Fault detectability for Learning-Augmented LPV Systems

Résumé

Fault detectability within prescribed time horizons is a critical requirement for safety-critical systems, where delayed detection may compromise system integrity and operational safety. This paper proposes a hybrid monitoring framework for finite-horizon fault detection in nonlinear systems formulated within the Linear Parameter-Varying (LPV) setting. The approach combines an LPV observer-based residual with a learning-enabled correction term through a convex formulation, enabling an integration of analytical model-based guarantees with data-driven adaptability. Under suitable regularity conditions, explicit time-varying bounds on the hybrid residual are derived using input-to-output stability arguments. These bounds are then exploited to establish formal finite-horizon detectability conditions and to characterize the minimum fault magnitude detectable within a prescribed time window. The proposed framework also provides a systematic procedure for optimizing the balance between model-based robustness and data-driven sensitivity. Numerical simulations show the effectiveness of the proposed approach.

sciencesconf.org:sagip2026:729307