Fault-tolerant Control of Discrete-time LPV systems using Virtual Actuators and Sensors

This paper proposes a new fault-tolerant control (FTC) method for discrete-time linear parameter varying (LPV) systems using a reconfiguration block. The basic idea of the method is to achieve the FTC goal without re-designing the nominal controller by inserting a reconfiguration block between the plant and the nominal controller. The reconfiguration block is realized by an LPV virtual actuator and an LPV virtual sensor. Its goal is to transform the signals from the faulty system such that its behavior is similar to that of the nominal system from the viewpoint of the controller. Furthermore, it transforms the output of the controller for the faulty system such that the stability and performance goals are preserved. Input-to-state stabilizing LPV gains of the virtual actuator and sensor are obtained by solving linear matrix inequalities (LMIs). We show that separate design of these gains guarantees the input-to-state stability (ISS) of the closed-loop reconfigured system. Moreover, we obtain performances in terms of the ISS gains for the virtual actuator, the virtual sensor and their interconnection. Minimizing these performances is formulated as convex optimization problems subject to LMI constraints. Finally, the effectiveness of the method is demonstrated via a numerical example and stator current control of an induction motor.

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