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Systems, Controls, and Robotics
Seminar Series

Kalman filtering for State Estimation: Beyond the zero-mean Gaussian

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ABSTRACT

One popular state estimation technique that has been established and used over the past decades is the Kalman filter. Its applications can be found in scenarios that require processing of measured data such as sensor fusion, uncertainty quantification, and fault diagnosis, to name a few. Even though several significant technological innovations, such as autonomous robots and self-driving cars, have been enabled by advanced Kalman filter theory, the practical effectiveness of such systems suffer from one significant drawback; Kalman filtering theory was built on the foundation of the zero-mean Gaussian noise formulation. However, the zero-mean Gaussian noise condition is never guaranteed in practice.

In this talk, I will revisit the very foundation of Kalman filtering; the long-established fact that the Kalman filter is the best linear unbiased estimator (BLUE) and optimal only when the process/system noise is zero-mean Gaussian. I will present a Kalman filter that is unbiased and optimal when the observation is a doubly stochastic Poisson process (cox process). Furthermore, I will present methods of more accurately propagating means and covariances of nonlinear transformations of non-Gaussian random variables. The methodologies I will discuss can be applied generally to a wide range of systems, and the filtering of data that can be characterized by a wide range of probability distributions.

BIOGRAPHY

Dr. Ebeigbe is an assistant professor in the Department of Electrical Engineering and the director of the Control and Autonomous Robotics Lab at Penn State. Prior to starting as an Assistant Professor, he was a Postdoctoral Scholar in the Center for Neural Engineering at Penn State where he developed state estimation and control techniques for the prediction, prevention, and treatment of communicable and