Calculation Method of EM Field Diffracted from a Conductive Circular Disk for Vertically Polarized Electric Dipole Incidence

Teruhiro Kinoshita* (1), Takashi Kuroki(2), and Toshihiko Shibazaki(2)
(1) Tokyo Polytech. Univ., Atsugi, Kanagawa, 243-0297, Japan
(2) Tokyo Metro. College of Industrial Tech., Shinagawa, Tokyo, 140-0011, Japan

The electromagnetic scattered field by a perfectly conducting circular disk is analyzed by using a technique developed by Y. Nomura and S. Katsura (J. J. Bowman, T. B. A. Senior and P. L. E. Uslenghi, *Electromagnetic and Acoustic Scattering by Simple Shapes*, 1969, pp.557-561), while a vertically polarized electric dipole source is located near the disk (see Fig. 1). A Hertz vector of the scattered field is expanded as follows:

$$\begin{matrix}\Pi_x^{(s)}(\rho,\varphi,z)\\ \Pi_y^{(s)}(\rho,\varphi,z)\end{matrix} = \sum_{n=0}^{\infty}\sum_{m=0}^{\infty}\epsilon_n \begin{matrix}P_{x_m}^{\,n}\\ P_{y_m}^{\,n}\end{matrix} S_m^n(\rho,z) \begin{matrix}\cos n\varphi\\ \sin n\varphi\end{matrix}, \qquad (1)$$

and ${\Pi_z}^{(s)} = 0$, where ${P_{x,y}}_m^n$ are expansion coefficients, $\epsilon_n = 2, (n \neq 0), = 1, (n = 0)$. Function $S_m^n(\rho,z)$ is seen in the literature (Y. Nomura and S. Katsura, *J. Phys. Soc. of Jap.*, **10**, 1955, pp.285-304). In the case of vertically polarized dipole incidence, i.e.

$$\vec{\Pi}^{(i)} = \frac{\eta Idl}{4\pi jk}\left(0,0,\frac{e^{-jkR}}{R}\right), \quad \left(R = \sqrt{(x-x_0)^2 + y^2 + (z-z_0)^2}\right),$$

from the boundary condition on the disk, the scattered Hertz vector is presented in the form

$$\vec{\Pi}^{(s)}(\rho,\varphi,0) = -\nabla_t U(\rho,\varphi) \qquad (2)$$

on the disk ($z = 0, \rho < a$), where $\nabla_t = (\frac{\partial}{\partial x},\frac{\partial}{\partial y},0)$, and U is a scalar function and satisfies a following two dimensional inhomogeneous wave equation:

$$\nabla_t^2 U(\rho,\varphi) + k^2 U(\rho,\varphi) = \left.\frac{\partial \Pi_z^{(i)}}{\partial z}\right|_{z=0} \qquad (3)$$

Applying the solution of Eq. (3) to Eq. (2), and matching with Eq. (1) on the disk, an infinite set of simultaneous linear equation of the expansion coefficients is obtained. After truncating the infinite equation and considering the edge condition, we can solve the equation, and the coefficients are evaluated numerically.

Fig. 2 shows the numerical result of the induced current distribution on the disk surface of upper side (z=+0), where the radius of the disk $a = 5\lambda$, the electric dipole source is located on the z-axis at $(0, 0, 10\lambda)$. In this case fields are symmetrical about the z-axis. 2D cylindrical FDTD current is shown for comparison. It seems that both of them agree well. In the figure dotted line shows the current on an infinite conductive plane.

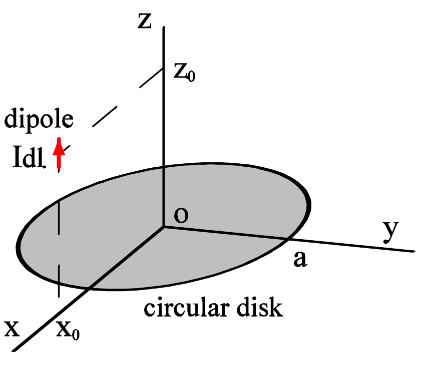

Fig.1 Geometry for the problem

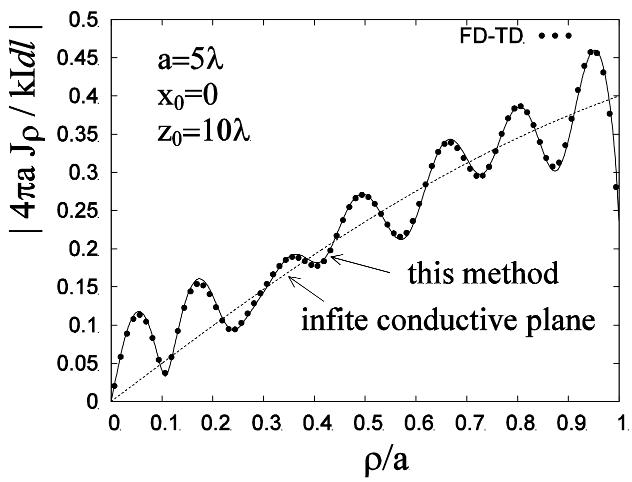

Fig.2 Current distribution on the disk (z=+0)