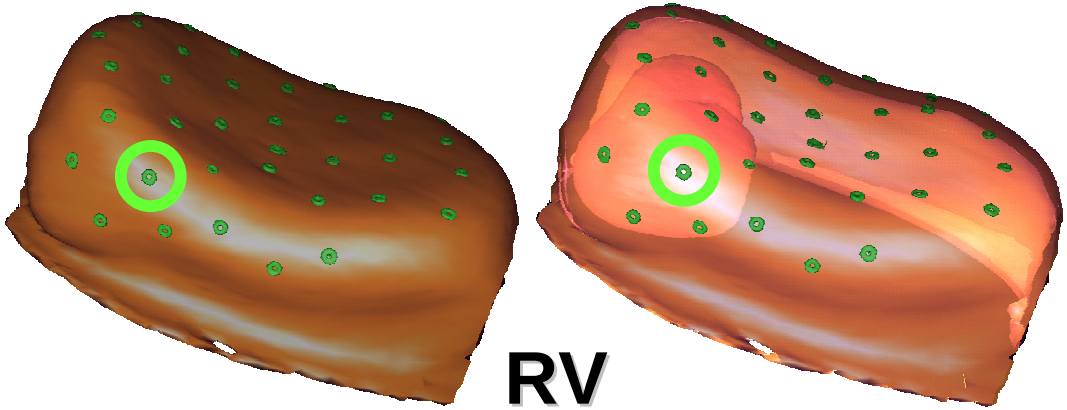
- Manual Registration of Virtual & Real
- Manual Tools Positioning & Tracking
- Manual Organs Tracking
- Impossible Virtual Organ Deformation

Automatic Augmented reality

Automatic registration of 3D view with real view



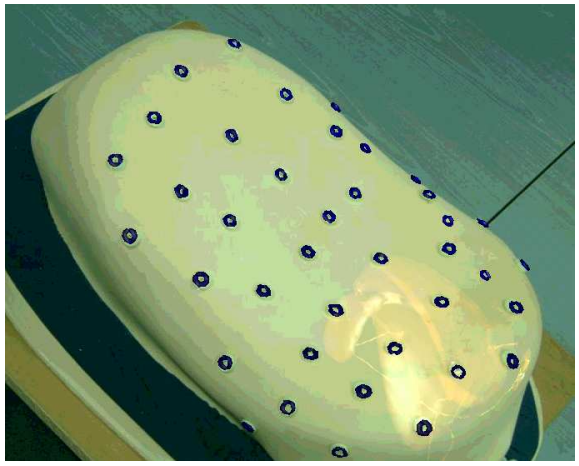




RV

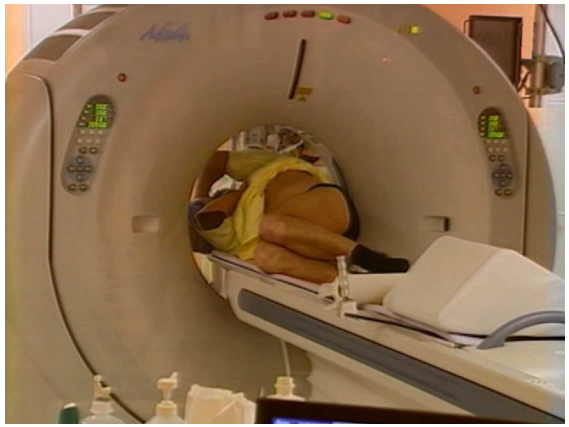
Automatic Augmented reality

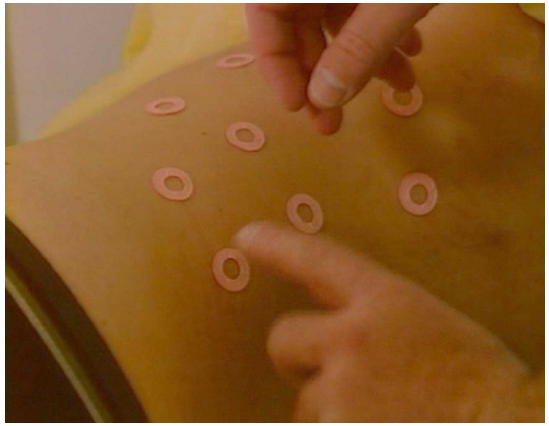
2 cameras ⟷ human eyes
Stereoscopic Vision

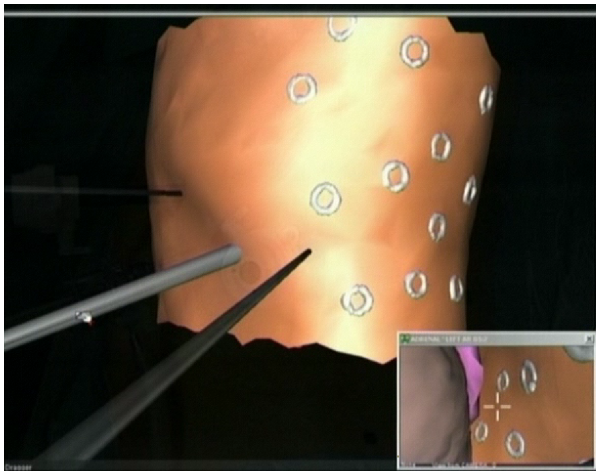


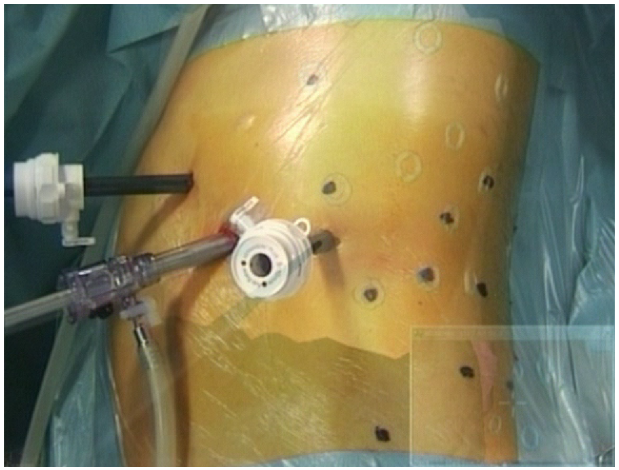
Automatic Augmented reality

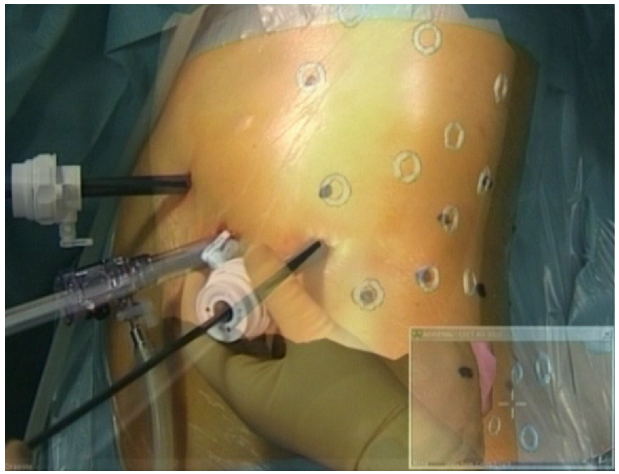
Clinical application











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Interactive Augmented reality

LIMITS

- ~~Manual Registration of Virtual & Real~~
- Manual Tools Positioning & Tracking
- Manual Organs Tracking
- Impossible Virtual Organ Deformation

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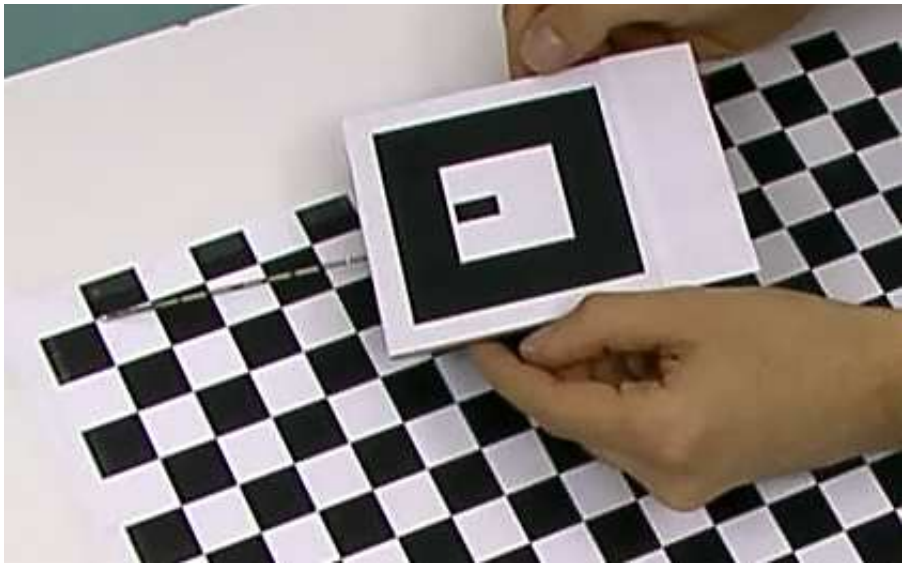
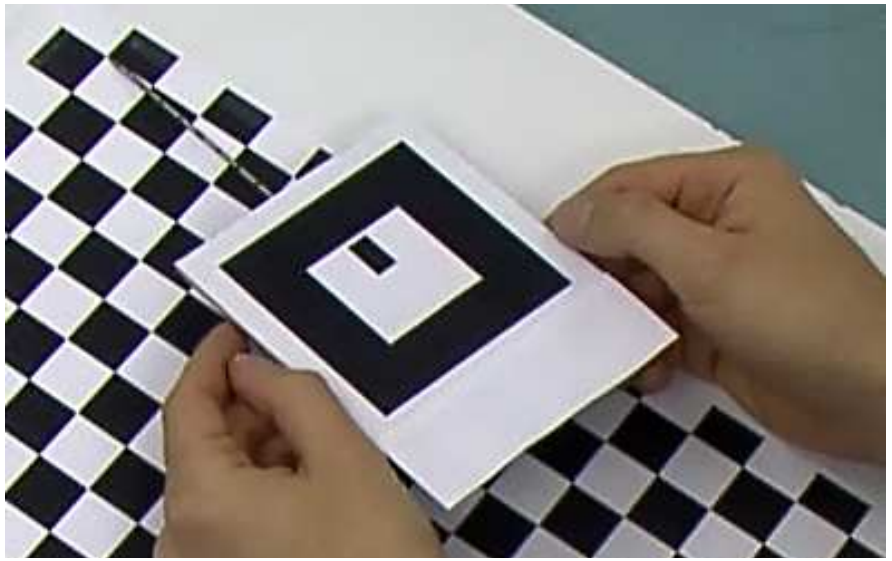
Automatic Augmented reality

Automatic Tools
Positioning & Tracking
Marker placement





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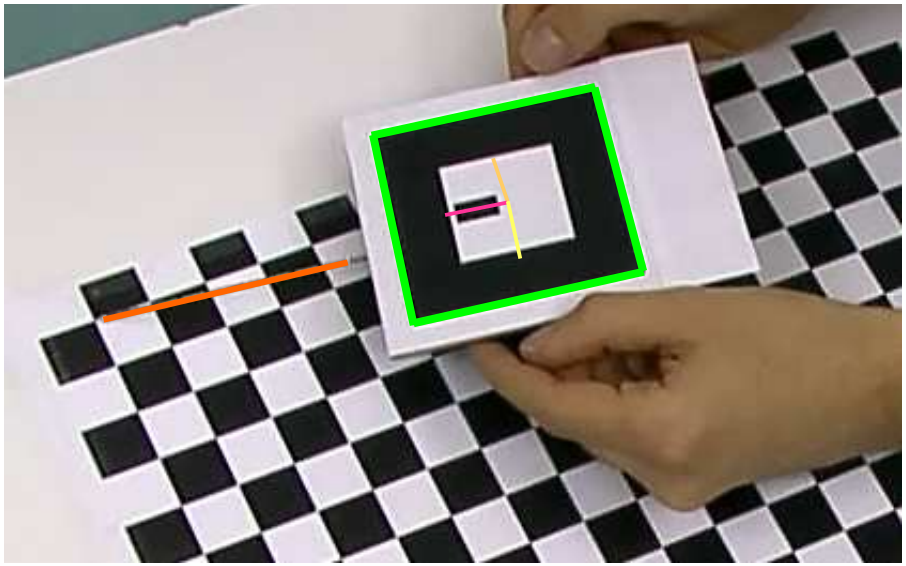
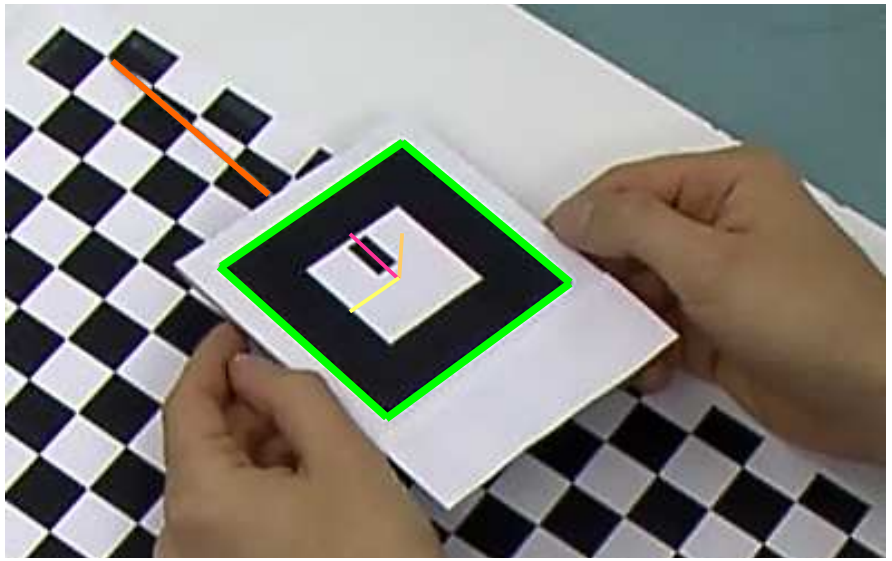
Automatic Augmented reality

