Abstract:

The problem of delay-dependent robust stability and stabilization of uncertain dynamical systems with interval time-varying state-delays based on Lyapunov-Krasovskii functional approach and Linear Matrix Inequality (LMI) technique has been considered in this thesis.

In the first part of the thesis, by exploiting a candidate Lyapunov-Krasovskii functional, and imposing a tighter bounding condition on the time-derivative of the functional using free-weighting matrix variables, a less conservative delay-dependent stability analysis is proposed, which, in turn, yields robust stability criteria for retarded and neutral type systems with interval time-varying state-delays. Two types of system uncertainties are considered in the stability analysis: (i) time-varying nonlinear perturbations and (ii) norm-bounded parametric uncertainties. Subsequently, delay-dependent robust stability problem is addressed for Lur'e type systems having an uncertain linear system (retarded/neutral type) in the forward path and a sector-bounded nonlinear element in the feedback path with a view to achieve less conservative results. In the sequel, the delay-dependent analysis is then extended for equivalent discrete-time systems with interval time-varying state-delays. In all the aforesaid cases, the stability criteria are expressed in LMI framework and the corresponding results are highlighted therein.

The next problem considered in the thesis focuses on synthesizing delay-dependent H_{∞} state feedback controller for an uncertain time-varying delay system with exogenous input and parametric uncertainties. Using suitable Lyapunov-Krasovskii functional, a sufficient condition is developed for the existence of robust H_{∞} state feedback controller that guarantees asymptotic stability as well as a prescribed H_{∞} performance level in the presence of admissible parametric uncertainties in the system. Subsequently, the proposed methodology is extended for the delay-dependent H_{∞} filtering problem for uncertain systems with interval time-varying state-delays and exogenous input. In the presence of measurement noises, the designed H_{∞} filter ensures that the estimation error converges asymptotically to zero; in addition, it also limits the effect of exogenous signal on the estimation error to a prescribed noise attenuation level.

Finally, the delay-dependent non-fragile H_{∞} control of uncertain stochastic systems with interval time-varying state-delays is considered. In this problem, the objective is to synthesize a robust controller that enables the closed-loop system to tolerate perturbations not only in system parameters, but also in the gains of the controller without compromising the desired performance level. The problem is significant from the implementation point of view wherein perturbations on the controller gains arise either from actuator degradation or from the controller tuning process. In such situations, a suitable non-fragile H_{∞} robust controller is designed to ensure closed-loop system stability in presence of admissible controller parameter perturbations. The proposed technique achieves less conservative delay bound and improved H_{∞} performance level than the existing result.

The effectiveness of the proposed results in the thesis is illustrated and compared with recently reported results using standard numerical examples.