X-Tutorial: Semiautomated 3D Cardiovascular Magnetic Resonance – 3D-Quanti

Noyan H[1], Liebich O[2], Lim C[1], Rudolph M[2], Neumeier S[2], Hickstein C[2], Zghaibeh A[1], Ha M[1], Hassani M[1], Hack J[2], Ammann C[1], Reisdorf P[1], Hadler T[1], Schulz-Menger J[1], Hickstein R[1,2]

[1] Working Group on Cardiovascular Magnetic Resonance, Experimental Clinical Research Center a joint Facility by MDC and Charité Universitätsmedizin Campus Buch
[2] Technische Universität Berlin;

Introduction (1)

- **Cardiac MRI**: Gold standard for cardiac morphology & function assessment[1]
- **3D sequences**: Enable qualitative & quantitative tissue differentiation[2]
- **Challenge**: Manual evaluation is time-consuming (~2h/case)
- **AI solution**: Semi-automated system to distinguish healthy vs. altered tissue
- **Training data**: Manual segmentation
- **Complete approach**: Combining Storage, quality assurance with AI solution, visualization, intuitive data retrieval

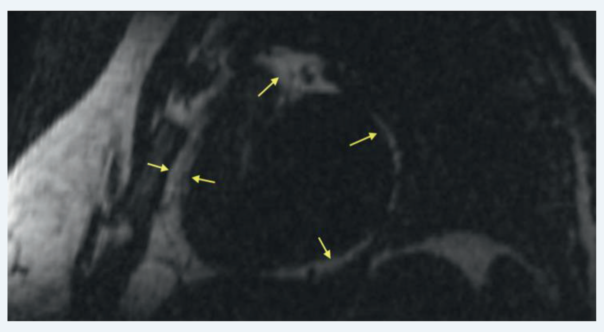

Fig. 1 3D Dixon MRI Image in short axis view. Yellow arrows point at epicardial adipose tissue.

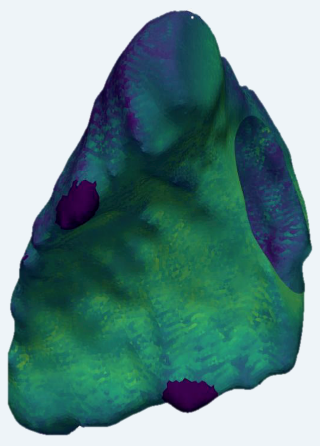

Fig. 2 Reconstructed 3D right ventricular LGE

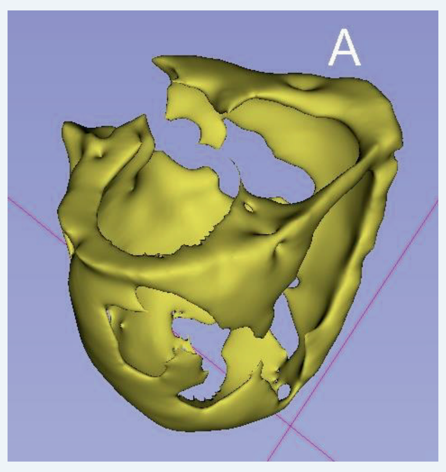

Fig. 3 3D ventricular Fat Reconstruction

Methods – Clinical Track (2)

Software used: CVI42 (for quality control), CEMRGApp[3], 3D Slicer[4]

Quality Assurance: Comparison of segmentations with gold-standard segmentation (level 3) to establish an intraobserver tolerance and ensure standardization for AI training.

Sequence: 3D-Late-Gadolinium-Enhancement (LGE)-Dixon

Postprocessing: 3D-LGE-Dixon Images analyzed using CEMRG and 3D Slicer for assessing **tissue changes quantified in 3D**

Methods – Tech Track (3)

- Definition of requirements based on clinical needs
- Analysis of use cases
- Choice of Tech Stack: Docker[5], Python[6], React[7], MongoDB[8], nnU-Net[9]
- Workflow: Distributed version- and quality-control

