EFFICIENT EXTRAPOLATION OF WIDEBAND RESPONSES OF HIGHLY RESONANT ANTENNAS AND STRUCTURES VIA A DAMPED SINUSOID AND ORTHOGONAL POLYNOMIAL EXPANSION TECHNIQUE

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Obtaining a wideband response (such as driving-point current) of a complex, highly resonant antenna or structure in both the time and frequency domain proves to be a computationally challenging task. In the time-domain, responses of resonant structures are inherently extensive; therefore, determining a complete temporal response using traditional modeling techniques such as the FDTD method requires significant computation time and memory resources. Frequency-domain techniques, such as MOM or FEM, require evaluation at each frequency of interest, and for high frequencies, the size of matrix formulations is a limiting factor. Potentially addressing these issues is a hybrid approach for wideband extrapolation using an orthogonal polynomial expansion (Rao et al, "Simultaneous extrapolation in time and frequency domains using Hermite expansions," *IEEE Trans. Antennas Propagat.*, vol. 47, pp. 1108-1115, June 1999). This technique requires only early-time and low-frequency data, which contain mutually complimentary information, to extrapolate a complete response in both domains. Extrapolating the most computationally intensive portion of a response (late-time and high-frequency) can potentially yield significant CPU time savings compared to the direct calculation of this information using traditional modeling techniques, especially when analyzing complex structures.

The focus of this presentation will be to describe efforts to extend the application of the expansion technique to the extrapolation of responses of highly resonant antennas and structures. Because the orthogonal polynomials utilized provide finite time-support, representation of the long time responses intrinsic to resonant structures proves troublesome. Modeling the late-time response of the structure as a damped sinusoid, however, can allow the structure's time response to be effectively shortened, potentially allowing for polynomial expansion and subsequent extrapolation of the complete response. Efforts to accurately determine damped sinusoid parameters will be discussed as well as the incorporation of the damped sinusoidal basis function into the extrapolation procedure. In addition, the use of the Padė approximation to interpolate frequency domain information for use in the extrapolation procedure will be explored. Lastly, the effectiveness of a proposed genetic algorithm (GA) optimization routine to systematically determine the optimal extrapolation input parameters will be examined.

FDTD codes using a rectangular computational grid will be used to generate early-time data while MOM triangular surface patch techniques will provide low-frequency information. Using Hermite polynomials, the proposed extrapolation procedure will be applied to several resonant structures, including thin-wire monopole configurations, patch antennas, and cavity-type structures. The relative accuracy and computational savings of the proposed technique will then be discussed.