Automatic Tools
Positioning & Tracking
Marker placement





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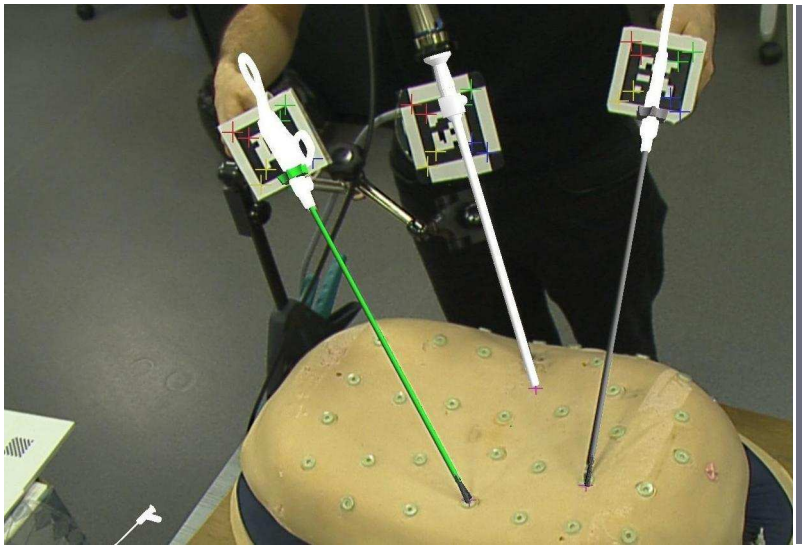

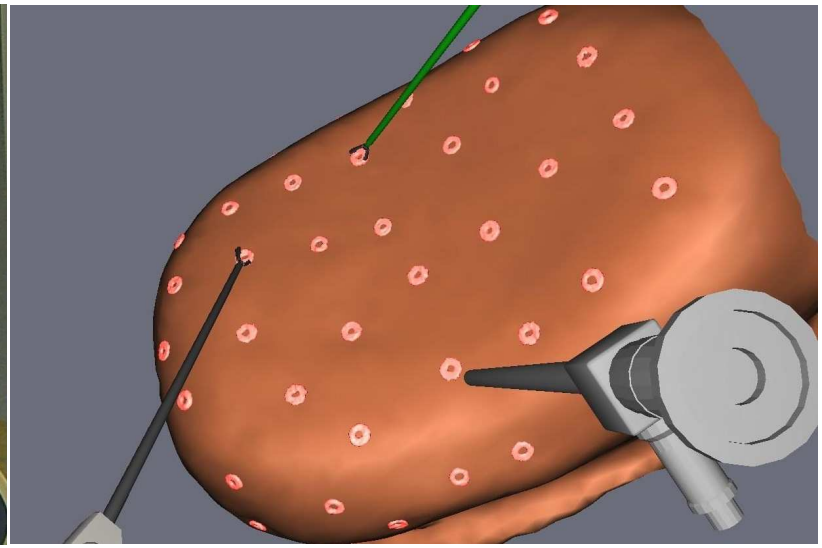

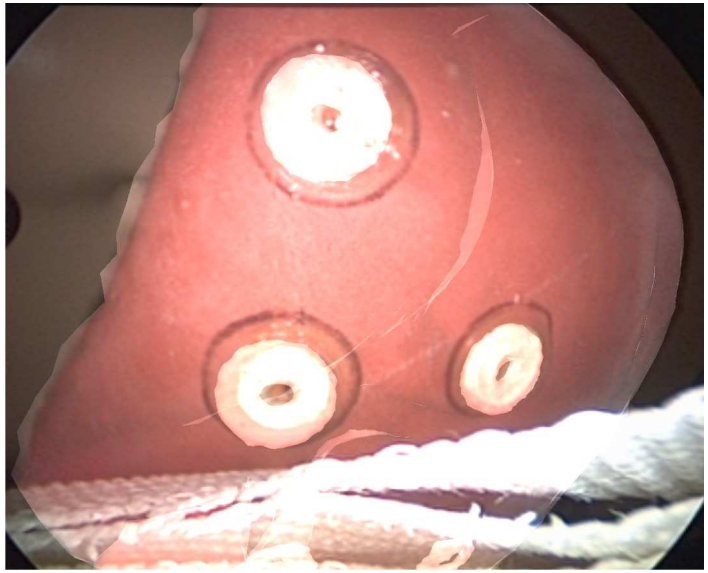

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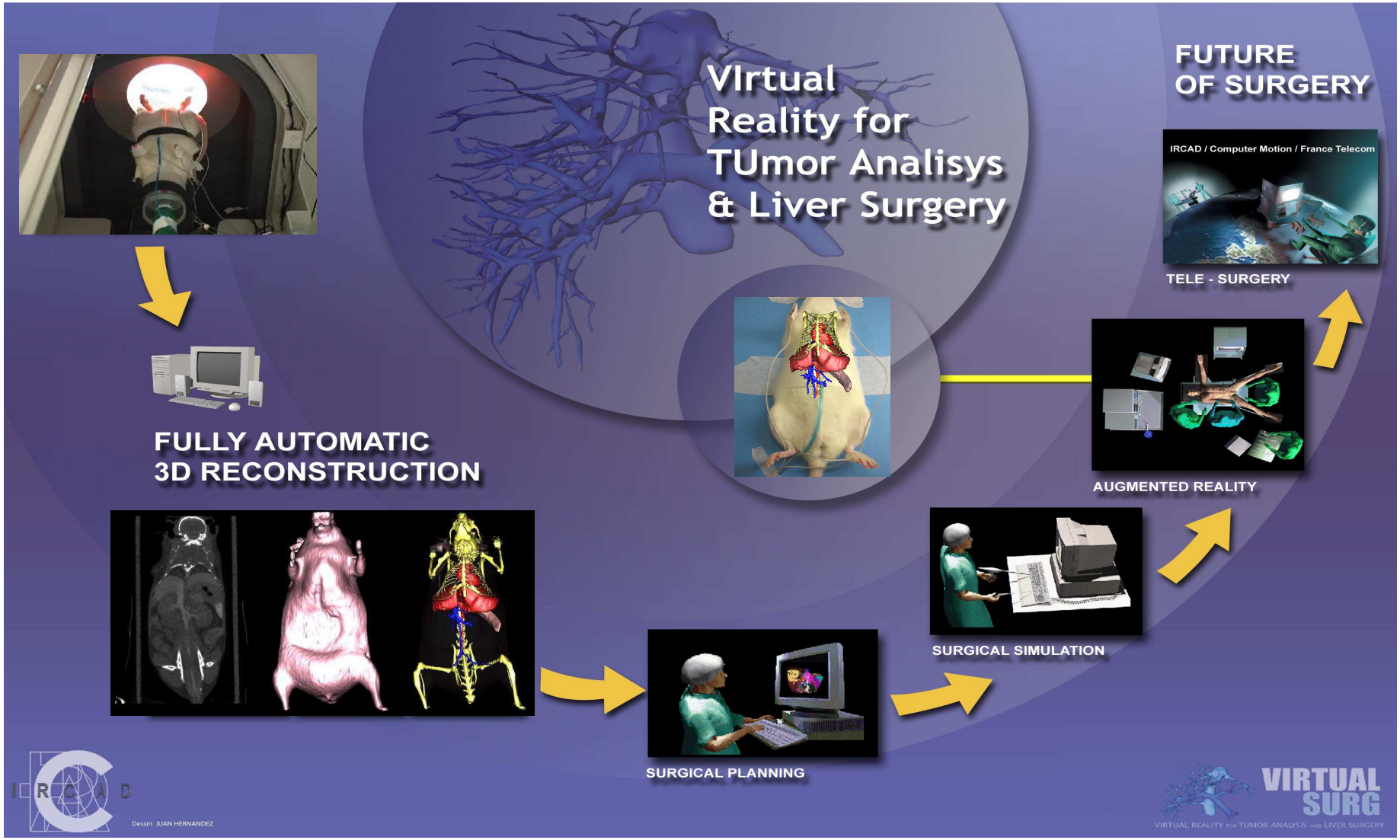
Preclinical Augmented Reality



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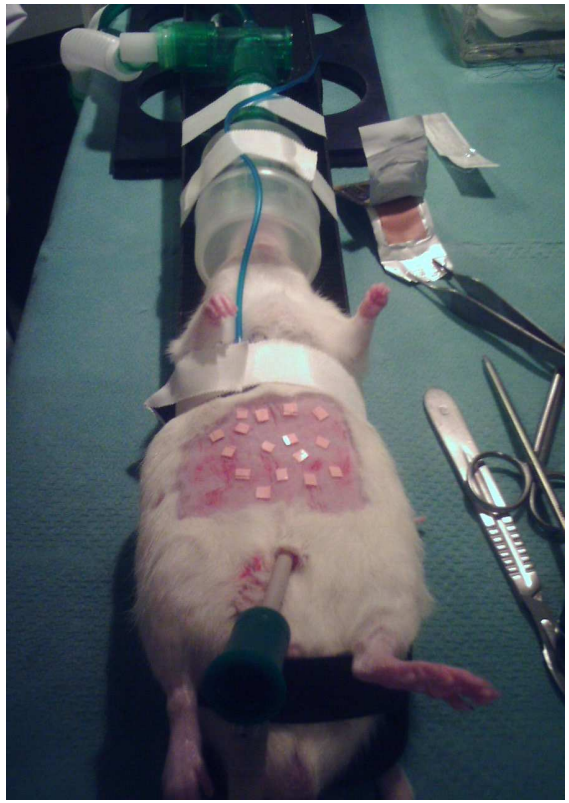
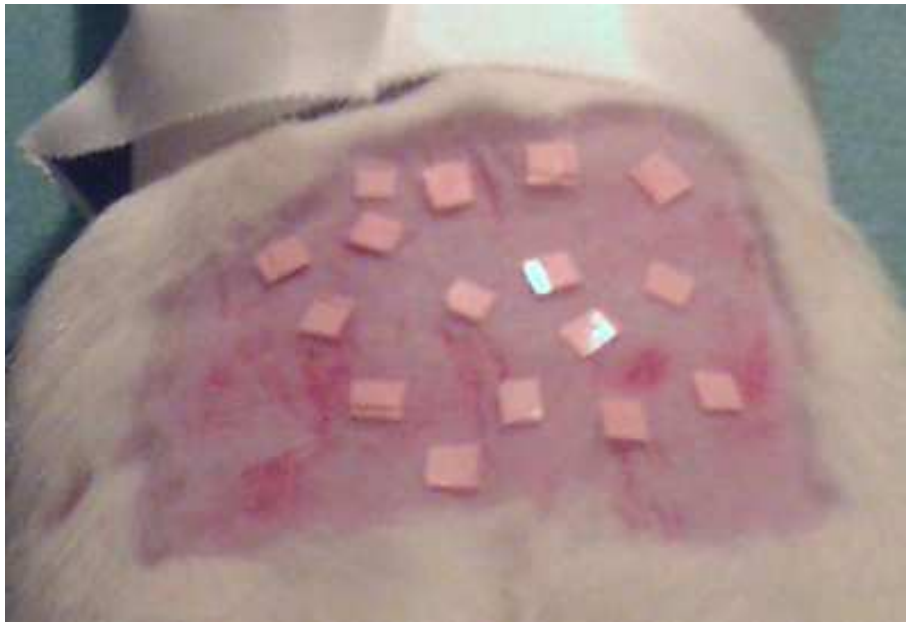
Automatic Augmented Reality

Preclinical studies on rats

First step : positionning of skin markers





Easy Shave of the animal with Depilatory cream

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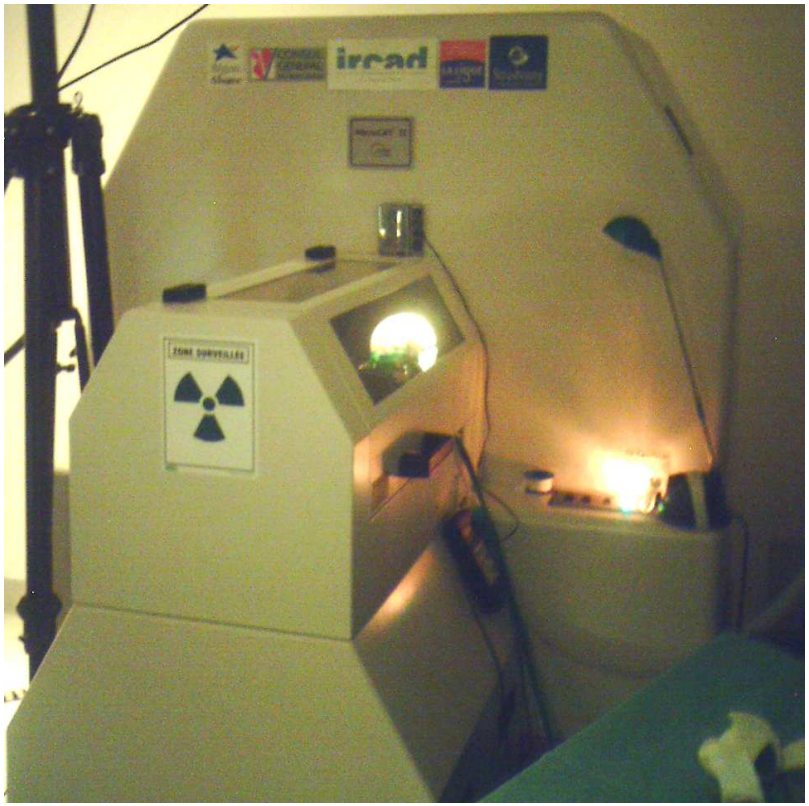
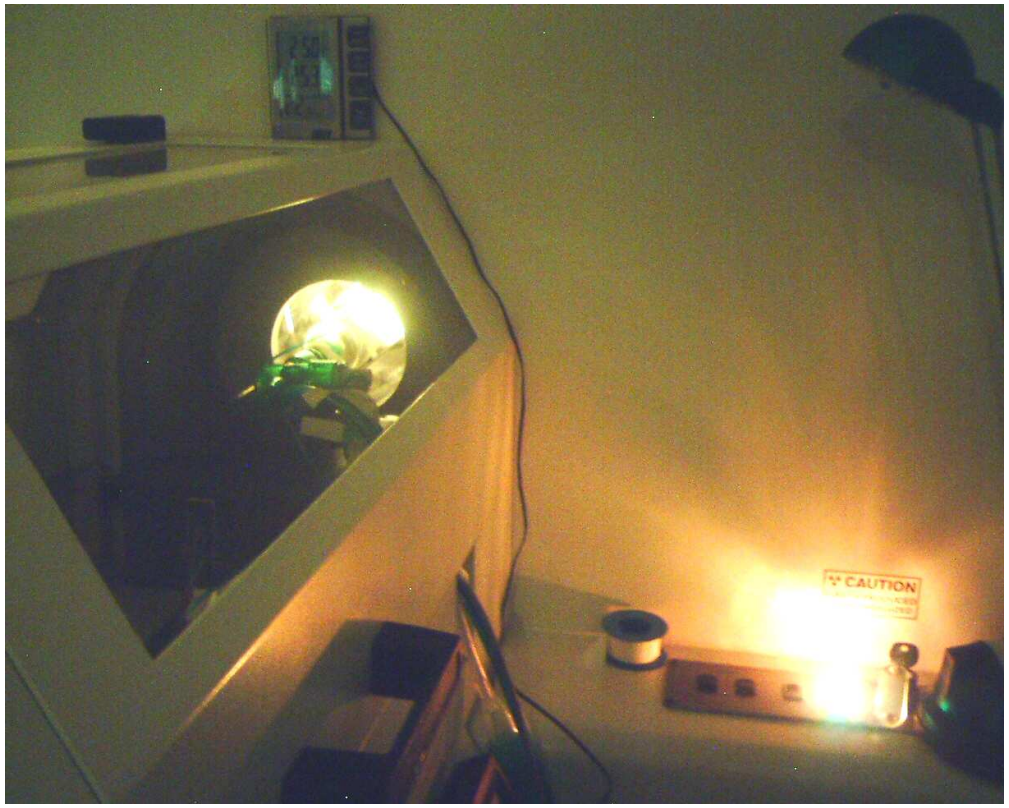
Automatic Augmented Reality

