

Robotics and Autonomous Systems Thesis Defense

Guaranteed State Estimation via Remainder-Form Decomposition Function-Based Set Inclusion for Nonlinear Discrete-Time Systems

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Abstract

This thesis proposes novel set-theoretic approaches for polytopic state estimation in bounded- error discrete-time nonlinear systems with nonlinear observations/constraints. Specifically, our approaches rely on two equivalent representations of polytopic sets known as zonotope bundles (ZB) and constrained zonotopes (CZ), which allows us to transform the state space to the space of the generators of the ZB/CZ that are generally interval-valued. This transformation enables us to leverage a recent result on remainder-form mixed-monotone decomposition functions for interval propagation to compute the propagated set estimate, i.e., a polytope that is guaranteed to enclose the set of the state trajectories of a nonlinear dynamical system. Furthermore, a similar procedure with state transformation and remainder-form decomposition functions can be applied to the nonlinear observation function to compute the updated set estimate, i.e., an enclosing polytope of the set of states from the propagated set estimate that are compatible/consistent with the observations/constraints. In addition, we also show that a mean value extension result for computing the propagated set estimate in the literature can also be extended to compute the updated set estimation when the observation/constraint function is nonlinear. Finally, the effectiveness of our proposed techniques is demonstrated using two simulation examples and compared with existing methods in the literature.

April 14, 2021; 10 AM;

Zoom Link: <https://asu.zoom.us/j/84037725720>