HORIZON 2020

H2020 - MUSICA

Efficient & accurate 4D reconstruction for mitral apparatus from echo

FEOPS insights for excellence

UNIVERSITEIT GENT

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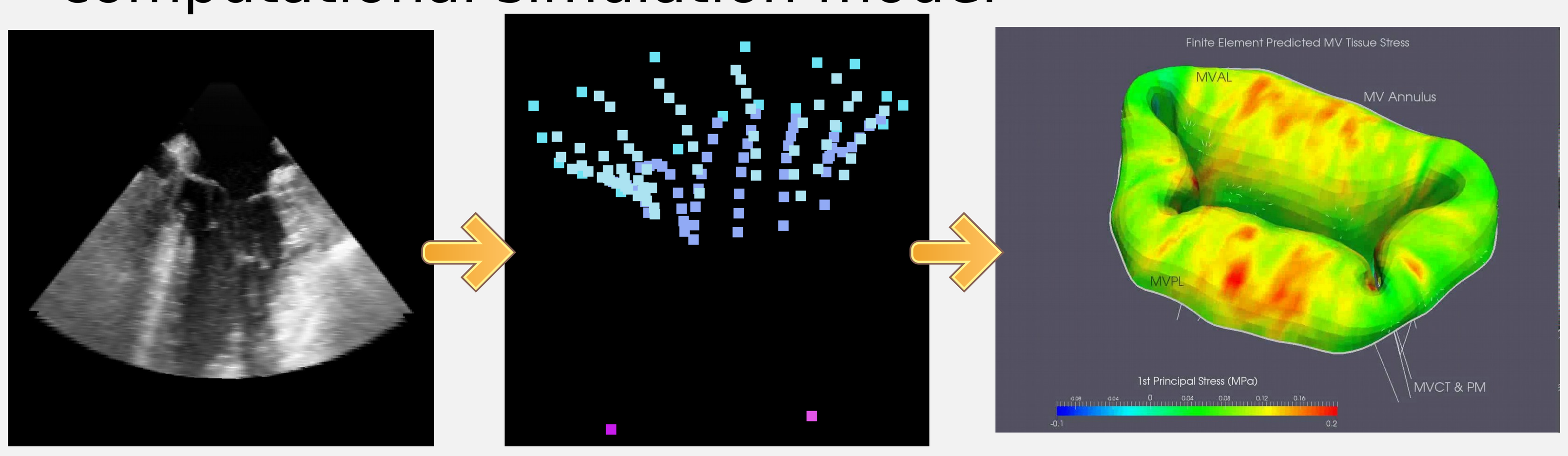
Background

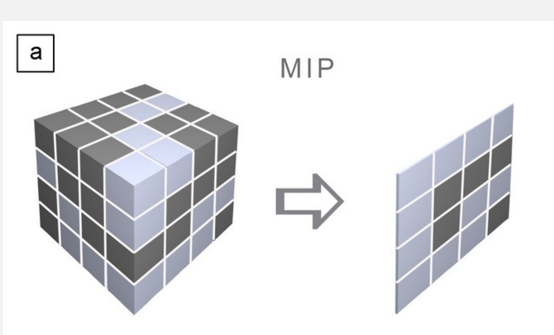
- Front-end approaches to valve treatment now imply shorter hospitalization, less pain and discomfort, and lower costs
- Computational models of the mitral apparatus can complement medical imaging, support the development of novel devices, patient specific treatments especially with trans-catheter procedures
- Computational models require images as input. Although echo is the most used format, it has some challenging properties (e.g. noise, quality,...)
- Our aim is to improve the trans-catheter mitral valve treatment by streamlining the conversion of patient specific mitral valve echo images into computer models

Workflow

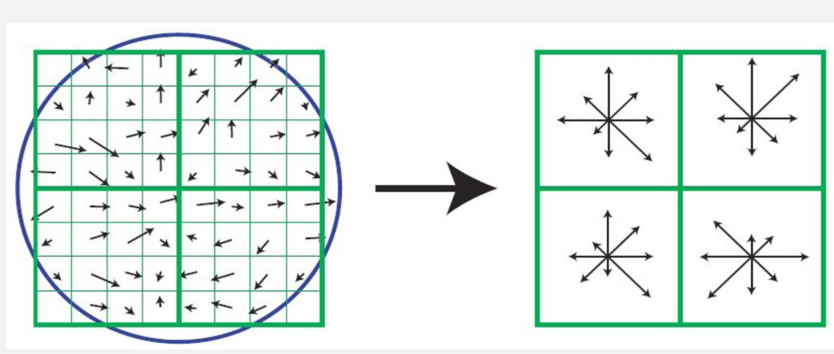
- Analyze 4D echo trans-esophageal and reconstruct the anatomical structures
  - Annulus
  - Leaflets (posterior & anterior)
  - Chordae
  - Papillary muscles
- Export the reconstructed 3/4D structure to a computational simulation model