Preclinical studies on rats

Second step : CT-scan of the animal





1 hour after intra-venous contrast agent injection

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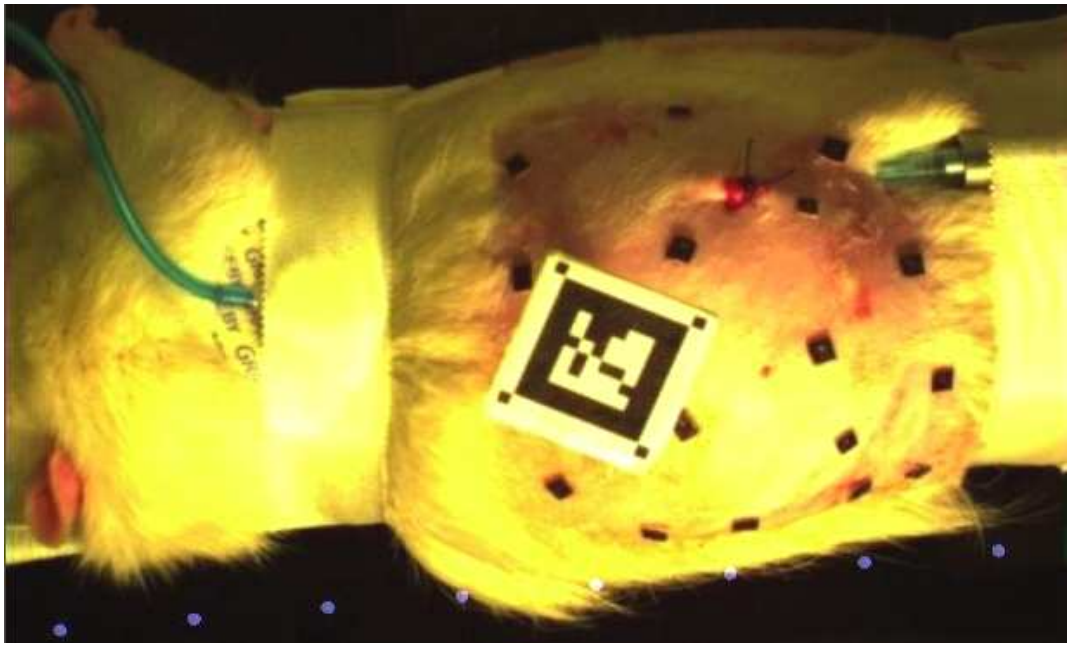
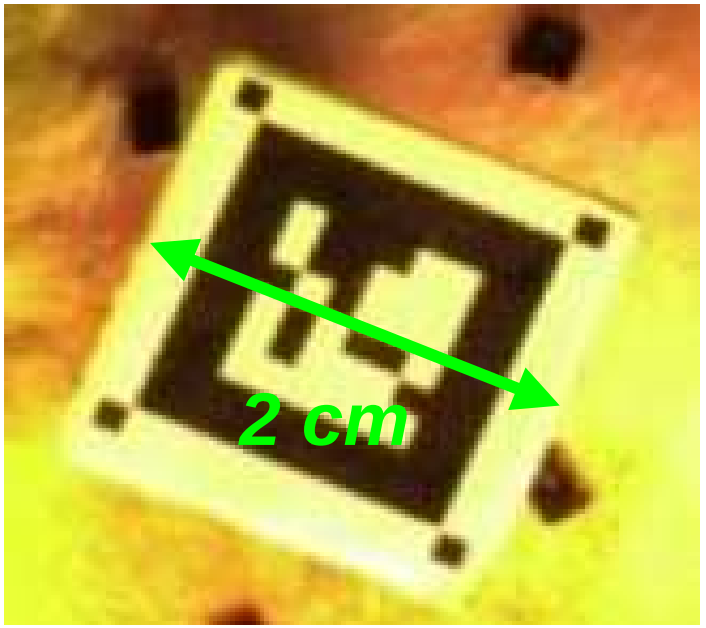
Automatic Augmented Reality

Preclinical studies on rats

Last step : Tracking of tool





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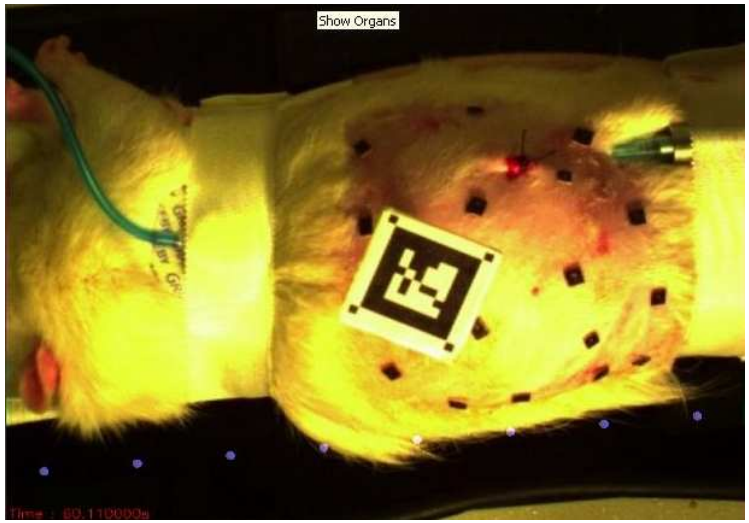
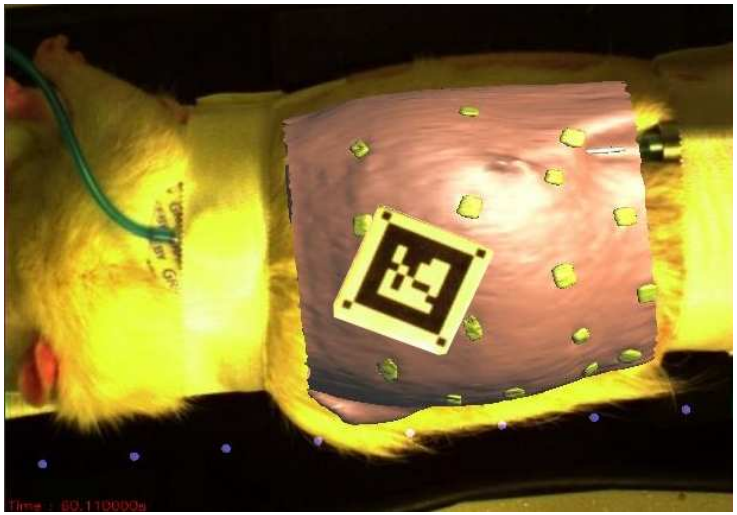
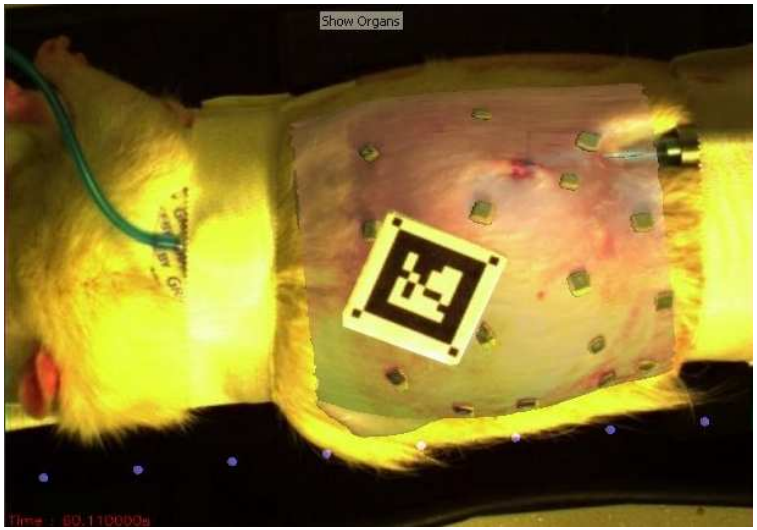
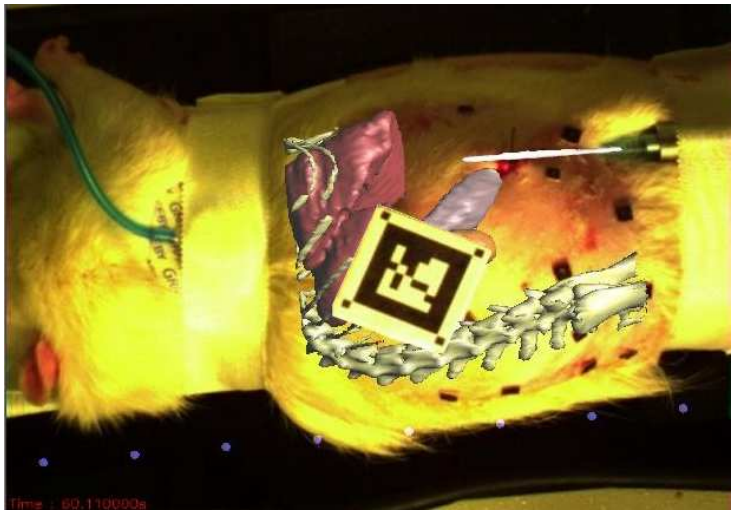
Automatic Augmented Reality









First Tests on rats

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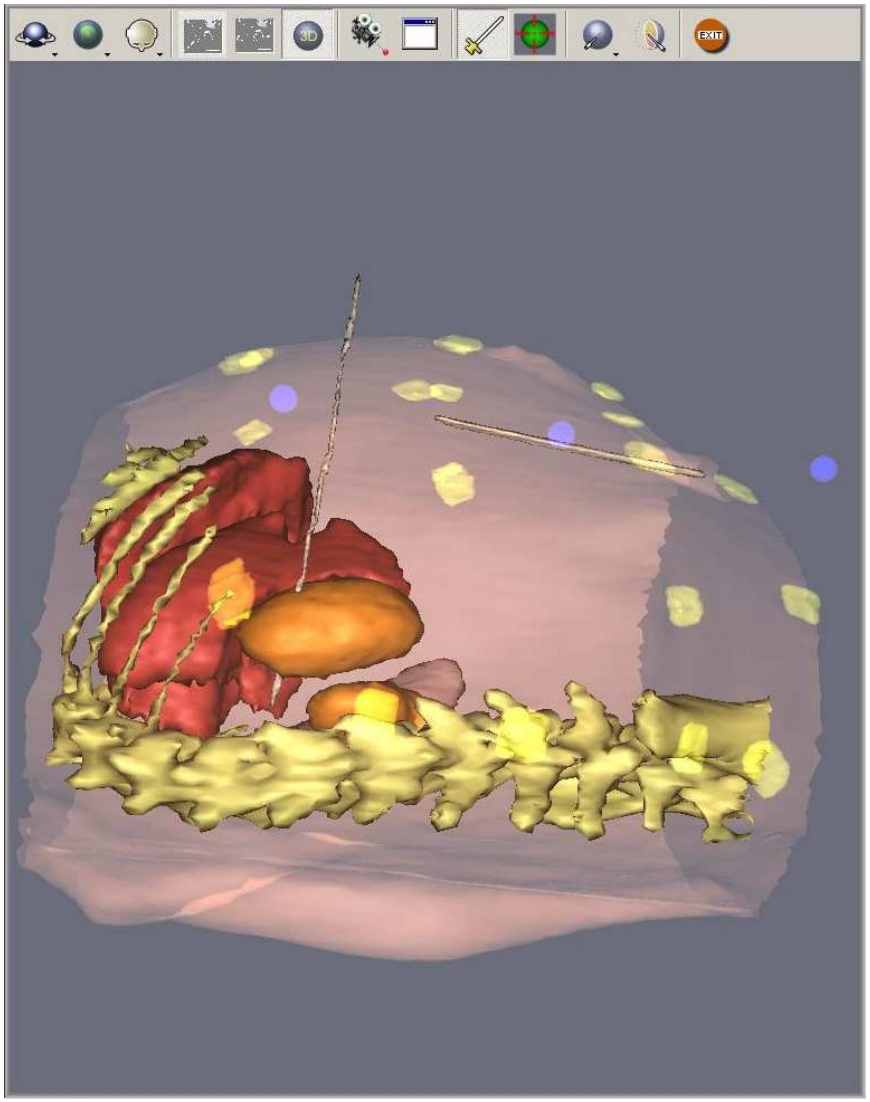
Automatic Augmented Reality



First Tests on rats (second camera)

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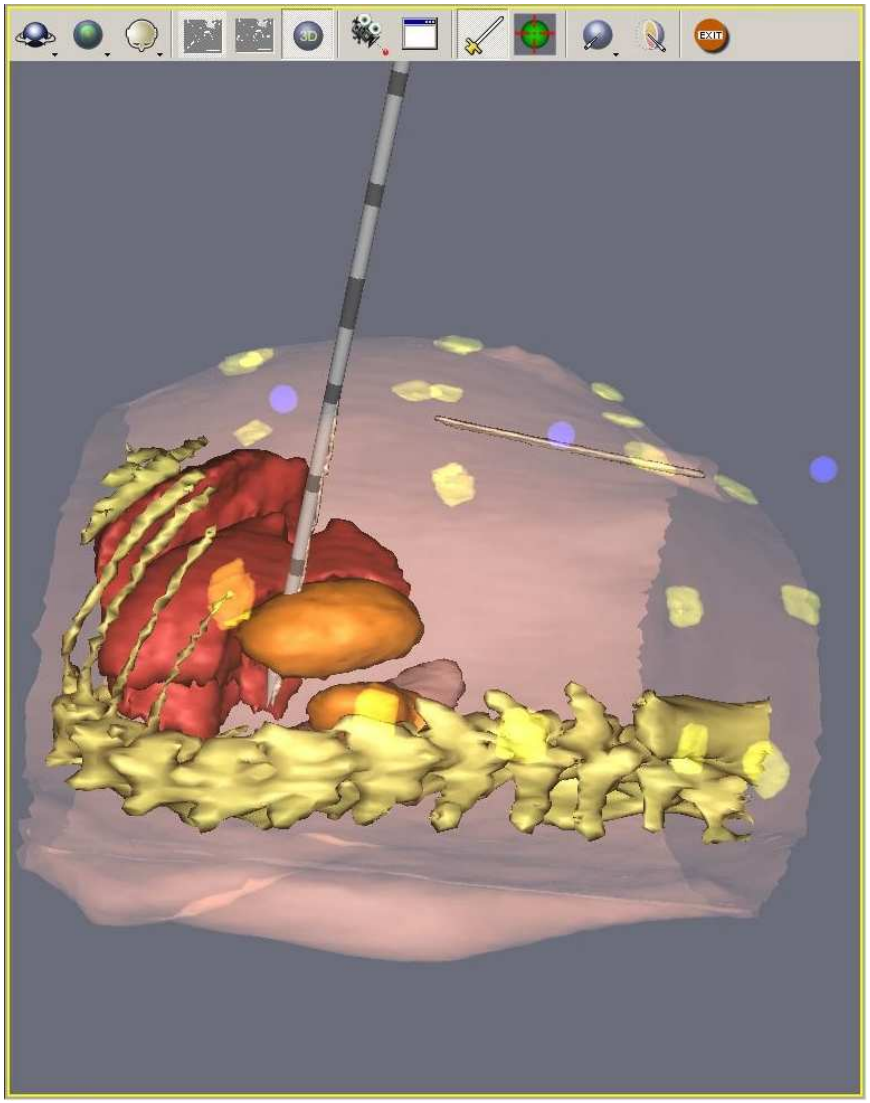
Automatic Augmented Reality



