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Albert-Ludwigs-Universität Freiburg

Department of Mircosystems Engineering
Systems Control and Optimization Laboratory

Prof. Dr. Moritz Diehl

www.syscop.de

Georges-Koehler-Allee 102
79110 Freiburg

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Master Thesis Proposal – Math/ESE/MST/SSE

Multi-Rate Partial Differential Equations for the Solution of Oscillatory Optimal Control Problems

The solution of optimal control problems involving highly oscillatory dynamics is numerically challenging since a large number of simulation steps are required to accurately simulate the fast oscillations over a long horizon. We want explore the possibility of formulating the dynamics as a multi-rate partial differential equation (MPDE). These can then be simulated using collocation methods where the solution is approximated by a combination of polynomials (for the slow timescale) and periodic basis functions (for the fast timescale). Such methods have been already used for the simulation of high-frequency circuits.

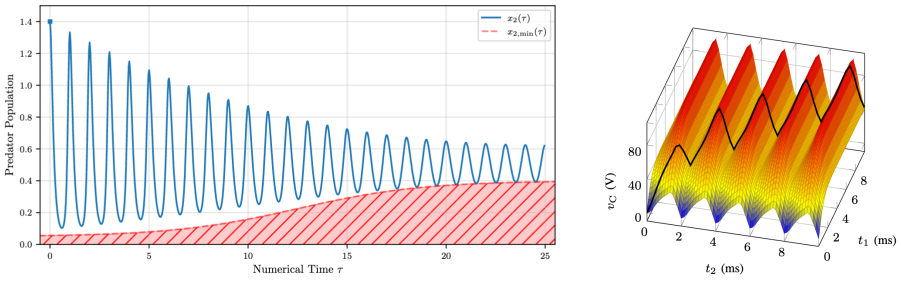

Figure 1: (left) A highly oscillatory solution of an optimal control problem, (right) Numerical solution of an MPDE in circuit simulation, from [1].

Master topic: We want to explore the formulation and solution of highly oscillatory optimal control problems using MDPEs, and how it compares against other (similar) approaches.

Your skills: Prior knowledge in systems, control, numerics and optimization is advisable. We will most likely be using a combination of Python along with the CasADi symbolic framework, so experience with these tools is recommended.

Supervisors and contacts: Prof. Dr. Moritz Diehl, Per Rutquist, Jakob Harzer

If you are interested, please contact Jakob Harzer:

jakob.harzer@imtek.uni-freiburg.de

[1] Pels, Andreas, et al. "Solving nonlinear circuits with pulsed excitation by multirate partial differential equations." IEEE Transactions on Magnetics 54.3 (2017): 1-4.