Modeling Radar Systems with MATLAB

OEM: MathWorks • Code: MW-MODELING-RADAR-SYSTEMS-WITH-MATLAB

COURSE DESCRIPTION

This two-day course provides a comprehensive introduction to radar system design and modeling with a focus on Radar Toolbox™ and Phased Array System Toolbox™. Radar systems engineering for preliminary radar design Scenario generation including targets, propagation, and terrain System simulation at the measurement and physics (IQ signal) level Signal processing for target detection Data processing for multi-object tracking Higher fidelity modeling including antenna array design, waveform analysis, clutter, polarization, and micro-Doppler signature generation

AUDIENCE PROFILE

- IT professionals and technical staff seeking hands-on training in this course's subject area.

PREREQUISITES

- Basic radar knowledge and experience using MATLAB®

COURSE OBJECTIVES

By the end of this course, participants will be able to:

- Understand course themes, including an overview of a radar system model that will be developed at different levels of fidelity as the course progresses.
- Understand how to use the Radar Designer app to characterize, analyze, and evaluate radar system requirements.
- Understand how to use Radar Toolbox to create a realistic scenario which can be used to evaluate a preliminary radar system design and to also drive system level simulations.
- Translate a preliminary radar design into a statistical model. Learn to generate detections, clustered detections, and tracks from the model. Implement workflow to move to a signal-level model directly from the statistical model.
- Generate detections from signal-level simulations. Estimate received signal parameters including direction-of arrival, range, angle, and Doppler response. Configure a multi-object tracker and perform adaptive tracking.
- Design and analyze phased array antennas.
- Integrate beamforming and Direction of Arrival (DOA) estimation to improve desired signal strength and reduce the impact of interference sources. Parameter estimate angle, Doppler
- Learn how to extend the fidelity of the signal-level model across the range of radar system and scenario components.
- Learn how to generate antenna patterns and model mutual coupling in an array.
- Select waveform parameters and build an agile waveform library.

COURSE OUTLINE

Module 1: Day 1 of 2

Working with Radar Toolbox

- Introduction to the products listed above with a focus on Radar Toolbox
- Introduction to a radar design workflow
- Introduction to a search and track radar model, which will serve as the course example

Radar Systems Engineering

- Evaluate the radar equation and evaluate performance against system-level metrics
- Calculate system gains and losses, transmit power, maximum range, SNR, and other key radar design parameters
- Analyze detection performance over a range of environmental conditions
- Explore signal and data processing engineering trade-offs to ensure requirements are addressed
- Plot SNR vs. range on a stoplight chart
- Generate MATLAB code from app

Radar Scenario Authoring

- Model motion, orientation, and SNR of radar platforms and targets
- Create and record a radar scenario containing platforms and emitters
- Plot ground truth trajectories, object detections, and power levels in a radar scenario

Radar Modeling and Simulation

- Translate preliminary design into statistical model parameters
- Run statistical model to generate detections and tracks
- Use radar transceiver to move from statistical model to signal-level model
- Validate results between different modeling abstraction levels

Radar Signal and Data Processing

- Radar signal and data processing overview
- Obtain properties of received signals such as matched filter response, stretch processor response, direction of arrival, range, angle, and Doppler response
- Implement a constant false alarm rate (CFAR) detection algorithm
- Create, delete, and manage tracks for multiple objects. Obtain object positions and velocities.

Module 2: Day 2 of 2

Antenna Array Design

- Generate radiation patterns for linear, planar, and conformal phased array antennas using Sensor Array Analyzer app
- Design arrays using subarray architectures
- Synthesize an array to match a known pattern
- Model transmit and receive signals through antenna arrays

Spatial Signal Processing

- Model narrowband and wideband beamformers
- Implement direction of arrival estimation

Radar Environment Modeling

- Model point targets and backscatter targets with angle dependent RCS
- Model free space, atmospheric and two-ray propagation, clutter, and jammers interferences
- Radar altimeter

Antenna Patterns and Mutual Coupling

- Generate antenna patterns using Antenna Designer app and Antenna Array Designer app
- Model arrays with custom elements
- Compute mutual coupling in small, medium, and large arrays

Waveform Libraries for Multifunction Radar

- Use Pulse Waveform Analyzer app to design radar waveforms
- Build library of waveforms which can be used in a multifunction radar
- Implement PRF, frequency, and beam steering agile models