First Tests on rats (second camera)

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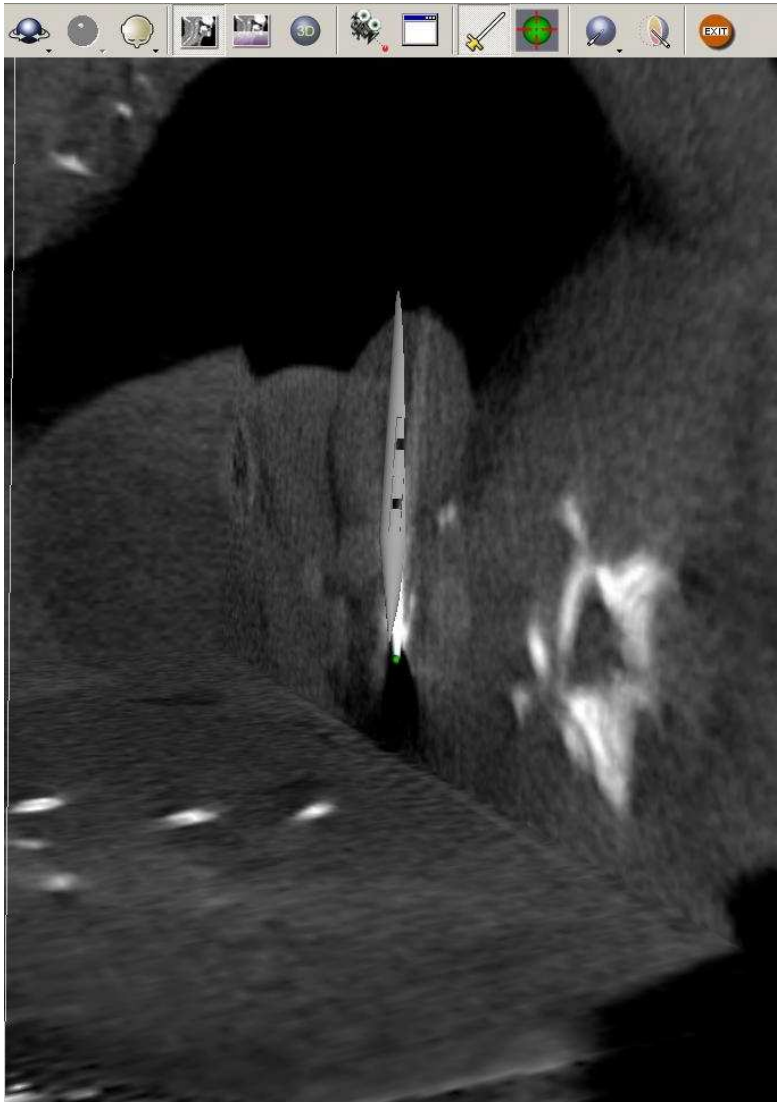
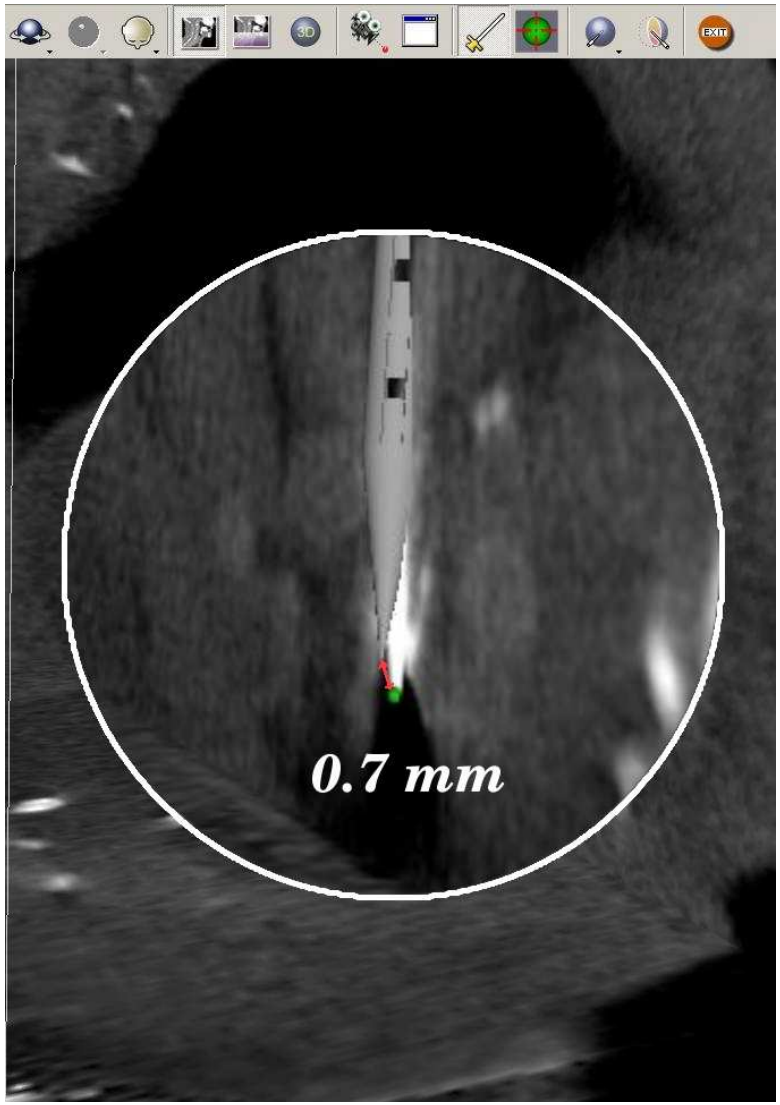
Automatic Augmented Reality





First Tests on rats (CT-scan control)

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Interactive Augmented reality

LIMITS

- ~~Manual Registration of Virtual & Real~~
- ~~Manual Tools Positioning & Tracking~~
- Manual Organs Tracking
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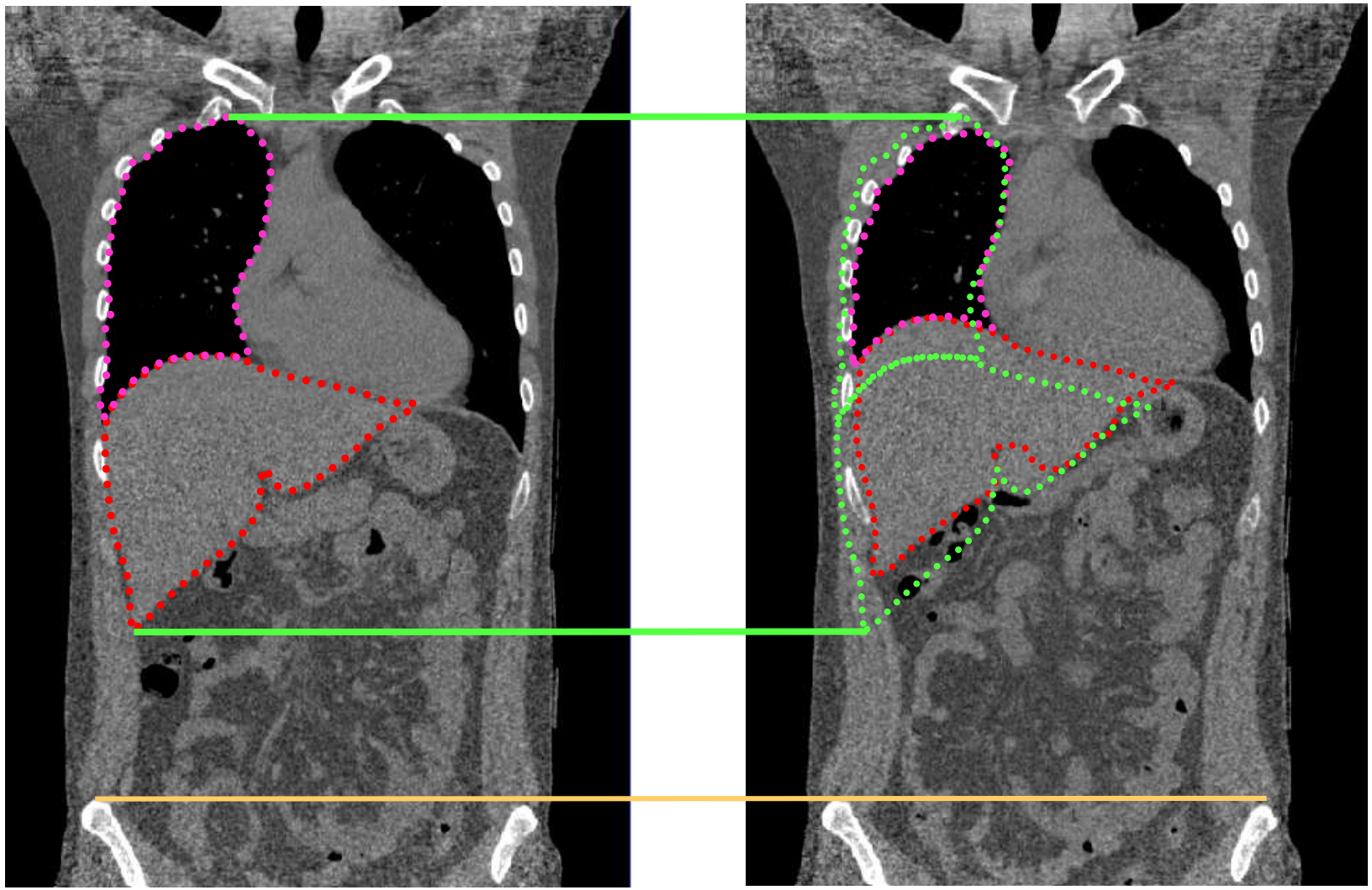
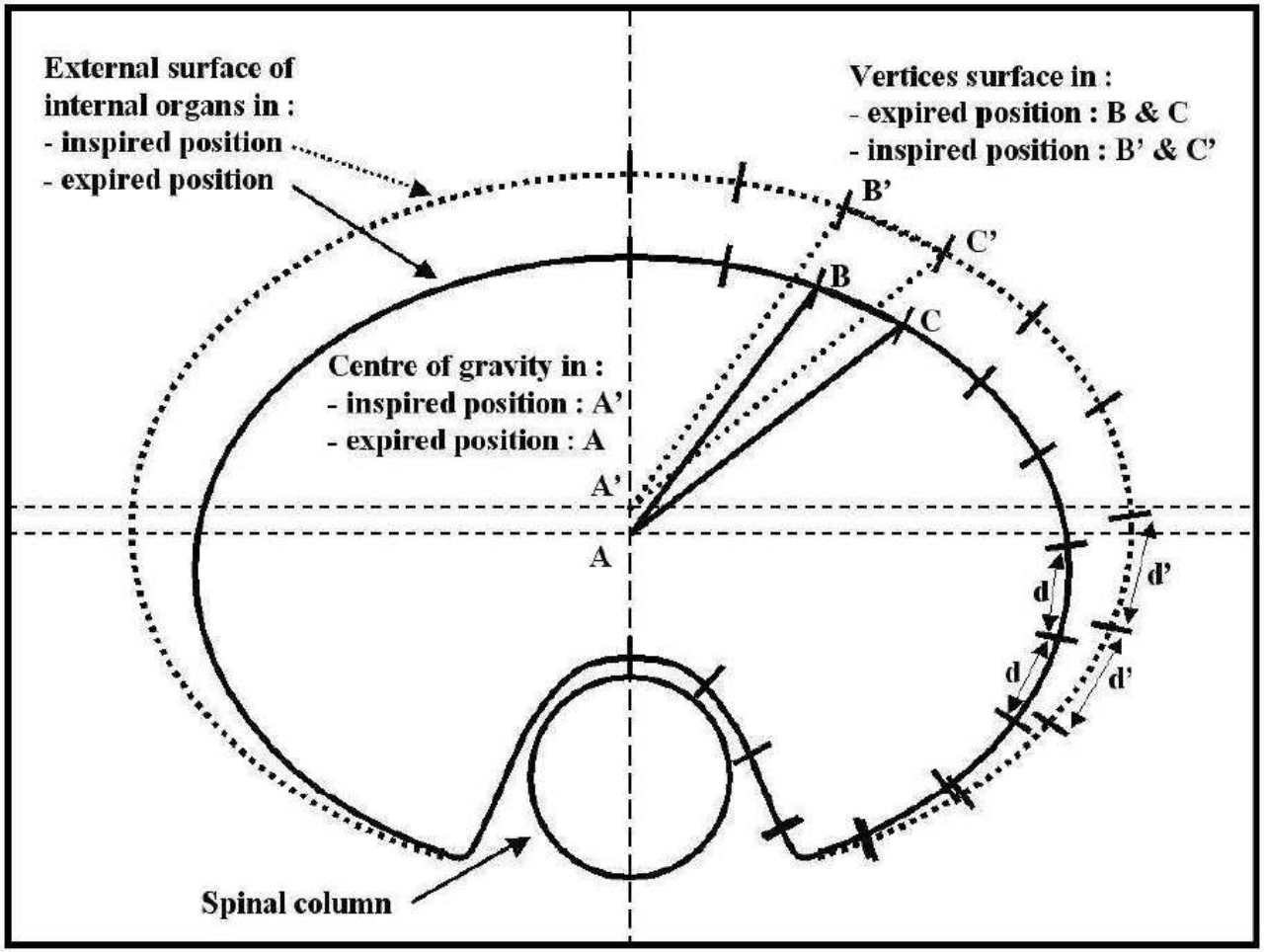
Augmented Reality



