Università degli studi di Pavia

Dipartimento di Ingegneria Civile e Architettura

Corso di laurea in Bioingegneria

Preoperative planning through CT data elaboration to minimize patient injury in heart surgery

Pianificazione preoperatoria attraverso l'elaborazione di dati TAC per ridurre al minimo le lesioni al paziente in cardiochirurgia

Supervisor: Prof. **Ferdinando Auricchio**

Co - supervisor: Dott. **Simone Morganti**

Pietro Canale

UIN 391485

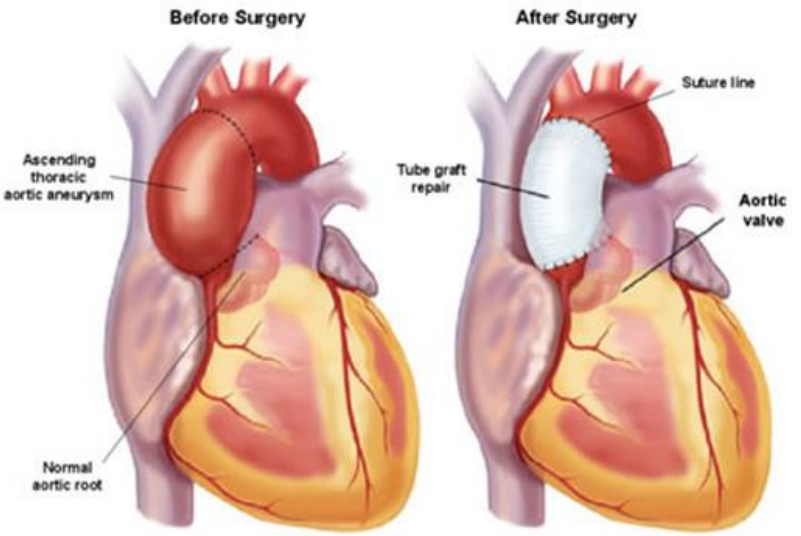
Academic Year: 2012/2013

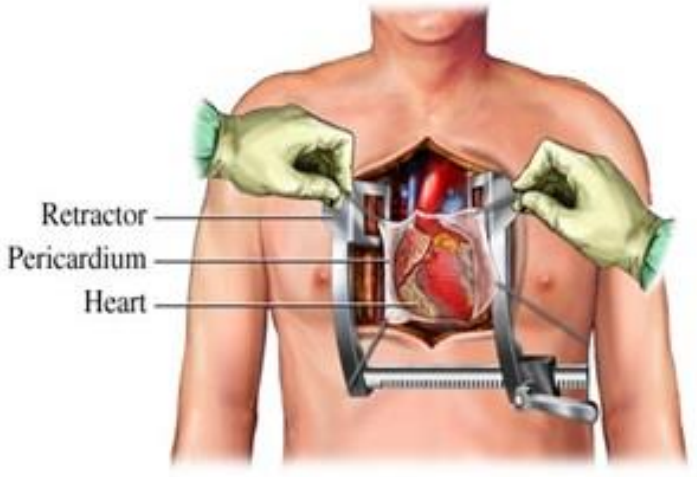
Collaboration

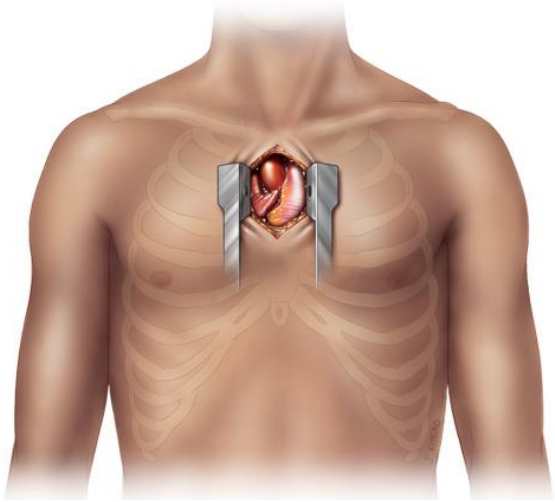
- Computational Mechanics and Advanced Materials Group of University of Pavia
  - Head: Prof. **Ferdinando Auricchio**

