An Approximate Approach For Altering The Current Kernel In Rough Surface Scattering

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The Magnetic Field Integral Equation (MFIE) for the current induced on a one-dimensional, perfectly conducting, rough surface has been solved by numerical methods such as Forward-Backward or Method of Ordered Multiple Interactions (MOMI). However, the methods are not amenable to surfaces rough in two-dimensions and they do not provide much insight into the electro-physical processes taking place on the surface. An attempt to overcome this latter shortcoming was the Single Scatter Subtraction (S^3) technique wherein the single scattering part of the current is subtracted from the integral term in the equation. This resulted in a modification to the kernel but the contribution of the subtracting term was difficult to assess particularly if a Neumann series is developed to "solve" the resulting integral equation.

The purpose of this paper is to present details showing how this shortcoming of S^3 can be overcome. Starting with the basic integral equation, the term $\bar{G}(x)J(x)$ is added to both sides of the equation. Here $\bar{G}(x) = \pm j\zeta_{xx}(x)/(2k_o)$ where $\zeta_{xx}(x)$ is the surface curvature at the point x on the surface, k_o is the wavenumber of the incident field and the sign is determined by the polarization (vertical or horizontal). The term $\bar{G}(x)J(x)$ on the right side of the equation can be ignored provided $|\bar{G}(x)| \ll 1$; however, this is restrictive in that one would like to have a valid result even when the curvature of the surface is locally large. To partially circumvent this problem, $\bar{G}(x)J_o(x)$ is both added and subtracted from the right side of the S^3modified integral equation. The added part is combined with the source current $J_o(x)$ while the subtracted part is grouped with the unknown current $J(x)$ to produce the following term for the latter; $[\bar{G}(x)/(1 + \bar{G}(x)][J(x) - J_o(x)]$. This is the term that we would like to be small. It is clear that it can, indeed, be made small under the following conditions; small $|\bar{G}(x)|$, $J(x)$ very close to $J_o(x)$ or a combination of these conditions. It should be noted that if $|\bar{G}(x)|$ is large, the undesirable term in question is equal to $[J(x) - J_o(x)]$ which depends entirely upon how close the actual current $J(x)$ is to the source current $J_o(x)$.

This approach does not solve the integral equation for $J(x)$ but does provide a condition under which the integral equation is both simplified and its kernel is modified in such a way to hopefully lead to a rapidly converging Neumann series solution.