Stability Analysis of Nonlinear Systems Using Lyapunov theories

Background

Safety critical systems like autonomous driving or medical devices demand for powerful verification methodologies. Formal verification offers this opportunity. However for analog circuits and systems formal verification suffers from complexity and nonlinearity of underlying equations in transistor models. Vera is a in-house tool used for equivalence checking and thus is a step to concur the verification task. The main concept of the algorithm lies in the sampling done in the state space. However, as the order of systems increase, the verification task becomes a challenge. Thus it would be beneficial if at least a statement about the stability of the system can be stated. This would have two effects: First, the stability of the system would be known. Thus proceeding to the verification only happens if the system is stable, as in most cases it's useless to verify an unstable system. Second, the examined region of the state space can now be specified or changed. This is of major importance as shown in [1].
This thesis aims to analyse the stability of a nonlinear system using Lyapunov theories

Description

Using Lyapunov theories, the stability of a nonlinear system should be analyzed. Compared to the classical approach, this approach utilizes the state space sampled points found by Vera. This means that since Vera discretized the state space, the values of the eigenvectors and eigenvalues are given for each point in the state space. Thus finding a descriptive Lyapunov function is an easier task.

Task

- Examine how Lyapunov theories can be used for verifying the stability of the nonlinear system
- Make use of the sampled state space to find a Lyapunov function
- generated a code (C++ or Matlab) that analyses the stability of a system as state above
- *Optional*: Use different stability theories to examine the stability of a nonlinear circuit

Literatur

[1] Ahmad Tarraf und Lars Hedrich. "Automatic Abstraction of Analog Circuits to Hybrid Automata". In: *Analoge-2018*. Sep. 2018, S. 6.

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Research project:
faveAC

type:
MA/BA

Research area:
Formal Verification

Programming language:
Can be choosen by student

Required skills:
Good mathematical background, programming in MATLAB

Language:
English, German

Date of submission:
15.6-9.2019

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