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Iterative Trefftz method for three-dimensional electromagnetic waves simulation

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Three dimensional electromagnetic waves simulation is an important issue in many applications. Industrial simulation frequently involves the solution of a large linear system. When resorting to direct methods (LU decomposition) the necessary memory for the inversion of the matrix increases very quickly with the size of the computational domain. A natural alternative is to use an iterative method such as a GMRES method or a domain decomposition method. However, classical methods (Finite Elements, Finite Volumes, Finite Differences) are not adapted to Krylov-type methods whereas Trefftz methods [2] are. These methods can be interpreted as a Discontinuous Galerkin method whose basis functions are local solutions of the studied equation or as a domain decomposition method. An iterative Trefftz solver whose solution is computed thanks to a preconditioned GMRES method using domain decomposition has been developed.

However, iterative Trefftz methods based on a plane wave approximation are ill-conditioned. In this talk, improvements of Cessenat and Després preconditioner [3] and of the basis reduction proposed in [1] will be presented. A special attention will be paid to the memory consumption. A matrix-free strategy allows to avoid the assembly of the matrix associated to the linear system and GMRES solver does not require the computation of the inverse. The efficiency of the method will be illustrated by several numerical experiments achieved in HPC context and comparisons with classical methods.

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