Fully automated Machine Learning-based selection of optimal bSSFP frequency offset for artifact reduction in cardiac MRI

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SCMR
Society for Cardiovascular Magnetic Resonance

EACVI
European Association of Cardiovascular Imaging
European Society of Cardiology

Declaration of interest

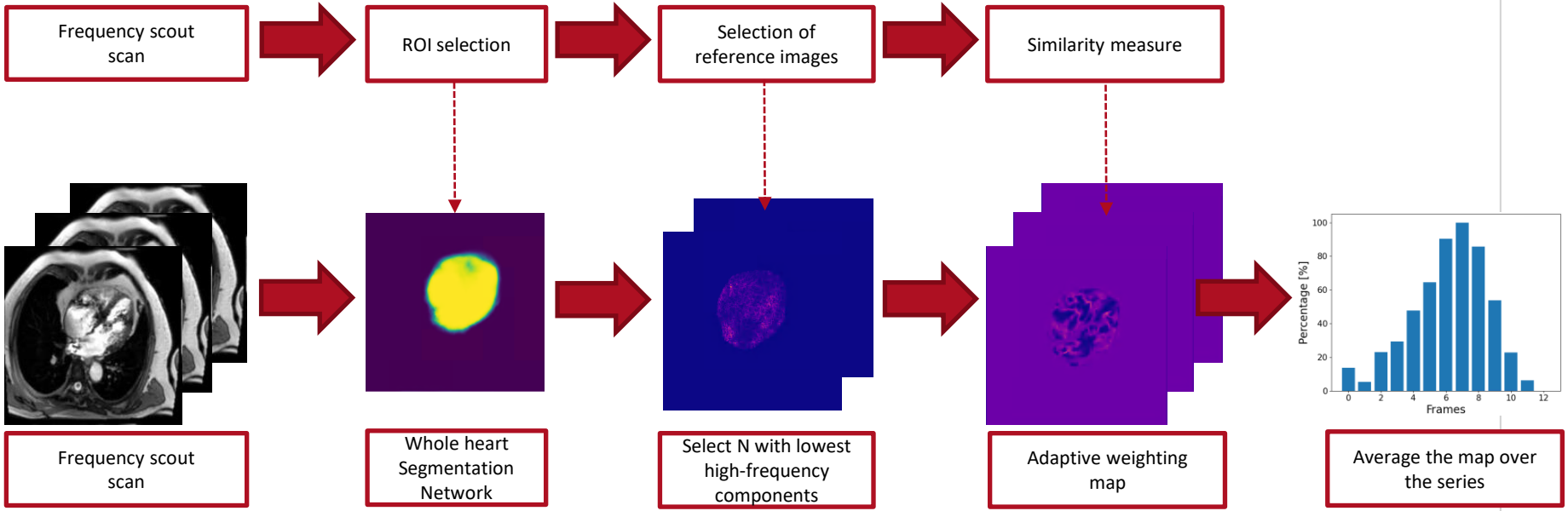
- **PhD stipend from Siemens Healthcare GmbH**

Introduction

- **In bSSFP sequences, signal modulation often occurs due to B_0 inhomogeneity at higher field strengths**
  - Banding (hypointensity) and flow artifacts (hyperintensity)
- **To minimize the artifacts in a region of interest (ROI), frequency scout scans are acquired**
- **The optimal frequency offset is visually selected in clinical practice[1,2]**
- **→ Fully automated image-based system for selecting the optimal frequency offset**

