Utilization of the Early Time In Target Characterization using the Half Fourier Transform

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In order to characterize an unknown object by remote sensing, certain electrical properties of the object may be used. In particular the impulse response, ramp response, and the natural resonant frequencies of the object have been proposed. To identify an object accurately, one must illuminate it with a band of frequencies whose wavelengths must at least contain components which are approximately the same dimensions as the overall length of the object. Since, in general, the size of an object is not known beforehand, it is necessary to illuminate the object by a broadband signal such as a waveform which is an approximation to an impulse. The transmitted pulse induces electrical currents on the object and these currents reradiate the incidental energy. The goal here is to obtain the electrical/physical properties of the object from the transmitted and received time domain waveforms.

Among the various identifier for the signatures, impulse response, ramp response and resonances, estimation of resonant frequencies or poles of a target from the transient response has been under active investigation since the work by Kennaugh and Moffatt ramp response. Because the complex poles are aspect independent, they are suitable for target identification/classification. The resonant frequencies of a conducting object can be used as a signature for that object to discriminate it from others for the purpose of target identification.

This paper presents a new technique for estimating parameters of damped sinusoids and impulse-like responses utilizing both early and late time transient scattering responses. Transient scattering responses are composed of damped sinusoids at late times and impulse-like components at early times. Due to the impulse-like components, it is difficult to extract meaningful damped sinusoids when analyzing the complete data set. In this paper, the entire time domain response is used to extract the signal parameters of interest utilizing both the early and late times. The fractional Fourier transform (FrFT), especially the half Fourier transform (HFT) is used to analyze the data for parameter identification. Impulse or Gaussian-like pulses can be easily separated from the late time damped exponentials in the HFT domain, as they have similar functional representations. In addition, the damped exponentials have a turn on time which needs to be solved for. Results from two examples show that the new technique is applicable for signals that are composed of damped exponentials with a turn-on time and short pulse-like components.