

On the Use of Truncated Surfaces in Rough Surface Scattering

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Practical problems involving rough surface scatter modeling usually involve very large surfaces relative to the electromagnetic wavelength. These kinds of problems are governed by an integral equation which describes the current induced on the rough surface by the incident field. Because of multiple scattering, the domain or support of this equation is frequently a point of question but should be determined by the incident field and the extent of the surface. In particular, it should extend at least to points on the surface which are very weakly illuminated by the incident field. Very frequently, satisfying this criterion is difficult either because (a) the required computational time is too large or (b) the solution method is not capable of accounting for such large surfaces. An example of the former limitation is when it is desired to carryout computations on a laptop computer while the latter problem occurs due to the need to invert large matrices. One approach to circumvent this problem is to simply stop or truncate the integration in the integral equation thereby also restricting the solution to this domain. While this approach was used when first starting to solve the rough surface scattering numerically, it was quickly realized that this was not satisfactory because of the uncertainty of the error the truncation caused. The next approach to an approximate solution of the problem was to set the roughness to zero outside a specific region; this is tantamount to placing a "patch" of roughness on an otherwise flat surface. For a perfectly conducting surface the justification for this approach was that any field incident upon the flat part of the surface would specularly reflect and not interact with the current on the rough part of the surface. Very little, if any, consideration was given to interaction of the rough surface current with the smooth or flat surface.

Recently, it has been shown that if the integral in the current integral equation is truncated, the resulting single scatter part of the current is modified to contain a degree of multiple scattering that depends upon the length of the truncation for a one-dimensional rough surface. This effect will disappear as the length of the truncated region goes to infinity because the current decreases as $1/L^{0.5}$ where L is the length of the truncated surface roughness; the effect is not a surface wave. In fact, the solution is shown to contain a cylindrical standing wave existing between the ends of the truncation. This effect has not been noted previously noted but it clearly does not represent what electrically goes on a large or unbounded surface. Of particular note is that the truncated surface current contains a pseudo multiple scattering that is purely a consequence of the truncation and is not representative of the true current. In this paper the integral equation for an infinite or unbounded, rough, one-dimensional, perfectly surface will be compared to the integral equation for a truncated rough surface on an otherwise flat plane. The terms involving the interaction between the current inside the rough patch and the currents on the two semi-infinite planes will be developed and explored in certain asymptotic limits. If time permits, the impact of these terms on the scattered field will also be presented.