Parameter identification with hybrid systems in a bounded-error framework

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Hybrid systems exhibit continuous and discrete dynamics and are encountered in many complex and safety-critical systems. Robust parameter identification is an important step for monitoring, control and fault detection.

We consider the "unknown but bounded error" framework where all the uncertain quantities (measurement errors, modeling errors and uncertainty) are taken in a bounded set with known bounds. With fault detection in mind, we then introduce a set-membership method to address parameter identification in the latter framework for hybrid dynamical systems with nonlinear dynamics and nonlinear guards and invariants. One of the main advantages of the set-membership estimation approach is that it provides a guaranteed decision about fault occurrence, in contrast with the classical notion of risk, usually defined in terms of probability of occurrence and false detection. In other words, these methods allow us to avoid false positive (false alarm).

To develop the parameter identification method, we foster on our recently proposed algorithms for performing hybrid reachability [1-2-3], which combine interval Taylor methods for continuous reachability with techniques to solve event detection and localization in hybrid systems. We then embed the latter hybrid reachability algorithm within SIVIA algorithm to obtain an algorithm that can solve the set inver-

sion problem underlying parameter identification with hybrid dynamical systems [4].

An illustrative example will be given which shows that our method can naturally reconstruct both inner and outer approximations of the parameter solution set, for parameters acting either on the continuous dynamics (ODE) or on the event (guard conditions and invariants).

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References

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