A Formulation for the Gradient of the Thin Wire Kernel

Donald R. Wilton[(1)] and Nathan J. Champagne[(2)]
(1) University of Houston, Houston, TX 77204–4005, USA
(2) Louisiana Tech University, Ruston, LA 71272, USA

Recently, a formulation for evaluating the thin wire kernel K was developed that employed a change of variable to smooth the kernel integrand, canceling the singularity in the integrand of K. Hence, the typical expansion of the wire kernel in a series for use in the potential integrals is avoided. Since the new expression for K is exact, it may be used directly to determine the gradient of the wire kernel ∇K, which consists of components that are parallel and radial to the wire axis. The result is an expression that, like K, contains smooth integrands. Hence, different quadrature weights are not needed for evaluating the integrals in ∇K.

When the source and observation points are close, the potential integrals over wire segments involving K are split into parts to handle the singular behavior of the integrand. Note that even though the *integrand* of K is smooth, K can still be singular. The singularity characteristics of ∇K are different than those of K, and the axial and radial components have different singularities. Nevertheless all the singularity characteristics are readily identifiable and variable changes can again be used to deal with all except those that reduce to delta function type. This paper will further examine the possibility of handling all singularities arising in ∇K via a single algorithm.

Although this approach for evaluating ∇K is useful for linear wire elements and basis functions, it is sufficiently flexible to be implemented in algorithms involving higher-order wire elements and basis functions. Hence, this formulation facilitates the calculation of near fields and the application of the MFIE for higher-order analysis.