RADAR TARGET DISCRIMINATION USING S-PULSE WAVEFORMS

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The E-pulse radar target identification scheme uses an aspect-independent waveform (E-pulse) which when convolved with the late-time scattered signal of an expected radar target eliminates the natural resonance spectrum of the target. An S-pulse, or single mode extraction waveform, eliminates all but one mode, leaving behind a single damped sinusoid. Interaction of an E-pulse or S-pulse with an unexpected target results in the excitation of the entire target modal spectrum, thus allowing discrimination between expected and unexpected targets. The theory of S-pulse waveforms is well developed but its application has been hampered by lack of an efficient means of interpreting the convolved signal. This paper suggests a simple means of quantifying S-pulse discrimination.

Consider the convolution of sine and cosine S-pulses with a return from the expected target. During a finite time period between the onset of late-time and the end of the measured return the convolved outputs will be single damped sinusoids of unknown amplitudes and unknown phases (differing by 90^{o}), but known complex frequency. These outputs are analyzed for expected single-mode content in an approach inspired by the matched filtering concept. Define DSR, the "S-Pulse discrimination ratio", as

$$DSR = \frac{\left[\int_{-\infty}^{\infty} |C(\omega)||F(\omega)|\,d\omega\right]^2}{\int_{-\infty}^{\infty} |C(\omega)|^2\,d\omega \int_{-\infty}^{\infty} |F(\omega)|^2\,d\omega}$$

where C(ω) is the Fourier spectrum (obtained via the FFT) of the sine and cosine single mode outputs combined to form a complex exponential, and F(ω) is the analytic spectrum of the expected complex exponential, taken over the same finite time interval. It is apparent that the DSR takes on a maximum of unity when the convolved output matches the expected signal. Note that the unknown phase of the convolved output is inconsequential since only the spectral magnitude is involved.

S-pulse discrimination will be demonstrated using measurements made from scale-model targets. It will be shown that by using several S-pulse waveforms, designed to extract different modes from each target, discrimination can be enhanced markedly over that allowed using only E-pulses.