Subproblem h-Conform Formulation for Accurate Thin Shell Models Between Conducting and Nonconducting Regions

Vuong Q. Dang[1], Patrick Dular[1,2], Ruth V. Sabariego[1], Laurent Krähenbühl[3], and Christophe Geuzaine[1]

[1] University of Liège, Dept. of Electrical Engineering and Computer Science, ACE, B-4000 Liège, Belgium

[2] Fonds de la Recherche Scientifique - F.R.S.-FNRS, Belgium

[3] Université de Lyon, Ampère (CNRS UMR5005), École Centrale de Lyon, F-69134 Écully, France

e-mail: quocvuong.dang@ulg.ac.be

A subproblem method (SPM) with $\boldsymbol{h}$-formulation is developed for correcting the inaccuracies near edges and corners that arise from using thin shell (TS) models to replace thin volume regions by surfaces. The developed surface-to-volume correction problem is defined as a step of multiple SPs, with inductors and magnetic or conducting regions, some of them being thin.

The TS model assumes that the fields in the thin regions are approximated by a *priori* 1-D analytical distributions along the shell thickness (C. Geuzaine *et al.*, "Dual formulations for the modeling of thin electromagnetic shells using edge elements," IEEE Trans. Magn., vol. 36, no. 4, pp. 799–802, 2000). Their interior is not meshed and rather extracted from the studied domain, which is reduced to a zero-thickness double layer with interface conditions (ICs) linked to 1-D analytical distributions that however neglect end and curvature effects. This leads to inaccuracies near edges and corners that increase with the thickness. To cope with these difficulties, the authors have recently proposed a SPM based on the $\boldsymbol{h}$-formulation for a thin region located between non-conducting regions (Vuong Q. Dang *et al.*, "Subproblem Approach for Thin Shell Dual Finite Element Formulations", IEEE Trans. Magn., vol. 48, no. 2, pp. 407–410, 2012). The magnetic field $\boldsymbol{h}$ is herein defined in nonconducting regions by means of a magnetic scalar potential ϕ, i.e. $\boldsymbol{h} = -\text{grad}\,\phi$, with discontinuities of ϕ through the TS.

In this paper, the SPM is extended to account for thin regions located between conducting regions or between conducting and nonconducting regions, in the general case of multiply connected regions. In these regions, the potential ϕ is not defined anymore on both sides of the TS and the problem has to be expressed in terms of the discontinuities of $\boldsymbol{h}$, possibly involving ϕ on one side only, to be strongly defined via an IC through the TS. In the proposed SP strategy, a reduced problem with only inductors is first solved on a simplified mesh without thin and volume regions. Its solution gives surface sources (SSs) as ICs for added TS regions, and volume sources (VSs) for possible added volume regions. The TS solution is further improved by a volume correction via SSs and VSs that overcome the TS assumptions, respectively suppressing the TS model and adding the volume model. Each SP has its own separate mesh, which increases the computational efficiency. Details on the proposed method will be given in the extended paper, with practical applications.