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Fault Tolerant Control System Using a Multiple Time Scale SMC Technique and a Geometric Approach

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Abstract : This paper proposes a new design of an active fault-tolerant flight control system against abrupt actuator faults. This overall system combines a multiple time scale sliding mode controller for fault compensation and a geometric approach for fault detection and diagnosis. The proposed control system is able to accommodate several kinds of partial and total actuator failures, by using available healthy redundancy actuators. The overall system first estimates the correct fault information using the geometric approach. Then, and based on that, a new reconfigurable control law is designed based on the multiple time scale sliding mode technique for on-line compensating the effect of such faults. This approach takes advantages of the fact that there are significant difference between the time scales of aircraft states that have a slow dynamics and those that have a fast dynamics. The closed-loop stability of the overall system is proved using Lyapunov technique. A case study of the non-linear model of the F16 fighter, subject to the rudder total loss of control confirms the effectiveness of the proposed approach.

Keywords : actuator faults, fault detection and diagnosis, fault tolerant flight control, sliding mode control, multiple time scale approximation, geometric approach for fault reconstruction, lyapunov stability
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