Department of Aerospace Engineering Seminar Series

Dr. Alinda Mashiku

Aerospace Engineer
NASA Goddard Space Flight Center

INFORMATION MEASURES FOR STATISTICAL ORBIT DETERMINATION USING PARTICLE FILTERS

April 29, 2015 | 3:30 PM
Aerospace Engineering Conference Room, 3164 Martin Hall

ABSTRACT: In most state estimation applications, such as orbit determination, there exists periods of long propagation of states in the absence of measurements, hence the need for accurately representing regions of state uncertainty. For linear systems, the region of uncertainty can often be accurately captured with a Gaussian distribution. This is not the case for nonlinear systems; even if the initial state may be approximately Gaussian, the region of uncertainty during propagation morphs into a non-Gaussian probability density function (PDF) over time. In order to accurately capture the non-Gaussian density during estimation, the use of Particle Filters (PF) have been proposed. The PF's accuracy increases with the increase of the number of particles, which in turn could be computationally costly for state estimation and state PDF representation. To address the final state representation cost, we propose to represent the final state PDF as a compressed PDF. The PDF compression of the PF Multivariate states are computationally costly and could potentially be numerically intractable. In this regard, the multivariate states are nonlinearly mapped and decorrelated based on the Multilayer Perceptron (MLP) neural network model to obtain independent states that can be univariately compressed and reconstructed using the Fast Fourier Transform and Wavelet Transform. The accuracy of these reconstructed distributions are quantified using the Kolmogorov-Smirnov (K-S) test and the cost reduction is measured by the number of terms required to represent the ephemeris. Both of these measures are used to assess the compression schemes of both the FFT and Wavelet transform. This approach and potential significance is demonstrated in an orbit determination application.

BIO: Dr. Alinda Mashiku is an Aerospace Engineer at NASA Goddard Space Flight Center (GSFC) in Greenbelt, MD in the Navigation and Mission Design Branch (NMDB). She earned her undergraduate degree form The Ohio State University in 2007, and both MSAAE and PhD from Purdue University in 2009 and 2013 consecutively. Her PhD dissertation work was based on nonlinear estimation theory for Statistical Orbit Determination and Data Compression techniques for Non-Gaussian distributions under the advisory of Prof. James Garrison. Dr. Mashiku was a recipient of the NASA Graduate Student Research Program (GSRP) Fellowship for 2010-2013 under the direction of Dr. Russell Carpenter at the Navigation and Mission Design Branch at GSFC. Her current responsibilities at GSFC are providing navigation analysis and support for the OSIRIS-REx and NICER missions, both planned to launch in 2016. Other research and work interests are in nonlinear estimation methods using the Cauchy density, hybrid systems estimation theory, system fault detection and identification, aerocapture trajectory design and collision avoidance techniques in highly perturbed environments.

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