Radar Waveform Optimization to Reduce Spectral Spreading and Maximize Target Detection

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Due to tightening spectral constraints, the choice of waveform for different radar applications, especially for range detection, becomes very complicated due to the bandwidth limitations. How can a waveform be chosen that maximizes the ability to detect the desired range/Doppler combination while abiding within spectral mask constraints? This presentation demonstrates innovations in waveform optimization research toward answering this question.

A waveform optimization routine from our group demonstrating the use of spectral mask criteria in the optimization is briefly described (Moldovan *et al.*, 2012). An optimum waveform is selected from a large catalogue of available piecewise linear chirps to maximize in-band flatness and in-band energy while abiding within the spectral mask. As a next step, the possibility of incorporating the ambiguity function into the optimization procedure is examined. The ambiguity function of a waveform describes the erroneous output of the correlator at a radar receiver for errors in range and Doppler. As such, including the ambiguity function in the optimization will allow detection and spectral properties to be Pareto optimized. The approach of minimizing areas of the ambiguity function in significant regions of the range-Doppler plane (for example at the relative range and Doppler of other targets) provides excellent promise for efficient calculation and optimization, as well as waveform construction that is relevant to the tracking problem under consideration. The use of such a spectrally conscious, detection-based optimization will be very useful for adaptive radar systems in applications such as target tracking.

The presentation concludes with examination of how waveform optimization can be used in conjunction with circuit optimization to create the desired detection waveform at the output of the transmitter amplifier while meeting spectral constraints. This result of this approach will be a computationally intelligent, adaptive radar transmitter capable of meeting changing spectral criteria.