Adaptive Sensor Fault Detection and Identification and Life Extending in Health Monitoring Systems

C. L. Philip Chen, Ph.D., F.IEEE
Professor and Chair
Department of Electrical and Computer Engineering
The University of Texas, San Antonio, Texas, U.S.A.
Email: Philip.Chen@ieee.org

Usually, solutions to sensor validation fall into two major categories: the data-based approaches and the model-based approaches. Model-based methods include nonparametric and parametric approaches. Belonging to the first category are neural-network-bank based approaches. The non-parametric methods are more robust, but a large number of training data are needed nevertheless. On the other hand, parametric approaches, including dynamic state space models (DSSM), provide better accuracy and tracking performance without the need of training. The price paid here is the need for high fidelity real-time system models. Particle filter (PF) is an alternative name for sequential importance sampling for DSSM. PF has been commonly employed to online processing of dynamic systems described by DSSM. We will also discuss a Markov jump DSSM (MJDSSM) for system modeling and mixture Kalman filter (MKF) solution-- a unique and efficient particle filtering detector being developed.

We have modeled and calculated the probability of failure due to component damage. Using this model, a Monte Carlo simulation is also performed to evaluate the likelihood of damage accumulation under various operating conditions. Using thermal mechanical fatigue (TMF) of a critical component as an example, it has been shown that that an intelligent acceleration algorithm can drastically reduce life usage with minimum sacrifice in performance. By means of genetic search algorithms, optimal acceleration schedules can be obtained with multiple constraints. The simulation results show that an optimized acceleration schedule can provide a significant life saving in selected engine components.

The ultimate goal of engine health monitoring is to maximize the amount of meaningful information to perform diagnostics and prognostics on engine health. To achieve highest level of intelligence in different levels and aspects, in the future work, we propose to implement the concept of data fusion that integrates data from multiple sources to obtain improved accuracy and more specific results.

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