TECHNISCHE UNIVERSITÄT MÜNCHEN
LEHRSTUHL FÜR INFORMATIONSTECHNISCHE REGELUNG
ORDINARIA: UNIV.-PROF. DR.-ING. SANDRA HIRCHE

MASTER'S THESIS

Development of theory and algorithms for robotics, control, and learning

Problem description:

While the field of robotics has seen a fascinating development in recent years, consider for example Boston Dynamic's Atlas robot doing parkour, there are still many open research questions to address. Minimal coordinates (also called generalized or joint coordinates) have historically dominated robotic simulation and control, possibly due to the perception that they lead to greater computational efficiency. However, for robotic systems in contact with the enivonrment, a representation in maximal coordinates can be more efficient [1]. Additionally, our recent findings indicate superior performance of maximal-coordinate control over minimal-coordinate control for linearized systems [2]. Consequently, deriving novel control algorithms, for example model-predictive control in maximal coordinates for walking robots poses an interesting research topic.
Besides walking, robotic grasping is another challenging research area. Due to the high complexity of grasping tasks, purely classical control algorithms are often insufficient. In contrast, a combination of classical methods and learning-based approaches can prove advantageous. We have recently developed a reinforcement-learning-based method for grasping [3], which could be further extended, also by integrating optimization-based concepts.
The general aim of master theses in the area of robotics is to derive advanced control and learning algorithms for robotic systems. Afterwards, the performance of the derived methods can be evaluated in simulation and applied on real robotic systems.

Tasks:

- Literature research on robotics, trajectory optimization and control strategies
- Derivation of novel control methods and algorithms
- Evaluation of performance and applicability to real robotic systems

Bibliography:

[1] J. Brüdigam, Janeva J., Sosnowski S., and Hirche S. Linear-time contact and friction dynamics in maximal coordinates using variational integrators. *arXiv e-prints*, arXiv:2109.07262 [cs.RO], 2021.
[2] J. Brüdigam and Z. Manchester. Linear-Quadratic Optimal Control in Maximal Coordinates. In *2021 International Conference on Robotics and Automation (ICRA)*, 2021.
[3] M. Schuck, J. Brüdigam, Sosnowski S., and Hirche S. Dext-gen: Dexterous grasping in sparse reward environments with full orientation control. *arXiv e-prints*, arXiv:2206.13966 [cs.RO], 2022.

Supervisor:	M. Sc. Jan Brüdigam
Start:	As soon as possible
Intermediate Report:	After 3 months
Delivery:	After 6 months

(S. Hirche)
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