A Class of Lyapunov Functionals for Analyzing Hybrid Dynamical Systems

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In this paper, we introduce a new class of Lyapunov functionals for analyzing hybrid dynamical systems. This class can be thought of as a generalization of the Lyapunov functional introduced by Yakubovich for systems with hysteresis nonlinearities which incorporates path integrals that account for the energy loss or gain every time a hysteresis loop is traversed. Hence, these Lyapunov functionals capture the path-dependence of the 'stored energy' in hybrid dynamical systems and are therefore less conservative over previously published approaches in analyzing such systems. More importantly, we show that searching over the proposed class of Lyapunov functionals to prove some specification (*e.g.*, stability) can be cast as a semidefinite program (SDP), which can then be efficiently solved (globally) using widely available software. Examples are presented to show the effectiveness of this class of Lyapunov functionals in analyzing hybrid dynamical systems.