

ECU448 DETECTION AND ESTIMATION THEORY

Pre-requisites: Random Signal Theory, Calculus, Linear algebra

Detection Theory

(1) Binary decisions - Single observation: (10 Hours)

Maximum likelihood decision criterion; Neymann-Pearson criterion; Probability of error criterion; Bayes risk criterion; Minimax criterion; Robust detection; Receiver operating characteristics.

(2) Binary decisions - Multiple observations (10 Hours)

Vector observations; the general Gaussian problem; Waveform observation in additive Gaussian noise; Integrating optimum receiver; Matched filter receiver.

Estimation Theory

(3a) Methods (7 Hours)

Maximum likelihood estimation; Bayes cost method - Bayes estimation criterion- Mean square error criterion; Uniform cost function; absolute value cost function; Linear minimum variance - Least squares method; Estimation in the presence of Gaussian noise - Linear observation; Non-linear estimation.

(3b) Properties of estimators (5 Hours)

Bias, Efficiency, Cramer-Rao bound, Asymptotic properties; Sensitivity and error analysis.

(4a) State Estimation: Prediction; Kalman filter. (5 Hours)

(4b) Sufficient statistics and Statistical Estimation of Parameters: (5 Hours)

Concept of sufficient statistics; Exponential families of distributions; Exponential families and Maximum likelihood estimation; Uniformly minimum variance unbiased estimation.

Text books

1. Steven M. Kay, *Statistical Signal Processing: Vol. 1: Estimation Theory, Vol. 2: Detection Theory*, Prentice Hall Inc., 1998.
2. Louis L. Scharf, *Statistical Signal Processing: Detection, Estimation and Time Series Analysis*, Addison-Wesley Publishing Company, 1991.

Reference books

1. Boaz Porat, *Digital Processing of Random Signals: Theory and Methods*, 4th edn., Prentice Hall Inc., 1994.
2. Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogan, *Statistical and Adaptive Signal Processing*, McGraw-Hill International Editions, 2000.
3. Harry L. Van Trees, *Detection, Estimation and Modulation Theory - Part 1*, John Wiley & Sons Inc., 1968.
4. Jerry M. Mendel, *Lessons in Estimation Theory for Signal Processing, Communication and Control*, Prentice Hall Inc., 1995.
5. Sophocles J. Orfanidis, *Optimum Signal Processing*, 2nd edn., McGraw-Hill, 1988.
6. Monson H. Hayes, *Statistical Digital Signal Processing and Modelling*, John Wiley & Sons Inc., 1996.
7. Dimitri Kazakos, P. Papanтони Kazakos, *Detection and Estimation*, Computer Science Press, 1990.
8. James L. Melsa and David L. Cohn, *Decision and Estimation Theory*, McGraw-Hill, 1978.