Master's Thesis:
Correction of Gradient Imperfections

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Overview

In magnetic resonance imaging (MRI), gradients play a crucial role. By manipulating the main magnetic field of an MRI scanner, spatial information is encoded into the signal from which images are reconstructed. Typically, the reconstruction relies on the assumption of perfect gradients producing a linear change in the field. In reality, imperfections lead to reduced image quality and artefacts. The aim of this master thesis is to characterize imperfections in the gradient system and use this knowledge to improve image reconstruction.

First, a reconstruction routine contained in BART, our free and open-source image reconstruction toolbox, should be modified to incorporate knowledge about imperfect gradients.

As a next step, the effect of gradient imperfections should be simulated: This could be achieved by extending the existing "phantom" tool in BART to incorporate imperfect gradients.

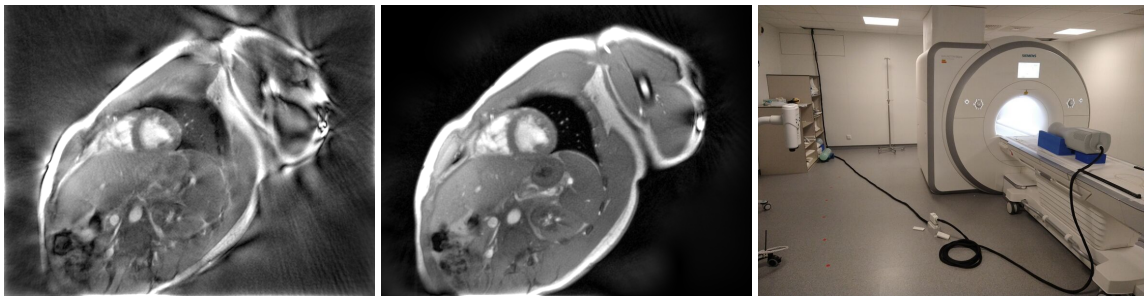
Last but not least, gradient imperfections in the scanner can be measured by either determining the Gradient Impulse Response Function (GIRF) or measuring with a so-called "field camera". The goal here would be to implement a sequence for measuring the GIRF, and optionally comparing with the field camera. Ideally, the image quality can be enhanced by addressing these imperfections in the reconstruction process.

Specific Tasks

- Literature review
- Simulation of gradient imperfections
- Validation of the simulation
- Correction in the reconstruction
- Documentation and illustration of the results

Recommended Knowledge

- Some MR knowledge would be advantageous.
- C, Linux and git workflow



Imperfect gradients can lead to severe image artifacts as seen in two images on the left. These have been acquired with different parameters influencing gradient errors. The image on the right shows the field camera in use at an MRI scanner.

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