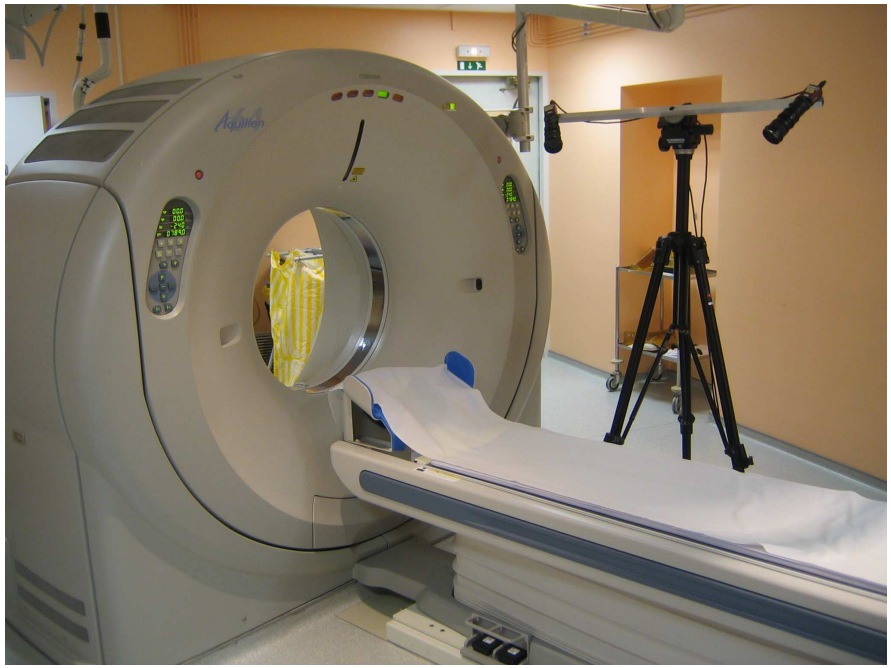
Internal organ motion

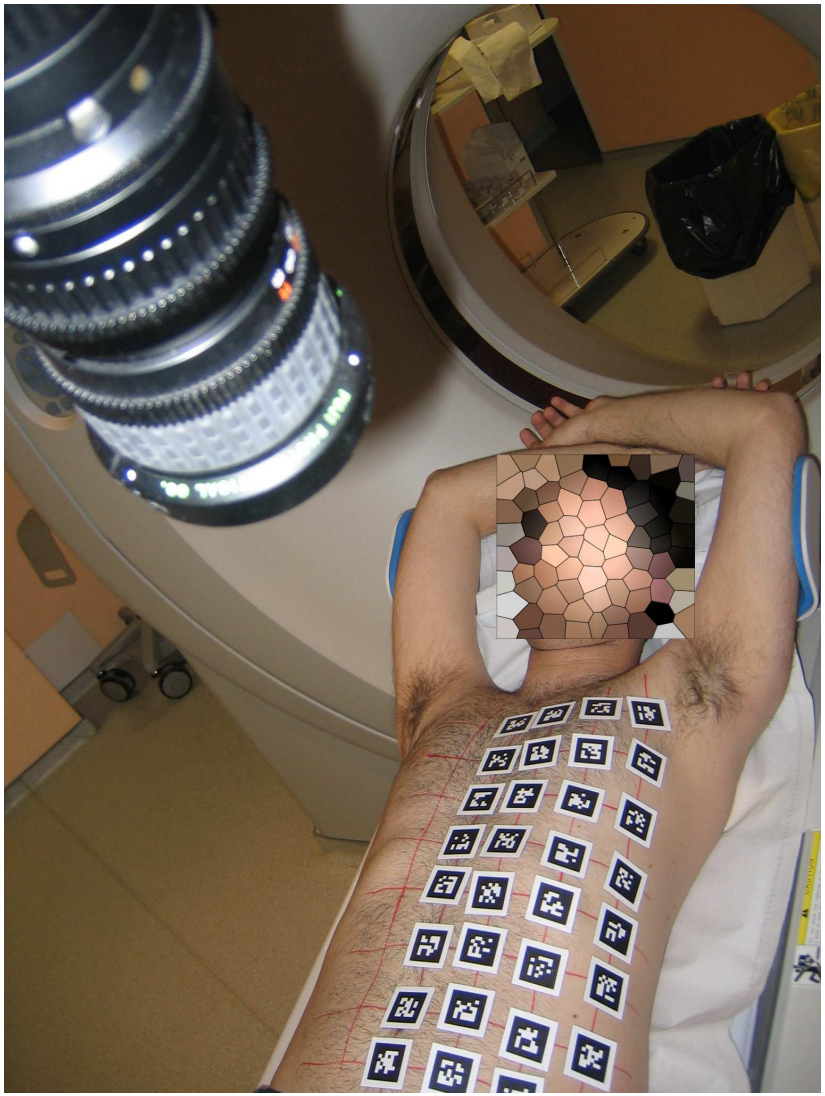
Augmented Reality



Deformation field generation

Augmented Reality





Set up for the human data acquisition

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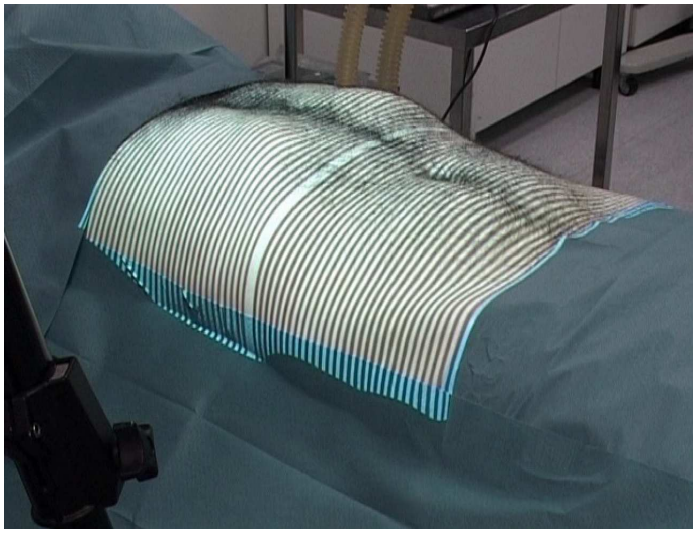
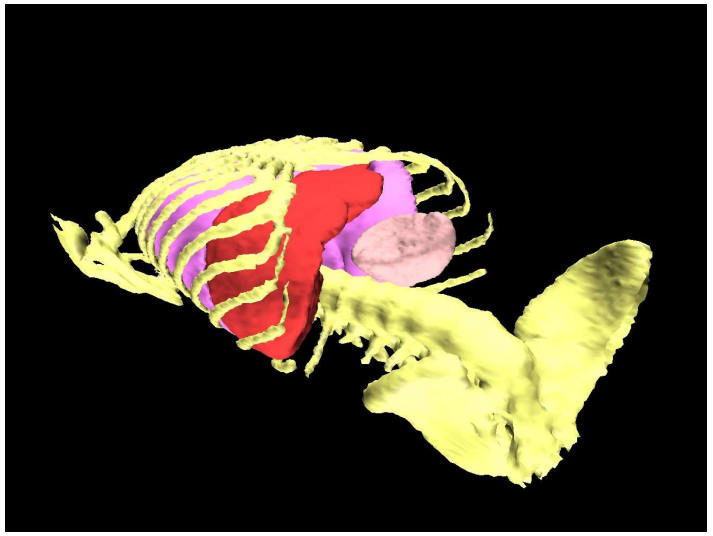
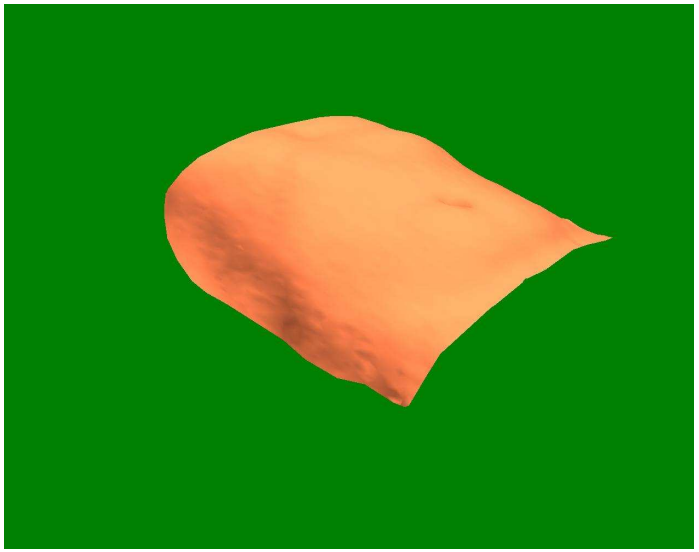
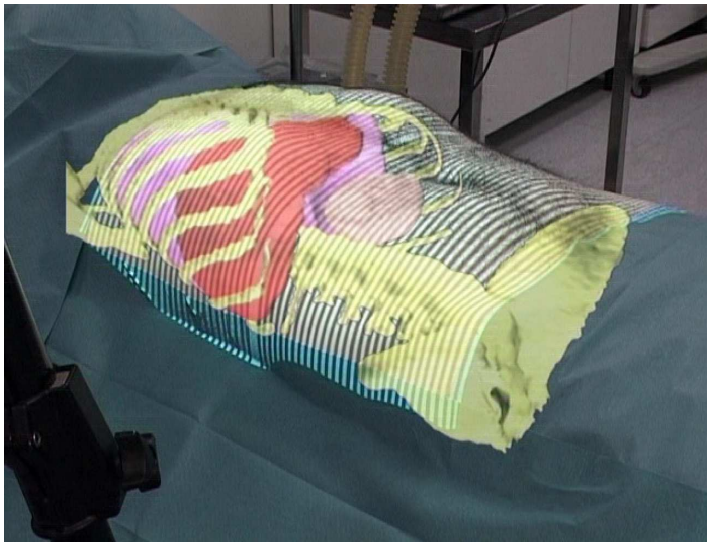
Structured light to replace markers









12 images/seconde

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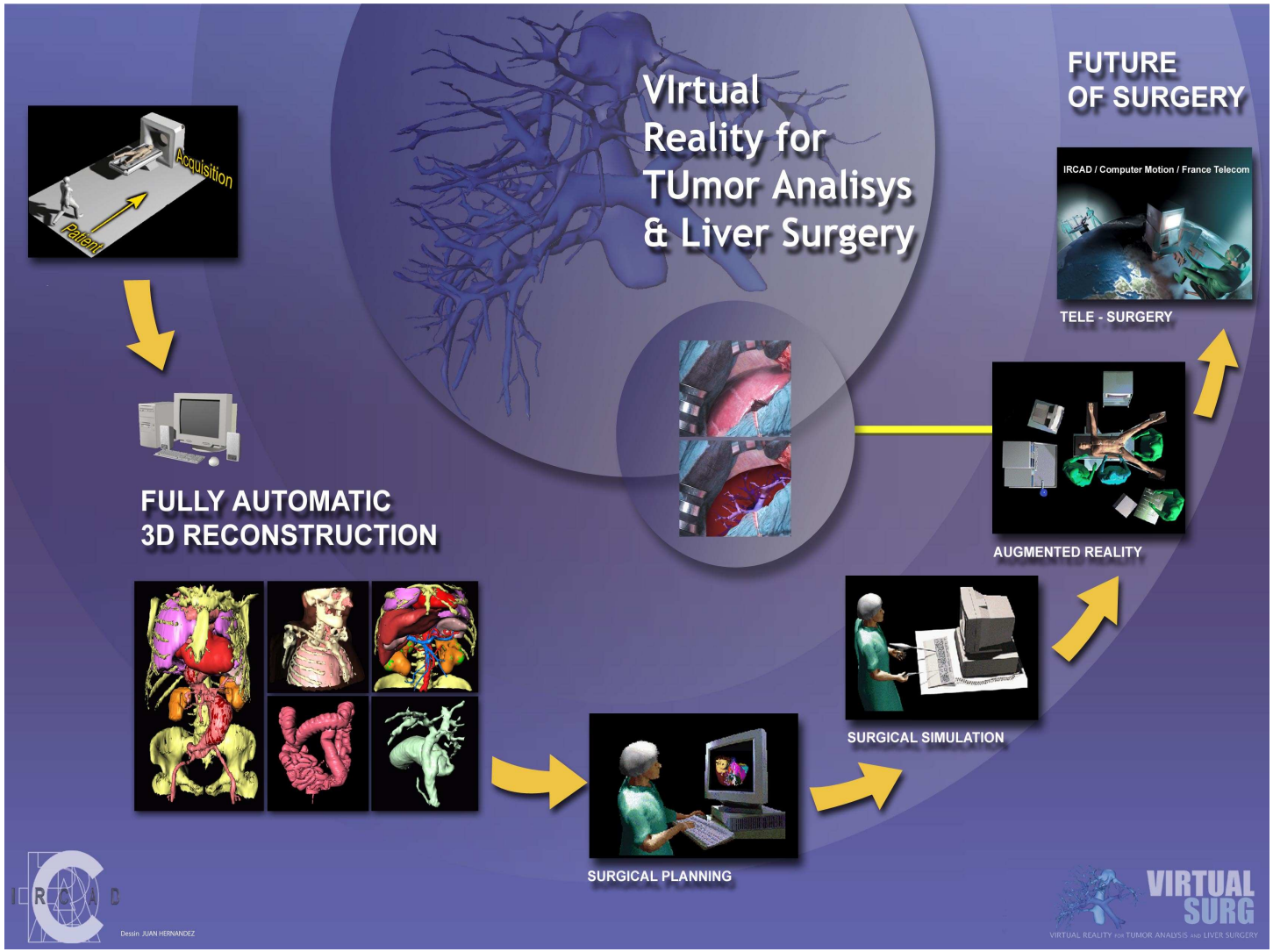
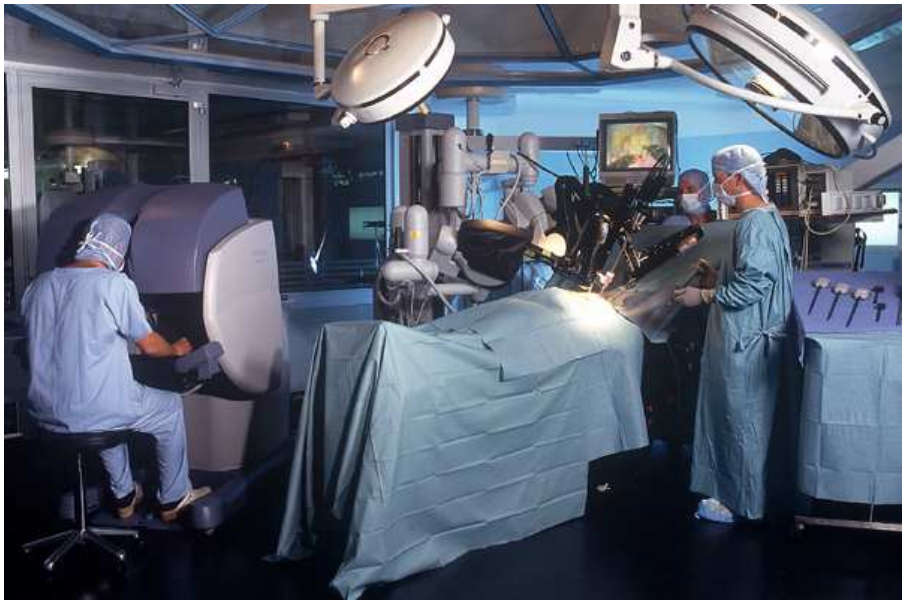
Robotics


