
Adaptive Residual Bounds for Finite-Horizon Fault Detection

Résumé

Finite-horizon fault detection is essential for aircraft systems in which faults must be identified within prescribed time windows. This paper proposes a practical observer-based framework for finite-horizon fault detection using residual signals and adaptive thresholds. First, a closed-form time-varying bound on the residual is derived from the stability properties of the observer error dynamics. Second, to enhance robustness in the presence of disturbances and modeling uncertainties, the analytical bound is combined with an adaptive residual envelope that mitigates false alarms while preserving detection sensitivity. Using this bound, expressions for the smallest detectable fault magnitude within a specified time window can be derived. The approach is illustrated through simulations based on a nonlinear model of aircraft longitudinal dynamics.