Continuous and piecewise affine Lyapunov functions using the Yoshizawa construction

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Abstract

We present a novel numerical technique for the computation of a Lyapunov function for nonlinear systems with an asymptotically stable equilibrium point. Our proposed approach constructs a continuous piecewise affine (CPA) function given a suitable partition of the state space, called a triangulation, and values at the vertices of the triangulation. The vertex values are obtained from a Lyapunov function in a classical converse Lyapunov theorem and verification that the obtained CPA function is a Lyapunov function is shown to be equivalent to verification of several simple inequalities. Furthermore, by refining the triangulation, we show that it is always possible to construct a CPA Lyapunov function. Numerical examples are presented demonstrating the effectiveness of the proposed method.