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The impact of curvature on surface current near the rounded corners of a scatterer.

Paul D. Smith*[(1)] and Audrey J. Markowskei[(2)]
(1) Macquarie University, Sydney, Australia; e-mail: paul.smith@mq.edu.au
(2) Macquarie University, Sydney, Australia; e-mail: audrey.markowskei@mq.edu.au

When a perfectly electrically conducting two-dimensional scatterer, which is smooth except at finitely many sharp corner points, is illuminated by an E-polarised electromagnetic plane wave, the surface current density exhibits singularities at those corner points, whilst in the H-polarised case the surface density exhibits singularities in its derivative at those points. Once the corners are rounded, the surface density becomes non-singular. It is of interest to examine the impact of this rounding upon the surface current and other observed physical quantities such as the far-field, as the rounding becomes more pronounced.

An integral equation formulation is a satisfactory basis of numerical studies of the scattering of plane waves by a smooth obstacle; its solution provides a surface density from which all physical quantities can be calculated; and with suitable adaptation, this approach is also appropriate for obstacles with sharp corners [1,2]. In this paper, we describe the appropriate modifications employed to quantify the changes induced in the surface density and far-field pattern when the corners are rounded. Numerically, the difference of the far-field pattern from that of the unrounded structure is found to be $O((k\rho)^m)$, where k is the wavenumber and ρ is the radius of curvature of the rounded corner, as $k\rho$ approaches zero, for some positive exponent m depending upon whether the boundary conditions correspond to the E- or H-polarised case. Where a single corner of internal angle 2Ω is examined, it is found that the exponent equals $2/\nu$ where $\pi\nu=2\pi-2\Omega$.

This integral equation formulation is also the starting point for analysis of the difference in the surface density due to rounding. In the unrounded structure the total field in the vicinity of the corner, in either the E- or H-polarised case, is approximated by that of the infinite wedge of the same internal angle [3]. We then formulate and solve an integral equation for the difference in the surface density due to rounding; it is found that the surface current behaviour at a single corner of internal angle 2Ω is $O((k\rho)^{1/\nu})$, as $k\rho$ approaches zero; also the difference in far-field pattern so obtained is in accord with the numerically observed dependence upon curvature.

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