Beating limitations of quantitative MRI by Model-based reconstruction

Background

Quantitative magnetic resonance imaging (MRI) allows clinicians to assess the state of the disease and it's microenvironment quantitatively. This information can be used to personalize treatments. For example, a well-perfused (quantified with MRI) tumour will be more likely react to chemotherapy than a tumour that is not perfused, as the chemo will need to reach the tumour. Hence, there is a great interest in quantitative MRI.

To assess quantitative MRI currently requires subsequently acquiring MRI data, reconstructing multiple MR-images from the data (Fourier transformation) and fitting a model to the data on a per-voxel (3D pixel) basis. However, this process is cumbersome and oversimplified. Instead, we are implementing model-based pipelines that dig in to MRI physics to go directly from raw data to quantitative parameter maps, instead.

Project

These model-based approaches overcome most of the shortcomings quantitative MRI currently is dealing with (low resolution, noisy parameter maps, deformations) as it handles all the MRI physics correctly. However, the reconstruction comes at a cost of substantially more computational power (solving equations with 10^5 unknowns). It is not trivial to find optima in such complex equations. Therefore, we are looking for enthusiastic students that like to work on these model-based reconstructions. Multiple projects are available, which include

- Implementing more advanced methods to solving these equations (mathematics, computational sciences, physics, or similar study)
- Adding physics to the model for (mathematics, computational sciences, physics, or similar study)
    - Sharper images
    - Removal of deformations
    - Faster imaging
- Parameter optimization and validation of the model in larger datasets (technical medicine, biomedical sciences, or similar study)

Administrative info:

The student will work at the Amsterdam UMC, location AMC, within the department of Radiology and Nuclear Medicine within the MRI physics group. This means that the student will be involved with MRI research and learn about MRI physics.

The student will have weekly meetings with the supervisor.

There are weekly group meetings in which the student will learn about MR-physics research (~45 members). Furthermore, there are (bi-)weekly quantitative abdominal MRI subgroup (~10 members) and model based reconstruction (5 members) meetings that are more informal and allow for discussion of the work with peers.

The student must be interested in MRI and/or healthcare.

Most analysis and reconstruction is currently done in Python, so experience in python is again desirable.

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