Joint detection of oversampled deep fluctuating targets

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Radar systems which detect and observe deep fluctuating targets routinely depend upon matched filter theory for "good" detection performance. The optimality of the matched filter occurs in the case of a single target in background noise. When a deep fluctuating target has large signal to noise ratio, the optimality of the matched filter is lost. Nevertheless, the (powerful) concept of the matched filter, and its closely related extention, the ambiguity function, has driven decades of radar waveform development.

We can nevertheless inquire if something better might be possible, especially in an era where substantial computational power is available. The presence of range and doppler clutter is quite clear in high SNR targets; adjacent ranges provide a non-white (although uncorrelated) noise-like spectrum. These adjacent processes evolve on a time scale much slower than the baud duration of most useful radar waveforms. For example, the bandwidth of 1.5 m electrojet irregularities is less than 500 Hz, but the illuminating waveforms typically have a bandwidth 100 times greater. This means that about 100 "looks" on the targets occur before the target has significantly evolved.

Communications systems such as CDMA share a similar challenge. CDMA provides a very nice matched filter detector, which works fairly well. However, it can be shown that joint detection of all users of a common channel provides superior performance (at the expense of more computation) (Uppala and Sahr, IEEE J. Sel. Areas Comm., **16**, 1736-46, 1999).

We will present an initial study of the possibly application of joint detection and estimation of high SNR, deep fluctuating targets, in contrast to typical matched filter methods.