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Switching controller synthesis for time-delayed hybrid systems. (Chinese. English summary)

Summary: How to design safe and reliable safety-critical cyber-physical systems (CPSs) so that we can
bet our daily lives on them is a grand challenge to computer science and control theory. Delays in feedback
control are ubiquitous, i.e., the behavior evolution of a system depends not only on its current state, but
also on its execution history. Obviously, delays may invalidate the stability/safety certificates obtained by
abstracting them away as in the design of modern CPSs normally. In this paper, we study the switching
controller synthesis problem of time-delayed hybrid systems, and propose an invariant-based approach
by extending the corresponding approach to the design of CPSs without delays. To this end, based on
spectral analysis and linearization, we first show that the differential invariant generation problem of
delayed dynamical systems can be reduced to computing reachable sets over bounded time horizons; we
then propose an abstract-based algorithm to over-approximate the reachable set over a given time bound;
finally, we implement a prototypical tool of our approach and illustrate it with examples.

MSC:
93B50 Synthesis problems
93C30 Control/observation systems governed by functional relations other than differential equations
(such as hybrid and switching systems)

Keywords:
time-delayed hybrid systems; delayed differential equations; differential invariants; switching controller;
safety

Full Text: DOI