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Extension of the UTD to the Diffraction of Complex-Source Beams

Giuliano Manara(1), Ludger Klinkenbusch(2)
(1) Dipartimento di Ingegneria dell'Informazione, University of Pisa, Pisa, Italy
(2) Institute of Electrical and Information Engineering, Kiel University, Kiel, Germany

1. Statement of the Problem

A survey of the two-dimensional solution for the diffraction of inhomogeneous plane waves by a perfectly conducting wedge in a lossless medium is provided. The field associated to the illuminating wave exhibits an exponential amplitude decay in the direction perpendicular to that of propagation. This condition may be met for instance when the incident wave is a surface wave. Also, it may occur locally when the wedge is illuminated by a Gaussian beam, at points away from the Gaussian beam axis. The analysis for inhomogeneous plane wave illumination is extended here to cover the more general case when the wedge is illuminated by a complex-source beam.

2. A UTD Solution

A uniform asymptotic solution for the scattering of an inhomogeneous plane wave by a perfectly conducting wedge was presented in [1], in the format of the Uniform Geometrical Theory of Diffraction (UTD) [2]. In the framework of high-frequency ray methods, the solution was written in terms of reflected and diffracted fields, so that it can be directly applied to calculate the scattering from more complex geometries with edges.

As a result, suitable expressions were provided for the edge diffraction coefficients. Numerical comparisons with the eigenfunction solution have shown that these diffraction coefficients are accurate, even when the field point is only $\lambda/4$ away from the edge. Furthermore, they are exact in the case of the half plane. In particular, the shadow (SB) and reflection (RB) boundaries result to be displaced from their classical locations, i.e. from the locations they assume when the incident plane wave is homogeneous (optical shadow boundaries). It is observed that the displacement is in the direction of decreasing field strength of the incident or reflected field. Moreover, the extent of the above mentioned displacement depends on the evanescence of the incident field. The transition regions adjacent to the shadow and reflection boundaries are bounded by an ellipse. Hence, at a sufficiently large distance from the edge, the classical Geometrical Theory of Diffraction (GTD) can be simply used.

The analysis is extended here to the more general case of illumination by a complex-source beam [3]. A deep physical insight is provided into the scattering phenomenon, discussing the location of both shadow and reflection boundaries, as well as the extension of the corresponding transition regions. Numerical comparisons with the eigenfunction solution are shown to demonstrate the accuracy of the proposed method.

3. References

1. R.G. Kouyoumjian, G. Manara, P. Nepa, and B.J.E. Taute, "The diffraction of an inhomogeneous plane wave by a wedge," *Radio Science*, vol. 31, Nov./Dec. 1996, pp. 1387-1397.

2. R.G. Kouyoumjian, and P.H. Pathak, "A uniform geometrical theory of diffraction for an edge in a perfectly conducting surface," *Proc. IEEE*, Vol. 62, No. 11, pp. 1448-1461, 1974.

3. M. Katsav, E. Heyman, and L. Klinkenbusch, "Scattering and diffraction of a complex-source beam by a wedge," *Proc. of the 2012 IEEE International Symposium on Antennas and Propagation*, DOI: 10.1109/APS.2012.6348778.