VIrtual
Reality for
TUmor Analisys
& Liver Surgery
FUTURE
OF SURGERY
Acquisition
Patient
IRCAD / Computer Motion / France Telecom
TELE - SURGERY
FULLY AUTOMATIC
3D RECONSTRUCTION
AUGMENTED REALITY
SURGICAL SIMULATION
SURGICAL PLANNING
Dessin JUAN HERNANDEZ
VIRTUAL
SURG
VIRTUAL REALITY FOR TUMOR ANALYSIS AND LIVER SURGERY

Robot : TeleSurgery

2 Robots, 1 Society : Intuitive Surgical

Da vinci



Zeus

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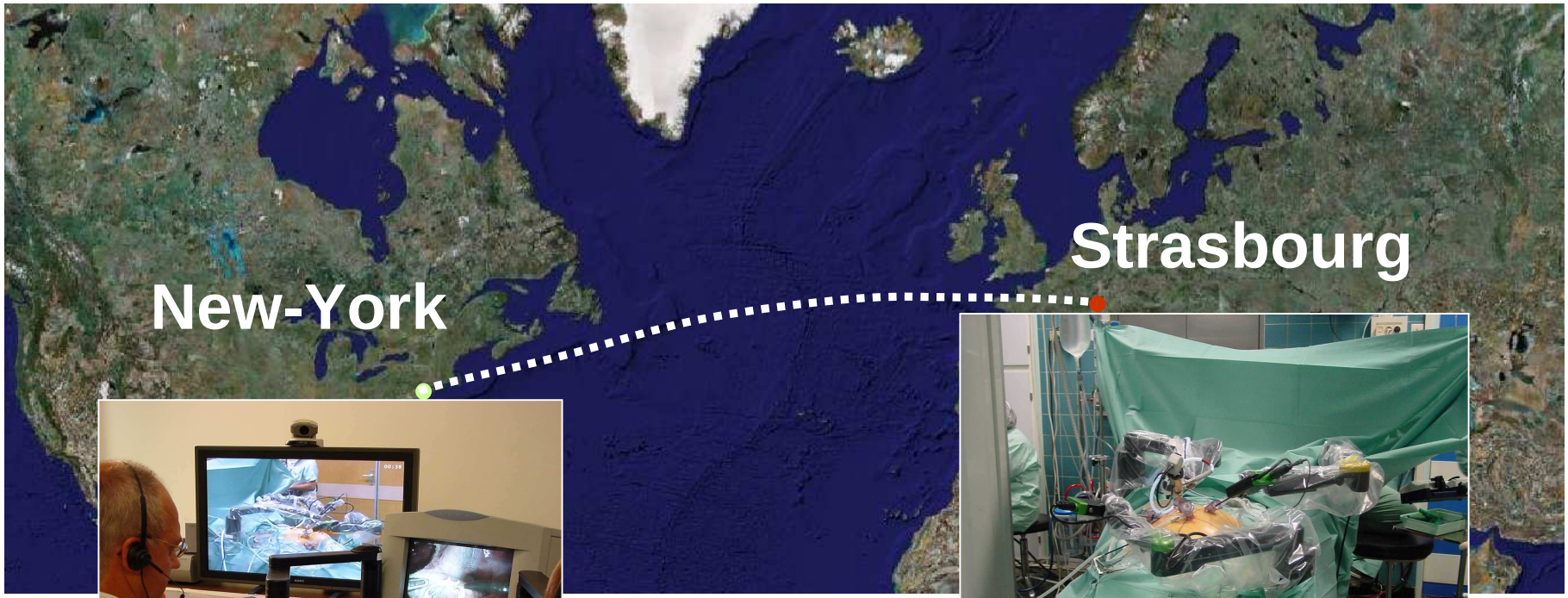
Robotics : An information system

Lindbergh Surgery : September the 7th 2001



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A medical revolution ?...

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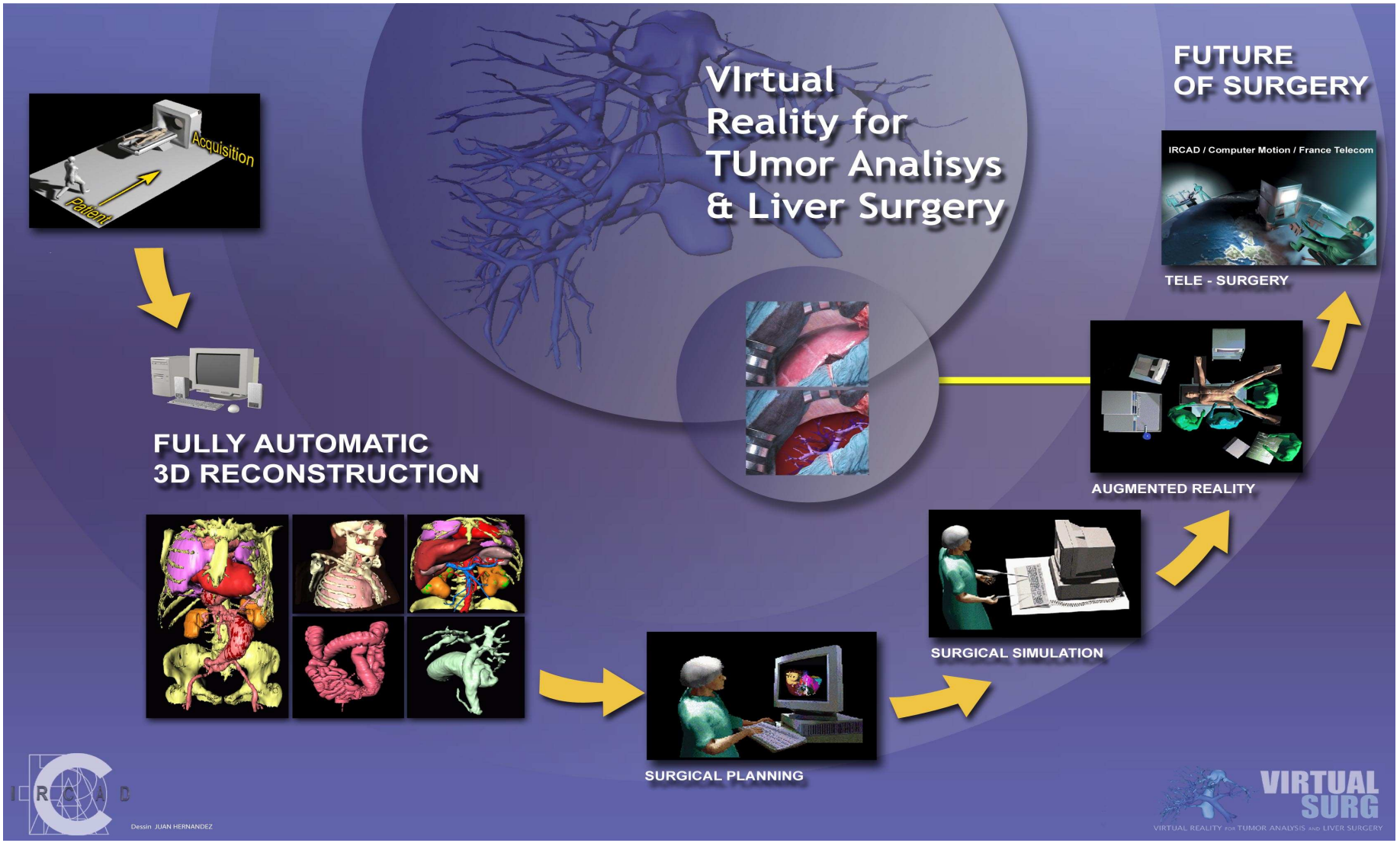
Robotic Tele-mentoring

*Courtesy of **InTouch Health***

Robotics → Automation



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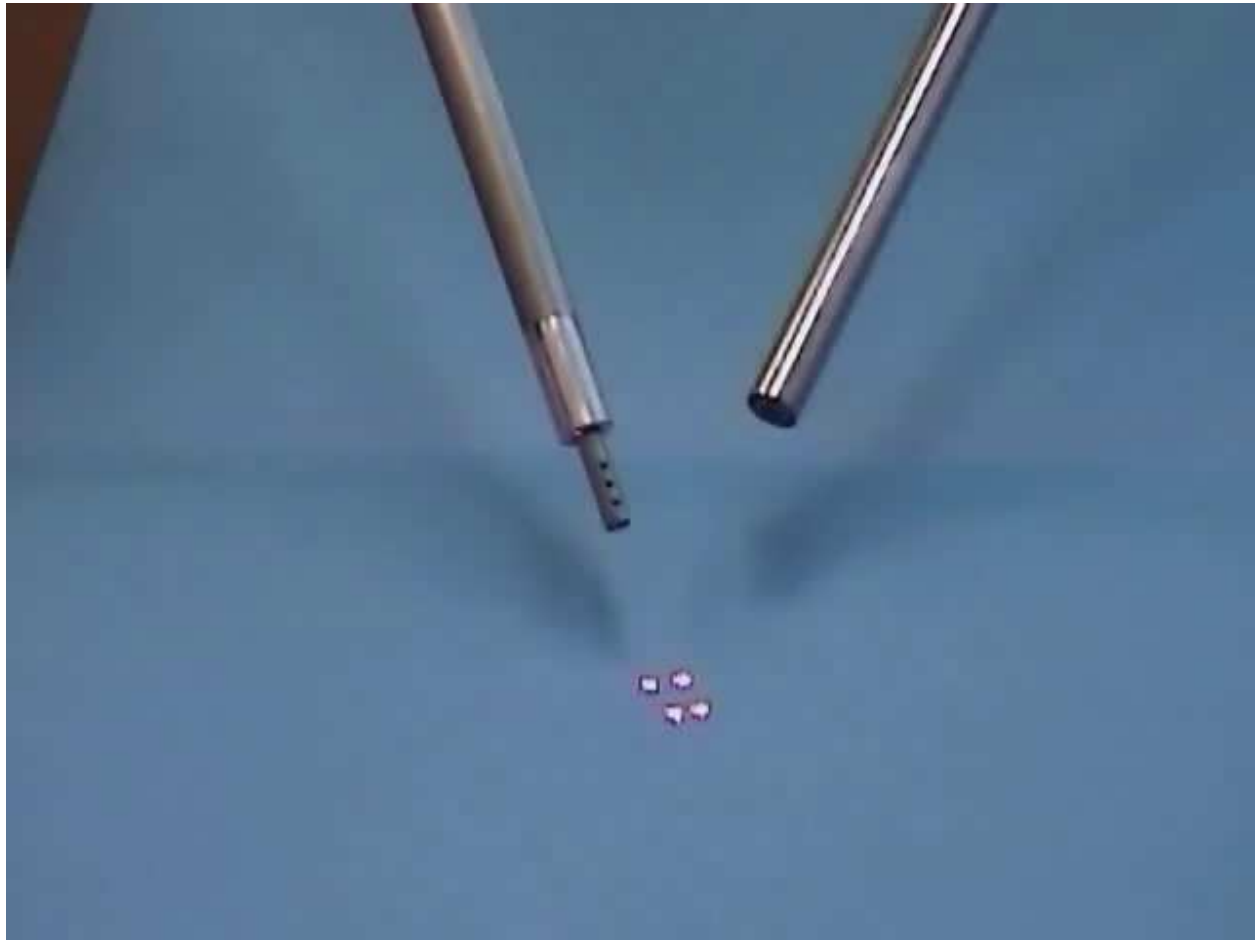
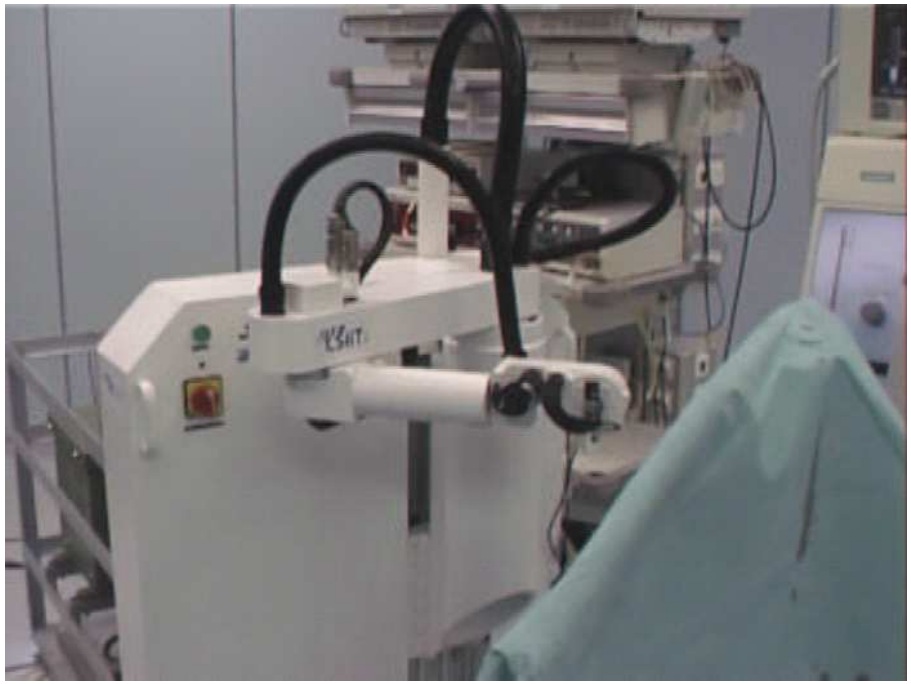
Automated Robotics

