ADVANCED SIGNAL PROCESSING FOR OVER-THE-HORIZON RADAR SYSTEMS

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A significant problem in over-the-horizon radar (OTHR) is robust high-resolution Doppler processing of accelerating or decelerating targets. This arises during aircraft and ship target manoeuvre and during observations of rockets during boost phase and mid-course flight. The complex Doppler signatures, present in these cases, reveal important information about the target.

The objective of this research work is to investigate and extend recent advances in signal analysis and processing for nonstationary signals to the problem of robust high-resolution of time-varying OTHR target returns. Of particular interest is the problem of multi-component target signal detection and identification, where important information of the manoeuvring targets should be revealed. Such information is of significant value for the classification of the targets and the prediction of ballistic destinations.

Most OTHR systems use classical Doppler processing where one Doppler spectrum is computed using one full coherent integration interval (typically 1s-100s in OTHR). Some systems use overlapped Doppler processing to provide a spectrogram analysis of time-varying Doppler. Both approaches implicitly assume that the target maintains constant velocity with respect to the radar throughout the coherent integration interval. Accelerating/decelerating targets smear in Doppler and have reduced detectability and localization. The smearing reduces resolution and can obscure important multi-component time-Doppler signatures. Modern time-frequency analyses and signal representations have been proven to be a powerful toll to solve the above problem.

There are numerous time-frequency distributions (TFDs) other than the spectrogram. Many TFDs provide superior localization in time and Doppler frequency. Previous applications of time-frequency signal representations to OTHR, however, have generally been disappointing. The fundamental challenge and demand in OTHR is that TFD must retain its desirable resolution and concentration properties in the presence of clutter that is typically 40dB or more stronger than the target (although possibly localized in a different region of time-Doppler).

As the result of the ongoing research work, we have developed a novel method for high resolution time-Doppler signature localization applied to the underlying OTHR system problem. The developed method provides robust estimation of multi-component time-varying Doppler signature in low signal-to-clutter ratio (SCR) scenarios. It is achieved by incorporating pre-processing effective clutter suppression, data-dependent time-frequency techniques for signal discrimination and enhancement, and coherent high-resolution spectrum analysis.