Reduced Basis Methods for Magnetic Resonance Electrical Impedance Tomography (MREIT)

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The numerical solution of parameter identification problems in a partial differential equation (PDE) setting from (noisy) measurements usually requires numerous amounts of forward solutions of the respective PDE. One way to speed up the solution process therefore is to reduce the computational time of the forward solution, e.g. via the reduced basis method.

The reduced basis method is a model order reduction technique which constructs a low-dimensional subspace of the solution space. Galerkin projection onto that space allows for an approximative solution. An efficient offline/online decomposition enables the rapid computation of the approximative solution for many different parameters.

This talk will focus on the problem of magnetic resonance electrical impedance tomography (MREIT), where the main objective is the acceleration of the well-known Harmonic B_z Algorithm [1] using the adaptive reduced basis framework that is able to handle very high-dimensional parameter spaces [2]. The general idea of the framework is to adaptively construct a small, problem-oriented reduced basis space instead of constructing a global reduced basis space like it is usually the case in reduced basis methods. This will be done in an iterative procedure: the Harmonic B_z Algorithm is projected onto the current reduced basis space and iterated until certain termination criteria are reached. The resulting parameter then is utilized to enrich the reduced basis space and therefore fit it to the given problem. This process is repeated until an iterate is accepted as the solution of the inverse problem. Numerical results will demonstrate the usefulness of the approach.

References:

[1] https://doi.org/10.1109/tbme.2003.816080

[2] https://doi.org/10.1137

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