Signal Detection and Estimation Theory - Web course

COURSE OUTLINE

Signal detection and estimation is the area of study that deals with the processing of information-bearing signals for the purpose of extracting information from them. Applications of the theory of signal detection and estimation are in many areas, such as communications, automatic control, radar/ sonar, speech and image processing and medical signal processing.

In general, detection and estimation applications involve making inferences from observations that are distorted or corrupted in some manner. As the information that one wishes to extract from such observation is unknown to the observer, it is useful to cast detection and estimation problems in a probabilistic framework in which unknown behavior is assumed to be random.

In Module 1, the detection and estimation problems are defined in modern context i.e., in discrete-time domain and the random processes are reviewed. Module 2 presents of basics of the statistical decision theory which provide the basis and the performance measures for most of the signal detection problems.

Modules 3 and 4, discuss the detection of deterministic and random signals using statistical models, respectively. Module 5 deals with the detection of signals without assuming any statistical model. Modules 6 and 7 deal with problems of estimation.

In Module 5, the elements and structure of parameter estimation is discussed. The signal estimation in discrete-time domain is explored in Module 7. A number of examples illustrating the theory are also provided in each of the modules.

COURSE DETAIL

Module No.	Topic/s	No.of Lectures
1	**Background:** Review of Gaussian variables and processes; problem formulation and objective of signal detection and signal parameter estimation in discrete-time domain.	2
2	**Statistical Decision Theory:** Bayesian, minimax, and Neyman-Pearson decision rules, likelihood ratio, receiver operating characteristics, composite hypothesis testing, locally optimum tests, detector comparison techniques, asymptotic relative efficiency.	8
3	**Detection of Deterministic Signals:** Matched filter detector and its performance; generalized matched filter; detection of sinusoid with unknown amplitude, phase, frequency and arrival time, linear model.	6

NP-TEL

NPTEL

http://nptel.iitm.ac.in

Electronics & Communication Engineering

Pre-requisites:

1. Linear Algebra (MA102).
2. Signals and Systems (EC220).
3. Probability and Random Processes (EC221).

Coordinators:

Dr. R. Sinha
Department of Electronics and Communication EngineeringIIT Guwahati

4	**Detection of Random Signals:** Estimator-correlator, linear model, general Gaussian detection, detection of Gaussian random signal with unknown parameters, weak signal detection.	6
5	**Nonparametric Detection:** Detection in the absence of complete statistical description of observations, sign detector, Wilcoxon detector, detectors based on quantized observations, robustness of detectors.	6
6	**Estimation of Signal Parameters:** Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, sufficient statistics, minimum statistics, complete statistics; linear models; best linear unbiased estimation; maximum likelihood estimation, invariance principle; estimation efficiency; Bayesian estimation: philosophy, nuisance parameters, risk functions, minimum mean square error estimation, maximum a posteriori estimation.	8
7	**Signal Estimation in Discrete-Time:** Linear Bayesian estimation, Weiner filtering, dynamical signal model, discrete Kalman filtering.	6
	Total	42

References:

1. H. L. Van Trees, "Detection, Estimation and Modulation Theory: Part I, II, and III", John Wiley, NY, 1968.
2. H. V. Poor, "An Introduction to Signal Detection and Estimation", Springer, 2/e, 1998.
3. S. M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory", Prentice Hall PTR, 1993.
4. S. M. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory", Prentice Hall PTR, 1998.