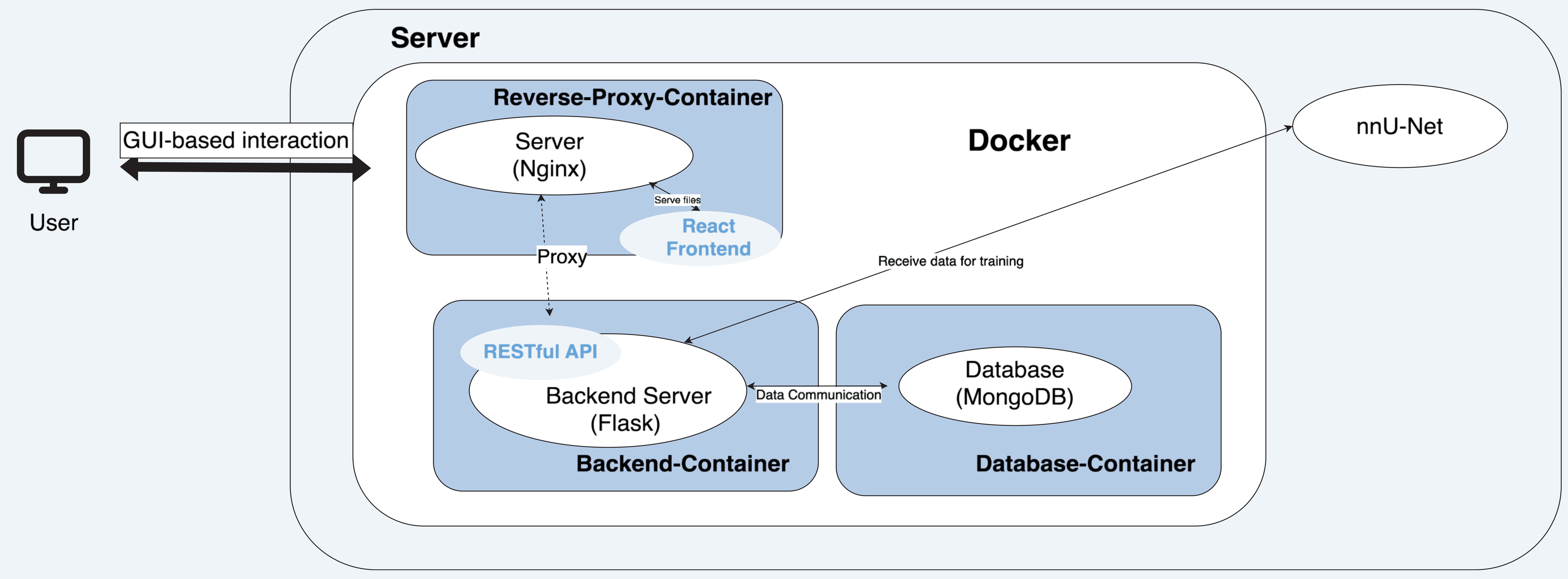

Fig. 4 Architecture diagram

Results (4)

- 80 manually segmented 3D-LGE Dixon datasets for Right Ventricle
- 36 manually segmented fat-separated datasets for ventricular epicardial adipose tissue
- First prototype of platform implemented
- First prototype of AI (2s for Case segmentation)

Fig 5: AI-generated segmentation of epicardial adipose tissue in a reorientation of the 3D Volume corresponding to a short axis view

Fig 6: Data-Platform: Use-Cases

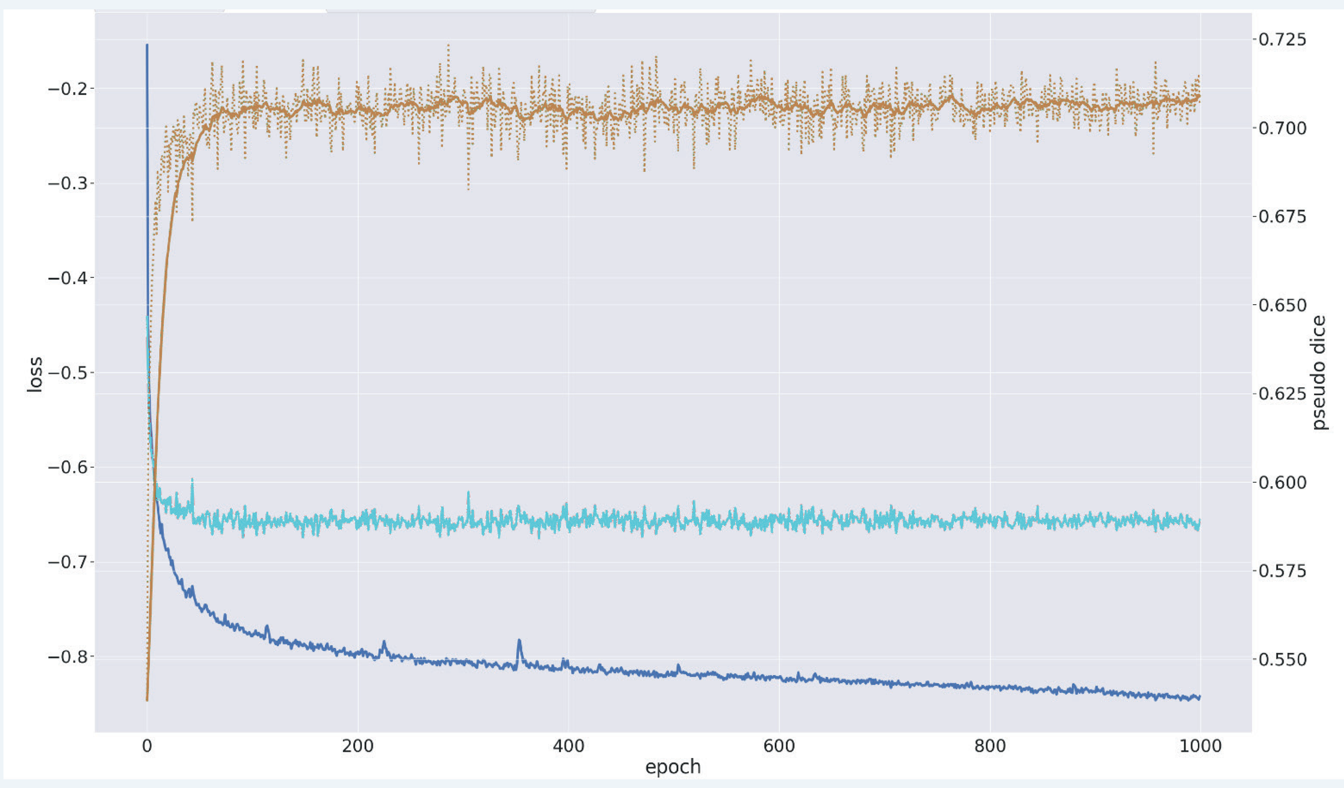

Fig 7: Pseudo Dice, tr loss, val loss during model training

Discussion (5)

- **Platform extends existing post-processing** by connecting data management and quality assurance
- AI segmentation much faster than manual segmentation (**2s vs 30min/case**), still needs supervision
- Using nnUNet-Framework enables accessibility of semiautomated AI-training for clinicians

Limitations

- **Open-Source Segmentation Softwares** certified for research use only
- **Dice** metric might be overly sensitive error metric for small structures
- Evaluation of AI performance on **limited sample size**

Outlook (6)

- Extensibility of platform
- Clinical Evaluation on larger samples sizes

References

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