Heuristic UTD and ITD for Edges in Penetrable and Coated Planar Screens

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A *revisited* exact solution has been obtained for the electromagnetic problems of edges illuminated at skew incidence, for both an half-plane with surface impedance faces and a surface impedance discontinuity on a plane [R. Tiberio and A. Toccafondi, *IEEE AP-S Symp*, Columbus, OH, June 2003]. Also, an explicit exact spectral integral representation has been obtained for dipole source illuminations and finite distance observations. It is nowadays a simple matter to derive from them the Uniform Geometrical Theory of Diffraction (UTD) formulations for the relevant canonical problems. From these same exact solutions, an Incremental Theory of Diffraction (ITD) formulation has been obtained [R. Tiberio et al., *IEEE AP-S Symp*, Columbus, OH, June 2003] for defining incremental field contributions from local edge discontinuities in planar surfaces with impedance boundary conditions. Of course, both rigorous, high-frequency UTD and ITD solutions have an applicability which is limited to those practical cases that can be modeled by surface impedance boundary conditions. Furthermore, their expressions involve the Malyuzhinets special functions, that are somewhat difficult and time consuming to calculate.

In this paper, first it is shown that both the UTD and ITD formulations can be manipulated to provide rigorous expressions, where the Malyuzhinets special functions are confined into a convenient multiplying term. It is found that this term reduces to unity at both the incidence (SB) and reflection (RB) shadow boundaries and exhibits a slowly varying behavior. Several numerical experiments have shown that, when this term is approximated by unity throughout the calculations, results are obtained that very well compare with those from the rigorous formulations. Thus, it is suggested that this approximation may effectively be employed in most practical applications. Indeed, by introducing this approximation the dyadic diffraction (UTD) and incremental (ITD) coefficients are expressed in closed form.

Next, these formulations are heuristically extended to treat the cases of edges in penetrable and coated planar screens. This is basically achieved by replacing in the rigorous formulation, the reflection coefficients at a planar surface impedance by those at the actual screens. To this end, it is worth pointing out that the heuristic approximations need to be introduced in the relevant 2D rigorous solution. Then, this heuristically modified 2D solution is introduced into the same formulation as that used in the exact solution to obtain the 2D-3D transformation. This is indeed a peculiar property of the formulation of the above mentioned exact solution, in which the 3D solution is obtained as a simple combination, involving only trigonometric functions, of relevant scalar 2D solutions. Thus, after introducing suitable heuristic modifications, closed form high-frequency expressions are obtained that explicitly satisfy reciprocity, rigorously provide the continuity across the shadow boundaries of the GO field and satisfy the boundary conditions at the dominant asymptotic order.

Then, it is shown how surface wave contributions can be included into the simplified treatment of impedance boundary conditions, as well as into its heuristic extension for penetrable and coated screens.

Numerical results from the simplified expressions for impedance boundary conditions are compared with those from the rigorous high-frequency formulations. Also, calculations relevant to penetrable and coated screens are presented and discussed.