Coverage Assessment Criteria for Approximate Bisimulation Theory and Introduction of Computer Games in Hybrid Systems Safety/Reachability Design

by

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ABSTRACT

This thesis addresses the issues arising from analysis and synthesis for hybrid systems using approximate bisimulation theory. The approximate bisimulation algorithms use sample safe trajectories of the system to construct safe neighborhoods in the set of testing parameters of the system. These neighborhoods are safe in the sense that for an arbitrary choice of the testing parameter in the neighborhood, we are assured that the trajectory is going to be safe.

The approximate bisimulation theory has already been introduced to hybrid system community and been used in different branches of the field especially in safety/reachability of hybrid system although the algorithms using this theory suffered from computational issues. The main contribution of this thesis is addressing two of these issues, namely the coverage assessment criteria and obtaining safe trajectories for the system.

In this thesis after introducing the approximate bisimulation theory, the coverage of the set of testing parameters is defined as the Euclidean volume of the covered region and three different methods for computation of the coverage are introduced. Analyzing different benchmarks such as feasibility of calculation and computational cost, the probabilistic method, also named Monte Carlo method, is then introduced as the most efficient one in general case. At the end, a simple computer game is presented as an example to obtain safe trajectories needed to construct the robust neighborhoods in the set of testing parameters for a sample 4-D hybrid system.