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A Sensor Placement Methodology for Chemical Plants

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Abstract : In this paper, a new precise and reliable sensor network methodology is introduced for unit processes and operations using the Constriction Coefficient Particle Swarm Optimization (CPSO) method. CPSO is introduced as a new search engine for optimal sensor network design purposes. Furthermore, a Square Root Unscented Kalman Filter (SRUKF) algorithm is employed as a new data reconciliation technique to enhance the stability and accuracy of the filter. The proposed design procedure incorporates precision, cost, observability, reliability together with importance-of-variables (IVs) as a novel measure in Instrumentation Criteria (IC). To the best of our knowledge, no comprehensive approach has yet been proposed in the literature to take into account the importance of variables in the sensor network design procedure. In this paper, specific weight is assigned to each sensor, measuring a process variable in the sensor network to indicate the importance of that variable over the others to cater to the ultimate sensor network application requirements. A set of distinct scenarios has been conducted to evaluate the performance of the proposed methodology in a simulated Continuous Stirred Tank Reactor (CSTR) as a highly nonlinear process plant benchmark. The obtained results reveal the efficacy of the proposed method, leading to significant improvement in accuracy with respect to other alternative sensor network design approaches and securing the definite allocation of sensors to the most important process variables in sensor network design as a novel achievement.

Keywords : constriction coefficient PSO, importance of variable, MRMSE, reliability, sensor network design, square root unscented Kalman filter
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