[1]Schar M. et al. MRM 2004 [2]Deshpande VS. et al. MRM 2003

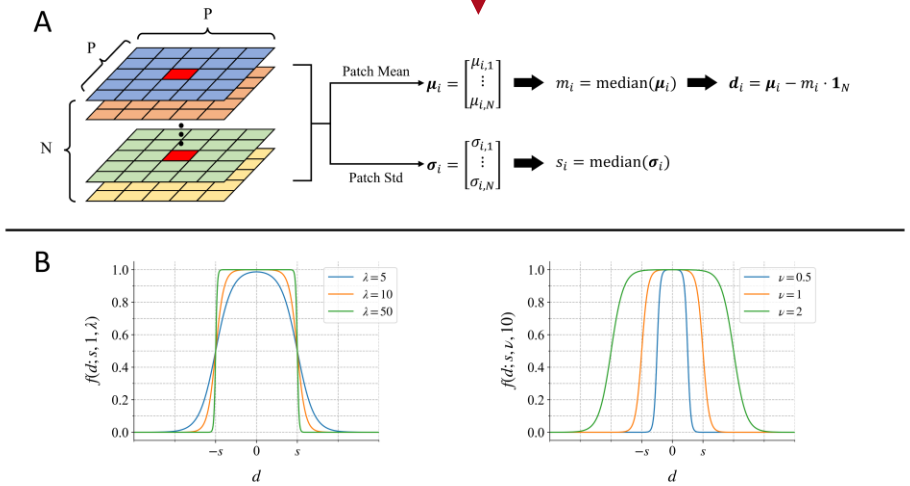
Methods


Frequency scout scan
ROI selection
Selection of reference images
Similarity measure
Frequency scout scan
Whole heart Segmentation Network
Select N with lowest high-frequency components
Adaptive weighting map
Average the map over the series
Percentage [%]
Frames

Methods

- **High frequency component extraction:**
  - Fourier transformation – high-pass filtering – inverse Fourier transformation and subtraction over series

- **Adaptive weighting map[1]:**

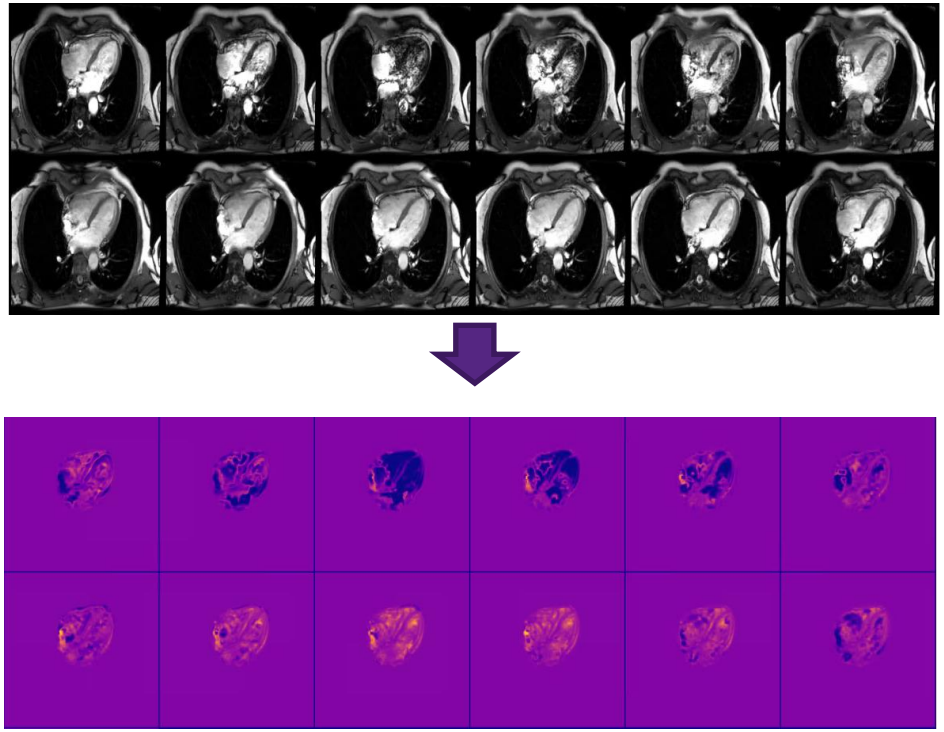


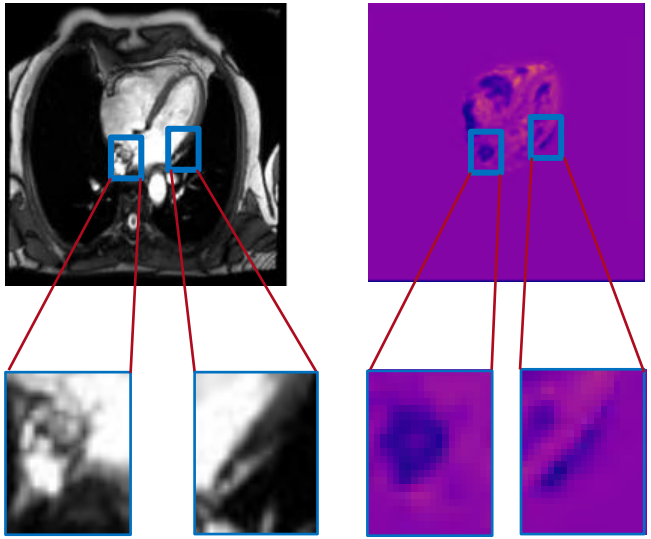
[1]Fasil G. et al. *submitted to MRM 2022*

