TECHNISCHE UNIVERSITÄT MÜNCHEN
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BACHELOR THESIS

Model Learning and Action Estimation in Human-Exoskeleton Shared Control

Problem description:

Physical human-robot interaction [3], for example using an exoskeleton, is characterized by the shared input to the dynamical system from both sides. While obtaining the force or torque input from the robot is an obvious task, understanding the human's contribution to the interaction is generally less trivial.
Since measuring the human input, i.e. muscle activity, directly is difficult, an observer is required. This observer will estimate the human input based on the system's dynamics model and the robot's input. However, with this approach, another difficulty arises. Since a precise model of the human is not available, it is also necessary to learn some of the unknown human dynamics and interaction parameters to obtain reliable measurements.
As a result, the two major tasks are learning the human model and estimating the human's input. While there exist some concepts for handling parts of these tasks [2, 1], an integrated approach for treating both issues at the same time remains an open question.
To this end, a dynamics simulation will be used on which the development and testing of learning and estimation algorithms can be performed. The aim of this thesis is to obtain precise and reliable estimations of the human input in an interaction based on an accurately learned human model.

Tasks:

- Literature research on human model learning and intention estimation
- Derivation of learning and estimation algorithms
- Implementation of the derived algorithms
- Evaluation of performance and accuracy of the developed concepts

Bibliography:

[1] T. Beckers, D. Kulić, and S. Hirche. Stable gaussian process based tracking control of euler-lagrange systems. *Automatica*, 103:390–397, 2019.
[2] F. Just, Ö. Özen, P. Bösch, H. Bobrovsky, V. Klamroth-Marganska, R. Riener, and G. Rauter. Exoskeleton transparency: feed-forward compensation vs. disturbance observer. *Automatisierungstechnik*, 66(12):1014–1026, 2018.
[3] S. Musić and S. Hirche. Control sharing in human-robot team interaction. *Annual Reviews in Control*, 44:342–354, 2017.

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Start: As soon as possible

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