

# EEE 598 Adaptive Radar and Cognitive Systems

School of Electrical, Computer, and Energy Engineering, Fall 2019

## Catalog Description:

Adaptive techniques for radar detection / estimation, and introduction to concept of cognitive radar.

## Course Overview:

Remote sensing radar systems (or sonar, lidar, infrared/CCD imaging, multiuser communications, etc.) extract information from noisy measurements plagued by non-stationary interference. Adaptive techniques for radar detection and parameter estimation that enable robust operation are covered. Statistical analyses and methods for assessing performance, including loss in signal-to-interference plus noise ratio (SINR), receiver operating characteristics (ROC) curves, and mean squared error (MSE) analyses of nonlinear schemes are discussed. Lastly, the emerging concept of cognitive radar is introduced whose nature inspired framework includes a perception-action-cycle capable of adapting system parameters as the environment changes.

**Prerequisites:** EEE 554 (or equivalent) - basic knowledge in random signals

## Textbook:

There is no official textbook for this course. Useful references include:

A. O. Steinhardt, "Adaptive multisensor detection and estimation," in *Adaptive Radar Detection and Estimation*, S. Haykin and A. O. Steinhardt, Eds. New York: Wiley, 1992, ch. 3.

J. R. Guerci, *Cognitive Radar: The Knowledge-Aided Fully Adaptive Approach*, Artech House, Inc., Norwood, MA, 2010.

S. Haykin, "Cognitive radar: a way of the future," *IEEE Signal Processing Magazine*, Vol. 23, No. 1, pp. 30–40, January 2006.

*Principles of Modern Radar: Basic Principles*, M. A. Richards, J. A. Scheer, W. A. Holm, Eds., SciTech Publishers, Inc., Raleigh, NC, 2010.

## Course Topics:

- Radar basics review
  - Space-time adaptive processing (STAP)
- Optimal linear filtering/beamforming
  - max SINR; minimum variance distortionless response (MVDR); max mutual information
- Constant false alarm rate (CFAR) processing
- Sample matrix inversion and complex Gaussian-based analyses
- Matched subspace detectors
  - adaptive matched filter; Kelly's generalized likelihood ratio test; adaptive coherence estimator
  - adaptive sidelobe blanker
- Adaptive maximum-likelihood estimation (range, Doppler, angle), Capon-MVDR spectral algorithm
- Methods for MSE analysis: Cramér-Rao bounds, Taylor's series
- Fuster's paradigm for cognition; cognitive architectures; cognitive radar framework