Letters

Comments on "Deterministic Approach to Full-Wave Analysis of Discontinuities in MIC's Using the Method of Lines"

Xiao-hong Jiang and Zhenyu Tang

There seems to be some negligence in the above paper [1]. Equations (16) and (17) could not be deduced from expressions (6) to (15).

According to [1] (omitting I and E which denote the impressed wave and excited wave respectively,

$$\frac{\partial^2[\psi^e]}{\partial z^2} \to \frac{1}{h_z^2}[\phi^e]\,[D_{zz}^e]\,[r_{ez}] \tag{14}$$

In [1], it is considered that the derivatives for $[\psi^e]$ and $[\psi^h]$ with respect to the x direction are the same as those in Ref. [2] (named Ref. [22] in [1]), so

$$\frac{\partial^2[\psi^e]}{\partial x^2} \to \frac{1}{h_x^2}[r_{ex}][D_{xx}^e][\phi^e] \qquad \text{(13a) and (14) in Ref. [2]}$$

Substituting the above expressions into the Helmholtz equation

$$\frac{\partial^2\psi^e}{\partial x^2} + \frac{\partial^2\psi^e}{\partial y^2} + \frac{\partial^2\psi^e}{\partial z^2} + \epsilon_r k_o^2 \psi^e = 0 \tag{A}$$

and using

$$[\phi^e] = [r_{ex}]^{-1}[\psi^e][r_{ez}]^{-1} \tag{11}$$

we have

$$\frac{1}{h_x^2}[r_{ex}][D_{xx}^e][\phi^e] + \frac{d^2}{dy^2}([r_{ex}][\phi^e][r_{ez}]) + \frac{1}{h_z^2}[\phi^e][D_{zz}^e][r_{ez}] + \epsilon_r k_o^2[r_{ex}][\phi^e][r_{ez}] = 0 \tag{B}$$

In the above equation, $[r_{ex}]$ and $[r_{ez}]$ could not be deleted, so equation (16) could not be obtained, and equation (17) could not be obtained either.

The negligence in paper 1 is due to the consideration that the discretization in the x and z directions is independent. In fact, the discretization in the x and z directions is coupled, for the modification (also omitting notes I and E), (6) should be

$$\frac{\partial[\psi^e]}{\partial z} \to \frac{1}{h_z}[r_{ex}][\phi^e][D_z]^T[r_{hz}] \tag{6*}$$

The argument is given as follows:

$$\left.\frac{\partial\psi^e}{\partial z}\right|_{i,k} \approx \frac{\psi_{i,k+1}^e - \psi_{i,k}^e}{h_{z_k}} \tag{C}$$

After normalization, (C) becomes

$$\sqrt{h_{z_k}/h_z}\left(h_z \left.\frac{\partial\psi^e}{\partial z}\right|_{i,k}\right) \approx \sqrt{h_z/h_{z_k}}\,(\psi_{i,k+1}^e - \psi_{i,k}^e) \tag{D}$$

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For $k = 1$, according to equation (5) in paper [1]

$$\left.\frac{\partial\psi^e}{\partial z}\right|_{i,1} \approx \frac{\psi_{i,2}^e - \psi_{i,1}^e}{h_{z_1}} = A^{\pm}\psi_1^e,$$

so

$$\sqrt{h_{z_1}/h_z}\left(h_z \left.\frac{\partial\psi^e}{\partial z}\right|_{i,1}\right) \approx \sqrt{h_z/h_{z_1}}\,(\psi_{i,2}^e - \psi_{i,1}^e) = \sqrt{h_z/h_{z_1}}\,h_{z_1}A^{\pm}\psi_1^e, \tag{E}$$

Equation (E) can also be written as follows:

$$\left(\sqrt{h_{z_1}A^{+,-}}\cdot\sqrt{h_z/h_{z_1}}\right)^{-1}\cdot\left(h_z\left.\frac{\partial\psi^e}{\partial z}\right|_{i,1}\right) \approx \sqrt{h_{z_1}A^{+,-}}\cdot\sqrt{h_z/h_{z_1}}\,\psi_1^e \tag{F}$$

Equations (D) and (F) can be combined and rewritten in the matrix form

$$[r_{hz}]^{-1}\left(h_z\frac{\partial[\psi^e]}{\partial z}\right) \to [r_{hz}][D][\psi^e]^T \tag{G}$$

where $[r_{hz}]$ is defined in paper 1 as equation (9)

$$[D] = \begin{bmatrix} 1 & & 0 \\ -1 & \ddots & \\ 0 & -1 & 1 \end{bmatrix} \qquad \text{For Fig. 2 with M} \cdot \text{W at } T_3$$

or

$$[D] = \begin{bmatrix} 1 & 0 \\ -1 \ddots & 1 \\ 0 \ddots & -1 \end{bmatrix} \qquad \text{For Fig. 2 with E} \cdot \text{W at } T_2$$

Furthermore, expression (G) can be transformed as follows:

$$h_z\frac{\partial[\psi^e]}{\partial z} \to [r_{hz}][r_{hz}][D][\psi^e]^T$$

or

$$\to [\psi^e][D]^T[r_{hz}][r_{hz}]$$
$$= [r_{ex}][\phi^e][r_{ez}][D]^T[r_{hz}][r_{hz}]$$
$$= [r_{ex}][\phi^e][D_z]^T[r_{hz}]$$

so

$$\frac{\partial[\psi^e]}{\partial z} \to \frac{1}{h_z}[r_{ex}][\phi^e][D_z]^T[r_{hz}]$$

