Chair of Applied Mechanics
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Comparison of controllers for trunk stabilization in a bipedal robot

Master's thesis

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Introduction and Problem Description

Balancing the trunk on long legs is a major challenge in bipedal walking. In order to avoid conflicting control objectives it needs to be tightly integrated with all other aspects of walking control.
A number of dynamic and kinematic stategies have been proposed. While Marc Raibert pursued an intuitive approach for keeping his robots balanced [2], Shen proposed a hip spring [3] while Lee investigated a control strategy based on adjusting the angle of attack before touch-down [1].
This thesis aimes at quantifying and analyzing the similarities and differences between different control stategies and testing them on a robotic testbed.

Task Description

The task in this thesis comprises of

- review of trunk stabilization approaches in bipedal robots
- implementation and simulation of relevant controllers in a computer model
- determination of quantitative parameters for comparing different approaches
- implementation and evaluation of selected approaches on the robotic testbed
- documentation and scientific discussion

All steps and results need to be documented in writing. A detailed work plan with specified problem description needs to be presented about four weeks after the starting date. A final presentation of main results is required after handing in the thesis. All researched and generated data (software, documents, figures, latex source) must be submitted for grading.

Requirements

Solid knowledge of design principles and techniques as well as experience with dynamical modelling of mechanical system) are required. Experience with MATLAB is a plus. The candidate should possess a structured and methodical problem solving approach, strong motivation, and work ethic.

References

[1] Lee, D. V., Comanescu, T. N., Butcher, M. T., and Bertram, J. E. "A comparative collision-based analysis of human gait". In: *Proc Biol Sci* 280.1771 (2013), p. 20131779. ISSN: 1471-2954 (Electronic) 0962-8452 (Linking). DOI: 10.1098/rspb.2013.1779. URL: https://www.ncbi.nlm.nih.gov/pubmed/24089334.

[2] Raibert, M. H. *Legged robots that balance*. MIT press, 1986.

[3] Shen, Z. H. and Seipel, J. E. "A fundamental mechanism of legged locomotion with hip torque and leg damping". In: *Bioinspir Biomim* 7.4 (2012), p. 046010. ISSN: 1748-3190 (Electronic) 1748-3182 (Linking). DOI: 10.1088/1748-3182/7/4/046010. URL: https://www.ncbi.nlm.nih.gov/pubmed/22989956.