- Division of Cardiac Surgery of Policlinico San Matteo of Pavia
  - Head: Dr. **Alessandro Mazzola**
  - MD: Dr. **Pasquale Totaro**

- **Cardiovascular diseases**
  - Thoracic aortic aneurysm
  - Malfunctioning of cardiac valves
- **Heart surgery**
  - Traditional approach
  - Minimally invasive approch







Motivation and Goal

Motivation:

- **Preoperative planning of optimal surgical access is required in case of minimally invasive cardiac surgery procedures**
  - Patient-specific
  - Operation-specific

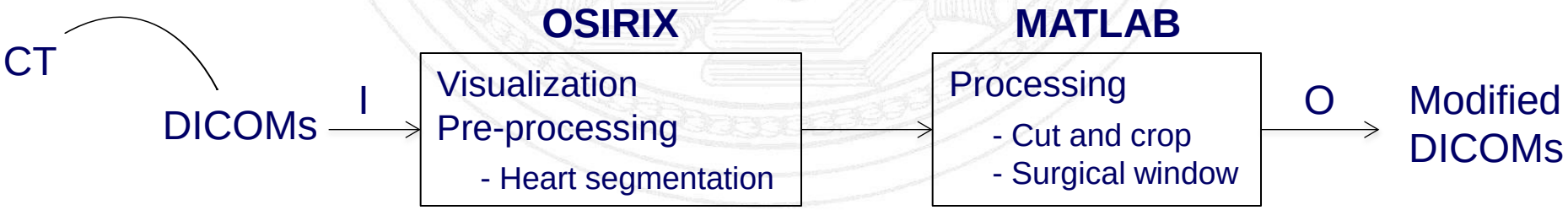
Goal:

- **To create virtual surgical windows in ministernotomy approaches to avoid:**
  - Unpredictable difficulties
  - Conversion to median sternotomy

- **OsiriX**
  - Imaging software

- **Matlab**
  - Computational software

Workflow:



