Abstract

This thesis presents delay-dependent robust stability and stabilization problems of uncertain retarded systems with interval time-varying state-delay. In this work, an effort has been made to derive less conservative and computationally efficient stability criteria in linear matrix inequality (LMI) framework using Lyapunov-Krasovskii functional approach.

For continuous-time linear systems with interval time-varying state-delay, a delay-dependent stability analysis result has been derived. By invoking a new Lyapunov-Krasovskii functional and imposing a tight bound on its time-derivative, a less conservative analysis result is proposed. The tight bound is obtained using Wirtinger's inequality and the extended reciprocally convex inequality. The derived stability analysis result is then extended to the framework for solving the robust stabilization problem of uncertain linear time-varying delay systems in presence of parametric uncertainty. Combining Wirtinger's inequality with the reciprocally convex combination lemma, a less conservative state feedback stabilization criterion is obtained. Further, an observer-based controller design method is developed by extending the above analysis result. In the thesis, both the analysis and synthesis results have been presented in LMI framework.

The delay-dependent stability analysis, robust stability and stabilization problems for linear discrete-time systems with interval time-varying state-delay have also been dealt with using LK functional approach. Less conservative results are obtained by applying the summation inequality and the extended reciprocal convex inequality. Both state feedback and observer-based stabilizing controllers have been designed for discrete-time delay systems in LMI framework.

Finally, applying the frequency-domain approach, a set of stabilizing proportional-integral-derivative (PID) controllers is designed for two-input two-output (TITO) systems with multiple time delays. The decoupling technique and Hermite-Biehler theorem are applied to

obtain a complete set of P/PI/PD/PID controller regions for TITO time-delay systems.

In the thesis, several numerical examples have been solved to show the effectiveness of the proposed results.

Keywords: Retarded time-delay systems, Interval time-varying delay, Lyapunov-Krasovskii functional, Robust stability, Uncertainty, State feedback, Observer-based controller, Linear matrix inequality, Extended reciprocally convex inequality, Wirtinger's inequality, Reciprocally convex combination lemma, Hermite-Biehler theorem.