TOWARDS AN *hp* FINITE ELEMENT APPROACH FOR THE NUMERICAL SIMULATION OF 3D EDDY CURRENT PROBLEMS OF RELEVANCE TO MRI SCANNERS

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Magnetic resonance imaging (MRI) has recently become a tool available in most of major medical centres. Its importance in the medical industry is continuously increasing due to its application to a wide range of medical areas such as tumour detection or neuroimaging. MRI scanners utilise a set of superconducting coils to generate a uniform strong magnetic field, and a set of gradient coils to produce pulsed field gradients in order to generate an image. These gradient fields give rise to eddy currents in conducting components, which leads to the generation of Lorentz forces, which cause these components to deform and vibrate. These vibrations have undesirable effects such as imaging artefacts, and patient discomfort due to the high levels of noise generated.

The aim of this work is to develop a computational tool to aid in the magnet design by achieving a better understanding of the induced vibrations. Nevertheless, in this first stage of the project we concentrate our efforts simulating the electromagnetic fields in three dimensional configurations. We focus on the accurate calculation of eddy currents rather than the solution of the coupled electromagneto-mechanical problem, which will be studied in a next stage. Eventually, we aim to extend the work presented in references [1], [3] to 3D problems.

We focus on the **A** based formulation of the eddy current problem. We present two different formulations in order to gauge our solution. In the first one we introduce a small perturbation parameter (penalty function) in the non-conducting regions instead of directly imposing the Coulomb gauge, which is the approach we use in the second formulation. To achieve a numerical solution, we employ a *hp*-H(curl) conforming tetrahedral finite element discretization in which both mesh (*h*-) and polynomial (*p*-) refinement are possible [2], [4]. We will compare *hp* refinement solutions for the different gauging strategies against benchmark problems for which either analytical solutions, experimental results or results from different computational tools are available.

References

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