University of Colorado at Boulder

AEROSPACE ENGINEERING SCIENCES

Seminar

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Adaptive Entrophy-based Gaussian-mixture Information Synthesis for Improved Space Situational Awareness

The US Strategic Command has developed and maintains a catalog of approximately 22000 man-made objects in space, the size of a softball and larger. Of these, only about 1400 are working or active and the remainder is debris. The current state-of-practice used for screening space traffic conjunctions are the state-vectors (i.e. means) of these objects and collision probabilities are based upon the state uncertainties (i.e. covariances). Moreover, in order to schedule space surveillance sensors for maintaining tracks of these objects and thus maintaining the knowledge in the space catalog, space object star vectors are used and at best, their covariances employed to acquire them in the sensor field of view. The salient caveat here is that this would be acceptable so long as the space object state error distributions are sufficiently well represented as Gaussian probability density functions (PDFs). One method that allows for the relaxation of the Gaussian PDF assumption is the so called Gaussian Mixture Model (GMM) which attempts to represent the underlying PDF as a weighted combination of Gaussian mixands. Traditional GMMs suffer from two issues, (1) having to choose the number of mixands a priori and (2) the weights of the mixands are held constant during state propagation and only updated during measurement processing (i.e. only updated with inputs from external observations). The work described during this talk will introduce a first-of-its-kind Adaptive Entropy-based Gaussian-mixture Information Synthesis (AEGIS) filter, developed to overcome both of these caveats and able to do this autonomously by exploiting “internal observations” of non-linearities via the exploitation of relative differential entropy. An example for space object trajectory prediction and rectification is provided and can be applied to improve space object collision probability, tracking, and sensor acquisition.

Thursday, Feb. 2, 2017
4:00pm
DLC Collaboratory

Biography:

Dr. Moriba Jah is the Director of the University of Arizona's Space Object Behavioral Sciences with applications to Space Domain Awareness, Space Protection, Space Traffic Monitoring, and Space Debris research to name a few. Prior to this, Dr. Jah was the lead for the Air Force Research Laboratory's (AFRL) Advanced Sciences and Technology Research Institute for Astronautics (ASTRIA) and a Principal Investigator for Detect/Track/Id/Characterize Program at AFRL's Space Vehicles Directorate. He received his B.S. in Aerospace Engineering from Embry-Riddle Aeronautical University, Prescott, Arizona, and his M.S. and Ph.D. in Aerospace Engineering Sciences from the University of Colorado at Boulder specializing in astrodynamics and statistical orbit determination. Before joining AFRL in 2007, he was a spacecraft navigator for NASA's Jet Propulsion Laboratory (JPL) in Pasadena, CA, serving on Mars Global Surveyor, Mars Odyssey, Mars Express (joint mission with ESA), Mars Exploration Rovers, Hayabusa (joint mission with JAXA), and the Mars Reconnaissance Orbiter. Dr. Jah serves as a member of the U.S. delegation to the United Nations Committee on the Peaceful Uses of Outer Space (UN-COPUOS) and is the chair of the NATO SCI-279-TG activity on defining a Common NATO Space Domain Awareness Operating Picture. Dr. Jah founded the American Astronautical Society's (AAS) Space Surveillance Technical Committee and is the Chair of the AIAA Astrodynamics Technical Committee. He is a member of the Astrodynamics Technical Committee of the International Astronautical Federation (IAF) and a permanent member of the Space Debris Technical Committee of the International Academy of Astronautics (IAA). Dr. Jah is a Fellow of the International Association for the Advancement of Space Safety (IAASS), the AFRL, the AAS and the Royal Astronomical Society (RAS), as well as an AIAA Associate Fellow, IEEE Senior Member, Associate Editor of the IEEE Transactions on Aerospace and Electronics Systems, IEEE Aerospace and Electronic Systems Magazine, and Elsevier Information Fusion Journal. Dr. Jah is a world-recognized subject matter expert in astrodynamics-based Space Domain Awareness sciences and technologies with 75+ publications in peer-reviewed journals, conferences, and symposia. He's been an invited lecturer and keynote speaker at 20+ national and international space events, workshops, and fora.