TOWARDS A REDUCED ORDER MODELLING FOR COUPLED ACOUSTO-MAGNETO-MECHANICAL PROBLEMS WITH APPLICATION TO MRI COIL DESIGN

G.Barroso[1], A.J.Gil[1], P.D.Ledger[1] and M.Mallett[2]

[1] *Zienkiewicz Centre for Computational Engineering, College of Engineering, Swansea University Bay Campus, Crymlyn Burrows, Swansea SA1 8EN, UK*
{*guillem.barroso, a.j.gil, p.d.ledger*}*@swansea.ac.uk*

[2] *Siemens PLC, Healthcare Sector, MR Magnet Technology, Wharf Road, Eynsham, Witney, Oxon OX29 4BP, UK*
michael.mallett@siemens.com

Abstract

Magnetic resonance imaging (MRI) is a scanning technique which obtains an image based on the distortion of a magnetic field. This approach has been intensely used in the field of medicine due to its non-intrusive nature and its high performance when imaging soft tissues and joints, being a key factor when dealing with tumour detection, cartilage damage and internal bleeding. A MRI scanner consists of two sets of coils; a static magnet which generate a strong stationary field and multiple gradient coils which emit magnetic pulses [1]. This process generates Lorentz forces in the conducting parts of the scanner which lead to vibrations and stresses, modifying the initial magnetic field and causing undesired ghosting effects.

The aim of this work is to develop a computational tool to simulate the fully coupled acusto-magneto-mechanical problem in order to aid in the coil design. Fast and reliable simulations are needed during the design stage and this becomes a challenge for instance when dealing with complex geometries or due to the amount of simulations required. For this reason, few assumptions are included such as neglecting the displacement current in the Maxwell equations, linearising the nonlinear problem, which permits a time harmonic formulation [2] and assuming a rotationally symmetric geometry and current source permitting an axisymmetric representation of the problem [3]. As mentioned above, several iterations regarding materials, geometry and boundary conditions may be required during the scanner design and hence, this suggests that numerical techniques regarding reduced order models can be applied to increase its efficiency. Thus, in this initial investigation, we will consider how the proper orthogonal decomposition (POD) and the proper generalised decomposition (PGD) [4] can be applied to this coupled problem to obtain a low-cost parametrised solution depending on several parameters of interest.

References

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