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CURRENT OUTPUT FILTER FOR STATE ESTIMATION OF NONLINEAR STOCHASTIC SYSTEMS WITH LINEAR MEASUREMENT

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Abstract. *A novel state estimation algorithm is proposed for stochastic nonlinear discrete systems with noisy linear measurement equations. First, the Extended Kalman Filter is revisited and its equations are derived by taking the last measurement into account and optimizing the coefficients of the unbiased filter in a special form. Then, by taking two successive measurements into account and optimizing the coefficients of the proposed filter structure, an unbiased minimum variance state estimation algorithm with guaranteed estimation error performance is derived for nonlinear discrete systems. The performance of this filter is shown to be superior to the Extended Kalman Filter in both theory and simulations.*
Keywords: Discrete-time nonlinear systems, State estimation, Stochastic systems

1. **Introduction.** The main purpose of this work is the introduction of a novel state estimator design for stochastic nonlinear discrete systems. Due to the fact that there is always noise interference with the measurement of the states of a nonlinear system, state estimation techniques were developed to reduce the noise effect in order to retrieve more accurate information about the system state variables. A classical state estimation technique for nonlinear stochastic system is the Extended Kalman Filter (EKF) [1-7], which is the extension of Kalman Filter for linear systems and is designed based on a local linearization around the current state estimate. The estimation performance and convergence conditions for EKF have been investigated by many researchers, e.g. in the works [8-9]. Although EKF is a well defined recursive locally optimal estimator for systems with differentiable nonlinearities, its performance may not be desirable for severe nonlinearities such as found in chaotic systems [10, 11, 12] and at high noise levels. For instance, in some applications such as chaotic communication [13, 14, 15], it is highly desirable for the EKF-based demodulator to work more efficiently, because the Bit Error Rate (BER) performance of the whole communication system would be greatly enhanced by this.

In this work, we develop a new nonlinear state estimation technique, namely, Current Output Filter (COF), which can effectively reduce the noise effect in the state estimation of stochastic nonlinear discrete systems. Instead of just using one previous measurement recursively for estimating system state in EKF, COF developed in this work uses both