Notice and Invitation

Oral Defense of Master's Thesis
The Volgenau School of Engineering, George Mason University

Vaibhav Chavali
Bachelor of Engineering, University of Mumbai, India

Coprime and Nested Array Processing of the Elba Island Sonar Data Set

Friday, April 28, 2017, 12:30 pm
Room 2901 Engineering Building
All are invited to attend.

Committee

Dr. Kathleen E. Wage, Thesis Director
Dr. Jill K. Nelson
Dr. Zhi Tian

Abstract

Sensor arrays can provide estimates of the spatial spectrum associated with propagating waves in a variety of environments, e.g., acoustic waves in the ocean. Vaidyanathan and Pal [IEEE Trans. Sig. Proc., 2010, 2011] describe coprime and nested array geometries that provide significant sensor savings when compared to densely populated Uniform Linear Arrays (ULAs). Coprime Sensor Arrays (CSAs) and Nested Arrays (NAs) consist of two interleaved subarrays with different sample spacings. To reduce the number of sensors, at least one of the subarrays is undersampled. There are several approaches to estimating the spatial power spectrum given a sparse set of CSA or NA measurements. The classical approach is to implement a multiplicative processor. Multiplication of the beamformed outputs of two undersampled subarrays eliminates the ambiguity due to aliasing, but requires temporal averaging to mitigate cross terms. This approach relies on the assumption that signals arriving from different directions are uncorrelated. Recently Liu and Buck proposed an alternative that is not restricted to uncorrelated signals [IEEE SAM, 2016]. Their min processor uses the minimum of the two subarray outputs as the spectral estimate.

The goal of this thesis is to design and implement CSA and NA processing for data from an underwater vertical line array deployed near Elba Island. Building on the work of Adhikari et al. [EURASIP J. Advances Sig. Proc., 2014], this thesis shows that CSA and NA designs for the Elba experiment can attain beampatterns comparable to a fully populated ULA while operating with 33% fewer sensors. As noted above, one drawback of the standard multiplicative processing approach is the need for time averaging to reduce cross terms. Prior work has not quantified the amount of averaging required. This thesis analyzes cross terms using a Gaussian signal model and shows that they decay at a rate of 5 dB per decade of snapshots averaged. Finally, this thesis implements CSA and NA multiplicative and min processing for the Elba data set. Compared to the conventional spectrum obtained with the ULA, the multiplicative CSA and NA spectra for the Elba data contains endfire interference due to cross terms associated with coherent mode arrivals. Liu and Buck's min processor applied to the NA design performs the best for the Elba data set.