Visual Control



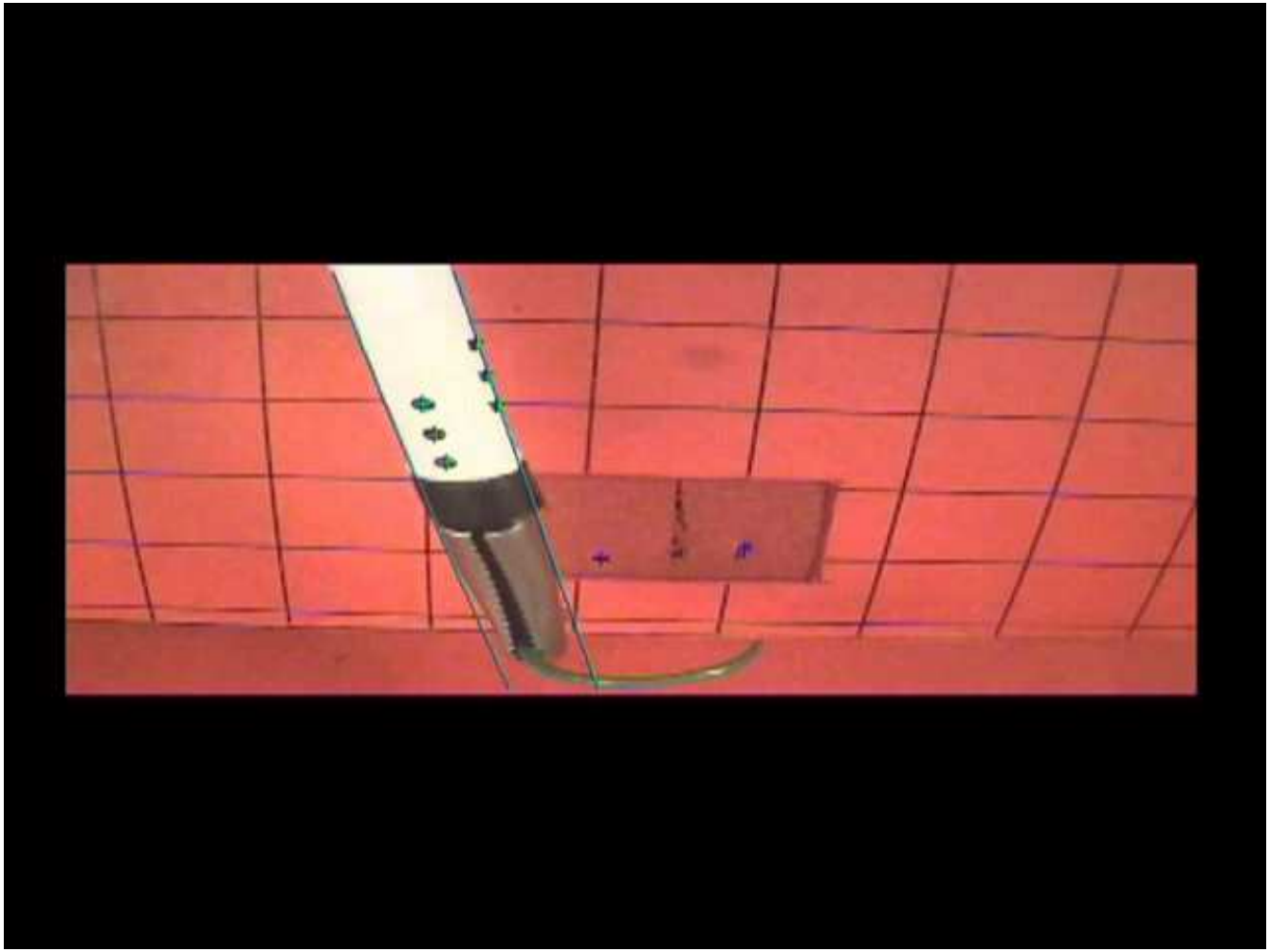
Automated Robotics

Visual Control



Automated Robotics

Visual Control



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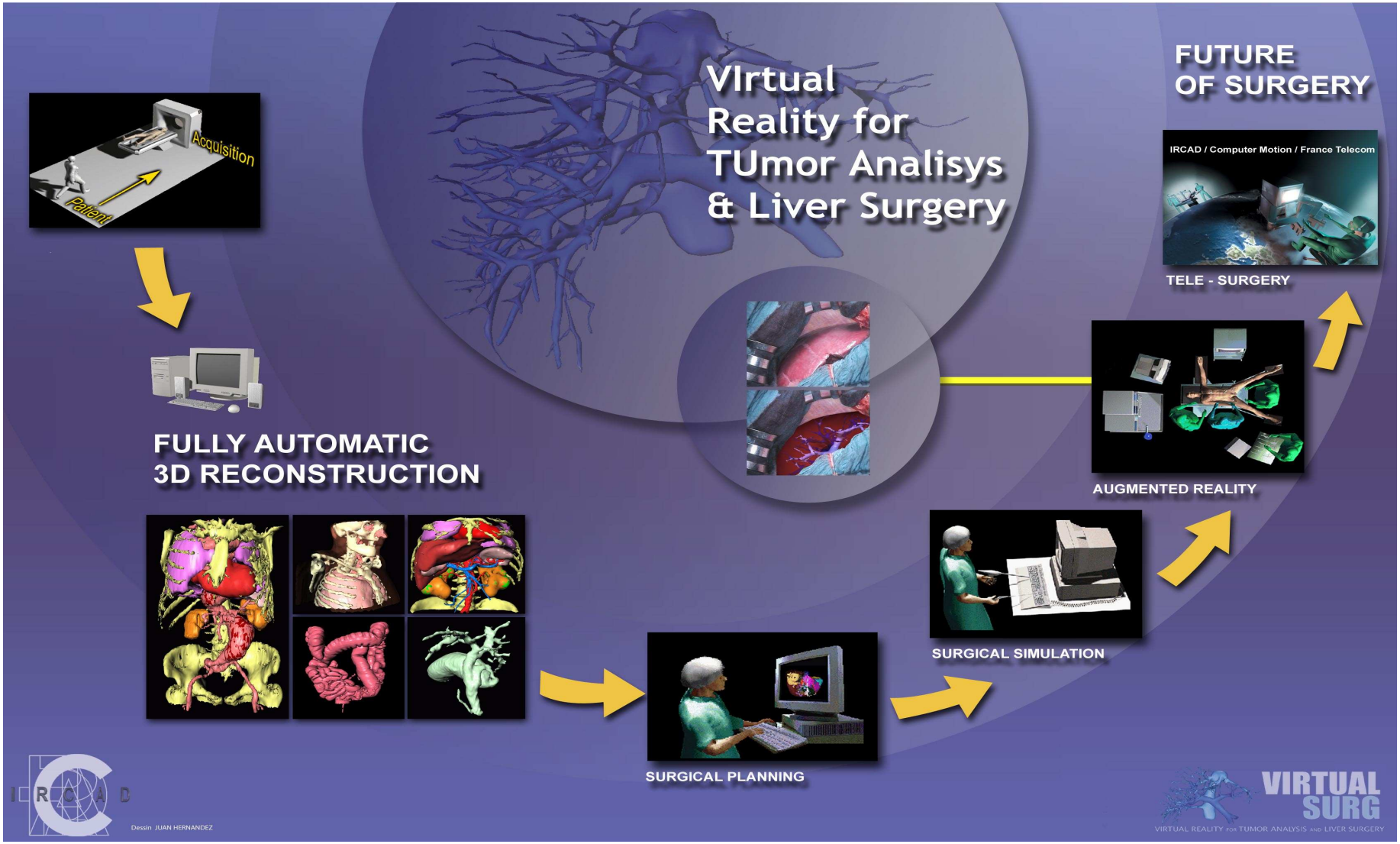
Next Step : Without Visible Scare



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INNOVATIONS THERAPEUTIQUES
pôle de compétitivité

ANUBIS
1rst labelled Project

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LSiiT

STORZ KARL STORZ — ENDOSKOPE

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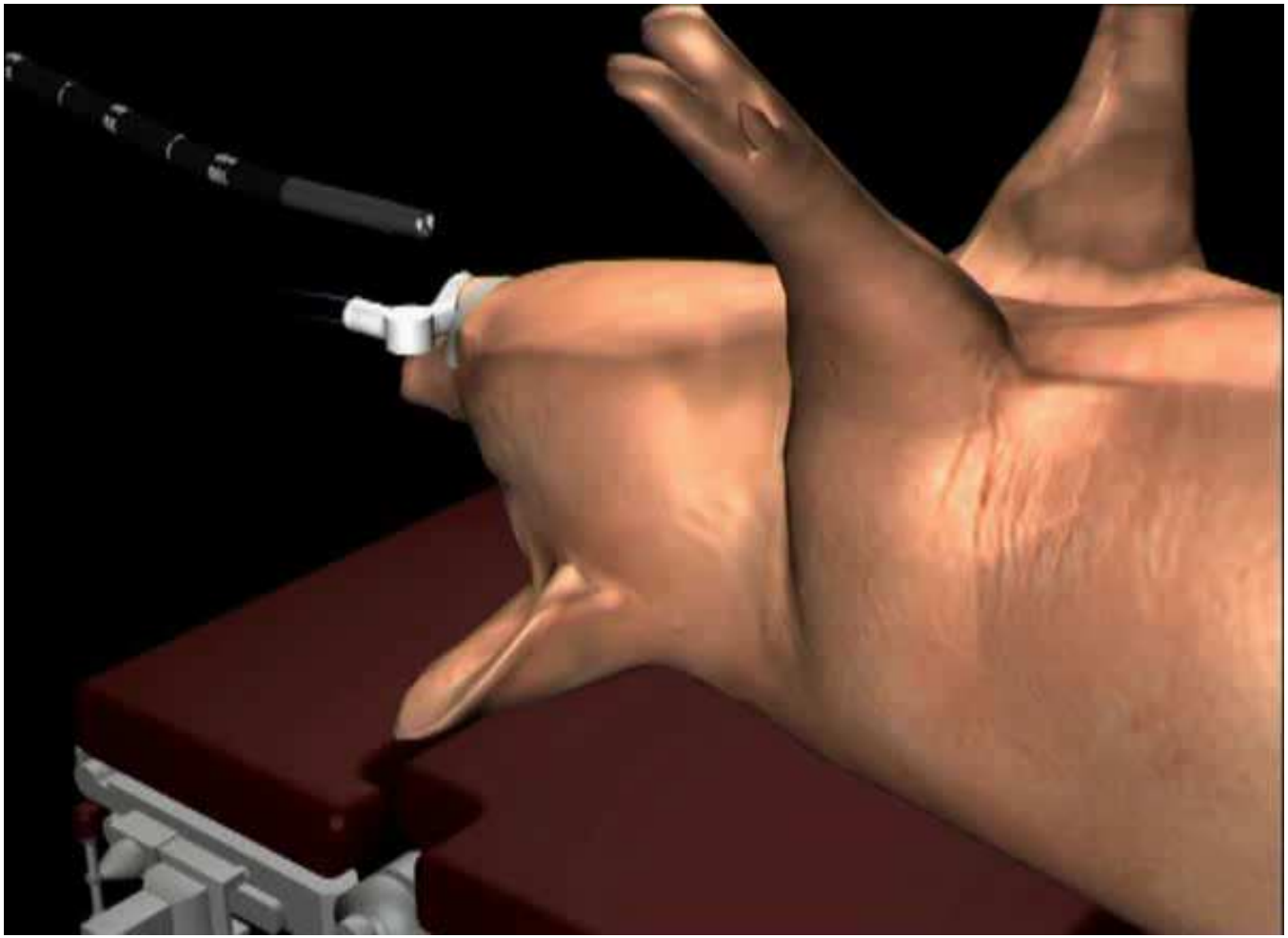
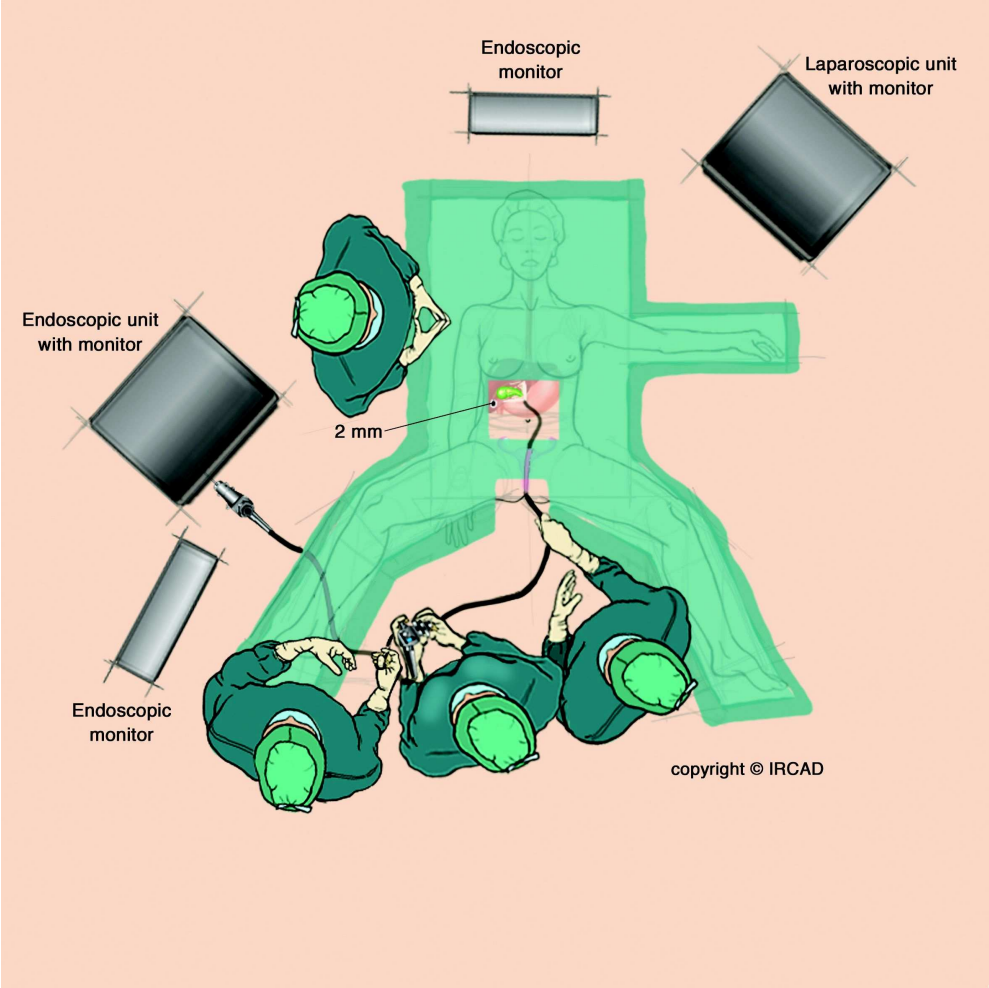
First System

