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FUSION 2017

Tutorial Workshop

Multitarget Tracking and Multisensor Information Fusion

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Objectives: To provide to the participants the latest state-of-the art techniques to estimate the states of multiple targets with multisensor information fusion. Tools for algorithm selection, design and evaluation will be presented. These form the basis of automated decision systems for *advanced surveillance* and *targeting*. The various information processing configurations for fusion are described, including the recently solved track-to-track fusion from heterogeneous sensors.

Eligibility: Engineers/scientists with prior knowledge of basic probability and state estimation (see, e.g., [2]). This is an intensive course in order to cover several important recent advances and applications.

OUTLINE

Introduction

(OV) Overview.

Review of the Basic Techniques for Tracking

[vhb1.4.1–1.4.4] Parameter estimation vs. state estimation. The Kalman, the Alpha-Beta(-Gamma) and the Extended Kalman filters: their capabilities and limitations.

Tracking Targets with Multiple Behavior Modes

[vhb1.4.6] The Interacting Multiple Model (IMM) estimation algorithm — a real-time implementable, self-adjusting variable-bandwidth, tracking filter.

[379v] A Multiple IMM Approach with Unbiased Mixing for Thrusting Projectiles

Reference: IEEE Trans. Aerosp. Electronic Systems, 48(4):3250–3267, Oct. 2012.

Multisensor Data Fusion

[vhb8.3] Information processing configurations in multisensor tracking.

Type I: Single sensor or reporting responsibility.

Type II: Single sensor tracking followed by track-to-track fusion. The dependence of local tracking errors at independent sensors.

Type III: Measurement-to-measurement association followed by central dynamic association and tracking.

Type IV: Centralized tracking/fusion.

Information Matrix Fusion

[vhb8.4] A special centralized tracking/fusion configuration. Algorithms for synchronous and asynchronous sensors.

Heterogeneous Track-to-Track Fusion

[383v] T2TF from an active and a passive sensor. Why T2TF can be superior to centralized fusion.

Reference: J. of Advances in Information Fusion, 6(2):131–149, Dec. 2011.

Bias Estimation for Passive Sensors

[416v] Bias estimation for optical sensor measurements with targets of opportunity. The minimum number of sensors and targets needed.

Reference: Journal of Advances in Information Fusion, 9(2):59–74, Dec. 2014.

Measurement-to-Measurement Fusion from Passive Sensors

[388v] Statistical efficiency of composite position measurements from fusing LOS (line of sight angle) measurements. The only obtainable covariance — from the CRLB (Cramer-Rao Lower Bound) — is shown to be the actual covariance.

Reference: IEEE Trans. Aerosp. Electronic Systems, 49(4):2799–2806, Oct. 2013.

The course is based on the book

[1] Y. Bar-Shalom, P. K. Willett and X. Tian, **Tracking and Data Fusion**, YBS Publishing, 2011, and additional notes.

Background text:

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

Brief Biography of Instructor

Yaakov BarShalom was born on May 11, 1941. He received the B.S. and M.S. degrees from the Technion, Israel Institute of Technology, in 1963 and 1967 and the Ph.D. degree from Princeton University in 1970, all in electrical engineering. Currently he is Board of Trustees Distinguished Professor in the Dept. of Electrical and Computer Engineering and Marianne E. Klewin Professor in Engineering at the University of Connecticut. His current research interests are in estimation theory and target tracking and has published over 500 papers and book chapters in these areas and in stochastic adaptive control. He coauthored and edited 8 books. He has consulted to numerous companies and government agencies, and originated the series of Multitarget-Multisensor Tracking short courses. He served as General Chairman of FUSION 2000, President of ISIF in 2000 and 2002 and Vice President for Publications in 2004-13. Since 1995 he is a Distinguished Lecturer of the IEEE AESS and has given numerous keynote addresses at major national and international conferences. He is corecipient of the M. Barry Carlton Award for the best paper in the IEEE Transactions on Aerospace and Electronic Systems in 1995 and 2000. In 2002 he received the J. Mignona Data Fusion Award from the DoD JDL Data Fusion Group. He was awarded the 2008 IEEE Dennis J. Picard Medal for Radar Technologies and Applications and is listed in "top authors in engineering" by academic.research.microsoft as the #1 cited author in Aerospace Engineering. He is the recipient of the 2015 ISIF "Lifetime of Excellence in Information Fusion" award.