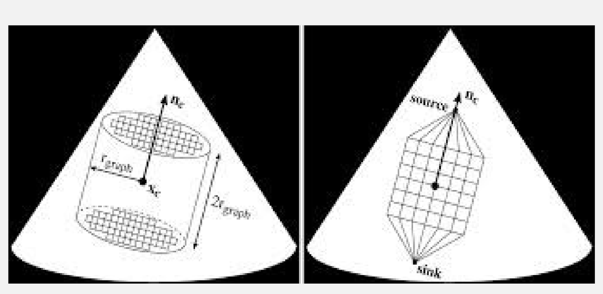
Methods



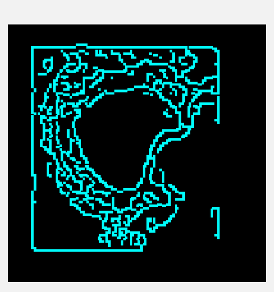
Maximum intensity projection (1)



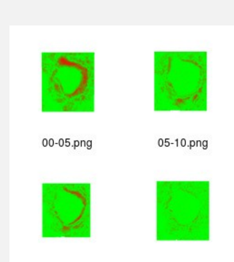
Scale invariant feature transform (2)



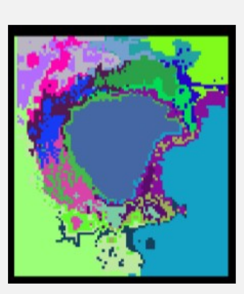
Min-cut based segmentation (3)



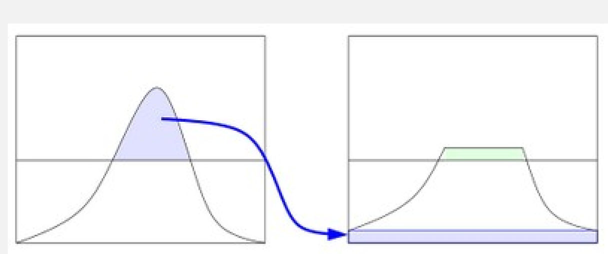
Edge detection (4)



Movement detection (5)

