Truncation Effects in the Single Scatter Subtraction Approach

Kevin Diomedi & Gary Brown*, ElectroMagnetic Interactions Laboratory,
Bradley Dept. of Electrical & Computer Engineering, Virginia Tech,
Blacksburg, VA 24061

In a previous USNC-URSI presentation, the Single Scatter Subtraction Approach (SSA) has been proposed and applied for the case of a plane wave illuminating an infinite, one dimensional, perfectly conducting, sinusoidal surface. The method comprises subtracting all the single scattering current terms from the integral in the one dimensional form of the Magnetic Field Integral Equation (MFIE). Single scattering is defined as that part of the total current which is independent of the current at more than one point on the surface. It was shown that this leads to an algebraic solution for the single scatter part of the current involving the integral of the kernel of the MFIE and a modified form of the MFIE for the multiple scatter part of the current. Extensive calculations for this single scatter current result were carried out and it was found that for long period surfaces where there is no significant multiple scattering, the Kirchhoff term is modified by a surface curvature term that is purely imaginary. In addition if the method is extended to small period surfaces where λ_s is comparable to λ_{em}, there are singularities in the integral of the MFIE kernel due to the sinusoidal oscillations of the surface and the electromagnetic wave canceling and leaving only the $(\text{distance})^{-1/2}$ dependence in the kernel integrand.

Finite extent illumination is clearly the way to avoid these infinities. First, it is shown that even though the incident illumination may be finite, e.g. such as with a Gaussian incident beam, this has no effect on the kernel integration because it enters through the current. In order to force the kernel integral to have bounded limits, *the integral equation* must be limited to a finite portion of the infinite surface. This should have no impact on the approach as long as the new limit is larger than the effective bounds imposed by the incident beam field. As with the unbounded surface, extensive calculations of the bounded integral of the MFIE kernel have been carried out and illustrate some very interesting results. First, the results are polarization sensitive in the phase of the current just as with the infinite surface case. Next, the integrated kernel is dependent on the slope of the surface for the TE or horizontal polarization. There is an inverse dependence of the current on the square root of the truncation distance resulting from the one dimensionality of the surface. Finally, the current exhibits a standing wave behavior resulting from waves being reflected from the points of truncation. Thus, with the exception of appearance of the surface slope, the remaining terms resulting from the truncation seem to have a valid reason to be a part of the current. However, since this is the single scattering part of the current which cannot depend on any other part of the surface, these new terms must be erroneous and should be minimized. This can be done by making the truncation points very far away from center of the incident beam and or making the slope small.