Novel Heuristic UTD Coefficient for the Characterization of Radio Channels

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Abstract — This work presents a novel heuristic coefficient for the uniform theory of diffraction, suited to characterize radio channels. The new coefficient combines features from two previously proposed heuristic coefficients. The diffraction by a conducting wedge is investigated in order to demonstrate the usefulness of the proposed coefficient.

I. Introduction

Several techniques have been developed to analyze the propagation of electromagnetic waves through complex environments. Among them, the uniform theory of diffraction (UTD) has been playing an important role, for its versatility and computational efficiency. The UTD coefficients were developed by Kouyoumjian and Pathak for perfectly conducting wedges [1]. Then, Luebbers established heuristic diffraction coefficients to account for lossy conducting wedges, suited for path loss predictions [2]. The concepts introduced by Luebbers were further extended by Aïdi and Lavergnat to define reciprocal coefficients [3]. Afterwards, Holm applied the Fresnel-Kirchhoff theory to propose a different heuristic coefficient with superior performance deep in the shadow region, where Luebbers's coefficient fails [4]. However, as in [2], Holm's coefficient does not obey reciprocity. Thus, our aim is to apply the concepts introduced by Aïdi and Lavergnat [3] into Holm's coefficient [4], in order to establish an efficient and reciprocal diffraction coefficient for radio channel characterizations. In order to estimate the usefulness and applicability of the proposed coefficient, diffractions by lossy wedges are investigated. The results obtained by the UTD heuristic coefficients are compared against those obtained via Maliuzhinets' coefficients [5].

II. New Heuristic UTD Coefficient

According to [4], but adopting the classical notation of [1], the proposed heuristic diffraction coefficient is given by

$$D = W_n D_1 + W_0 D_2 + R_n(\alpha_n) D_3 + R_0(\alpha_0) D_4 , \qquad (1)$$

where $D_{1,2,3,4}$ are the usual UTD coefficients [1] and $R_{0,n}$ are the Fresnel reflection coefficients at faces 0 and n, respectively, functions of the angle α, defined accordingly with [3] as

$$\alpha_0 = \alpha_n = \min(\phi_i , \phi_d , n\pi - \phi_i , n\pi - \phi_d) , \qquad (2)$$

where ϕ_i and ϕ_d are the angles of the incident and diffracted rays, as depicted in Fig. 1. The factors W_0 and W_n proposed in [4] must be redefined to render reciprocal diffraction coefficients, in consistency with (2):

$$W_0 = \begin{cases} 1, & \phi_i < n\pi/2 \\ R_0 R_n, & \phi_i \ge n\pi/2 \end{cases} \quad \text{and} \quad W_n = \begin{cases} R_0 R_n, & \phi_i < n\pi/2 \\ 1, & \phi_i \ge n\pi/2 \end{cases} \qquad (3)$$

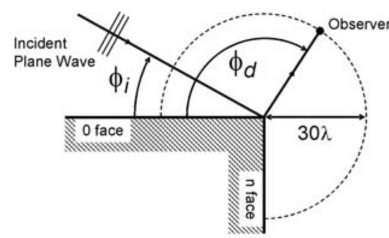

Fig. 1. Right-angle wedge with $\varepsilon_r = 10$ and $\sigma = 0.01$ S/m.

III. Results

To illustrate the improvement provided by the proposed coefficient, the TM plane-wave scattering (with $\phi_i = \pi/6$) from a right-angle lossy wedge ($\varepsilon_r = 10$ and $\sigma = 0.01$ S/m) was investigated, simulating the diffraction of a vertically polarized wave by a building wedge. Observations were made around the wedge ($0 \le \phi_d \le 3\pi/2$) at 30λ from it. The results are shown in Fig. 2 and demonstrate that the present coefficient is capable of considerably improving the back-scattering prediction.

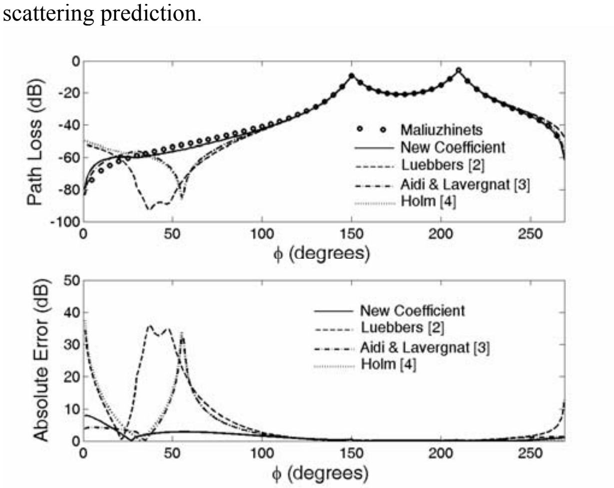

Fig. 2. TM diffracted field around the wedge of Fig. 1.

IV. References

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