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M A S T E R ' S T H E S I S
for
Hannah Bernauer
Student ID 03617681, Degree EI

Two-Armed Object-Level Impedance Control of Redundant Robots: Design, Validation, and Comparison

Problem description:

Humanoid service robots are predicted to become more and more important in our society in the next decades. Such systems are typically equipped with two robotic arms and hands in order to be able to dexterously fulfill tasks and to interact with the environment. Therefore, an object-level impedance controller is desirable, which makes two-armed/two-handed manipulation efficient by allowing the user-defined specification of the Cartesian impedance behavior of the object itself.
In this work, the student will first implement a classical Cartesian impedance controller and extend it to the case of two collaborating arms using the method of "coupling springs" [1]. In a second step, the student has to develop and implement an optimization-based approach for the same task on the humanoid robot Justin of the DLR. Afterwards, the algorithms will be evaluated and compared in a theoretical and experimental way.

Tasks:

- Literature review on impedance control, object-level control, and optimization methods,
- Implementation of a two-armed Cartesian impedance controller based on "coupling springs" [1],
- Development and integration of an optimization-based approach for the same control problem,
- Theoretical and experimental evaluation and comparison of the algorithms,
- *Optional/encouraged*: Development of further ideas to solve the problem of object-level impedance control and consideration of these approaches in the evaluation/comparison/discussion above.

Bibliography:

[1] T. Wimböck, C. Ott, and G. Hirzinger. Impedance behaviors for two-handed manipulation: Design and experiments. In *Proceedings 2007 IEEE International Conference on Robotics and Automation*, pages 4182–4189, April 2007.

Supervisor:	Dr.-Ing. Alexander Dietrich, Dipl.-Ing. Bernd Henze
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(D. Lee)
Univ.-Professor