Comparison of L1 Adaptive Augmentation Strategies for a Differential PI Baseline Controller on a Longitudinal F16 Aircraft Model

In this paper two different approaches are presented to design an adaptive augmentation using L1 Adaptive Control. In terms of reference dynamics, the first one takes the closed-loop aircraft with baseline controller into account. The second approach tries to maintain nominal open-loop aircraft dynamics, with the baseline controller wrapped around the adaptive augmentation. They are compared by application to a model of the longitudinal dynamics of a F16 aircraft. The aircraft model is equipped with a Differential PI (DPI) baseline controller. The design of the combination of baseline controller and augmentation takes saturation as well as rate limitation of the control signal directly into account. Simulation results show the nominal closed-loop behavior is not harmed by the adaptive augmentation and that an increase of performance in case of uncertainty can be achieved. As an exemplary uncertainty case a rapid shift of the center of gravity (CG) is examined. The robustness of the controller structure is assessed by the use of both linear and non-linear methods to obtain the Time Delay Margin (TDM) and the Gain Margin (GM) of the closed loop system. It can be observed, the adaptive augmentation leads to a significant decrease of robustness w.r.t. the plant input channel. This drop in TDM and GM can be fully restored by the application of a hedging strategy.