A fast boundary element method for eddy current problems with prescribed current densities on contacts

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We consider an industrial electric device which is driven by an alternating current. The amperage and the frequency are given which means that they are prescribed on some contacts of the device. The goal is to model and compute the Ohmic losses which are a function of the electric field inside the device.

Starting with the eddy current model for Maxwells equations [3] one can derive boundary integral equations for the unknown traces of the electric and the magnetic field on the boundary. The given amperage on the contacts translates into a given normal component of the electric field inside of the device. This gives rise to impose a special jump on the tangential component of the magnetic field as a boundary condition. The unknown magnetic trace can then be restricted to its divergence free part. The jump can be computed by solving an auxiliary problem for some surface potential on the boundary which there is the solution of the Laplace-Beltrami equation .

For discretization we derive a stabilized mixed Galerkin method on the boundary which leads to a sparse system and gives quasioptimal convergence rates. The discretization of the main system is done via Raviart-Thomas elements on the boundary. The divergence constraint on the magnetic trace is incorporated by using Lagrangian multipliers. The compression of the fully populated boundary element matrices is done via the adaptive cross approximation method [1, 2]. The kernel functions arising in the eddy current model are all asymptotically smooth with constants independent of the wavenumber which makes the method work independent of the wavenumber.

Some numerical examples will be presented, which are in agreement with the theoretical results.

References

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[3] R. Hiptmair, *Boundary element methods for eddy current computation.* to appear.