**Notice and Invitation**
Oral Defense of Doctoral Dissertation
The Volgenau School of Engineering, George Mason University

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**Colored Noise Whitening and Source Enumeration in High Dimension, Low Sample Size Scenarios**

Friday, May 1, 2020, 2:00 pm
WebEx Link:
https://gmu.webex.com/gmu/onstage/g.php?MTID=eb880f6d4e3774ec380ddd8744f19b2d9
All are invited to attend.

**Committee**
Dr. Kathleen E. Wage, Chair
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**Abstract**

Source enumeration algorithms typically rely on an eigendecomposition of the spatial sample covariance matrix (SCM) to estimate the number of signals. Most classical source enumeration methods assume a white noise background and large numbers of snapshots to estimate the spatial SCM. Many environments, e.g., the underwater channel, are characterized by strong noise with a complicated time-varying structure. The colored noise in these environments masks low level sources. Source enumeration using an array in colored noise typically relies on a whitening transformation as a preprocessing stage. Whitening requires the estimation of the noise-only sample SCM, which is a challenging problem for large arrays in nonstationary environments due to the limited number of available snapshots. The amount of data required to estimate the spatial covariance scales with array size. This dissertation proposes the dominant mode rejection (DMR) whitening transform, based on Abraham and Owsley's DMR beamformer. The DMR technique replaces the small eigenvalues of the SCM by their average, thereby reducing the number of snapshots required to estimate an invertible noise-only SCM. Using random matrix theory (RMT) and high dimension, low sample size (HDLSS) asymptotics, this dissertation derives the probability distribution of the largest DMR-whitened eigenvalue and defines a threshold for the source enumeration algorithm that guarantees a specified probability of false alarm. RMT characterizes the statistical behavior of SCM's eigenvalues and eigenvectors when the number of sensors and snapshots grow to infinity, while their ratio stays fixed. HDLSS characterizes the statistical behavior of the SCM's principal eigenvalues and eigenvectors when the number of sensors grows to infinity while the number of snapshots stays fixed. Although these asymptotic approaches are derived for infinite dimension arrays, it is possible to use them to analyze arrays of moderate size. Specifically, the derivation builds on Jung et al.'s results on HDLSS asymptotics for principal component analysis and Paul's RMT spiked covariance model for the largest principal eigenvector. The approach assumes a generalized spiked covariance model for the narrowband noise received by the array. The proposed probabilistic model predicts the largest DMR-whitened eigenvalue as a function of the array dimension and number of snapshots. Simulations and real data analysis from an underwater experiment demonstrate the accuracy of the new model. [Work supported in part by ONR and NSWCDD's NISE and ILIR programs.]