Universität Stuttgart

Institut für Nichtlineare Mechanik

Masterarbeit

Relating Passive Motions to Optimally Actuated Gaits

Themengebiete:	Nonlinear Dynamics, Limit Cycles, Bifurcations
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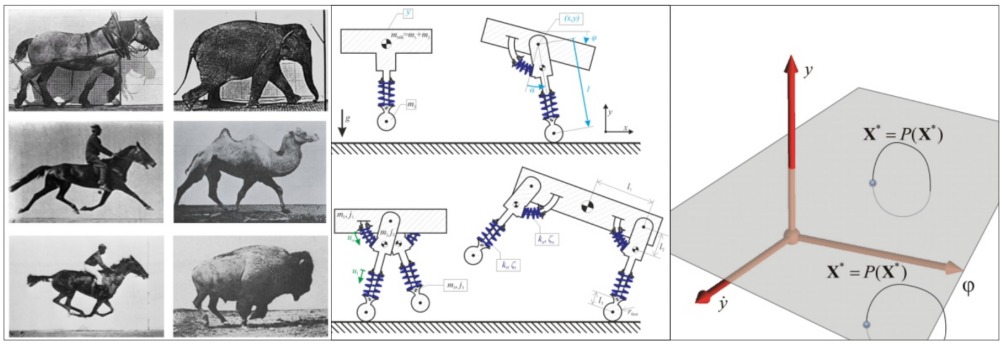
Vorkenntnisse:	Dynamics of Mechanical Systems, Nonlinear Dynamics, Matlab

Research in our group aims at understanding the role that different gaits play in legged locomotion. We are further interested in how these different gaits could be exploited in legged robotic systems. In this context, we have previously discovered that fully passive models of bipedal robots can replicate the most common gaits found in nature [1]. Similarly, when using robot models with actuation and losses, motions that minimize energy consumption do also closely resemble gaits found in nature [2]. It is our hypothesis that the passive dynamic motions (or nonlinear modes of the dynamical system) are exploited in the active models to improve energetic economy.

Your task in this project is to validate this hypothesis using numerical tools for dynamics simulation and continuation. We will develop a simplified model that, based on a dissipation parameter, can replicate the properties of both the passive and the active models. Using numerical continuation, we will be tracing the optimal motions of this model as it varies from fully passive to fully actuated. By monitoring the KKT conditions, we can validate optimality and establish existing relationships between possible motions of the passive system and optimal motions of the active model. The methods developed in this thesis will become a powerful tool in the design of motions and morphologies for legged robotic systems and will also shed new light on the existence and use of different gaits in nature.



How do optimal gaits relate to underlying passive dynamic motions?

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

[2] *Xi, Weitao, Yevgeniy Yesilevskiy, and C. David Remy. "Selecting gaits for economical locomotion of legged robots." The International Journal of Robotics Research.*