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SUFFICIENT CONDITIONS FOR THE STABILIZATION OF FEEDBACK DELAYED DISCRETE TIME FAULT TOLERANT CONTROL SYSTEMS

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Abstract. *A discrete time fault tolerant control system (DTFTCS) model in noisy environments driven by a delayed state feedback controller is developed. Delay-independent results are obtained using Lyapunov function approach and formulated as feasibility solution for a set of linear matrix inequalities (LMIs). In particular, second moment stability for the proposed feedback-delayed DTFTCS is considered. Tractable sufficient conditions that guarantee the second moment stability and achieve δ-level of disturbance rejection are derived. An FDI-driven state feedback controller is designed as a feasible solution for a set of LMIs. A numerical example is used to demonstrate the theoretical findings.*
Keywords: Fault tolerant control systems with Markovian parameters (FTCSMP), Stochastic stability, Delay systems, Linear matrix inequality (LMI)

1. **Introduction.** Fault Tolerant Control Systems with Markovian Parameters (FTCSMP) belong to a class of hybrid stochastic systems specifically designed for safety-critical applications to achieve high levels of system survivability and reliability under normal and faulty operating conditions. FTCSMP model was originally developed to deal with constraints related to the integration of the FDI process and the control reconfiguration mechanism in one unified framework [11]. In FTCSMP two separate random processes with different state spaces are defined: one to model system component failures and the second to model the non-deterministic decisions of the FDI process. This unique modeling broaden the applicability of the FTCSMP model to accommodate several practical issues and physical limitations. Several researchers were attracted to research in FTCSMP and significant contributions were made in relation to stability properties in noisy environments with detection errors and delays, with parameter uncertainties and with actuator saturation, and the design of a fault tolerant controller and H_∞ control. A comprehensive review of the stochastic stability and stabilization of continuous FTCSMP using Lyapunov function approach can be found in [6]. Lately, the analysis of stochastic stability and H_∞ stabilization of continuous FTCSMP was revisited in [1] using convex programming framework, integral quadratic constraints were defined for FTCSMP and a stabilizing controller was synthesized in [12], the LQR problem with time delays was considered in [4].

The class of discrete time fault tolerant control systems (DTFTCS) drove less attraction than the continuous contour part. The difficulty to characterize the stochastic behavior of DTFTCS is due to the complexity of the model and tools needed to complete the studies [10]. Just recently, [7] developed a general framework for DTFTCS and proposed