EXTRACTION OF COMPLEX NATURAL RESONANCES FROM RADAR SIGNATURES MEASURED IN TIME DOMAIN

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Radar signatures, in the resonance region, can be recognized thanks to their Complex Natural Resonance's (CNR's), in the context of the Singularity Expansion Method (S.E.M). Hence the time domain response $r_t(t)$ of a target, illuminated by an E.M. wave, can be written as the sum of two terms:

$$r_t(t) = f_e(t) + \sum_{i=1}^{N} R_i e^{\sigma_i t} \sin(\omega_i t) \tag{1}$$

The first term $f_e(t)$ represents the impulsive behaviour of the signal.
The second term is the "late time response" which describes all the phenomena occurring on the object surface (e.g. creeping waves). It represents the time domain area used to determine the CNR's.
σ_i and ω_i are respectively the damped coefficient and the resonance pulsation of the i^{th} CNR. R_i is the corresponding residue of the i^{th} CNR.

CNR's can be extracted in the time domain thanks to some improved versions of Prony method, such as TLS Prony or TSD-TLS Prony. In practice all these formalisms still remain sensitive to important additional noise. A new approach consists in considering a pre-conditioned signal. It can be shown, with analogy of High Resolution Techniques, that the use of the auto-correlated signal after filtering keeps the late time response properties (sum of damped sinusoids) and reduces effects of additional noise. Then, the use of improved Prony methods with auto-correlated measured signals increases the accuracy of CNR's extraction.

The presentation will show the benefits of using auto-correlated measured signals in order to improve CNR's extraction. The results will be presented mainly for conducting canonical targets (dipole, sphere, cylinder, …). The signatures have been recorded using an UWB laboratory measurement system developed by CELAR (French defense organization) in an anechoic chamber.