Transgastric Surgery



First Woman Transluminal Surgery



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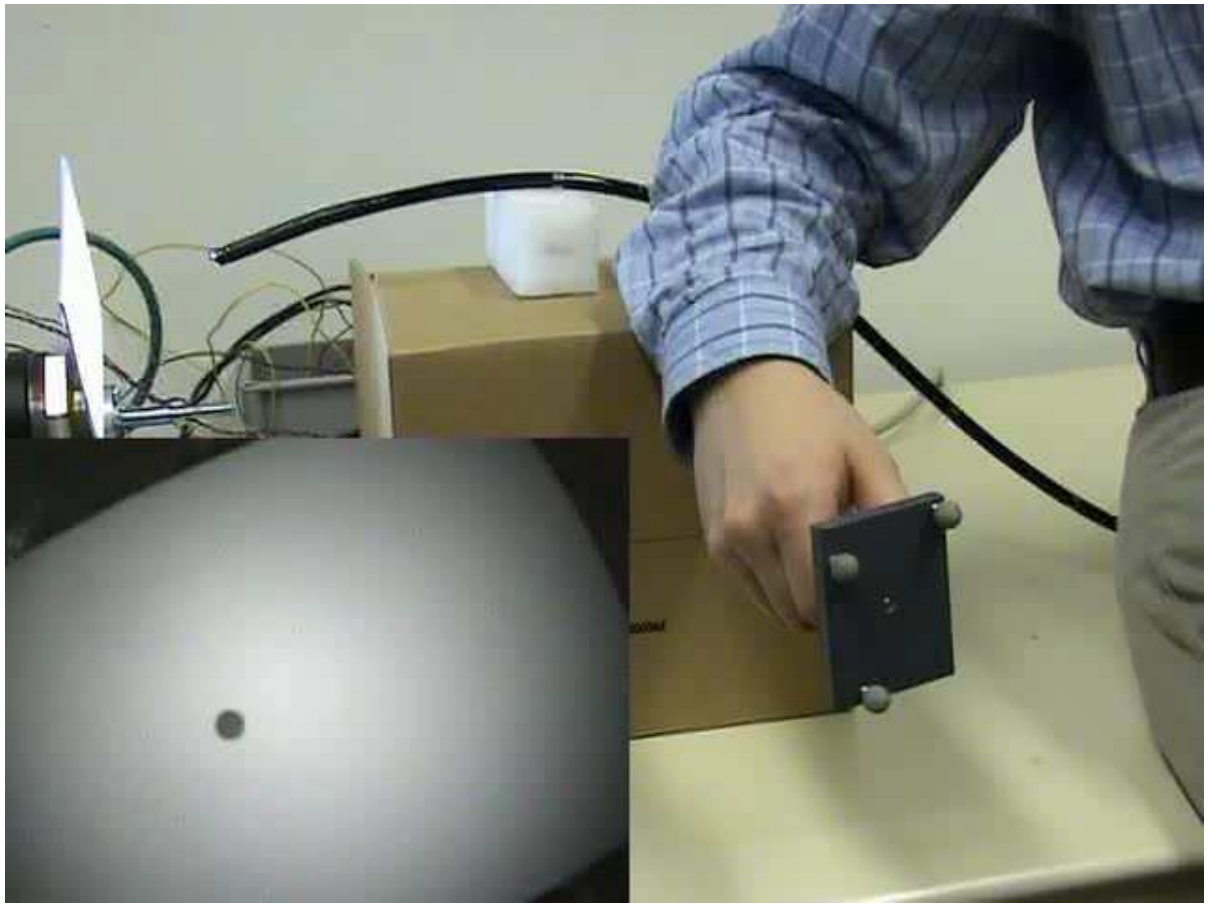
Anubis : Endoscope Robotisation

Easy interactive flexible endoscope control



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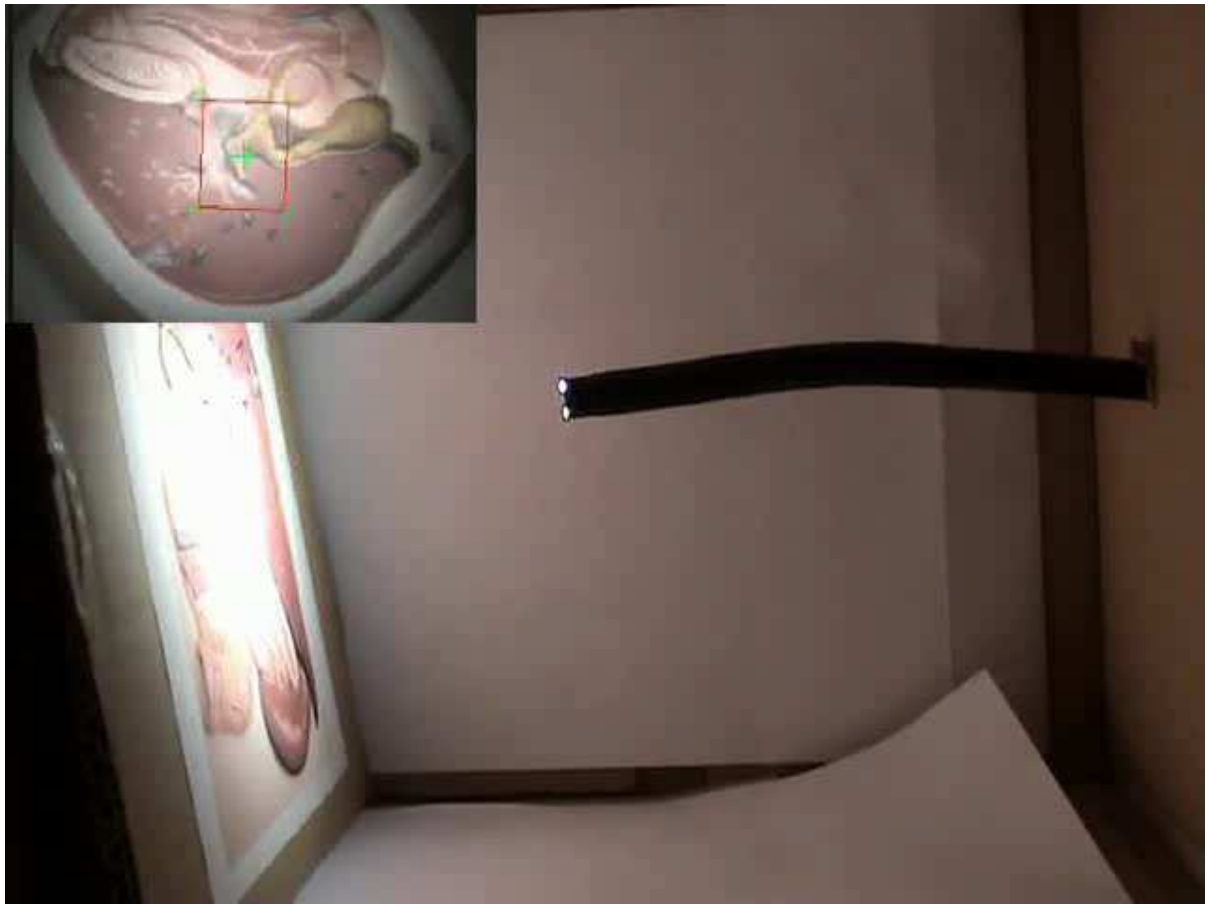
Anubis : Endoscope Robotisation

Automatic Flexible endoscope control



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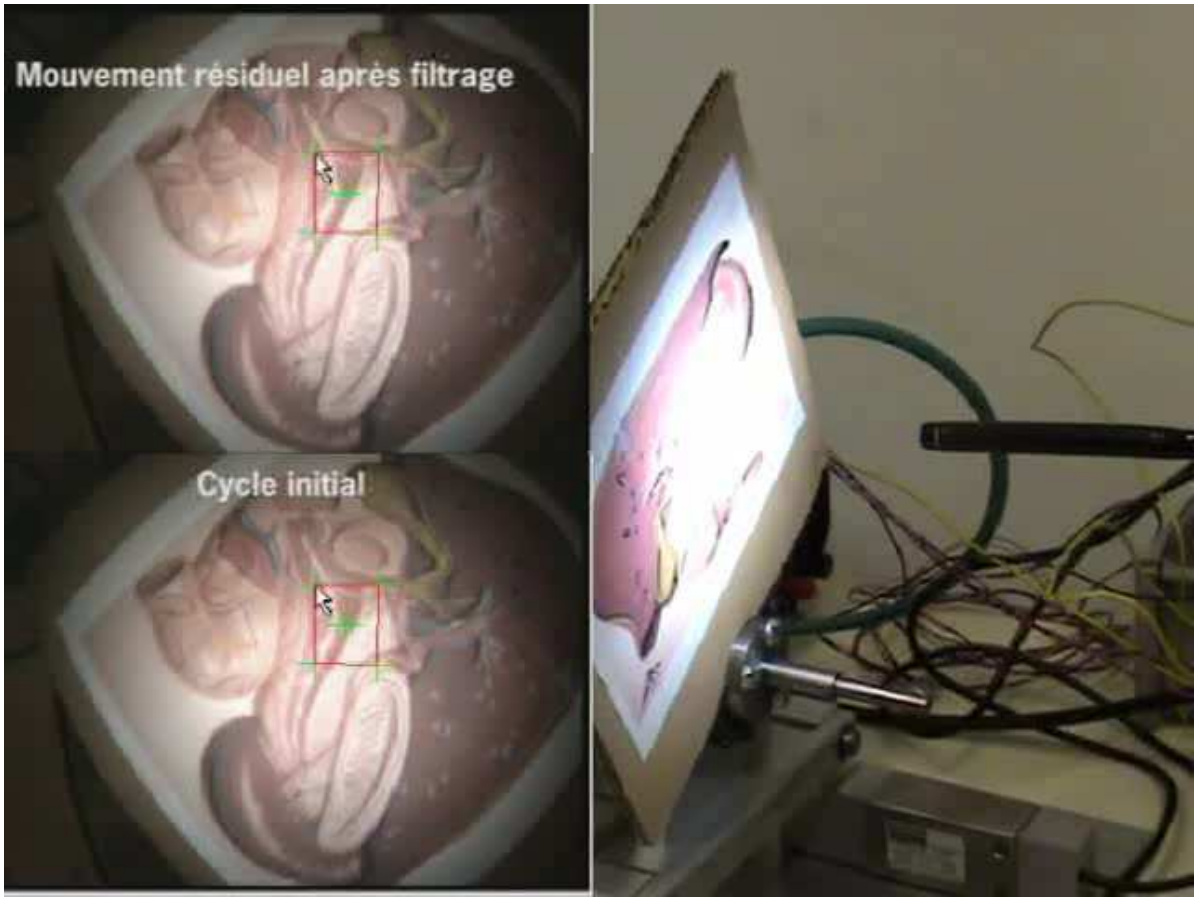
Anubis : Endoscope Robotisation

Automatic Flexible endoscope control



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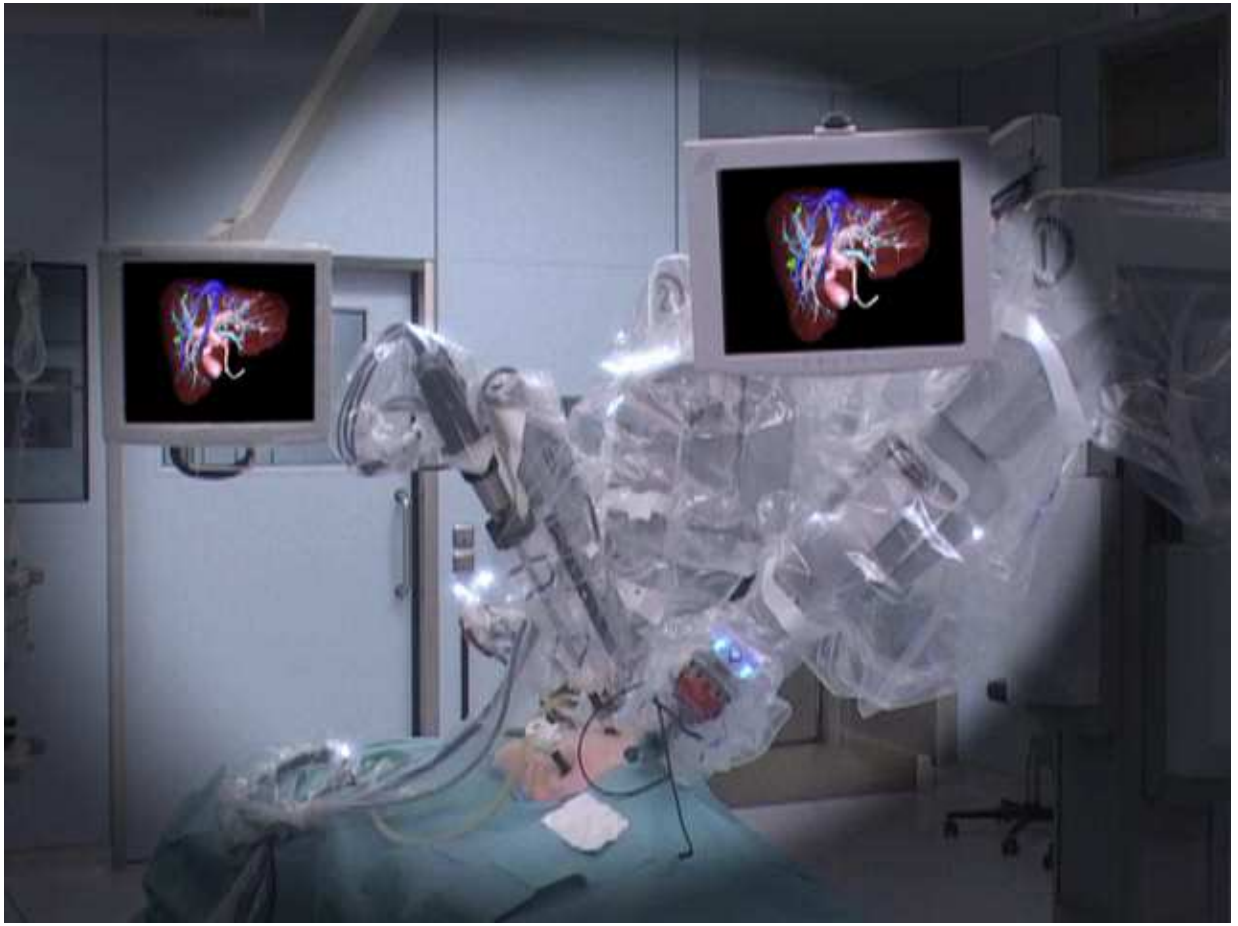
Conclusion

Automated procedure



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Conclusion

Robot for a better control of the surgery

Under the control of surgeons

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Thanks for your attention

R&D Team of IRCAD

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