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Tutorial Workshop

1 Day

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Multitarget Tracking and Multisensor Fusion

Lecturer: Yaakov Bar-Shalom, Distinguished IEEE AESS Lecturer

Objectives: To provide to the participants the latest state-of-the art techniques to estimate the states of multiple targets with multisensor information fusion. In particular, low observable targets will be considered. Tools for algorithm selection, design and evaluation will be presented. These form the basis of automated decision systems for *advanced surveillance* and *targeting*. Tracking in the presence of electronic countermeasures is also illustrated together with radar management. A number of real data applications are provided.

Eligibility: Engineers/scientists with prior knowledge of basic probability and state estimation. This is an intensive course in order to cover several important recent advances.

OUTLINE

Introduction

(OV) Overview of the course.

Review of the Basic Techniques for Tracking

[1.5.1–1.5.3] The Kalman, the Alpha-Beta(-Gamma) and the Extended Kalman filters: their capabilities and limitations.

[1.6] [204I] Debiased consistent measurement conversion from polar to Cartesian that allows the use of optimal linear filters in practical problems (implemented in the E-2C upgrade; applicable to long-range AEW radars).

Tracking Targets with Multiple Behavior Modes

[1.5.4] The Interacting Multiple Model (IMM) estimation algorithm — a real-time implementable, self-adjusting variable-bandwidth, tracking filter.

[E11.8] Algorithm selection: when is an IMM estimator needed vs. a KF?

Agile beam radar allocation

[1.8] The NSWC Benchmark Problem I for high-g targets. Use of a radar emulator (SPY-1) for targets off beam boresight. Solution with an adaptive revisit time selection algorithm for minimum radar energy with the IMM estimator.

Tracking in Clutter

[3.4.11] The Probabilistic Data Association filter (PDAF).

Agile Beam Radar Allocation and ECM

[186A] The NSWC Benchmark Problem II for high-g targets in the presence of RGPO and jamming. Radar management (detection threshold, waveform, and revisit time selection, target RCS and jammer power estimation) and tracking with the IMMPDAF. Comparison with the MHT (Multiple Hypothesis Tracker). The real-time experiment with an Aegis SPY-1 and F-14s at Wallops.

Air Traffic Control Tracking

[8.7] Example of multisensor track formation and maintenance on real data (60 targets) from two FAA/JSS radars. Fusion of primary and secondary radar data.

[200C] IMM vs. KF on real data (800 targets, from 5 FAA/JSS radars). How to evaluate estimation improvement without knowing the ground truth. Why multisensor tracking is cheaper computationally than single sensor tracking.

Large-Scale Tracking of Ground Targets

[199G, 199GG] The Variable Structure IMM (VS-IMM) with topographic information and road constraints for precision tracking of ground targets with airborne GMTI radars. Application to a Joint STARS scenario. Evaluation of VSIMM vs. IMM and different depth assignment (optimization based MHT) algorithms. GEOP (Geometric enhancement of precision) from multiple (asynchronous) radar data fusion.

Acquisition of LO Targets

[3.7, 247B] Track formation for low SNR targets. The CRLB in the presence of false measurements. The limit of extractable track information from cluttered data.

[210BB] Acquisition of a 4 dB SNR TBM target with an ESA radar.

[225BBB] The ML-PDA estimator applied to real EO data. Comparison with the MHT.

The course is based on the books

Y. Bar-Shalom and X.R. Li **Multitarget-Multisensor Tracking: Principles & Techniques**, YBS Publishing, 1995.

Y. Bar-Shalom, X. R. Li and T. Kirubarajan, **Estimation with Applications to Tracking and Navigation: Algorithms and Software for Information Extraction**, Wiley, 2001.

and more recent advances. Notes will be given to each participant.