Pre-processing with OsiriX

CT

DICOMs

I

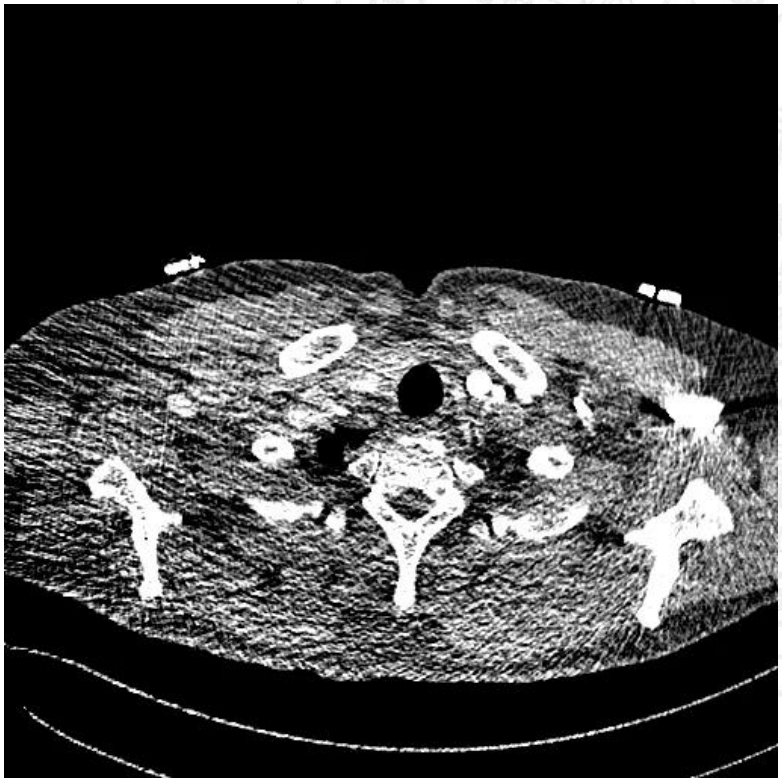
OSIRIX

Visualization
Pre-processing
- Heart segmentation

O

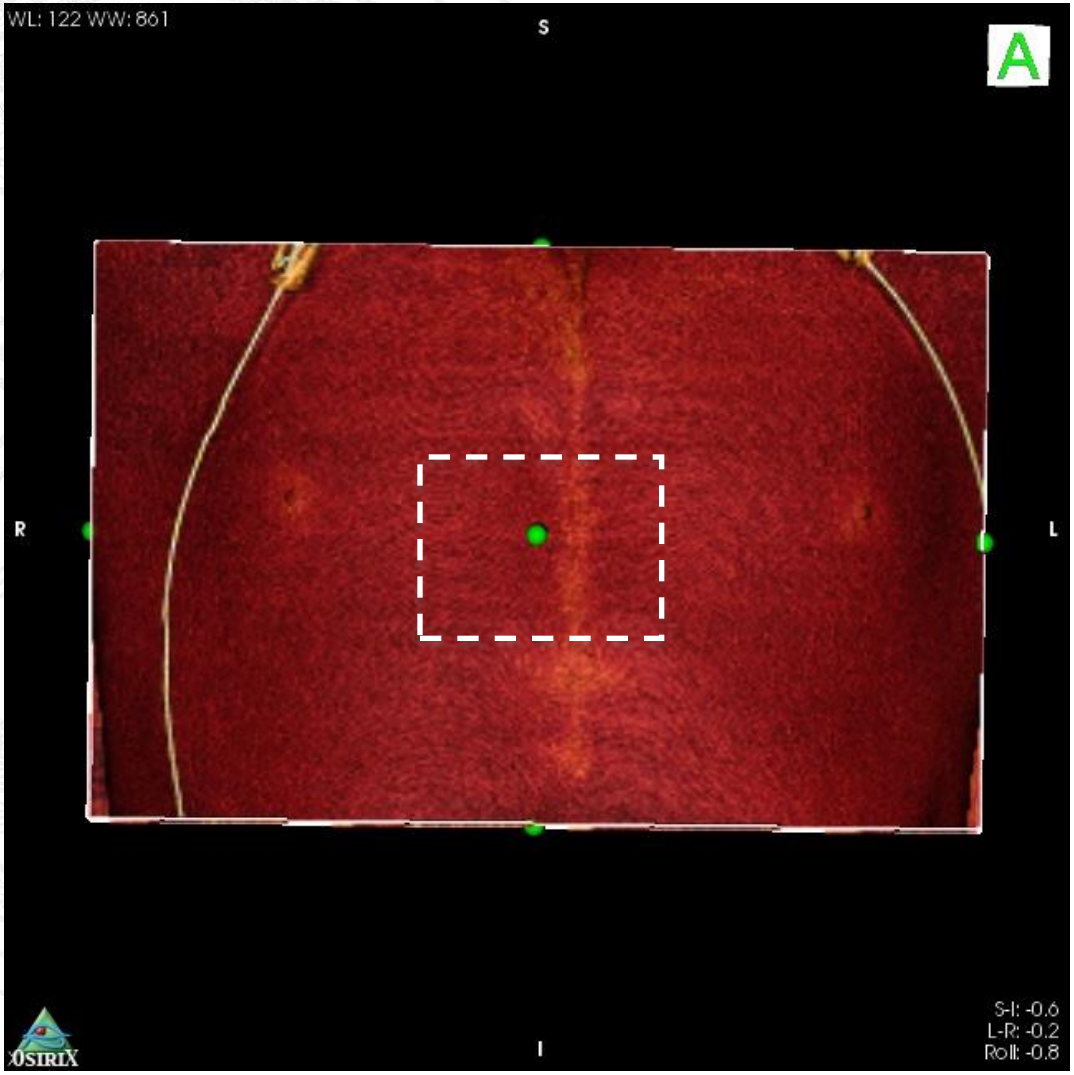
Original CT DICOMs
2D image
Segmented Heart DICOMs

