The Contribution of Prof. Robert Kouyoumjian to Edge Diffraction and Field Transition at and Near Shadow Boundaries Using UTD

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Abstract

The development of the Kouyoumjian & Pathak UTD diffraction coefficient will be summarized. Applications of the UTD on basic and complex structures (from ground planes to airframes), based on my own personal experience, will be presented and the impact of the K & P UTD diffractions coefficient will be highlighted.

1. Introduction

When electromagnetic fields strike sharp surface discontinuities, such as edges and corners, they create diffraction. In high-frequency methods, the field generated when a wave impinges upon a PEC wedge can be accounted by using Geometrical Optics (GO), based more on Snell's Law of Reflection, and Diffraction based on Fermat's Principle for diffraction [1]. The diffraction phenomenon and its field contributions can be accounted for by utilizing diffraction coefficients for the appropriate discontinuities. This procedure leads to field predictions which become even more accurate as the frequency increases, and are usually referred to as high-frequency asymptotic methods; in the limit should approach the exact solution. The diffraction coefficients are derived by performing a high-frequency asymptotic expansion, using the Method of Steepest Descent (Saddle Point Method), based on the exact solution of a source at and near a PEC wedge. Based on page limitations, this procedure is not going to the outlined here but it is detailed in [1].

One set of diffraction coefficients were derived by Keller [2], and they were dubbed as Keller's diffraction coefficients based on the Geometrical Theory of Diffraction (GTD). These diffraction coefficients exhibited singularities along the incident and reflection shadow boundaries (ISB and RSB), and limited their use. Another set of diffraction coefficients were derived by Kouyoumjian and Pathak [3], and they were dubbed as the K & P diffraction coefficients based on the Uniform Theory of Diffraction (UTD). The UTD diffraction coefficients eliminated the singularities along the ISB and RSB and provided smooth transition from one side to the other side of the respective shadow boundaries. In addition, they provided more accurate representation of the field. This was accomplished in the UTD formulation by introducing Fresnel integral transition functions which removed the singularities and provided a more accurate representation of the field at and near the shadow boundaries. The UTD diffraction coefficients received international acclaim and expanded the application of diffraction theory to many otherwise intractable boundary-value problems, from simple geometries (such as strips and ground planes) to more complex (such as airframes, ships, and ground vehicles).

The same approach was later implemented to diffraction by wedges, both interior and exterior, with impedance surfaces utilizing Maliuzhinets functions [1], [4]. The diffraction coefficients for the wedge with impedance surfaces are related to those of K & P; however the K & B are basically multiplied by a factor utilizing Maliuzhinets and auxiliary Maliuzhinets functions to obtain those of the impedance wedge. Also for the impedance wedge, an additional component is introduced to account for surface waves, which

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are usually more prevalent for low grazing angles. Some of these applications, from basic structures (such as ground planes) to more complex (such as airframes aircraft, including the Space Shuttle) will be illustrated in this presentation based on my own experience as a graduate student, practicing engineer, and faculty, especially during the early development stages of GTD/UTD. The immense impact of the K & P UTD diffraction coefficients will be highlighted.

2. References

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