MSc Thesis

intended start: February 1st 2026

Multiparametric (TI-TE) MRI sequence adaptation and implicit neural representation (INR)-based reconstruction

Problem statement

Multiparametric MRI sequences allow for the acquisition of images with varying tissue contrast within a single scan. The resulting multiparametric images can be used to extract quantitative information on tissue microstructure. To make such multiparametric sequences feasible for clinical routine, the usually very long scan times need to be shortened e.g. through undersampling in k-space. However, this comes with challenges for the reconstruction. In general, advanced reconstruction techniques such as compressed sensing or deep learning-based approaches (1) can enable the acquisition of high-quality images despite the acceleration. For multiparametric MRI sequences very high accelerations can be achieved by leveraging redundant anatomical information e.g. through joint reconstruction with an implicit neural representation (INR) network (2).

Goals

This project aims to extend an MPnRAGE (3) (multiple inversion times, TI) acquisition and reconstruction framework by adding an echo time (TE) dimension. The first part of the project will involve modifying the existing MPnRAGE sequence, including iterative improvements on the scanner. The second part of the project will focus on adapting the INR-based reconstruction for the multiparametric (TI-TE) data.

The student will benefit from:

- Guidance from both MRI and AI experts in a collaborative, interdisciplinary research setting.
- Hands on experience with the MRI scanner and coding.
- Opportunity to contribute to ongoing research and potential publication in medical imaging journals or conferences.

Requirements

- 1 year master thesis (such as in BEMP MSc).
- Prior experience and good understanding of MRI physics and machine learning.
- Very good programming skills in Python (PyTorch) and Matlab.
- Experience in using Unix systems (Linux, macOS Terminal).
- Interest in MRI and hands-on experience with the MRI scanner.

Application

Please send an email, involving a CV, a current transcript of records, and a brief statement on why you are interested in the project, to natascha.niessen@tum.de.

Affiliation

Prof. Dr. Julia Schnabel

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Supervision: Natascha Niessen, Dr.-Ing. Lina Felsner

References

1. *Deep learning for accelerated and robust MRI reconstruction.* **Heckel R, Jacob M, Chaudhari A, Perlman O, Shimron E.** s.l. : MAGMA. 2024;37(3):335-368.

2. *INR Meets Multi-contrast MRI Reconstruction.* **Niessen N, Pirkl CM, Solana AB, Eichhorn H, Spieker V, Huang W, Sprenger T, Menzel MI, Schnabel JA.** s.l. : Reconstruction and Imaging Motion Estimation, and Graphs in Biomedical Image Analysis: First International Workshop, RIME 2025, and 7th International Workshop, GRAIL 2025, pp. 23–33, Springer-Verlag, Berlin, Heidelberg, 2025, 2025.

3. *MPnRAGE: A technique to simultaneously acquire hundreds of differently contrasted MPRAGE images with applications to quantitative T1 mapping.* **Kecskemeti S, Samsonov A, Hurley SA, Dean DC, Field A, Alexander AL.** Magn Reson Med. 2016 Mar;75(3):1040-53.