Scattering from a Target on a Rough Surface using Decoupled Spectral Techniques

Khalid Jamil, Joel T. Johnson, and Robert J. Burkholder*
Dept. of Electrical Engineering, The Ohio State University,
ElectroScience Lab, 1320 Kinnear Road, Columbus, OH, 43212.
Phone 614-292-4597, E-mail rjb@esl.eng.ohio-state.edu

The prediction of the radar scattering from realistically large targets such as a ship on a rough sea surface is very challenging. Different decoupled approaches have been proposed in the past to compute the scattering from the large rough surface separately from the complex target itself. Efficient techniques are available to compute each problem separately and efficiently.

The approach being proposed here is to decouple the surface scattering from the target scattering itself using a reciprocity formulation (K. Jamil and Robert J. Burkholder, IEEE AP-S/URSI conference, 2004). This reduces the solution domain from an infinite surface to the target itself. This requires two quantities to be computed. Firstly, the forward-scattered fields incident upon the target scattered from the surface in the absence of the target, and secondly, the surface currents on the target excited by these incident fields. The forward-scattered fields can be found analytically (L. Tsang, J.A. Kong and R.T. Shin, Theory of Microwave Remote Sensing, 1985) and are represented in terms of their spatial spectrum. Then, physical optics is used to approximate the surface currents on the target in the absence of the surface. Finally, integrating these two quantities over the surface of the target yields the backscatter from the target. The reciprocity formulation used here is similar to the four-path ray model approach (J.T. Johnson, Microwave Opt. Technol. Lett., Vol. 30, pp. 130-134, July 2001) which involves first-order and second-order scattering from the rough surface. First-order and second-order statistics are found analytically which can be used to find the probability distribution function of the scattered fields using standard distribution functions (K. Jamil, Jerry R. Smith, Robert J. Burkholder and Joel T. Johnson, Statistical analysis of a propagation channel over time-evolving rough sea surface surface at grazing, IEEE AP-S/URSI conference, 2005).