

# Anomaly Detection: A Particle Filtering Framework with an Application to Aircraft Systems

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## Abstract

This endeavor introduces a novel methodology for the early detection of anomalies or faults with confidence in critical aircraft systems. The anomaly detector is based on particle filtering estimation techniques and is intended to recognize deviations from the nominal operation of a system or component. An appropriate baseline is defined first from available historical data and is expressed as a probability density function in the particle filtering framework. Real-time vibration signals and information regarding the system's operational state are made available on-line and pre-processed to de-noise the data and extract useful features or condition indicators. Statistical analysis is performed on these features and the latter are compared, as they progress in time, with baseline statistics. The algorithm determines the probability of anomalous conditions, the probability of false alarms, and an indicator that reports the time instant of the presence of a fault or anomaly for a specified confidence level. A case study with actual experimental data derived from seeded fault testing is used to demonstrate the efficacy of the proposed approach.