# RADAR SIGNAL PROCESSING

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# ABSTRACT

This dissertation contains three chapters. Each chapter describes a portion of this study that makes an independent contribution to our understanding of radar. Chapter 1 focuses on the determination of a detection-performance bound for binary-phase-modulated signals. The work described in Chapter 1 examined the Minimum achievable Peak autocorrelation Sidelobe Level (MPSL) for length-N binary codes in terms of the Peak Sidelobe Level (PSL) Probability Distribution Function (PDF). PSL PDFs were computed for sequence lengths up to 45 by means of exhaustive search. These PDF results displayed distribution convergence properties that suggested it may be possible to use PDF moments from lower code lengths to predict higher-code-length PDF moments. A probabilistic model for PSL-distribution estimation was developed. The model's predicted PDFs were then compared with exhaustive search results.

Chapter 2 describes work that considered two Joint Time-Frequency Transforms (JTFTs) for use in a SAR (single sensor/platform Synthetic Aperture Radar)-based 3D imaging approach. The role of the JTFT is to distinguish moving point scatterers that may become collocated during the observation interval. A Frequency Domain Velocity Filter Bank (FDVFB) was compared against the well-known Short Time Fourier Transform (STFT) in terms of their maximal-time-frequency-energy concentrations. The FDVFB and STFT energy concentrations were compared for a variety of radar scenarios. In all cases the STFT achieved slightly higher energy concentrations while simultaneously requiring half the computations needed by the FDVFB.

Chapter 3 describes the development of an algorithm for detecting multiple-scattering events between separate scattering centers within the 3D Geometric Theory of Diffraction (GTD)-based Jackson-Moses scattering model. Microlocal analysis techniques were used to compute the locations of multiple-scattering events in SAR data. The proposed multiple-scattering detection algorithm utilized the theory of geometric invariants to estimate the microlocal analysis-predicted multiple-scattering events. After multiple-scattering returns were estimated, the algorithm employed the Generalized Radon Transform to determine the existence of multiple scattering in the measured data. The algorithm was tested on an X-band simulation of isotropic point scatterers.