A Fast Hybrid UTD-PO for the Analysis of Very Large Cylindrical Reflectors with a Linear Feed Array

P. H. Pathak, K. Tap*, T.-H. Lee and T. Lertwiriyaprapa

ElectroScience Lab, The Ohio State University
1320 Kinnear Road, Columbus, OH 43212, USA
E-mail: pathak.2@osu.edu

In some radar applications it becomes necessary to employ a cylindrical reflector, fed by a linear antenna phased array for electronic scanning with a very high gain beam in the plane containing the array, and with a shaped beam in the other, orthogonal, plane. Conventional methods for analyzing such reflector and feed array combinations employ a physical optics (PO) integration over the reflector surface. The current induced on the reflector is calculated within the PO formulation in terms of the field incident from each antenna element of the array. Such a procedure becomes very time consuming and even intractable for electrically very large reflectors because the number of samples in the numerical PO integration increases rapidly with the electrical size.

A method is developed here to overcome the above problem and make the PO integration highly efficient. In particular, a given array distribution is expressed in terms of a very compact Discrete Fourier Transform (DFT) expansion, where each DFT term produces an asymptotic closed form expression for the field of the entire long array. Such an array field can be described via rays that emanate from an interior point on the array, and from the two end points of the array, respectively. This ray description follows the earlier development of (L. Carin, L. B. Felsen, and T.-T. Hsu, IEEE Trans. AP, AP-44, 1, 1-11, Jan. 1996; O. A. Civi, P. H. Pathak, H.-T. Chou, and P. Nepa, Radio Sci., 35, 2, 607-620, Mar.-Apr. 2000; F. Capolino, S. Maci, and L. B. Felsen, Radio Sci., 35, 2, 579-593 Mar.-Apr. 2000). Furthermore, this asymptotic ray field description for the array radiation can be expressed in the format of the uniform geometrical theory of diffraction (UTD). Such a composite UTD array field, which is incident on the cylindrical reflector, can facilitate the PO integral over the reflector surface to be performed essentially in closed form. Thus, one arrives at a highly efficient hybrid UTD-PO approach, utilizing UTD for the feed array together with PO for the cylindrical reflector, which allows one to treat feed array and cylindrical reflector combination that otherwise may become intractable using conventional element by element array field superposition used in conjunction with numerical PO based reflector field calculation. Numerical results will be presented to illustrate the speed and accuracy of the hybrid UTD-PO for treating very large array feed and cylindrical reflector combination.