11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

Implement of the Domain Decomposition Method in the Time-Harmonic Eddy Current Analysis with Complex Data Types

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Key Words: *Parallel Computing, Domain Decomposition Method, Time-Harmonic Eddy Current Analysis.*

A computational object tends to be large and complicated for numerical analysis recently. In addition, subdivision of the mesh is performed for the improvement of accuracy. Therefore, large-scale computations are increasingly important in electromagnetic field problems. To meet this requirement, we have already introduced Hierarchical Domain Decomposition Method (HDDM) [1] to 3D time-harmonic eddy current problems using the A method and the A-ϕ method with the continuity of the electric current density [2]. To confirm effectiveness of our method, a simple model with the solenoidal coil was analyzed changing its Degrees of Freedom (DOF) several times up to 43 million DOF. The computations were performed with a PC cluster that consists of 32 PCs. As a result, a time-harmonic eddy current problem with 43 million DOF was successfully solved in about 4.8 hours [3].

The possibility of large-scale analysis in 3D time-harmonic eddy current problems that are represented by complex numbers has been shown. However, a computation of the simple model with 55 million DOF diverged (**Fig. 1**). Therefore we have to improve convergence of the interface problem. In this paper, to improve the convergence, the solution strategy of Finite Element Analysis (FEA) in subdomains is reexamined.

Usually, FEA in subdomains is performed by the direct method. However, because the finite element equation that we employ is singular, it is solved by the ICCOCG method, namely Conjugate Orthogonal Conjugate Gradient method that uses the shifted incomplete Cholesky factorization as the preconditioner. If the direct method is applied for solving FEA in subdomains, because the accuracy of the solutions in subdomains is improved, the characteristic of convergence of the interface problem can be improved. Moreover, the computation time seems to be reduced by storing matrices that are results of the LU decomposition on the main memory. In 3D non-linear magnetostatic problems that are represented by real numbers, the characteristic of convergence of the interface problem has been much improved by introduction of the direct method [4]. Therefore, to solve FEA in subdomains by the direct method, we consider the A method that doesn't neglect the Lagrange

multiplier p in subdomains.

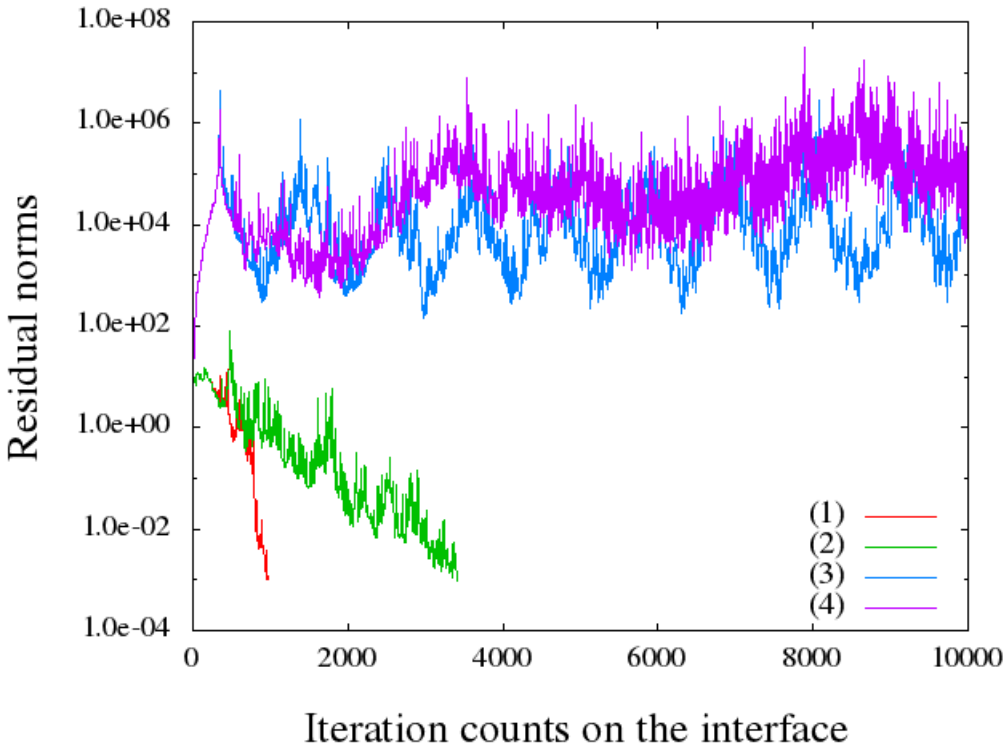

Fig. 1. Convergence history.
(1) 43M DOF (A-ϕ method), (2) 43M DOF (A method)
(3) 55M DOF (A-ϕ method), (4) 55M DOF (A method)

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