Universität Stuttgart

Institut für Nichtlineare Mechanik

Bachelorarbeit
Studienarbeit

Comparing and Contrasting Different Approaches to Bipedal Locomotion

Themengebiete:	Nonlinear Dynamics, Modeling and Simulation, Gait Generation
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Verantwortlicher Professor:	Prof. C. David Remy
Vorkenntnisse:	Mechanical Engineering able to communicate in English

Given the hybrid dynamics of a biped robot, there are two commonly used approaches in the literature for generating bipedal walking gaits (i.e., periodic motions of the hybrid dynamics): foot-placement algorithms and limit-cycle gait generators. It is generally accepted that foot planners generate more robust gaits that are less prone to falling over, but that limit-cycle generators can find more energy-efficient gaits which can extends a biped's battery life.

The primary goal of this project is to explore the sets of gaits that foot-step planners and limit-cycle generators find and to compare and contrast these approaches using a planar or 3D version of the model in Abbildung 1. While the two approaches make different assumptions about the robot's dynamics, can we develop a unified framework using physical and virtual holonomic constraints (see [2]) for generating both types of gaits in a well-defined space of hybrid trajectories?

Given the goal of this thesis, the main tasks are to 1) implement these two approaches for gait generation using a planar (and potentially 3D) model of the biped, 2) compare and contrast gait properties such as walking speed, robustness, and energy efficiency of the gaits generarted across the two approaches, and 3) derive a common framework for representing these gaits or provide anecdotal evidence as to why such a framework may not exist based on familiarity with the two walking approaches gained during the thesis.

We expect this project will extend a student's knowledge on modeling and simulation of impulsive dynamical systems and develop a familiarity with two common and popular approaches to gait generation (see references in [1, 2]). You must be comfortable communicating and writing in English. Strong competency with a modern programming language is a plus.

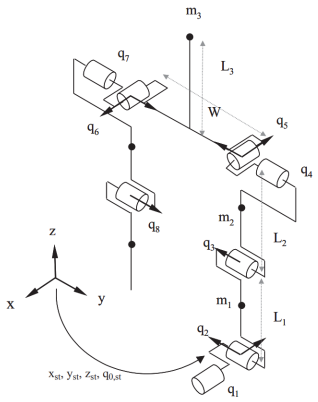

Abbildung 1: A five-link 3D biped model from [2].

[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

[2] C. Chevallereau, J. W. Grizzle, and C. Shih, "Asymptotically stable walking of a five-link underactuated 3D bipedal robot", IEEE Trans. Robotics, vol. 25, no. 1, pp. 37–50, 2008.