Improvements 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 defined 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). 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.

In this update of the ongoing research, the question of incorporating the finiteness of the incident field illumination is considered. First, it is shown that even though the illumination may effectively be finite, e.g. such as with a Gaussian incident beam, this has no effect on the kernel integration. In order to force this 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 bounding 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 which is not expected for single scattering. Next, the integrated kernel is dependent in a nonlinear fashion on the surface, e.g., the square of the surface slope. Finally, the integrated kernel results have the appearance of sharp edge diffraction which is in agreement with what is being done when the surface is truncated. Consequently, these results are taken to be unphysical and erroneous. Fortunately, it is found that these results can be minimized by either making the truncation distance very long and/or using only surfaces with small slopes. If these results are minimized, it is found that the infinite, long wavelength surface results are applicable.

It is concluded, therefore, that these new results should be minimized because they lead to physically unrealistic conclusions. Conversely, their worth lies in providing a quantitative measure of the error that sharp surface truncation produces.