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State Estimation of a Biotechnological Process Using Extended Kalman Filter and Particle Filter

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Abstract : This paper deals with advanced state estimation algorithms for estimation of biomass concentration and specific growth rate in a typical fed-batch biotechnological process. This biotechnological process was represented by a nonlinear mass-balance based process model. Extended Kalman Filter (EKF) and Particle Filter (PF) was used to estimate the unmeasured state variables from oxygen uptake rate (OUR) and base consumption (BC) measurements. To obtain more general results, a simplified process model was involved in EKF and PF estimation algorithms. This model doesn't require any special growth kinetic equations and could be applied for state estimation in various bioprocesses. The focus of this investigation was concentrated on the comparison of the estimation quality of the EKF and PF estimators by applying different measurement noises. The simulation results show that Particle Filter algorithm requires significantly more computation time for state estimation but gives lower estimation errors both for biomass concentration and specific growth rate. Also the tuning procedure for Particle Filter is simpler than for EKF. Consequently, Particle Filter should be preferred in real applications, especially for monitoring of industrial bioprocesses where the simplified implementation procedures are always desirable.

Keywords : biomass concentration, extended Kalman filter, particle filter, state estimation, specific growth rate
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