A Lyapunov-based small-gain theorem for infinite networks

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Existing tools for control synthesis do not scale to today’s increasingly complex systems. In large-scale vehicle platooning, for instance, classic distributed/decentralized control designs lead to nonuniformity in the rate of convergence of solutions; i.e., as the number of participating subsystems goes to infinity, the resulting network becomes unstable. Infinite networks, composed of an interconnection of infinitely many finite-dimensional subsystems, appear naturally as overapproximations of finite but very large networks with a possibly unknown number of subsystems.

Small-gain theory is widely known as an efficient tool for analysis of design of large-scale systems. In this talk, we introduce a Lyapunov-based small-gain theorem providing sufficient conditions for exponential input-to-state stability of infinite networks. Operator, which collects all the information about the internal Lyapunov gains, has the spectral radius less than one, the overall network is exponentially input-to-state stable. The effectiveness of our results is illustrated through several examples including nonlinear spatially invariant systems with sector nonlinearities and a road traffic network.

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