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Scattering by Penetrable Obstacles in RFID communication scenarios

M. Frongillo (1), G. Gennarelli (2), and G. Riccio* (3)
(1) SIRA – Member of the Kathrein Group, Caponago (MB), Italy; e-mail: mfrongillo@sira.mi.it
(2) I.R.E.A. – C.N.R., Naples, Italy; e-mail: gennarelli.g@irea.cnr.it
(3) D.I.E.M. – University of Salerno, Fisciano (SA), Italy; e-mail: griccio@unisa.it

The RFID technology relies on a bi-directional flow of information between a reader and one or more tags allocated in a communication scenario. Since the electromagnetic waves represent the physical carrier for the wireless data transfer, a correct analysis of the wave propagation dynamics is fundamental for the successful design, implementation and operation of the RFID systems. A ray-tracing approach based on the Geometrical Optics (GO) and the Geometrical Theory of Diffraction (GTD) can be used to handle efficiently the wave propagation in RFID scenarios, where the objects surrounding the readers as well as the tags affect the propagation conditions. Reflection, transmission and diffraction by walls, floor, ceiling, furniture and items onto which the tags are attached (e.g., pallets in a warehouse) must be considered for a correct propagation analysis.

Metallic and dielectric wedges represent canonical geometries, which can be used to evaluate the diffraction contributions originate by obstacles in the propagation scenario. Many results in literature refer to metallic wedges. For what concerns dielectric wedges, analytical and heuristic approximate solutions have been proposed, as well as procedures combining analytical and numerical techniques for solving the diffraction problem in an exact sense. Although of great interest from the theoretical viewpoint, most of them have limited applicability owing their low computation efficiency.

This contribution proposes Uniform Asymptotic Physical Optics (UAPO) solutions to evaluate the plane wave diffraction by dielectric wedges forming simple or composite structures. The approach starts by considering the scattering integral and using a PO approximation of the electric and magnetic equivalent surface currents lying on the boundary of the observation domain. Useful approximations and analytical calculations allow one to apply a uniform asymptotic evaluation to the resulting integrals for obtaining the diffraction coefficients, which are expressed in terms of the reflection and transmission coefficients of the structure and the transition function of the Uniform Geometrical Theory of Diffraction (UTD) [1]. Moreover, the time domain UAPO diffraction coefficients can be determined according to [2] by taking advantage of the UTD-like formulation of their frequency domain counterparts. The UAPO solutions have the same effectiveness and ease of handling of those derived in the UTD context and, in addition, they have the inherent advantage of providing the diffracted field from the knowledge of the GO field as the heuristic solutions. On the other hand, the use of a PO approximation implies inaccuracies in the case of grazing incidence and in correspondence of the interfaces.

1. 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**, 1974, pp. 1448-1461.

2. T. W. Veruttipong, “Time domain version of the uniform GTD,” *IEEE Trans. Antennas Propagat.*, **38**, 1990, pp. 1757-1764.