RADAR SIGNAL PROCESSING

Course Code:15EC2105

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

Course Outcomes: After completion of the course, the student will be able to

CO1: Revisit analysis of radar fundamentals and design matched filters in noise environment

CO2: Perform modeling with various parameter configurations can be efficiently achieved.

CO3: Comprehend types of pulse compression techniques for increasing range resolution.

CO4: Analyze statistical framework necessary for the development of automatic target detection.

CO5: Comprehend different phase coding techniques for various radars.

UNIT-I (10-Lectures)

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 (10-Lectures)

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 (10-Lectures)

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 (10-Lectures)

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-Pearson Detection Rule, Threshold Detection of radar signals.

UNIT-V (10-Lectures)

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.