Data sets

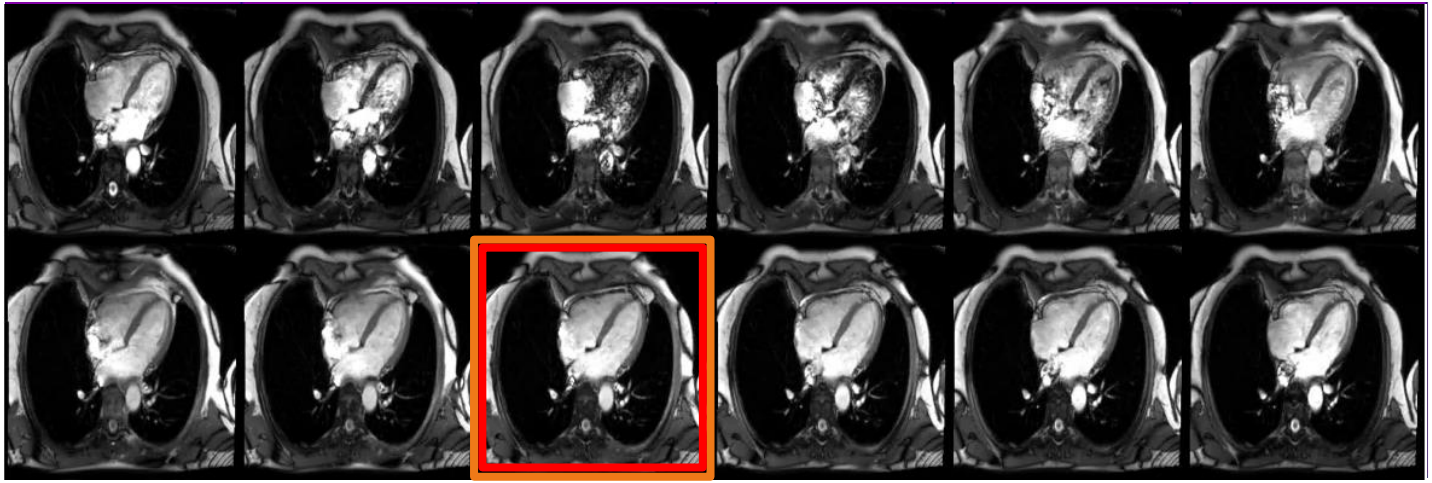
- **Multiple 3T scanners (n=38)**
- **Part of the data used for our validation originates from the Hamburg City Health Study**
- **Manual annotation**
  - Range of acceptable frequency offset values

