Seminar Talk

Christopher Rogers
PhD Candidate
Department of Electrical & Computer Engineering
Old Dominion University

Friday, March 22, 2019
3:00 p.m. KH 224

Title: Compressed Sensing and Its Application to a Novel MIMO Radar System to Detect Multiple Extended Targets in Clutter

Abstract:

The resolution of detection and classification radar systems is reliant on both the transmission and reception of wide bandwidth signals such as a linear chirp or a pseudonoise sequence over a small observation time. These requirements drive the need for costly and complex wideband receivers that require speedy analog to digital (A/D) converters and depend upon pulse compression and matched filtering for detection, where it is well understood matched filter banks are susceptible to such detriments as sidelobe interference. Capitalizing on the inherently sparse nature of radar scenes, Compressed Sensing (CS) techniques have been proposed to improve upon the constraints of conventional radar architectures, namely eliminating the need for matched filter detection while reducing the requisite A/D conversion bandwidth. Formalized by Candes, Tao, Romberg and Donoho, CS refers to the process by which signals are sampled and then reconstruct sparse signals with substantially fewer measurements than would otherwise be required by the Nyquist sampling theorem.

This talk explores the detection and false alarm rate performance of a novel waveform and received filter design algorithm as part of a larger CS based Multiple Input Multiple Output (MIMO) bistatic radar system. Transmit waveforms and receive filters were jointly designed using an algorithm that minimizes the mutual coherence of the combined transmit waveform, target frequency response, and receive filter matrix product as an alternative design criterion to meeting the Restricted Isometry Property. Detection performance of the novel system was characterized via mutual coherence measures, reconstruction error, and receiver operation characteristic curves for multiple realistic target scenarios amidst both clutter and noise. Furthermore, the radar scene as reconstructed using multiple sparse reconstruction algorithms, including: Regularized Orthogonal Matching Pursuit (ROMP), Compressive Sampling Matching Pursuit (CoSaMP) and Complex Approximate Message Passing (CAMP) algorithms. It was found that the waveform and receive filter design algorithm significantly outperforms statically designed, benchmark waveforms for radar k waveforms for

and false alarm rate performance and implying that the selection and specification of the sparse reconstruction algorithm for this radar system is not trivial. Rather, in CS radar system design, the radar designer must carefully choose and specify the sparse reconstruction technique and appropriate detection threshold in addition to designing transmit waveforms and receive filters well suited for target detection.

Bio:

Chris Rogers is currently a PhD candidate in Electrical and Computer Engineering at Old Dominion University. He attended the United States Coast Guard Academy and graduated with Honors with a degree in Electrical Engineering in 2008 and while a cadet, was a part Division II national championship rugby team. After graduation, he served as the operations officer aboard the BRISTOL BAY in Detroit, MI and then as a Search and Rescue Coordinator at Coast Guard Sector New Orleans, LA where he directed the initial response to over 160 search and rescue cases resulting in 15 lives saved and hundreds of mariners assisted. While off duty, he competed for the

Old Dominion University from 2012-2014 and earned a Masters of Engineering in Electrical and Computer Engineering. Finally, from 2014 -