**Universität Stuttgart**

Institut für Nichtlineare Mechanik

Studienarbeit

# Continuation Methods for Legged Robots

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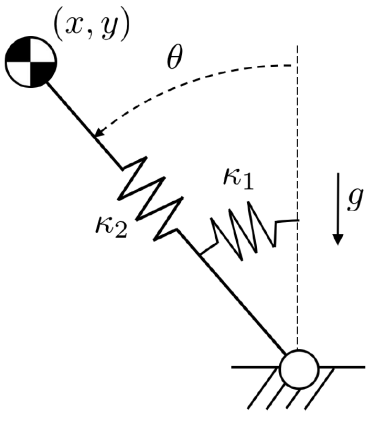
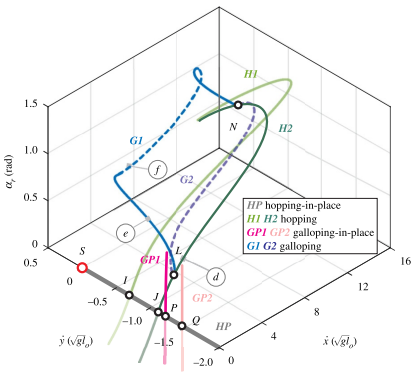
|---|---|
| Themengebiete: | Nonlinear Dynamics, Numerics, Limit Cycles, Bifurcations |
| Betreuer: | Maximilian Raff, raff@inm.uni-stuttgart.de |
| Verantwortlicher Professor: | Prof. C. David Remy |
| Vorkenntnisse: | Nonlinear Dynamics, Matlab |
| | Courses (ideally): Nichtlineare Dynamik Mechanischer Systeme |

Humans and animals use different gaits to adapt to a variety of situations. Each gait follows a distinctly different motion pattern. It can be characterized by a specific periodic footfall sequence and how gravitational, potential, and kinetic energies are exchanged throughout a stride.
With these periodicity constraints in hand, a root-finding problem can be formulated for conservative legged systems to find periodic solutions. A single periodic motion represents a gait at a certain speed or rather energy level. To find all periodic motions in the full range of a specific gait, numerical continuation techniques can be utilized. Furthermore, with this systematic approach, it is possible to identify a change in gait (bifurcation).

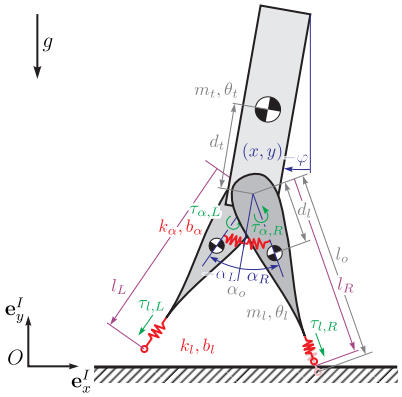
Your task in this project is to get familiar with already existing continuation techniques and apply them first to simple smooth mechanical systems like the inverted spring pendulum. This idea will then be transferred to non-smooth problems including impacts.
The goal of this project is utilizing these numerical continuation methods in a given Matlab-framework for a planar bipedal robot to find gaits.




Inverted Spring Pendulum




Continuation of Periodic Solutions




Model of a planar bipedal robot

[1] Gan, Zhenyu, et al. "All common bipedal gaits emerge from a single passive model." *Journal of The Royal Society Interface*. (2018)

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