Random Matrix Theory Analysis in Passive Sonar

Dr. Kathleen E. Wage

ECE Department Seminar
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Research Hall, Rm 163

Abstract

Passive sonar systems often require adaptive beamformers to improve detection of quiet sources in the presence of loud interference and noise. The performance limits of many adaptive algorithms are not well understood. This is particularly true for large arrays operating in non-stationary environments where it is difficult to obtain sufficient snapshots to estimate signal statistics. Recent mathematical developments in random matrix theory (RMT) provide new tools for analyzing snapshot-deficient signal processing problems. RMT predicts the behavior of the eigenvalues and eigenvectors of covariance matrices estimated from data, which are often used to design adaptive weights. This talk presents an RMT analysis of the Dominant Mode Rejection algorithm, a reduced-rank adaptive beamformer. RMT predictions match experimental measurements for a deep water array operating in the Philippine Sea. The talk will conclude with a brief discussion of future research directions in adaptive signal processing for ocean acoustic applications.

Biography

Dr. Kathleen E. Wage is an Associate Professor in the Electrical and Computer Engineering Department at George Mason University. She received the B.S. degree in electrical engineering from the University of Tennessee-Knoxville, and the S.M., E.E., and Ph.D. degrees in electrical engineering from the Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program. She has taught at Mason since 1999. Dr. Wage's research is a multi-disciplinary synthesis of array processing and underwater acoustics. Her current work applies random matrix theory to problems in sonar signal processing and underwater acoustic propagation. Other recent projects explored the design of sparse arrays for underwater environments and investigated ambient noise in the deep ocean. Much of Dr. Wage's research incorporates real data from ocean experiments. During her career she has spent over 100 days on research ships in the North Pacific and Philippine Sea. Her work has been funded by the Office of Naval Research Undersea Signal Processing and Ocean Acoustics core programs and the Basic Research Challenge and Young Investigator programs. The IEEE honored her with the the Mac Van Valkenburg Early Career Teaching Award (2008) and the Harriet B. Rigas Award (2016). She received the John Toups Presidential Medal from George Mason University in 2019. She has been an Associate Editor for the IEEE Journal of Oceanic Engineering (2005-2021) and chair of the IEEE Underwater Acoustic Signal Processing Workshop (2013-2017).