Comments

Comments on "A Super Absorbing Boundary Condition for the Analysis of Waveguide Discontinuities with the Finite-Difference Method"

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In the above letter,[1] the authors may have overlooked our paper, which introduced a numerically derived Absorbing Boundary Condition for the solution of open region scattering problems [1].

In [1], the idea was to present the unknown field or its derivative at a terminal node in terms of a weighted summation of neighboring nodes that lie in the interior. The weighting coefficients are solved for by representing the field at the terminal node in terms of a finite number of its spatial harmonics (three or five dominant harmonics). In [1], we demonstrated the concept by applying it to cylindrical harmonics in the context of the finite-element method, whereas the authors of the above letter[1] considered planar waveguide harmonics in the context of the finite-difference method.

References

[1] O. M. Ramahi, A. Khebir, and R. Mittra, "Numerically derived absorbing boundary condition for the solution of open region scattering problems," *IEEE Trans. Antennas Propagat.*, vol. 39, pp. 350–353, Mar. 1991.

Authors' Reply

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As early in 1992, Prof. K. K. Mei and his student R. Pous sucJcessfully applied the MEI method to solve waveguide discontinuity problems [1]. In Pous' thesis, the scattering parameters of an inductive post in a rectangular waveguide are calculated by finite difference-measured equation of invariance (FD-MEI) method with conformal meshes around the surface of the post (as shown in Fig. 1), where the Green's function was used to calculate the MEI coefficients. It is known that the Green's function in a rectangular waveguide is an infinite summation of harmonic functions, so the calculation of MEI coefficients costs most of the computing time. In 1993, the second author of our letter proposed the concept of measuring loop based on the Equivalence Principle and applied the MEI to scattering problems involving penetrable media [2]. Meanwhile, the author further extended the concept to waveguide discontinuity problems by which conformal meshes are replaced by standard orthogonal meshes and the "metrons" on the surface of the post are moved to planes A and B, as shown in Fig. 2. If sine and cosine functions are chosen as "metrons," the results after integrating with Green's function are just the waveguide modes. So, we need only use waveguide modes to measure the MEI's for determining the MEI coefficients that entirely avoided the Green's function and finally results in dramatic saving in computing time. If we use first three modes to measuring the four-

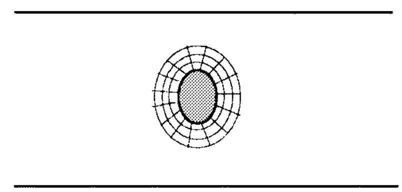

Fig. 1. A conducting post in a rectangular waveguide and the conformal meshes.

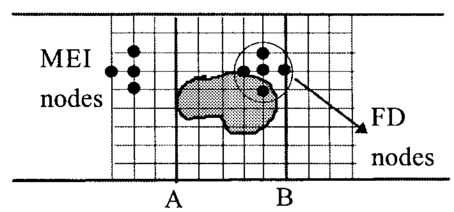

Fig. 2. Arbitrarily shaped obstacle and standard rectangular meshes.

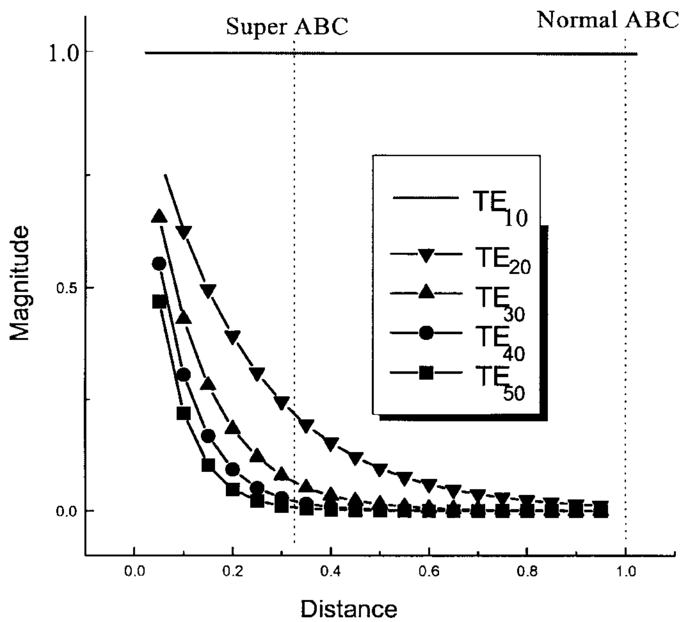

Fig. 3. Attenuation of the modes in a rectangular waveguide.

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[1] J. Y. Zhou and W. Hong, *IEEE Microwave Guided Wave Lett.*, vol. 7, pp. 147–149, June 1997.

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point MEI, the resulting MEI's will rigorously absorb the first three waveguide modes.

We noticed that the modes in the waveguide were clearly known, and in the proper frequency band all the high-order modes attenuated except the dominant mode. The higher the mode was, the faster it attenuated (as shown in Fig. 3). From Fig. 3, we found that if the ABC could absorb the first two high-order modes, we could set the truncated plane much closer to the discontinuity. Based on the idea mentioned above, we proposed the super ABC as described in our letter. From the history of the derivation of the super ABC, it can be seen that this work has no relation to the work in [3]. Anyway, if one carefully reads our letter and [3], one finds that they solved different problems based on different physical concepts.

After receiving the comments, we read the paper [3] carefully. In [3], scattering problems were solved based on a numerical ABC. In fact, there is no modes concept in such problems. In waveguide problems, however, modes and their characteristics are known. The ABC in our paper does not depend on the shape of the discontinuity. The ABC in [3], however, is efficient for quasi-cylinder shapes. For irregular shape, the error is a bit large, as which we can find in that paper.

References

[1] Ph.D dissertation, Univ. California, Berkeley, 1992.

[2] W. Hong, Y. W. Liu, and K. K. Mei, "Application of the measured equation of invariance to solve scattering problems involving penetrable medium," *Radio Sci.*, vol. 29, no. 4, pp. 897–906, 1994.

[3] O. M. Ramahi, A. Khebir, and R. Mittra, "Numerical derived absorbing boundary condition for the solution of open region scattering problems," *IEEE Trans. Antennas Propagat.*, vol. 39, pp. 350–353, Mar. 1991.