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Daniel Hotel
Herzlia



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Paul Zarchan has more than 35 years of experience designing, analyzing, and evaluating missile guidance systems. He has worked as Principal Engineer for Raytheon Mission Systems Division and has served as Senior Research Engineer with the Israel Ministry of Defense and has worked as Principal Member of the Technical Staff at C.S. Draper Laboratory. Mr. Zarchan is currently

working on problems related to theater missile defense as a Member of the Technical Staff for MIT Lincoln Laboratory. He is an Associate Fellow of AIAA, author of *Tactical and Strategic Missile Guidance* and co-author of *Fundamentals of Kalman Filtering: A Practical Approach*, both of which are books in the AIAA Progress in Astronautics and Aeronautics Series.

IAAC the Israeli Association for Automatic Control Course

fundamentals of Kalman filtering: a practical approach

Course outline:

► Numerical Techniques

presentation of the mathematical background required for working with Kalman filters; numerous examples to illustrate all important techniques

► Method of Least Squares

how to build a batch processing least squares filter using the original method developed by Gauss; illustration of various properties of the least squares filter

► Recursive Least Squares Filtering

how to make the batch processing least squares filter recursive; develop closed-form solutions for the variance reduction and truncation error growth associated with different order filters

► Polynomial Kalman Filters

showing the relationship between recursive least squares filtering and Kalman filtering; how to apply Kalman filtering and Riccati equations to different real world problems with several examples

► Kalman Filters in a Non Polynomial World

how polynomial Kalman filters perform when they are mismatched to real world; how process noise can fix broken filters

► Continuous Polynomial Kalman Filter

illustrating the relationship between continuous and discrete Kalman filters; examples of how continuous filters can be used to help understand discrete filters through such concepts as transfer function and bandwidth

► Extended Kalman Filtering

how to apply extended Kalman filtering and Riccati equations to a practical nonlinear problem in tracking; showing what can go wrong with several different design approaches and how to get designs to work; why choice of states can be important in a nonlinear filtering problem

► Drag and Falling Object

designing two different extended filters for this problem

► Cannon Launched Projectile Tracking Problem

developing extended filters in the Cartesian and polar coordinate systems and comparing performance; showing why one must not always pay attention to the academic literature; comparing extended and linear Kalman filters in terms of performance and robustness

► Tracking a Sine Wave

developing three different extended Kalman filter formulations and comparing performance of each in terms of robustness

► Satellite Navigation (Two-Dimensional GPS Examples)

determining receiver location based on range measurements to several satellites; showing how receiver location can be determined without any filtering at all; how satellite spacing influences performance; illustration of filter performance for both stationary and moving receivers

► Biases

filtering techniques for estimating biases in a satellite navigation problem; how adding extra satellite measurements helps alleviate bias problem

► Linearized Kalman Filtering

develop equations for linearized Kalman filter and illustrate performance with examples; comparing performances and robustness of linearized and extended Kalman filters

► Miscellaneous Topics

detecting filter divergence in the real world and a practical illustration of inertial aiding



Under the auspices of IEEE Israel, CS/CAS Chapter

For registration and further details call 04-8294780 or see the website <http://iaac.technion.ac.il/events.html>