Abstract

Estimation efficiency and fault robustness are closely related to fusion methodology. In this dissertation, we propose a new fusion methodology that can provide an improved real-time fault-detection environment compared with the conventional fusion methodologies of centralized fusion, state fusion, and measurement fusion. The proposed time-propagated measurement fusion methodology is advantageous in performing the synthesis and the analysis of various linear time-varying estimators and in improving the estimation robustness to faults.

To show the effectiveness of the time-propagated measurement fusion in synthesis, several new compression filters are derived based on the proposed fusion methodology. The derived compression filters can maintain correct statistical information unlike the conventional filters based on the data compression techniques. Among the derived compression filters, the de-correlated full-state compression filter shows how optimality can be maintained based on time-propagated measurement fusion. The correlated partial-state compression filter is computationally efficient and has a good physical interpretation in that it minimizes the equivalent measurement error with respect to the sensor-oriented partial-states.
among all the system states.

To show the effectiveness of time-propagated measurement fusion in analysis, we derived a stochastic radius of attraction of the linear time-varying Kalman filter where all the effects of stochastic driving terms to the selected Lyapunov function are considered. For this purpose, we utilized the concept of orthonormalized compressed measurement by which multiple-step propagations of the Lyapunov function candidate can be simplified to single step propagation.

To show the effectiveness of time-propagated measurement fusion in improving the robustness to faults, we propose an efficient method for Global Positioning System (GPS) receivers under multipath environments. Multipath error is hard to detect by conventional fault detection methods since it acts like a soft fault. To solve this problem, we derive an efficient multipath detection algorithm, a channelwise scalar compression filter algorithm, and a host positioning filter algorithm. Simulation and experiment results verify the effectiveness of the proposed method in actual environments.

**Keywords:** time-propagated measurement fusion; real-time; estimation; soft fault; detection; isolation; compression filter; host filter; GPS; multipath.