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Physical optics approximation from the modified EFIE and MFIE integral equations

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Extended Abstract

The computation of the scattered field from an object and its Radar Cross Section (RCS) can be a very time consuming task and may also require a high memory. Indeed, as the problem's size scales with the number of edges N_{Edge} of the object, the need of fast and memory-efficient algorithm arose to solve high frequency problems. Thus, to overcome this issue, approximations can be introduced in order to reduce the computing time. In high frequency, a possible candidate can be the Physical Optics (PO), and can be obtained from the principal value (PV) of the Magnetic Field Integral Equation (MFIE). That way, the mesh can be coarser, which reduces the number of unknowns N_{Edge} and thus both decrease the memory requirement and the computation time.

However, the MFIE is known to be inaccurate with some geometries, particularly when edge diffraction occurs, and can only be used for closed surfaces [1]. At the contrary, EFIE is more accurate but its main problems come from its ill-conditioned matrix [2]. The purpose of this paper is to construct the PO approximation from the EFIE, hoping that the resulting sparse impedance matrix predicts better results than those obtained from the PV of the MFIE.

This new method was then tested on different geometries and its results were compared to other methods, such as the EFIE, the MFIE, and the classical PO. Similarly to PO, we also used shadowing on this new method, and results were compared to the ones obtained with the methods previously cited, with and without shadowing.

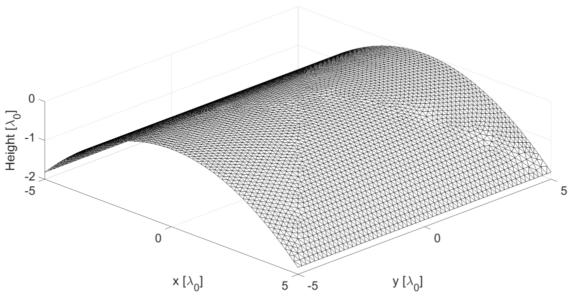

Figure 1. Geometry used in the simulation: $10\lambda \times 10\lambda$ parabola with a 20° slope

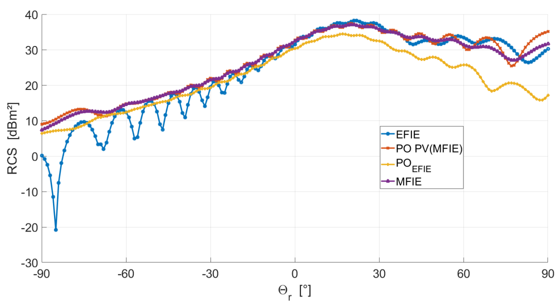

Figure 2. Bistatic RCS between -90° and 90° of the geometry shown in Figure 1, computed with different methods, with $\Theta_{inc} = -70$

Figure 2 shows the bistatic RCS of the object illustrated in Figure 1, illuminated with $\Theta_{inc} = -70$, computed with various methods (EFIE, Physical Optics computed with the principal value of MFIE, Physical Optics coming from an approximation of the EFIE, and MFIE).

References

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[2] W. C. Chew, C. P. Davis, K. F. Warnick, Z. P. Nie, J. Hu, S. Yan, et al., "EFIE and MFIE. Why the difference?", *Proc. IEEE Antennas Propagation Society Int. Symp.*, pp. 1-2, 2008