Equation (7) should be

$$[D_z] = [r_{hz}]\begin{bmatrix} 1 & & 0 \\ -1 & \ddots & \\ 0 & -1 & 1 \end{bmatrix}[r_{ez}] \qquad \text{For Fig. 2 with M} \cdot \text{W at } T_3 \tag{7*}$$

Equation (8) should be

$$[D_z] = [r_{hz}]\begin{bmatrix} 1 \ddots & 0 \\ -1 \ddots & 1 \\ 0 & -1 \end{bmatrix}[r_{ez}] \qquad \text{For Fig. 2 with E} \cdot \text{W at } T_2 \tag{8*}$$

(12) should be

$$\frac{\partial[\psi^h]}{\partial z} \to -\frac{1}{h_z}[r_{hx}]\left[\phi^h\right][D_z][r_{ez}] \tag{12*}$$

(14) should be

$$\frac{\partial^2[\psi^e]}{\partial z^2} \rightarrow \frac{1}{h_z^2}[r_{ex}][\phi^e][D_{zz}^e][r_{ez}] \tag{14*}$$

(15) should be

$$\frac{\partial^2\left[\psi^h\right]}{\partial z^2} \rightarrow \frac{1}{h_z^2}[r_{hx}]\left[\phi^h\right]\left[D_{zz}^h\right][r_{hz}] \tag{15*}$$

The transformations of the derivatives of $[\psi^e]$ and $\left[\psi^h\right]$ with respect to the x direction are not the same as those in Ref. [2], but are

$$\frac{\partial^2[\psi^e]}{\partial x^2} \rightarrow \frac{1}{h_x^2}[r_{ex}][D_{xx}^e][\phi^e][r_{ez}] \tag{H}$$

$$\frac{\partial^2\left[\psi^h\right]}{\partial x^2} \rightarrow \frac{1}{h_x^2}[r_{hx}]\left[D_{xx}^h\right]\left[\phi^h\right][r_{hz}] \tag{I}$$

Now, equations (16) and (17) can be obtained from the modified expressions (14*), (15*), (H) and (I).

References

[1] Z.-Q. Chen and B.-X. Gao, *IEEE Trans. Microwave Theory Tech.*, vol. 37, pp. 606–611, Mar. 1989.
[2] H. Diestel and S.B. Worm, "Analysis of hybrid field problems by the method of lines with nonequidistant discretization," *IEEE Trans. Microwave Theory Tech.*, vol. 32, pp. 633–638, June 1984.

Reply to Comments on "Deterministic Approach to Full-Wave Analysis of Discontinuities in MIC's Using the Method of Lines"

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As mentioned by Xiao-hong Jiang and Zhenyu Tang, there are some negligences in [1]. In the right sides of (6), (12), (14), (15), $[\phi^e]$ and $[\phi^h]$ should read $[r_{ex}][\phi^e]$ and $[r_{hx}][\phi^h]$, respectively. Those negligences had been corrected in papers [2] and [3]. However, we don't think there is any error in (7) and (8).

References

[1] Z. Chen and B. Gao, "Deterministic approach to full-wave analysis of discontinuities in MIC's using the method of lines," *IEEE Trans. Microwave Theory and Tech.*, vol. 37, pp. 606–611, Mar. 1989.
[2] Z. Chen, "Full-wave analysis of the passive components in microwave and millimeter wave planar transmission line circuits using the method of lines," (in Chinese), Ph.D. dissertation, Tsinghua University, Beijing, Nov. 1988.
[3] Z. Chen and B. Gao, "Fullwave analysis of step discontinuities of planar transmission lines by the method of lines," Proceedings of 2nd International Symposium on Recent Advances in Microwave Technology (ISRAMT'89), pp. 24–27, Beijing, 1989.

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Corrections to "A Linear-Operator Formalism for the Analysis of Inhomogeneous Biisotropic Planar Waveguides"

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In the above paper,[1] due to an algebraic error, the coefficients Q, α_2 and B with the radiation modes are incorrectly derived in Appendix III. Defining (with $s = 1, 2$) $\alpha_s = \sin(\sigma_s t')$ and $b_s = \cos(\sigma_s t')$, then the following corrections should be made:

1) Equation (A17) should read

$$\alpha_2 = y[(a_1 - Ra_2) - Q(b_1 + b_2)].$$

2) Equation (A19) should read

$$B = \frac{y\sigma_2\beta_+}{\alpha_1\rho\Delta}[Q(Ra_1 - a_2) + R(b_1 + b_2)]$$

or also

$$B = \frac{\sigma_2\beta_+}{\alpha_2\rho\Delta}[Q(Ra_1 + a_2) + R(b_1 + b_2)].$$

3)-Finally, from the two preceding expresisons for B, one may readily derive, instead of the wrong equation (A16), a quadratic equation for Q of the form

$$g_2Q^2 + g_1Q + g_0 = 0$$

thus leading to a *pair* of radiation modes corresponding to the two solutions of this quadratic equation for a given value of the transverse wavenumber ρ (in the air). The expressions for g_0, g_1 and g_2 are omitted for the sake of brevity.

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[1] C.R. Paiva and A.M. Barbosa, *IEEE Trans. Microwave Theory Tech.*, vol. 40, pp. 672–678, Apr. 1992.