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Title: Systems with infinite delays with application to traffic flow models

New sufficient conditions for the exponential stability of linear (probably, uncertain) systems with infinite distributed delays are presented. Such systems arise in population dynamics, in traffic flow models, in networked control systems, in PID controller design and in other engineering problems. In the early Lyapunov-based analysis of systems with distributed delays [1], the delayed terms were treated as perturbations, where it was assumed that the system without the delayed term is asymptotically stable. Later, for the case of constant kernels and finite delays, less conservative conditions were derived under the assumption that the corresponding system with the zero-delay is stable [2]. We will generalize these results to the infinite delay case by extending the corresponding Jensen’s integral inequalities and Lyapunov-Krasovskii constructions. Our main challenge is the stability conditions for systems with gamma-distributed delays, where the delay is stabilizing, i.e. the corresponding system with the zero-delay is not asymptotically stable. Here the results are derived by using augmented Lyapunov functionals. Numerical examples illustrate the efficiency of the method. Thus, for the traffic flow model on the ring, where the delay is stabilizing, the resulting stability region is close to the theoretical one found in [3] via the frequency domain analysis.

References

