Modeling of Radio Frequency Electromagnetic Fields in MRI Using a Volume Integral Equation Approach
Duration: nine months

Simulating the interaction of radio frequency (RF) fields with the human body is computationally intensive. Fast and efficient methods are needed to facilitate the design of RF coils/antennas, dielectric pads, B_1^+ field optimization, subject specific SAR estimation, etc. Inside the human body, large differences in conductivity and permittivity occur between different tissue types and dielectric pads used to enhance magnetic resonant imaging are characterized by a high permittivity as well. It is of paramount importance to correctly model the electromagnetic field in these strongly inhomogeneous structures and an accurate discretization scheme should properly take the electromagnetic boundary conditions into account. Specifically, the tangential components of the computed electric and magnetic field strength must be continuous upon crossing an interface and the normal component of the induced current densities must be continuous as well. In this project, we aim at developing a volume integral equation solver for RF fields in MRI that meets these requirements. More precisely, the aims of the project are:

- Formulate domain integral equations for the electromagnetic field inside the human body
- Discuss existing ways of formulating/solving these integral equations
- Develop own approach (include motivation)
- Code development in Matlab: make use of what is already available
- Evaluate the performance of different iterative solvers
- Aim at a 3D implementation, otherwise 2D (H-polarization)
- Benchmark code against analytic solutions for a canonical configuration (e.g. layered sphere/cylinder)
- Investigate the application of Rytov approximation in MRI (B1+ phase)
- Write a masters dissertation

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