Cognition-guided heart surgery II
The role of computer science

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Cognition-guided heart surgery

Perception

Data acquisition before, during and after surgery

Ontology

Knowledge base

Interpretation

Ring „Edwards Physio II“, Size 32

Action

Annuloplasty ring selection
Two-Dimensional Echocardiography

 доволь
 high temporal resolution, cheap, widely used
Three-Dimensional Echocardiography
Mitral Annulus Modelling

3D+t Echo-cardiography

Interactive Setting of Annulus Plane and Commissural Points;
Placing of an Empirical Standard Model

3D+t Mitral Annulus Model

Mitral Annulus Modelling

Set mitral plane and anchor points
Enhanced Disease Characterization

**Time-based Quantifications** [1]

**Mitral Leaflets Modelling**

**Problem:**
Interactive Segmentations are labor-intensive

- Intuitive slicing concept
- Interactive Setting of Leaflet Tips and Body Points
- 3D+t Mitral Valve Modelling
Valve Segmentation

Automatic Modelling

- External Force
- Internal Force
- Temporal Force

\[ \vec{F} = w_E \cdot \vec{F}_E + \vec{F}_I + w_T \cdot \vec{F}_T \]

Valve Segmentation

**Internal Force**

- Adjustments to anatomically plausible angles and point-distances

**External Force**

- Adjustment to image information

Temporal Force

- Adjustments to a sinusoidal movement

- robust to low image quality and severe pathologies
- 2.25 mm average error
- results are on the scale of experts' models

Spatio-temporal mitral leaflets modelling

Region of Interest

Thin Tissue Detector

Leaflet Separation Using Graph Cuts

Valve Segmentation

Model Initialization       Model Optimization Over the Whole Cycle       3D+t Mital Valve Model

Valve Segmentation

![manual and automatic segmentation comparison](image)

Automatic Coaptation Zone Assessment

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Open source imaging informatics platform, developed by the Neuroinformatics Research Group at Washington University St. Louis

- Upload any kind of data
- Organize and share data
- Role permission system
- View and Download data

www.xnat.org
Data Processing & Development in open-source MITK

XNAT integration

XNAT Tree Browser Plugin

<is derived from>

<type description>

Semantic Representation
Problem: no standardized approach!

- variability of methods & results

Visual assessment performed by the surgeon: annuloplasty ring sizing with “sizer”
Intraoperative Decision Support

- spatial measurements
- visual guidance & cognition-guided decision support
- ring implantation
Intraoperative Decision Support

- minimal invasive vs. open surgery
- different course of action / deviation from protocol
- limited size of tracking volume / occlusions
- repair vs. replacement
- stable version of latest software version
- training of OP team
- only relevant instruments visible

NDI Polaris
Viewstation
Application of the intraoperative assistance system (4 x) :

1x minimal invasive mitral valve reconstruction

2x open mitral valve replacement
1x open mitral valve reconstruction
Mille grazie!

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