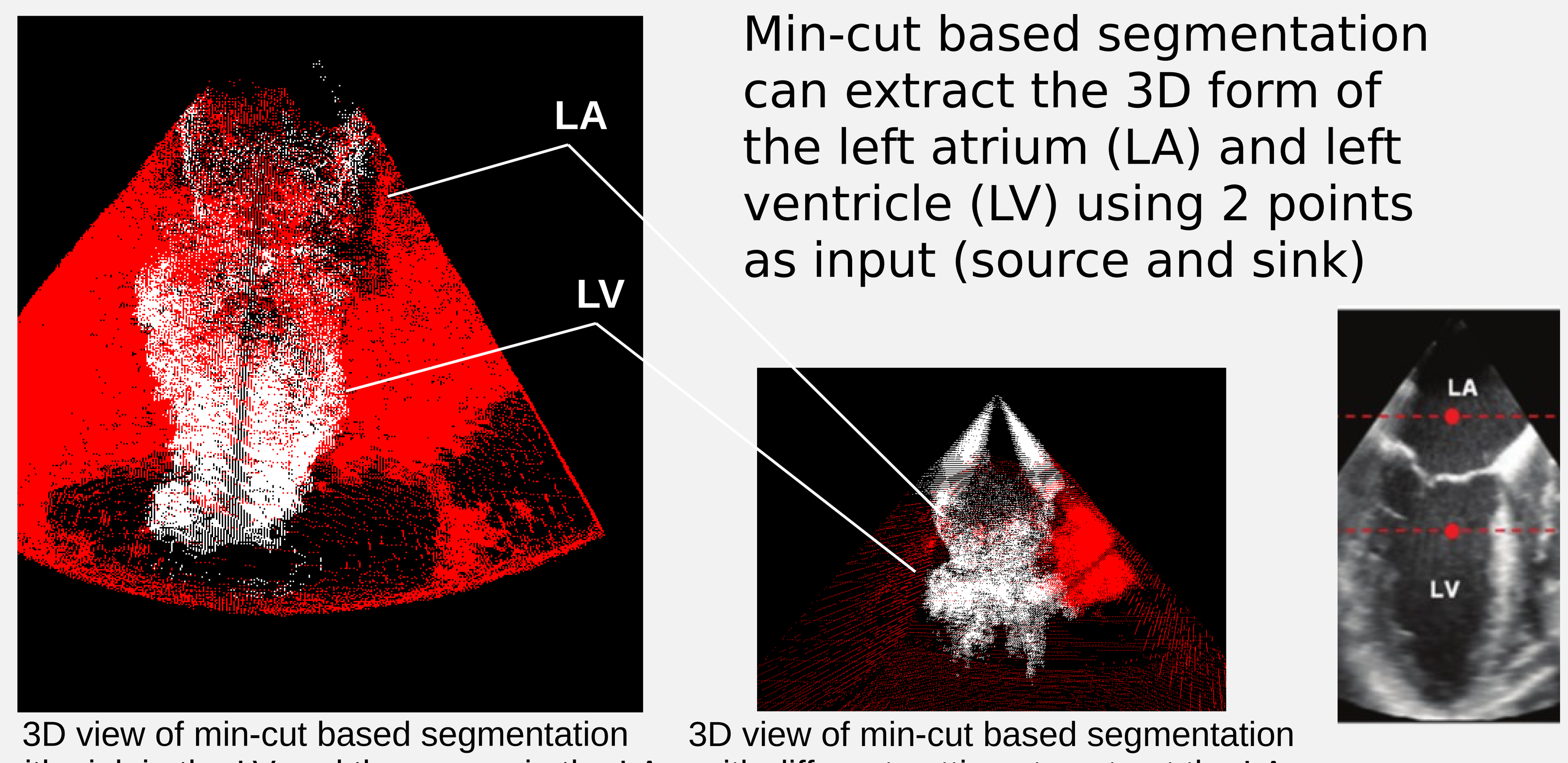


RGB Region growing (6)



Contrast limited adaptive histogram equalization (7)

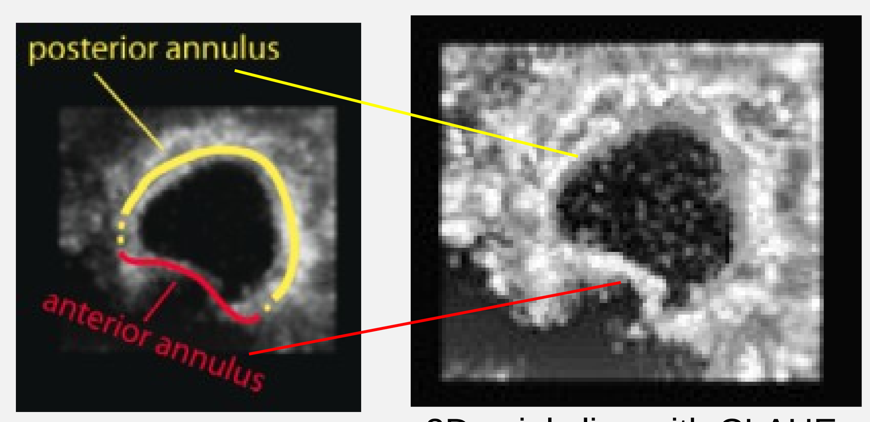
Results



3D view of min-cut based segmentation with sink in the LV and the source in the LA

3D view of min-cut based segmentation with different settings to extract the LA

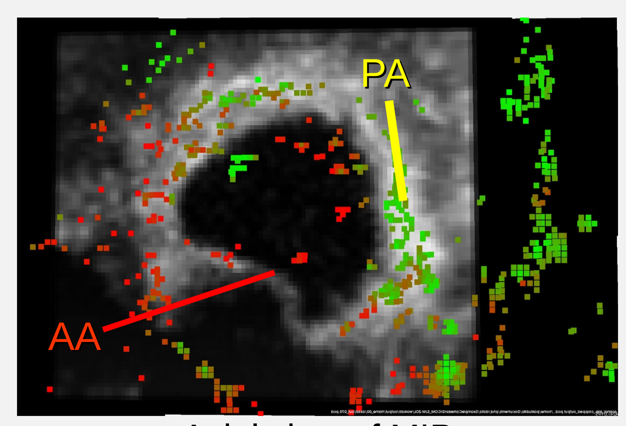
Min-cut based segmentation can extract the 3D form of the left atrium (LA) and left ventricle (LV) using 2 points as input (source and sink)



