Chair of Imaging and Computer Vision

RWTH AACHEN UNIVERSITY

Master/- Bachelor Thesis

Investigating Differentiable MRI Sequences: Computational Graph Optimization of RF/Gradient Timing Under Practical Constraints

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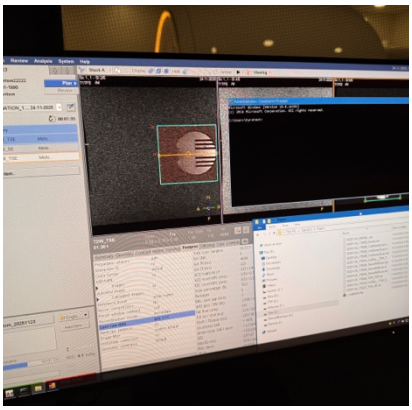
Keywords

Low-Field MRI | **Software** | **Hardware** | **Simulation**

Background



Magnetic resonance imaging (MRI) is an imaging technique that uses magnetic fields and radio waves to create detailed images of the inside of the body. Low-field MRI systems work with a weaker magnetic field. In the DeLoRi project, together with the Fraunhofer MEVIS Institute, we are developing a low-field MRI device to support cancer diagnostics. A differentiable MRI sequence workflow treats sequence parameters (RF amplitudes/phases) as continuous, optimizable variables inside a computational graph, enabling gradient-based optimization through a differentiable forward model. While this approach promises systematic, task-driven sequence design, its practical adoption is limited by challenges such as constraint enforcement, discretization to hardware timing grids, simulator speed, and model mismatch.

Tasks

The aim of this work is to develop a proof-of-concept MRI sequence framework and real-time interpreter that allows selected sequence parameters to be modified during runtime. You will design a parameter interface and execution model that separates time-critical waveform scheduling from high-level parameter updates, enabling deterministic, low-latency changes while preserving sequence validity and safety constraints. You will implement the interpreter and a minimal set of representative sequence primitives, including mechanisms for constraint checking and safe fallbacks when updates violate limits. Finally, you will validate the approach in simulation using MR simulation frameworks, demonstrating correct interpretation, stable runtime updates, and the impact of parameter changes on signal and image/contrast outcomes.

Your Profile

For the successful implementation of the project, you should have an interest in one or more of the following subject areas:

- MR Sequence Development
- Python | Compilers

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. You will also have access to a workshop and rapid prototyping facilities, to support fast iteration from design to hardware.