COMPUTING THE IMPEDANCE MATRIX ELEMENTS USING LINE INTEGRALS

John S. Asvestas*
NAVAIR
RF Sensors Division 4.5.5
B2187, S2190 48110 Shaw Rd.
Patuxent River, MD 20670

Henry J. Bilow
Naval Research Laboratory
Code 5314
4555 Overlook Ave. SW
Washington, D.C. 20375

It was shown in a recent article (W. B. Gordon and H. J. Bilow, *IEEE Trans. Antennas Propagat*., **50**, 308-311, 2002) that, given a planar surface and a vector-valued function tangential to it, then the integral of this vector over the surface can be expressed as a line integral over the boundary of the surface. The vector in the line integral is not the same as in the original integral. What in effect has been done through this transformation is to, in a way, perform one of the integrations in the surface integral and reduce it to a single integral over the boundary of the surface. Where numerical evaluation of integrals is involved, it is usually easier to deal with single (line) integrals than double (surface) integrals.

With this as the motivation, and also in the hope of reducing the computational load for the same level of accuracy, we use the approach of Gordon and Bilow (G&B) to calculate the elements of the impedance matrix for the case when the integration surface is made of triangular facets and the Rao-Wilton-Glisson functions are used as basis and testing functions. For this case, the integral that represents the vector in the line integral can be evaluated analytically. We are especially interested in the case when the observation point is close enough to the integration triangle so as to cause numerical instabilities. In a typical fashion, we extract the static part of the integrand in the surface integral, and evaluate it exactly using the approach of Gordon and Bilow rather than triangle coordinates. We then reduce the remaining integral to a line integral around the triangle's perimeter. For the observation point near the triangle, this integral can be computed using a Gauss-Legendre quadrature (GLQ) over each side of the triangle. We consider a worst-case scenario and compute this integral. We compare the results with those obtained using the traditional approach of a seven-point GLQ for the surface integral over the surface of the triangle. As a reference ("exact") solution we use one where the integral is computed in double precision via a Simpson Rule over a very fine mesh. We compute Gaussian quadrature results in both single and double precision arithmetic to allow separation of the errors due to round-off and cancellation from the errors due to approximating the integral via GLQ.

Commission and Session: Commission B7 (Numerical methods: int. eq. based)
What new knowledge is contributed by this paper? This study is conducted in the interest of increasing the accuracy of the impedance matrix elements and decreasing the computational load.
Relationship to previous work: See reference above.