- Visualization and 3D reconstruction



2D image: frontal view of the chest

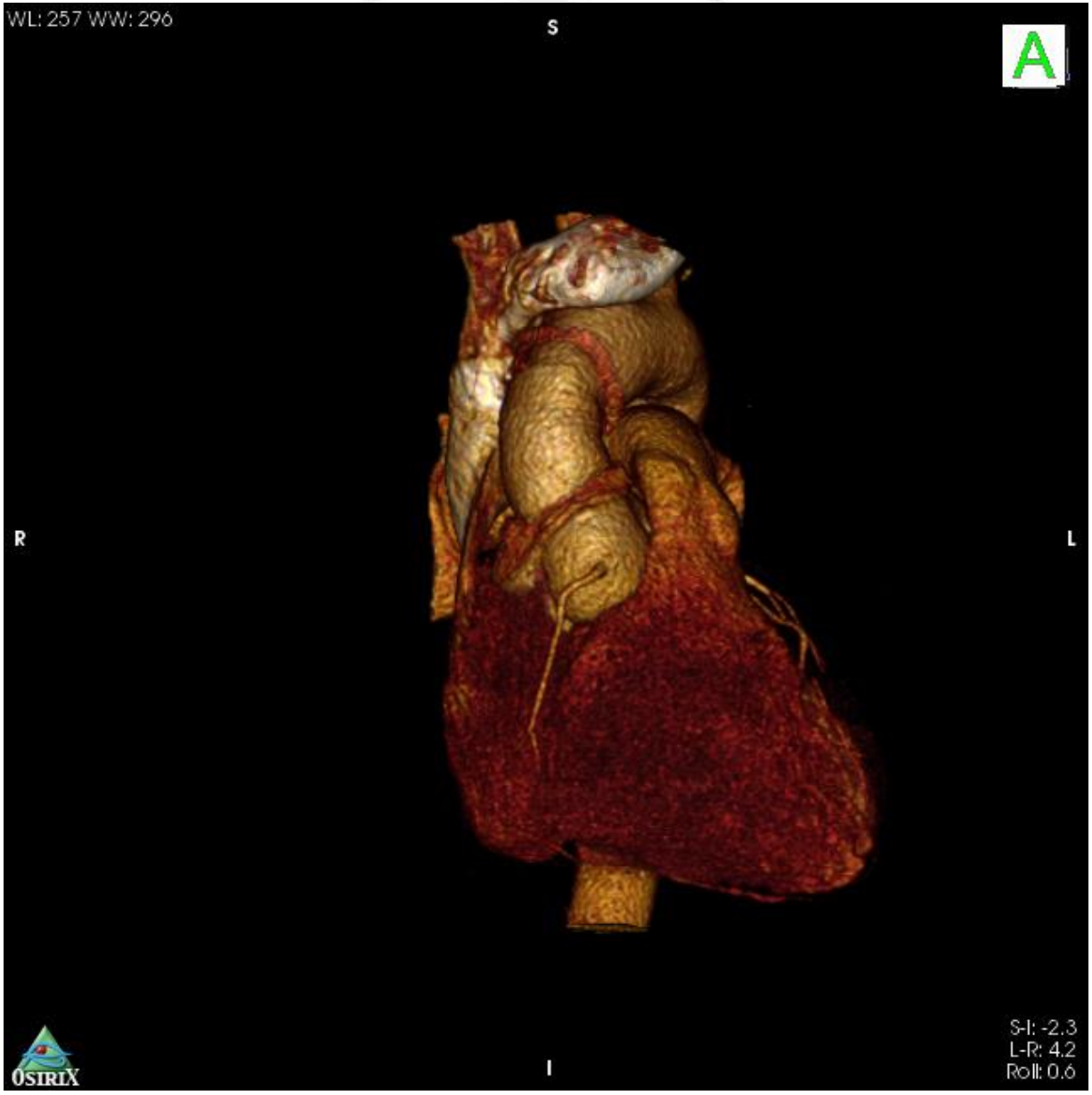
- Crope Cube tool



Heart/ascending aorta segmentation

- **Heart segmentation**
  - Experience
  - From 5 to 30 minutes (depending on CT quality)

