RADAR SIGNAL PROCESSING

Course Code: 13EC2105

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Pre requisites: Analog and digital communication systems, DSP, Basic Radar engineering.

Course Educational Objectives:

1. To understand matched filter.
2. Detection of Radar signals in noise.
3. Radar waveforms.
4. Pulse compression techniques.

Course Outcomes:

1. Design Radar systems in different noise environment.
2. Detection of targets in noise environment.
3. This course provides foundation for more advanced work in detection theory adaptive signal processing.

UNIT-I

RANGE EQUATION & MATCHED FILTER:

Radar Block Diagram, Radar Equation, Information Available from Radar Echo, Radar Range Performance– General Radar Range Equation, Radar Detection with Noise Jamming, Beacon and Repeater Equations, Bi-static Radar.

Matched filter Receiver – Impulse Response Frequency Response Characteristic and its Derivation, Matched Filter and Correlation Function, Correlation Detection and Cross-Correlation Receiver. Efficiency of Non-Matched Filters, Matched Filter for Non-White Noise.

UNIT-II

SIGNAL MODELS:

Amplitude model, Radar cross section, Statistical description, clutter: Noise model, Signal to Noise ratio, jamming. Frequency models: Doppler shift, Spatial Models: Variation with angel cross range multipath

UNIT-III

SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS:

Domain criteria for sampling radar signals ,sampling in the fast time dimension ,Sampling in slow time ,Sampling the Doppler spectrum, spatial and angel dimension ,Quantization.

Radar Waveforms: Waveform Matched filter of moving targets Ambiguity function, Pulse burst Waveforms. Frequency Modulated pulse compression wave forms: Introduction, significance, Types. Linear FM Pulse Compression – Block Diagram, Characteristics reduction of Side lobes, Stretch Techniques. Generation and decoding of FM Waveforms-block, schematic and characteristics of passive system, digital compression.

UNIT-IV

DOPPLER PROCESSING:

Moving Target Indication: Pulse cancellers, matched filters for clutter suppression, blind speeds Pulse Doppler processing: DFT of moving targets, Sampling of DTFT, Fine Doppler estimation. Pulse pair processing .Detection Fundamentals: Neynan-PearsonDetection Rule, Threshold Detection of radar signals

UNIT-V

PHASE CODING TECHNIQUES:

Principles, Binary Phase Coding, Barker Codes, Maximal Length Sequences (MLS/LRS/PN), Block Diagram of a Phase Coded CW Radar. Linear FM and Frequency Coding Techniques: Principles, Linear FM pulses, Generation and Decoding, Distortion effects on LFM Signals, Discrete Frequencies, Waveform Analysis, Capabilities, Resolution properties of Frequency Coded Pulses,Poly Phase Codes: Frank Codes, Costas Codes, Non-Linear FM Pulse Compression, Doppler Tolerant PC Waveforms – Short Pulse, Linear Period Modulation (LPM/HFM). Side lobe Reduction for Phase Coded PC Signals.

TEXT BOOKS:

[1] Mark.A.Richards, "*Fundamentals of Radar Signal Processing*", TMH, 2005.

REFERENCES:

[1] Fred E. Nathanson, "*Radar Design Principles: Signal Processing and the Environment*", 2nd ed., PHI, 1999.

[2] Peyton Z. Peebles Jr, "*Radar Principles*", John Wiley, 2004.

[3] R. Nitzberg, "*Radar Signal Processing and Adaptive Systems*", Artech House, 1999.

[4] F.E. Nathanson, "*Radar Design Principles*", 1st ed., McGraw Hill, 1969.

[5] M.I. Skolnik, "*Introduction to Radar Systems*", 3rd ed., TMH, 2001.