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Robust Stabilization of Discrete-Time Switched Systems with Application to a CSTR

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This work addresses the robust control of discrete-time switched systems subject to bounded disturbances and hard state and input constraints. To demonstrate the applicability of the proposed theoretical results, the modal dynamics of a continuous stirred tank reactor (CSTR) are considered as a motivating example. The combined presence of switching, disturbances, and constraints significantly complicates the control design and necessitates systematic guarantees of stability and robustness. Initially, mode-dependent state-feedback controllers are designed using linear matrix inequality (LMI) based techniques along with multiple Lyapunov functions. Under an average dwell-time switching framework, sufficient conditions are derived to guarantee exponential stability of the switched system in the absence of disturbances. These stability results are then extended to the case of bounded disturbances, where input-to-state stability is established, ensuring that the system states remain bounded for all admissible switching signals. Based on the obtained stability analysis, a tube-based robust model predictive control (MPC) scheme is developed for constrained switched systems. The control input is decomposed into a stabilising feedback component and an optimised nominal control component. A robust positively invariant set is constructed to handle the effect of disturbances and to ensure robust satisfaction of state and input constraints. Furthermore, recursive feasibility of the proposed predictive control problem is also ensured.

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