A Method Combining the Body of Revolution Method and Spectral Integral Method for Solving Scattering Problems

Yu-Ke Li *(1), Jun Hu (1), Wei-Feng Huang(2), Zaiping Nie(1) and Qing Huo Liu *(2)
(1) School of Electronic Engineering, University of Electronic Science and Technology of China, Chengdu 611731, China
(2) Department of Electronic and Computer Engineering, Duke University, Durham, NC 27705, U.S.

The spectral integral methods (SIM) already have seen successful applications in the electromagnetic computation of 2-D, 3-D, and periodic structures. These methods, benefiting from the transformation from spatial domain to spectral domain, have been shown to be able to improve the computational efficiency and accuracy. In this work, we extend the SIM application to the scattering of the body of revolution (BoR), so this method is called the BoR-SIM.

BoR is a rotationally symmetric three-dimensional object formed by rotating a planar curve around the axis of symmetry. The BoR method has been proposed to solve the problems of rotationally symmetric structures with reduced computational complexity. In the BoR method, the current in the azimuthal ϕ direction is expanded by the Fourier series. Due to the rotational symmetry, the Fourier series corresponding to different modes are orthogonal to each other, which means that the BoR method only involves a series of small matrices instead of a huge one in the MoM linear system for the original 3D problem. On the other hand, the expansion of Fourier series also reduces the number of sampling points to 2 per wavelength from 10 according to the Nyquist theorem.

Like the conventional BoR method, the BoR-SIM retains the advantage of decomposing the current into different orthogonal modes, where the current of each mode can be solved independently. On the other hand, this method extends the Fourier series to expand the current along the generatrix. By this strategy, only two unknowns per wavelength are adequate to achieve a convincing accuracy according to the Nyquist theorem. Considering the geometry error, the number of sampling points per wavelength should be a little more than 2, the necessary number of unknowns of this method is still far less than the conventional BoR method. Furthermore, being accelerated by FFT, this method would show a significant advantage in time consumption. Numerical results show that this method can gain a much higher accuracy compared with the conventional BoR method by choosing the same number of unknowns, or consume much less time while achieving a relatively higher accuracy.