A UTD Diffraction Coefficient for Vertices at the Tip of a Pyramid Formed by Truncated Curved Wedges

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The uniform geometrical theory of diffraction (UTD) (R.G. Kouyoumjian and P.H. Pathak, Proc. IEEE, 62, 11, 1448-1461, 1974) is a well established approach for calculating the electromagnetic (EM) field scattered by electrically large objects; i.e., objects that are large in terms of the wavelength. It has been widely employed for the prediction of the radar cross section (RCS) of large complex targets or for the computation of radiation characteristics of antennas in the presence of their large platforms (e.g., aircraft, ships, satellites, etc.), (J.J. Kim and W.D. Burnside, IEEE Trans. Antennas Propagat., AP-34, 4, 554–562, 1986; R.J. Marhefka and W.D. Burnside, Proc. IEEE, 80, 1, 204–208, 1992). In modern codes, radiating/scattering objects are typically being represented by interconnecting parametric surfaces. The junctions of different surfaces form curved wedges and pyramidal vertices (tips).

In any UTD ray field representation, the leading asymptotic contributions are the Geometrical Optics (GO) direct and reflected rays of k^0 asymptotic order, where k is the wavenumber. Wedge diffracted rays restore the total field continuity across GO ray shadow boundaries (SBs) and augment the accuracy of the solution to the asymptotic order $k^{-1/2}$. However, discontinuities in the total field are still present at diffracted ray SBs, albeit of weaker asymptotic order. Such residual ray discontinuities, if significant, together with the fact that a vanishing field is predicted in their associated ray shadow regions might render the resulting UTD description inaccurate. Therefore higher order ray contributions, such as vertex diffracted rays, must be added to complete the field description in order to remove the above deficiency.

In this work we focus our attention on the vertex diffracted ray contributions. Recently, a UTD diffraction coefficient for a vertex formed by truncated straight edges in a pyramidal surface, and illuminated by a spherical source, has been proposed (M. Albani, F. Capolino, G. Carluccio, and S. Maci, IEEE Trans. Antennas Propag., 57, 12, 3911–3925, 2009). Here we heuristically modify such diffraction coefficient by introducing proper distance parameters which take into account for the curvatures of the edges that form the vertex, as well as the radii of curvature of the incident astigmatic wavefront. These new distance parameters are derived by imposing the continuity of the total field at the vertex shadow boundary transition regions. The final analytical vertex diffracted ray field expression is very simple and provides a new effective engineering tool. During the presentation, the formulation of the problem will be presented and its effectiveness and accuracy will be demonstrated by resorting to some numerical examples.