Preprocessing Issues in High Resolution Radar Target Classification

by

Anthony Zyweck, B.E. (Hons.), B.Sc.

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The University of Adelaide
Faculty of Engineering
Department of Electrical and Electronic Engineering

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ABSTRACT

Research in the area of radar target classification has been active for at least 30 years. The bulk of the research effort has been directed at aspect-independent techniques which classify a target according to its resonant response. Recently there has been a renewed interest in radar target classification, particularly in techniques which provide target classification from high resolution radar imagery. This dissertation addresses preprocessing issues for radar target classification from high resolution radar imagery.

This thesis begins by examining radar backscatter from full-scale aircraft targets. High resolution radar imagery of real aircraft in flight and of a MIRAGE aircraft on a turntable is examined. Several important backscatter characteristics such as engine cavity backscatter and jet engine modulation (JEM) are highlighted. The observed radar backscatter phenomena are discussed in the context of preprocessing for radar target classification. A high resolution radar data simulator called ISARLAB (ISAR LABoratory) is created to produce data for target classification studies. The design of ISARLAB is based upon well established radar backscatter theory and the examination of radar backscatter from real full-scale aircraft. ISARLAB only models the essential target attributes which are likely to be useful for radar target classification.

Radar target classification from a high resolution range profile (HRRP) is required when other techniques such as inverse synthetic aperture radar (ISAR) are unavailable. This dissertation discusses the important preprocessing issues for HRRP target classification. In particular the issues of: aspect independent classification; target localisation; HRRP averaging and HRRP thresholding are highlighted. A classification experiment, using real data of fullscale aircraft, is conducted to further illustrate the preprocessing issues for radar target classification.

An algorithm to coherently average HRRPs is proposed. The algorithm is applicable when the target is at medium to long range or when the target rotation rate is small. The coherent averaging algorithm provides the best possible averaged HRRP, in terms of target scatterer detectability, for a given number of HRRPs averaged. The algorithm coherently processes a sequence of HRRPs and the target return is separated from the noise on the basis of Doppler frequency. The target return, which is localised in Doppler, is extracted to give a coherently averaged HRRP. The averaged HRRP is thresholded using constant false alarm rate (CFAR) processing.