2D axial slice

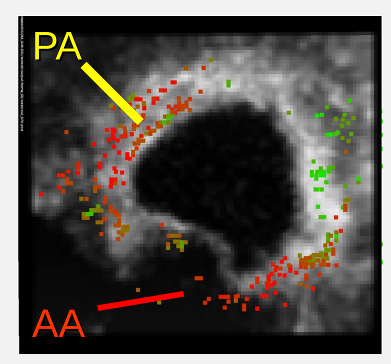
2D axial slice with CLAHE

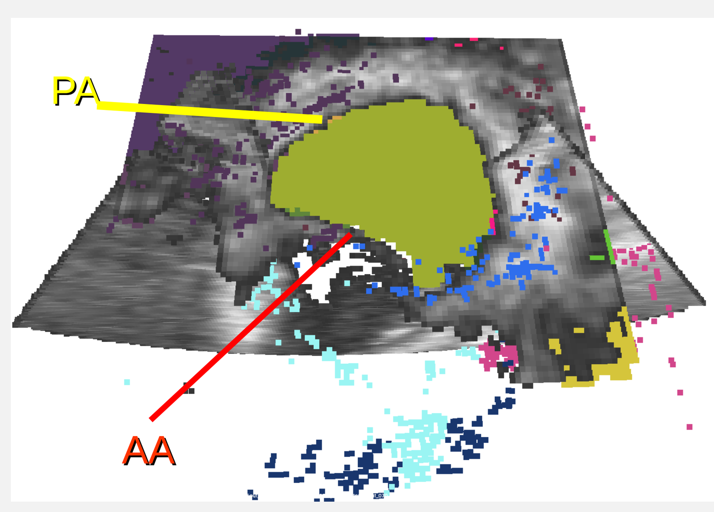
Contrast limited adaptive histogram equalization (CLAHE) increases the contrast and helps us find the anatomical structures.



Axial view of MIP

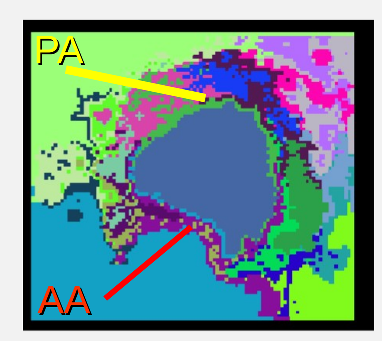
CLAHE with maximum intensity projection mapping (MIP) can narrow down the location of the mitral valve annulus



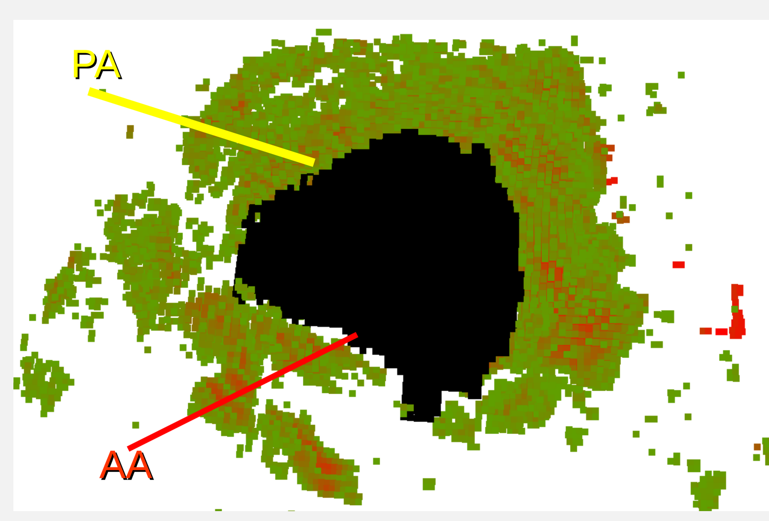


3D view of RGB region growing

RGB region growing can narrow down the shape of the annulus and other region of interest



Axial view of RGB region growing



Axial view of movement detection

Movement detection between frames, where green is no movement and red is movement, detects regions of movement

Conclusions

The quality of the echo images are difficult to analyze. Therefor we need to evaluate a range of methods. We target diseased mitral apprati so the challenge remains to detect unhealthy anatomical structures. For our future work, we want to verify our results with patients.

1) Wallis JW, Miller TR, Lerner CA, Kleerup EC (1989). Three-dimensional display in nuclear medicine.
2) Lowe, D. G. (1999). Object recognition from local scale-invariant features.
3) Aleksey Golovinskiy and Thomas Funkhouser. Min-cut Based Segmentation of Point Clouds.
4) Canny, J., A Computational Approach To Edge Detection.
5) Patricio Astudillo
6) Qingming Zhan, Yubin Liang, Yinghui Xiao, Color-based segmentation of point clouds.
7) K. Zuiderveld: Contrast Limited Adaptive Histogram Equalization.

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