Bachelorarbeit
Studienarbeit

Time-Based vs. State-Based Impacts of a Biped Robot

Universität Stuttgart

Institut für Nichtlineare Mechanik

Themengebiete:	Nonlinear Dynamics, Modeling and Simulation, Bifurcations
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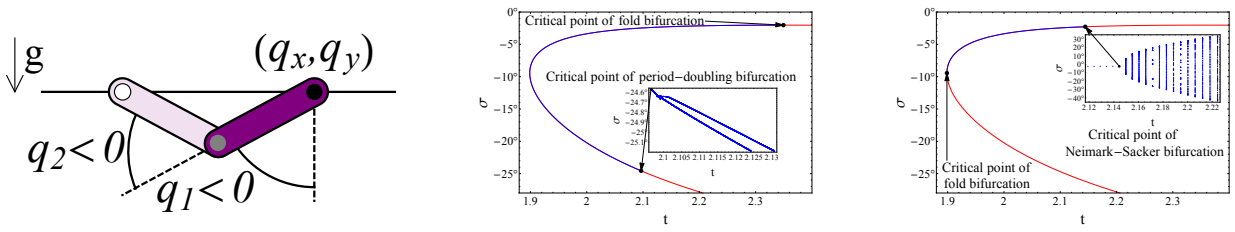
Vorkenntnisse:	Mechanical Engineering able to communicate in English

In the bipedal locomotion community, there is a spirited debate over whether bipeds should utilize time-based or state-based walking strategies when it comes to finding stable walking gaits in a biped's space of trajectories. While most comparisons focus on the input signal to the joints (e.g., the time-based central pattern generator vs. the state-based Hybrid Zero Dynamics framework), what insight can we gain by comparing time- and state-based impact strategies? In other words, do we find more stable gaits when foot-ground collisions occur (1) after a period of time has elapsed (a time-based impact strategy) or (2) whenever the biped's swing foot touches the ground (a state-based impact) and why?

In this project, you will build upon existing work [1] to

- investigate the open-loop stability of a two-link biped,
- characterize the bifurcations and routes to chaos, and
- research the benefits and drawbacks of gait generation

under these two impact strategies. The project will extend your knowledge of modeling and simulation of impulsive dynamical systems, numerical continuation methods, and bifurcation analysis. You must be comfortable communicating in English.



A set of gaits projected onto the impact time-walking slope plane of a simple two-link model (left) under a state-based (middle) and time-based switching strategy (right). Each plot represents the same set of gaits, but subject to different impact strategies. The blue dots are stable walking gaits and the red dots are unstable. The insets show the resulting bifurcations of the different impact strategies.

[1] Rosa, N. and Lynch, K.M. (2013). The Passive Dynamics of Walking and Brachiating Robots: Results on the Topology and Stability of Passive Gaits. In *Nature-Inspired Mobile Robotics* (pp. 633-640). World Scientific Publishing Co.. https://doi.org/10.1142/9789814525534_0080