World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:13, No:10, 2019

Real-Time Radar Tracking Based on Nonlinear Kalman Filter

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Abstract : To accurately track an aerospace vehicle in a time-critical situation and in a highly nonlinear environment, is one of the strongest interests within the aerospace community. The tracking is achieved by estimating accurately the state of a moving target, which is composed of a set of variables that can provide a complete status of the system at a given time. One of the main ingredients for a good estimation performance is the use of efficient estimation algorithms. A well-known framework is the Kalman filtering methods, designed for prediction and estimation problems. The success of the Kalman Filter (KF) in engineering applications is mostly due to the Extended Kalman Filter (EKF), which is based on local linearization. Besides its popularity, the EKF presents several limitations. To address these limitations and as a possible solution to tracking problems, this paper proposes the use of the Ensemble Kalman Filter (EnKF). Although the EnKF is being extensively used in the context of weather forecasting and it is being recognized for producing accurate and computationally effective estimation on systems with a very high dimension, it is almost unknown by the tracking community. The EnKF was initially proposed as an attempt to improve the error covariance calculation, which on the classic Kalman Filter is difficult to implement. Also, in the EnKF method the prediction and analysis error covariances have ensemble representations. These ensembles have sizes which limit the number of degrees of freedom, in a way that the filter error covariance calculations are a lot more practical for modest ensemble sizes. In this paper, a realistic simulation of a radar tracking was performed, where the EnKF was applied and compared with the Extended Kalman Filter. The results suggested that the EnKF is a promising tool for tracking applications, offering more advantages in terms of performance.

Keywords : Kalman filter, nonlinear state estimation, optimal tracking, stochastic environment
Conference Title : ICASA 2019 : International Conference on Aerospace Systems and Avionics
Conference Location : Lisbon, Portugal
Conference Dates : October 30-31, 2019