Segmented heart



Support in planning surgical intervention

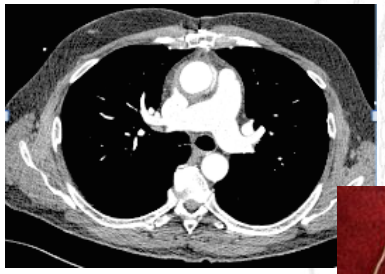
- DICOM processing

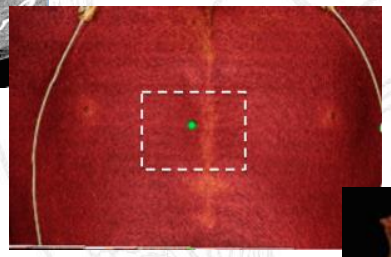
MATLAB

Original CT DICOMs
Segmented Heart DICOMs
2D image

I → Processing
- Cut and crop
- Surgical window

→ O → Modified DICOMs





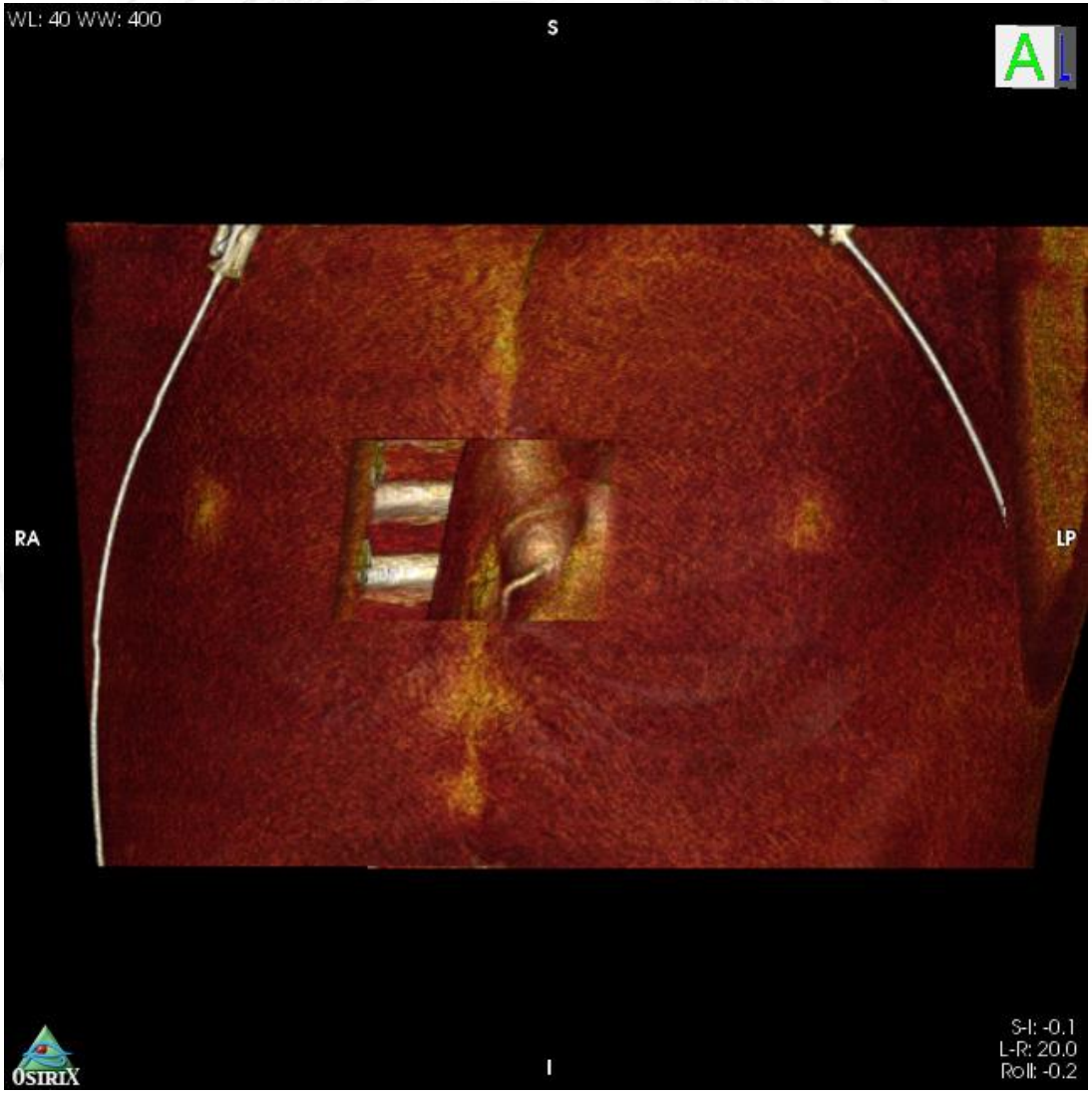
The algorithm

Editor - /Users/pietrocanale/Documents/MATLAB/Surgical window/PC_virtual_window.m

File Edit Text Go Cell Tools Debug Desktop Window Help

```
22
23      %close(help)
24 -    chest = DCM_1;
25
26      %% Read 2D frontal image saved in Osirix 3D view
27 -    path_start=cd;
28 -    [filename, pathname] = uigetfile('*.jpg','Read 2D image');
29 -    cd(pathname);
30 -    imm_2d = imread(filename);
31 -    figure1 = figure(1);
32 -    imshow(imm_2d);
33 -    cd(path_start);
34
35      %% Selecting points to calibrate and to create initial virtual window
36      %User must choose 6 points: 4 to calibrate, 2 to create virtual window
37 -    help = helpdlg(sprintf('Select points in order:\nPoint 1: up\nPoint 2: down\nPoint 3: left\nPoint 4: right
38      %button = MFquestdlg([0.6, 0.1],sprintf('Select points in order:\nPoint 1: up\nPoint 2: down\nPoint 3: le
39 -    set(help, 'position', [100 500 240 140]);
40
41 -    [y,z] = ginput(6);
