Chair of Imaging and Computer Vision

RWTH AACHEN UNIVERSITY

Bachelor’s & Master’s Thesis

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Various Topics in Low-Field Magnetic Resonance Imaging (MRI) – From Hardware to AI

Background

Magnetic resonance imaging (MRI) is an imaging technique that uses magnetic fields (1.5 Tesla) and radio waves to create detailed anatomical images of the inside of the body. Low-field MRI (50 millitesla) is an emerging field targeting compact, low-cost, and portable MRI systems to bring MRI diagnostics to the patient bed, emergency rooms/vehicles, and low-income countries. Together with the Fraunhofer MEVIS Institute, we are developing a low-field MRI device and investigating innovative concepts in hardware and software. One area of research is the interconnection and integration of physics-informed AI up to the final, diagnostically conclusive image.

Figure 1: Image of the portable low-field MRI system in our laboratory. The scanner consists of hundreds of permanent neodymium magnets, arranged in a Halbach configuration to create the static 50 mT B_0 field.

Selection of Potential Tasks

- *Simulation&Coding:* Establish a physics-informed, deep-learning-based MRI image reconstruction (e.g., Diffusion Models and PINNs).
- *Laboratory&Coding:* Develop a noise-canceling pipeline to reduce the effect of external Electromagnetic Interference (EMI) from, e.g., AM Radio and LED Lighting that contribute to the MRI signal. *OR* Design and evaluate shimming strategies, including passive shims and dedicated resistive shim coils, to reduce residual B_0 inhomogeneity.
- *Simulation&Laboratory:* Investigate a resistive coil setup using PyCoilGen that allows for field cycling imaging (FCI) targeting brain, prostate, or breast imaging.

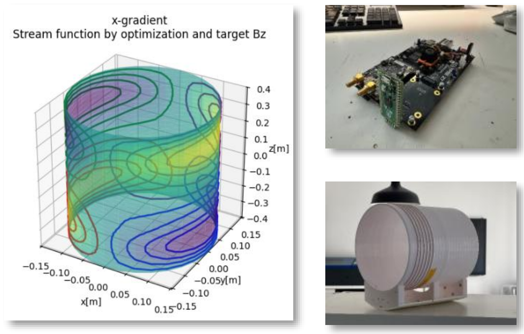

Figure 2: Magnetic flux simulation results (left) of a “fingerprint” gradient coil design. MRI-electronic components (right) with the bottom image showing an RF coil on a 3D-printed frame.

Your Profile

- Studies in Physics, Electrical Engineering, Computer Science, or a related field.
- Solid foundation in Hardware and/or Software development.
- Self-driven, independent, and passionate about advancing medical imaging.

Our Offer

We offer a collaborative culture in a dynamic team of students, PhD candidates, and postdocs that values new ideas and lively discussion. A workstation can be provided in our student office, together with modern IT infrastructure that includes around 2000 CPU cores and 100 GPUs, including multiple NVIDIA RTX PRO 6000 class server GPUs. You will also have access to a workshop and rapid prototyping facilities, including 3D printers with multi toolhead capability, to support fast iteration from design to hardware.