Verification of Analog Circuits with Reachset Conformance Checking

Background

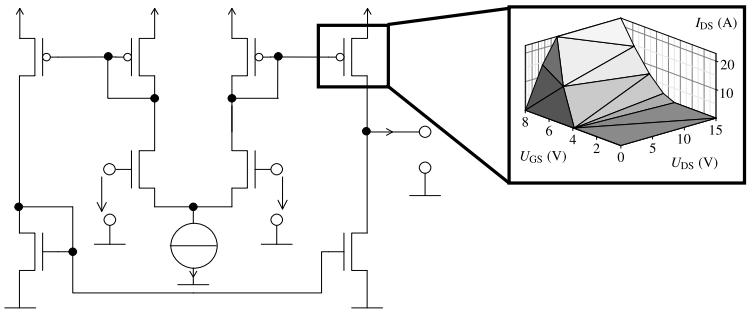
For savety critical applications, verification of technical systems is a crutial requirement. One state-of-the-art technique to verify that a certain system model properly describes all possible behaviors of the real technical system is conformance checking based on reachability analysis [2]. The approach was already sucessfully applied to several applications like for example autonomous driving or robotics. One very challenging application are analog electrical circuits, since the high nonlinearity of some circuit elements prevents the efficient use of reachability analysis. With a new technique based on piecewise linearization of nonlinear functions however, this problem can be avoided, which finally enables the application of rechablity analysis based conformance checking to analog circuits.

Description

The focus of this thesis is the implementation of a reachability analysis based conformance checking tool for analog circuits, which is based on the CORA toolbox and the SPICE simulator:

- CORA is a Matlab toolbox for reachability analysis [1]. The toolbox will be used to calculate the reachable sets of the piecewise linear model that over-approximates the nonlinear dynamics of the analog circuit.
- SPICE is a tool for the modelling and simulation of large-scale analog circuits. For this thesis, the tool will be used to simulate the original nonlinear circuit in order to check if the simulated trajectories are consistent with the reachable set of the piecewise linear model.

The correctness of the implementation of the conformance checking tool should be tested on several benchmark circuits. As an optional extension, it is possible to test the tool on a real analog circuit, where measurements on the real circuit replace the simulations with SPICE.



Tasks

- Literature Review about conformance checking
- Gaining practice with the SPICE simulation tool
- Gaining practice with the CORA toolbox for reachability analysis
- Implementation of a conformance checking tool that is based on SPICE and CORA
- Tests on several benchmark ciruits
- *Optional:* Tests with measurements from a real analog ciruit

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Research project:
faveAC

Type:
BA/MA

Research area:
Conformance Checking, Reachability Analysis

Programming language:
Can be chosen by student

Required skills:
Good mathematical background, programming in MATLAB

Language:
English, German

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References

[1] Matthias Althoff. An introduction to cora 2015. In *ARCH@ CPSWeek*, pages 120–151, 2015.

[2] Hendrik Roehm, Jens Oehlerking, Matthias Woehrle, and Matthias Althoff. Reachset conformance testing of hybrid automata. In *Proceedings of the 19th International Conference on Hybrid Systems: Computation and Control*, pages 277–286. ACM, 2016.

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