Fast Iterative Solution of Eddy Current Problems by a 3–D Hybrid Approach Coupling the Cell and the Boundary Element Methods

F. Moro* and L. Codecasa†

*Dipartimento di Ingegneria Industriale
Università degli Studi di Padova
Via Gradenigo 6/A, 35131 Padova, Italy
E-mail : federico.moro@unipd.it

† Dipartimento di Elettronica, Informazione e Bioingegneria
Politecnico di Milano
Via Ponzio 34/5, 20133 Milano, Italy

ABSTRACT

Hybrid methods, combining e.g. FEM and BEM, can be very effective when applied to eddy current problems because the air region mesh is not required [1]. The Cell Method (CM) and the Finite Integration Technique (FIT) are alternative to FEM because the field problem is formulated in a circuit-like manner in terms of degrees of freedom (DoF). This feature is suitable for modelling multiphysics problems, where different type of couplings occur [2]–[4]. An integral CM for analyzing eddy currents in thin multiply connected shells was presented in [5]. A novel hybrid 3-D CM for magnetostatics, with a fast MINRES iterative solution, was proposed in [6]. This approach has been recently extended to induction heating problems with electrothermal coupling [7].

A novel hybrid approach for solving three-dimensional eddy current problems in the frequency domain is presented. The interior problem in the bounded domain is discretized by the Cell Method, whereas the exterior domain, which is unbounded, is discretized by the Boundary Element Method to avoid the air region meshing. The interface coupling is obtained by introducing a new topological framework, i.e. the *augmented dual grid* [8]. The electromagnetic hybrid formulation results in a partly dense indefinite complex linear system, which can be solved by a fast TFQMR iterative method. Test cases show the accuracy of the hybrid CM in comparison to FEM and software computing requirements.

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