Radar Target Classification Using DOA Information

Ismail Jouny
Lafayette College, Easton, PA

This is an application paper where existing ultra wideband (UWB) direction of arrival (DOA) techniques are utilized for estimating the direction of arrival of a radar signal with respect to the broadside of an antenna array. Such arrival information (or target azimuth) is then invested in improving the recognition performance of an unknown target. This application examines the impact of knowing the exact target azimuth position on the classifier's performance. The paper uses real UWB radar data of commercial aircraft models recorded via a stepped frequency radar. The classifier uses the target high range resolution (HRR) profile that is dependent on the target's aspect angle.

HRR radar signatures are wideband by definition and their DOA requires the use of an appropriate UWB DOA technique. Therefore, two steps are needed ahead of recognition; 1) DOA estimation, and 2) beamforming. This paper uses the linearly constrained minimum variance beamforming approach (the Frost beamformer). This paper also uses the beamspace DOA estimation method. The effects of DOA estimation errors on the target HRR and consequently on the recognition performance are also examined, but it is assumed that the absolute value of the error will be far below 5 degrees which is within the range of available radar data.

To assess the performance of the proposed system, real radar returns of models of commercial aircraft; Boeing 707, 727, 737, and DC10 were used. It is assumed that each receiver records the target return at a certain azimuth position. The aspect angles of 0, 10, and 20 were used in this case. The data was recorded in a compact range at very high SNR (80 db) using a stepped-frequency radar in the 2-12 GHz range with a 50MHz step. Independent Gaussian noise was added to the real and imaginary components of the radar data each with a variance of ½ the additive noise power.

The results show that a priori knowledge of the target's azimuth position may be equivalent to at least 3 dB gain in SNR. They also show that a gross estimation error may lead to the collapse of the recognition process. Furthermore, examining the target at more than a single azimuth position will significantly improve the recognition performance. Knowledge of the target's zero-time reference is more critical to a successful recognition process than knowing the azimuth position of the target.