

STATISTICAL AND 'FUZZY POLE' CHARACTERIZATION OF
THE COMPLEX POLES OF A CONDUCTING SPHERE AND A
WIRE

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Developments in ultra-wideband radar, communications and surveillance systems require reliable scatter characterization and modeling. Time-domain, scatter-response characterization based on the Singularity Expansion Method (SEM) has been a popular approach (C. E. Baum, IEEE Antennas and Prop. Society Symp. 11, 459462, 1973). Early SEM research emphasized the accuracy of various extraction methods and algorithms for noisy time-domain data. Some research has also focused on the accuracy of the poles extracted from the noisy data in terms of the percentage error. However, no effort has been undertaken to demonstrate the distribution of complex poles in the presence of noise. Here, analytical as well as measured scatter responses of a conducting sphere and a straight wire will be analyzed for various noise levels. The complex poles will be extracted from the time domain response using the Matrix Pencil Method (T. K. Sarkar, and O. Pereira, IEEE Antennas and Prop. Mag., 37, 4855, 1995).

Empirically observed distributions of the extracted complex poles for various noise levels will be matched to known distributions using iterative search of the distribution parameters. The real and imaginary components of the complex poles or resonances will be treated separately. These advances in the statistical characterization of complex poles will contribute to the development of a comprehensive wideband channel model that incorporates scatterer response.

Complex poles extracted from empirical data form clusters due to the measurement noise. Fuzzy cluster representations of the time-frequency domain signatures are widely used to model buried targets. A similar approach will be applied to characterize a cluster of complex poles by a single fuzzy pole using the Fuzzy Cluster Mean (FCM) algorithm (J. Bezdek, J. Cybernetics, 3, 5871, 1974). The FCM algorithm iteratively searches for a fuzzy pole by minimizing a cost function as in a constrained optimization problem. Advances in fuzzy pole representation will provide characterization of target signatures using fewer complex poles.

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