Reachable Set Control based on Zonotopic Approximation

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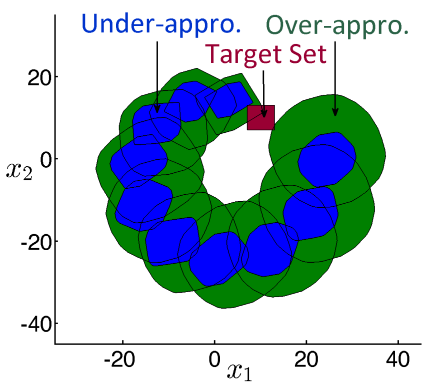
Background

Traditional control theory is concerned with the design of a controller with desirable asymptotic behavior according to a single static point, while an increasing number of phenomenons, like autonomous vehicle control and power system stabilization, require certain performances for a set of static points under common system dynamics. Thus, it demands a new technique for the challenging task that a set of points are able to be driven under a designed controller.

Description

The key problem in the area of reachable set control is to drive an initial set to a target set under uncertainties. This problem can be divided into two subproblems. The first one is a decision problem to check whether there exists a controller such that the initial state can be steered into the target set. The other one is to design a feedback controller such that the goal and performance of reachable set control can be achieved.

For the decision problem, one efficient way is to calculate the backward reachable set of the target set under systemic dynamics. The set-based computation should be employed to get the approximation of backward reachable set, and the decision problem can be solved via checking the relationship between the backward reachable set and the initial set. In addition, a linear feedback controller is used to drive the reachable set. Thus, the corresponding backward reachable set with a linear feedback controller should be obtained and zonotope is exploited to represent the backward reachable sets.



Tasks

- Induction into set-based techniques and zonotopic technique
- Compute the backward reachable sets
- Design a reachable set controller with certain performance requirement
- Test results with electrical power systems and smart grid

References

[1] M. Althoff. *Reachability Analysis and its Application to the Safety Assessment of Autonomous Cars*. Dissertation, Technische Universität München, 2010. http://nbn-resolving.de/urn/resolver.pl?urn:nbn:de:bvb:91-diss-20100715-963752-1-4.

[2] A. B. Kurzhanski and P. Varaiya. Dynamic optimization for reachability problems. *Journal of Optimization Theory and Applications*, 108(2):227–251, 2001.

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Research project:
ROCS-Grid

Type:
BA/MA

Research area:
Control Systems, Verification

Programming language:
MATLAB

Required skills:
Knowledge in control theory and system dynamics

Language:
English

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