



Phase Retrieval in Radar Signal Processing

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The ability of a radar to discriminate in both range and Doppler velocity is completely characterized by the ambiguity function (AF) of its transmit waveform. Mathematically, it is obtained by correlating the waveform with its Doppler-shifted and delayed replicas. We consider the inverse problem of designing a radar transmit waveform that satisfies the specified AF magnitude. This process may be viewed as a signal reconstruction with some variation of phase retrieval methods [1] [2]. We provide a trust-region algorithm that minimizes a smoothed non-convex least-squares objective function to iteratively recover the underlying signal-of-interest for either time- or band-limited support. The method first approximates the signal using an iterative spectral algorithm and then refines the attained initialization based upon a sequence of gradient iterations.

Next, we consider recovering the radar waveform from the magnitude of the fractional Fourier transform (FrFT) formulation of its AF [3]. The advantage of this formulation is that the recovery of the waveform now becomes a convex optimization problem. Our theoretical analyses for both AF and FrFT-based AF problems show that unique waveform reconstruction is possible using signal samples no more than thrice the number of signal frequencies or time samples. We demonstrate the recovery via numerical experiments.

References

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