Abstract

High-frequency asymptotic techniques are preferred methods for solutions of large scale electromagnetic problems. Their accuracy increases with frequency as they possess the in-built asymptotic nature ($\lambda \to 0$). The Geometrical Theory of Diffraction (GTD) and its immediate supplements i.e., the Uniform Theory of Diffraction (UTD) and the Uniform Asymptotic Theory of Diffraction (UAT) are the most widely used among these techniques. GTD by its nature, exhibits singularities in accordance with the boundaries present as a consequence of wave incidences at the edges. This behavior of GTD around the ray-shadow boundaries was addressed by UTD and UAT (hence called uniform solutions), while away from these boundaries they reduce to the calssical GTD form.

The problem of diffraction by a straight edge in a curved screen is a subject of interest for over few decades, and the application of UTD was limited by its inadequacy in providing uniform solutions for grazing incidence at the edges and for concave side incidence around the reflection boundary (RB). On the other hand, UAT formulation was available only for the case of convex side incidence on the curved screen.

In this thesis, a UTD-type diffraction coefficient to account for the diffraction by a straight edge in a cylindrically curved screen has been established, maintains the simplicity of the UTD form, yet exhibiting the physically exact nature of the UAT form. The proposed coefficient is uniformly applicable for all aspect angles including the convex and the concave side incidence, and does not suffer from the existing problem of the grazing incidence at the edge. The plane wave and the spherical wave solutions of this diffraction coefficient have been validated by using the available experimental results in literature and the simulations using full-wave integral equation based solver (WIPL-D). The reciprocity condition of the diffraction coefficient has been verified for the problem of grazing incidence at the edges. The closed-form expressions have been derived to compute the backscattered RCS of cylindrically curved plates and an accurate shape reconstruction algorithm has been proposed for the inverse problem from amplitude only measured/simulated RCS data.

Keywords: Bistatic RCS, Diffraction by curved screen, Grazing incidence, High-frequency asymptotic methods, Phase detour, RCS of curved plate, Reciprocity, Shape reconstruction, UAT, UTD.