42 -    n_imm = size(chest,3);
43 -    p1 = n_imm * (z(5) - z(1)) / (z(2) - z(1));
44 -    z1 = int16(p1);
45 -    p2 = n_imm * (z(6) - z(1)) / (z(2) - z(1));
46 -    z2 = int16(p2);
47 -    g1 = 512 * (y(5)-y(3)) / (y(4)-y(3));
48 -    y1 = int16(g1);
49 -    g2 = 512 * (y(6)-y(3)) / (y(4)-y(3));
50 -    y2 = int16(g2);
51
52 -    close(figure1)
53 -    close(help)
```

- View results



Conclusions and future developments

Conclusions:

- The work of this thesis has enabled the creation of an automated tool for defining patient-specific optimal surgical window (in ministernotomy approaches)
- The procedure is well guided and required operations are easy to perform → tool usable directly by the surgeon

Future developments:

- Implementation in a unique software
- Surgical window simulation in minithoracotomy

Università degli studi di Pavia

Dipartimento di Ingegneria Civile e Architettura

Corso di laurea in Bioingegneria

Preoperative planning through CT data elaboration to minimize patient injury in heart surgery

Pianificazione preoperatoria attraverso l'elaborazione di dati TAC per ridurre al minimo le lesioni al paziente in cardiochirurgia

Supervisor: Prof. **Ferdinando Auricchio**

Co - supervisor: Dott. **Simone Morganti**

Pietro Canale

UIN 391485

Academic Year: 2012/2013