An Iterative Domain Decomposition Method for Eddy Current Problems with the Gauge Condition

TAGAMI, Daisuke*

*Institute of Mathematics for Industry, Kyushu University
Motooka 744, Nishi-ku, Fukuoka 819-0395, JAPAN
tagami@imi.kyushu-u.ac.jp

ABSTRACT

An iterative domain decomposition method is introduced to solve quite large scale computational models of eddy current problems. The numerical scheme of eddy current problems in case of conventional one domain, called the A method, ignores the gauge condition and regards the magnetic vector potential A as only one unknown function, which enables us to obtain the efficiently convergent iterative linear solver. However, this numerical scheme yields an indeterminate linear system, it is difficult to mathematically justify numerical results; for example, the unique solvability of the problem and the convergence of the approximate solution. Moreover, as the iterative procedure progresses, an orthogonal properties to be satisfied by the magnetic vector potential is broken down, which is related to the gauge condition. On the other hand, some theoretical results has been introduced in, for example, Kikuchi [1], where a mixed formulation of magnetostatic problems with the Lagrange multiplier is introduced in order to impose the gauge condition. Owing to the introduction of the Lagrange multiplier, their mixed formulation enables us to prove the unique solvability of the problem and the convergence of the approximate solution.

Therefore, by introducing the Lagrange multiplyer as in magnetostatic case introduced by Tagami [2], we formulate an iterative domain decomposition method based on a mixed formulation of eddy current problems with the gauge condition, which enable us to prove the unique solvability of the problems and the convergence of the approximate solution. Even as the iterative procedure progresses, the magnetic vector potential can keep the orthogonal properties related to the gauge condition. Moreover, to reduce computational costs, we simplify our iterative domain decomposition method into another one.

Finally, we show some numerical results, where the proposed method enable us to solve ultra-large-scale computational models, whose degrees of freedom is more than 10^9.

REFERENCES

[1] Kikuchi, F., Mixed formulations for finite element analysis of magnetostatic and electrostatic problems, *Japan J. Appl. Math.*, 6 (1989), pp.209–221.

[2] Tagami, D., An Iterative Domain Decomposition Method with Mixed Formulations, in *COE Lect. Notes Series*, vol. 45, Kanayama, H. Ed., Kyushu University, 2013, 19–26.