Universität Stuttgart

Institut für Nichtlineare Mechanik

Masterarbeit
Studienarbeit

Tracing Optimal Gaits of the Compass Gait Biped

Themengebiete:	Nonlinear Dynamics, Optimal Control, Simulation, Bifurcations
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Vorkenntnisse:	Mechanical Engineering, Matlab

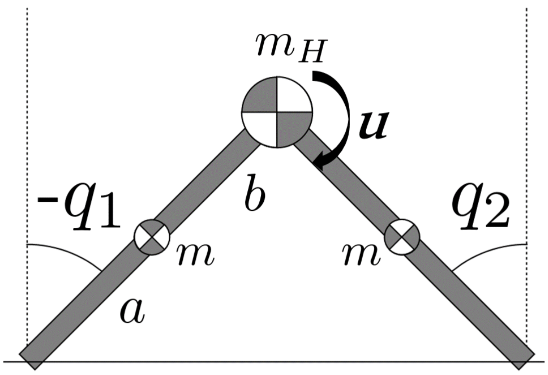
Finding optimally actuated periodic solutions (gaits) for dynamical systems is a difficult problem. One particular challenge is the lack of a systematic method of finding an initial point that converges to a local minimum. This is especially true for high-dimensional systems with nonsmooth dynamics such as those found in legged robotics.

In this project, the approach in [1] is extended to an actuated compass-gait walker moving on level ground. By choosing a class of objective/cost functions which are minimal in the upright standing equilibrium of the robot, we want to investigate the use of numerical continuation methods (NCM) [2] to find optimal walking gaits at different horizontal velocities.

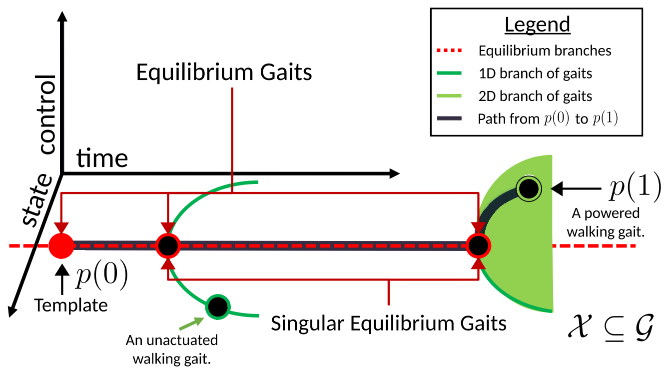
The actuation u at the joint of the robot will be parameterized by polynomial/harmonic functions and thus, produces an open-loop controller. To include these control parameters in NCM, the first-order optimality is implemented, which then introduces the desired shaping constraints.

The application of NCM facilitates the study of bifurcation points and thus gives insight into the qualitative change of optimal periodic gaits.

To start this quest, you are asked to derive the equations of motion as well their first- and second-order derivatives analytically or symbolically utilizing Matlab. These higher-order derivatives are required to follow and switch paths in NCM efficiently.



Compass Gait Walker



Connected Gaits originating from equlibria

[1] Rosa & Lynch. *Extending equilibria to periodic orbits for walkers using continuation methods.* 2014 IEEE/RSJ International Conference on Intelligent Robots and Systems. IEEE, 2014.

[2] Allgower & Kurt. *Numerical continuation methods: an introduction.* Vol. 13. Springer Science & Business Media, 2012.

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