ECE 653
Detection Theory
Fall 2019

Prerequisites: ECE512, and ECE 514 or equivalent

Course Credits: 3

Place & Time: Engr. B2, TR: 4:00pm-5:15pm

Textbook: "Fundamental of Statistical Signal Processing-Detection Theory", S. M. Kay, Prentice-Hall, 1998.

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Office Hours: TR 1:30-2:30pm

Course Description:
The objective of this course is to introduce the students to the techniques for signal detection. Particular emphasis will be placed on the Neyman-Pearson and Bayes detectors with applications in the areas of Communications, digital Signal/Image Processing (DSP/DIP), Controls and Power Systems. Additional topics that will be covered include: matched filters and matched subspace detectors and methods for distributed detection in sensor networks.

Student Learning Objectives:
Upon completion of this course students will
- (a) Learn detection theory and methods for various signal and noise models,
- (b) Gain exposure to a wide range of application areas,
- (c) Learn how to design and implement a detector for a given signal detection problem,
- (d) Analyze the performance of the designed detectors using different performance metrics.

Course Outline:

Week 1: Introduction to the detection area and applications in Communications and DSP/DIP areas.
Weeks 2-4: Binary hypothesis testing: Neyman-Pearson theorem, receiver operating characteristics (ROC), minimum error probability criterion, Bayes risk, sufficient statistics, uniformly most powerful (UMP) test.
Weeks 5-6: Detection of deterministic signals: matched filter, generalized matched filter, multiple signal models linear discriminant functions, applications to binary and M-ary communication systems.
Weeks 7-8: Bayes criterion: Bayes test, Minmax tests, multiple alternative hypothesis, composite hypothesis testing, generalized likelihood ratio test (GLRT).
Weeks 9: Review and Midterm exam.
Weeks 10-12: Detection of signals with unknown parameters: different deterministic and random signal models, some classical signal processing problems and derivations of GLRT, incompletely known signal covariance, weak signal detection.
Weeks 13-14: Matched subspace detectors: GLRT and invariance properties for different signal, interference and noise subspace models, geometrical interpretations and properties.
Week 15: Distributed detection in sensor networks: different network configurations, distributed detection without and with fusion, design of fusion rules, detection with parallel fusion, distributed Neyman-Pearson detection.
Week 16: Final project.

Grading:

Homework (5 each 4%)	20%
Computer Assignments (3 each 8%)	24%
Midterm Exam	26%
Final project/exam	30%