Towards self-tuning residual generators for UAV control surface fault diagnosis

Control surface fault diagnosis is essential for timely detection of manoeuvring and stability risks for an unmanned aircraft. Timely detection is crucial since control surface related faults impact stability of flight and safety. Reliable diagnosis require well fitting dynamical models but with the high cost of detailed modelling and wind tunnel testing, it would be highly desirable if good diagnosis could be obtained with very generic models that are adapted to individual conditions of aircraft and of its operation. This paper presents an approach where a basic generic model is applied and necessary parameters in residual generators are identified on the fly. Initial estimates of parameters are known from off-line analysis of previous flights. The paper analyses how such self-tuning residual generators are combined with change detection to obtain timely fault diagnosis. The paper investigates the parameter convergence and detection properties for the suggested combination of identification and change detection techniques and shows design aspects and trade-offs to be made to make this scheme an effective and robust system for diagnosis or even prognosis. Results are verified using a number of test flights with different members of a population of UAVs that have inherent model uncertainty from one member to another and from one flight to another. Events with actual faults on control surfaces demonstrates the efficacy of the approach.

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