

EFFICIENT ALGEBRAIC PRECONDITIONERS FOR LARGE-SCALE ELECTROMAGNETIC PROBLEMS

TZANIO V. KOLEV AND PANAYOT S. VASSILEVSKI

Numerical simulation of electromagnetic phenomena is of critical importance in a number of practical applications. In many simulation codes, Maxwell's equations are reduced to a second-order PDE system involving one of the vector fields or a new vector potential. The so-called definite Maxwell equations, for example, arise after discretization in time, while magnetostatics with a vector potential leads to the semi-definite Maxwell problem.

In this talk, we will present some recent work on algebraic preconditioners for the lowest order Nedelec finite element discretizations of the above problems. These preconditioners target large-scale unstructured problems that could not be solved efficiently by the previously existing black-box algebraic multigrid (AMG) solvers. The main focus will be on a family of methods which are based on a new stable decomposition of the Nedelec space due to Hiptmair and Xu. In contrast to previous approaches, the HX-decomposition employs nodal auxiliary spaces defined on the original computational mesh. This allows the development of optimal preconditioning schemes utilizing internal AMG V-cycles for scalar and vector Poisson-like matrices. We will discuss a variety of numerical experiments with a parallel implementation of these algorithms, with emphasis on their scalability and robustness with respect to problem parameters.

CENTER FOR APPLIED SCIENTIFIC COMPUTING, LAWRENCE LIVERMORE NATIONAL LABORATORY, P.O. BOX 808, L-560, LIVERMORE, CA 94551

E-mail address: tzanio@llnl.gov, panayot@llnl.gov

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