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M A S T E R ' S T H E S I S
for
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Alternative Approach to Identify the Stiffness Characteristic of a Soft Continuum Mechanism

Problem description:

It is predicted that humanoid service robots will become much more important in the coming decade. Such systems are typically equipped with a variety of actuated degrees of freedom. Humanoid robots can be supported with novel joints, which are distinguished by high mechanical robustness, flexibility and dynamics. The novel joints make it possible to achieve a maximum motion freedom and robust behavior while interacting with the environment. Because the joints are modeled by continuum mechanical approaches, the system will end up with many degrees of freedom. However, the material and geometry parameters in this case are hard to identify.
In this thesis an alternative, innovative identification concept should be tested in simulation and implemented on hardware afterwards [1] [2]. The soft continuum mechanism serves as the neck of the humanoid robot "David". Here, the soft continuum mechanism is deflected externally via a robot. The resulting Cartesian wrench and the Cartesian displacement is measured by external sensors. From the data obtained a stiffness map [3] should be generated, which will be approximated in the final step using parametrized curves, e.g. multivariate polynomials.

Tasks:

- Literature research on stiffness identification
- Simulation of the identification process
- Conduction of the identification experiment in the real system
- Curve fitting with multivariate polynomials (optional)

Bibliography:

[1] J. Klodmann, R. Konietschke, A. Albu-Schaeffer, G. Hirzinger. Static calibration of the DLR medical robot MIRO, a flexible lightweight robot with integrated torque sensors. In *IEEE/RSJ International Conference on Intelligent Robots and Systems*, 2011
[2] Julian Klodmann. Kalibration des medizinischen Leichtbauroboters MIRO hinsichtlich der elastischen Roboterkinematik, der internen Momentensensorik und der Massenparameter. In *Diplomarbeit. DLR-Interner Bericht*, 2010
[3] D. Lakatos, D. Rueschen, J. Bayer, J. Vogel, P. van der Smagt. Identification of human limb stiffness in 5 DoF and estimation via EMG. In *ISER*, 17.-21. Jun. 2012, Quebec City, Canada.

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