A Robust Adaptive Doppler Processing Technique for Short Radar Dwells with Strong Clutter

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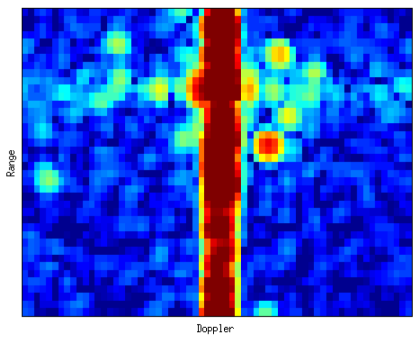
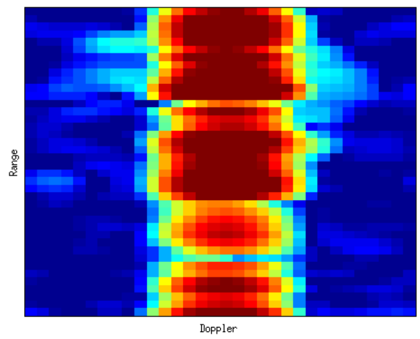
In wide area surveillance applications, the coverage of an electronically-scanned radar can be increased by reducing the coherent processing interval (CPI). However, detecting slow moving targets in the presence of strong clutter is a significant challenge when short CPIs are used. The radar Doppler processing usually involves applying heavy tapers to control sidelobes of strong clutter returns to detect the much weaker moving targets of interest. A taper broadens the mainlobe of the clutter. In short CPIs, such a broadening of the clutter mainlobe could occupy a significant portion of the Doppler spectrum, masking the slow moving targets.

In this work, we utilize the Iterative Adaptive Approach (IAA) for Doppler processing short CPIs with significant performance enhancement over traditional window based techniques. We further improve the robustness of standard IAA by modifying the covariance estimation using a similar concept to notch widening in robust adaptive beamforming. The robustness against motion or uncertainty of an interferer can be improved by widening the notch width in an adapted beam pattern. A similar method developed in this work for IAA, called Robust IAA (IAA-R), can outperform standard IAA in terms of slow moving target detection.

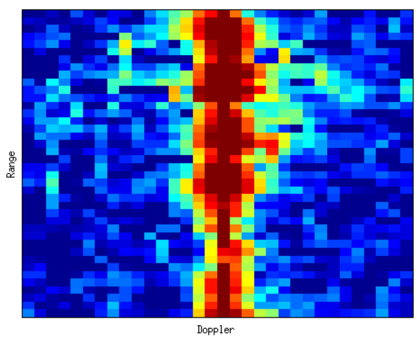
The significant gain of standard IAA over the window based method, and gain of IAA-R over IAA were determined using a probability of detection analysis. We further analysed variations in detection performance with different robustness factors. The new techniques were also applied to data from the Jindalee Operational Radar Network (JORN), and significantly improved range-Doppler maps were obtained for short CPIs, as shown in Figure 1. Although techniques are demonstrated through over-the-horizon radar (OTHR) examples, they would be applicable to other radar applications as well without loss of generality.



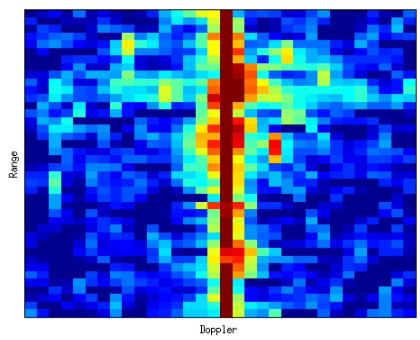
(a) Windowed FFT (64 sweeps)



(b) Windowed FFT (16 sweeps)



(c) IAA (16 sweeps)



(d) IAA-R (16 sweeps)

Figure 1: Data collected from JORN Radar 1. Range-Doppler maps were processed by windowed FFT (64 and 16 sweeps), IAA (16 sweeps), and IAA-R (16 sweeps) techniques.