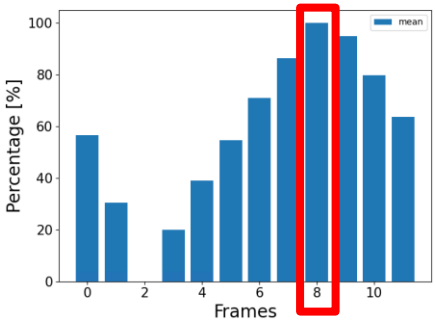
Results





Results

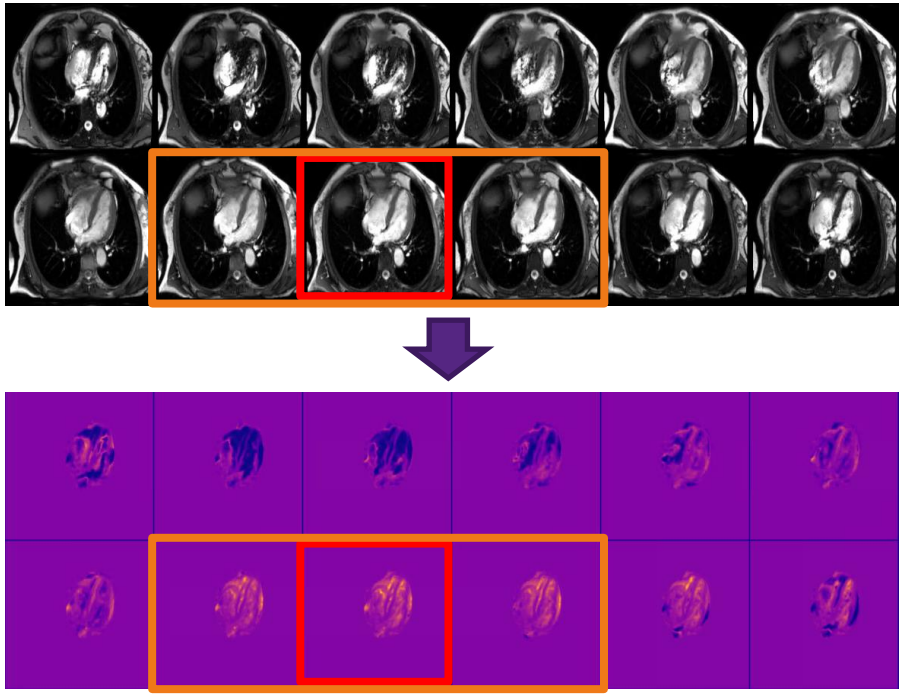


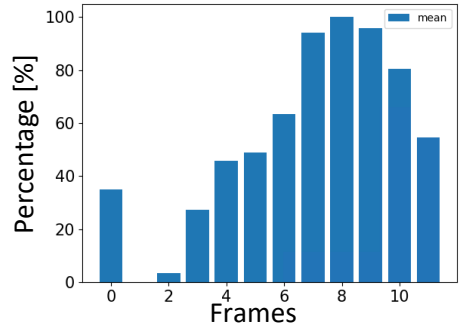


= system selection

= expert annotation

Results





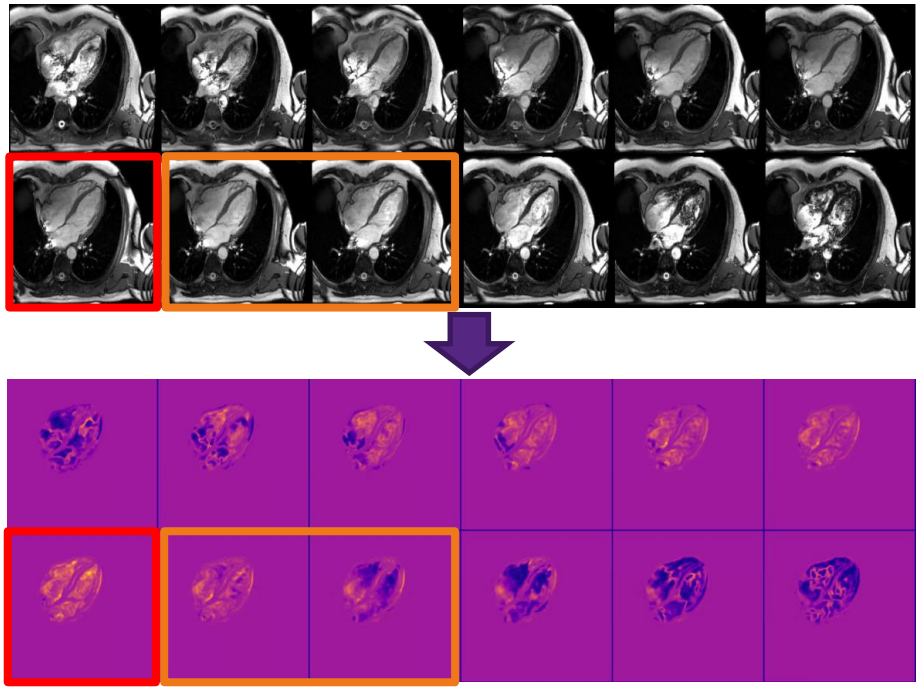
= system selection

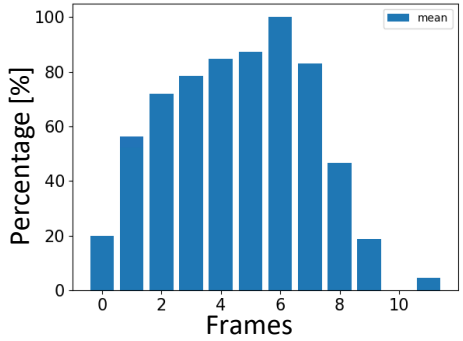
= expert annotation

Results

- **The system achieved an accuracy of 92.1%.**
- **The maximum difference was off by 2 frames.**

Results





= system selection

= expert annotation

Discussion and future work

- The adaptive weighting map correctly detects areas containing artifacts
- The heuristic approach of selecting N reference images can be replaced by a neural network algorithm
- Evaluate on a larger dataset