Computational Electromagnetics II
Advanced Computational Methods for 3D Magnetostatic Problems and their Analysis

Ulrich Langer
Special Research Program SFB F013
Institute for Computational Mathematics
Johannes Kepler University Linz, Altenberger-Str. 69, A-4040 Linz, Austria
Home page: http://sfb013[numa].uni-linz.ac.at
E-mail: ulanger@numa.uni-linz.ac.at

In the second lecture, we construct and analyze efficient solvers for 3D magnetostatic problems in bounded and unbounded regions. We mention that a fast solver for 3D magnetostatic problems can be used as a basic module for more complicated application such as the eddy current equations or even magnetomechanical problems (see third lecture).

In the first part of this lecture, we consider 3D magnetostatic boundary value problems in bounded Lipschitz domains with one closed boundary. For this problem class, we have developed efficient parallel multigrid preconditioned conjugate gradient (PCG) method that allows us to solve the corresponding large-scale finite element (FE) equations on parallel computers very efficiently.

The second part of this lecture is devoted to the 3D magnetostatic Maxwell equations in R^3 that can again be reduced to a mixed variational formulation in a bounded domain by means of the symmetric boundary intergral technique. The coupled finite and boundary element (BE) discretizations lead to a symmetric and indefinit system that is solved by the PCG method proposed by J. Bramble and J. Pasciak. The preconditioner contains the approximate solution of an interior FE Neumann problem and an exterior BE Neumann problem. The analysis ensures that the number of iteration is independent of the discretization parameter h provided that both Neumann preconditioners are asymptoticlly optimal. The numerical results show that in practise the symmetric V-cycle approximation to the Neumann problems yields h-independent convergence rates of the PCG solver.