Chair of Automatic Control

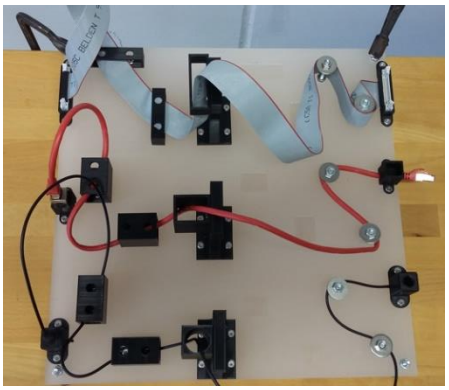
FAU

Research project / Student thesis

Robotic manipulation of deformable linear objects

Motivation

Automated robotic manipulation of deformable linear objects is a relevant and challenging research domain. It involves tasks such as knot tying and cable threading. A major challenge arises due to the deformable nature of objects. In contrast to rigid objects which can be represented by position and orientation, describing the configuration of a deformable object is inherently more complicated. Different aspects such as perception, modeling, planning, control and simulation are vital in the manipulation of deformable linear objects.



NIST task board #3

Task description

In a thesis/research project, a subtask from the NIST boards should be selected as a first step. These boards feature a number of benchmark tasks for the manipulation of deformable linear objects. An approach from the modeling or the planning domain should then be selected and developed for the respective subtask. In modeling, a relation between the configuration of the deformable object and the poses of the robotic grippers should be found. Models can be based on mechanical relations which e.g. describe the deformation energy via stretch, bending and torsion. Data-driven models which approximate the deformation model on the basis of recorded data are an alternative for this task. In planning, a gripper path should be determined such that the object is brought to a desired configuration while considering environmental contacts. Methods from reinforcement learning or sampling-based planning can be employed to solve this task. The availability of suitable simulation environments is very beneficial as it makes testing of novel approaches very easy. A research project could also deal with building suitable simulation scenarios that correspond to tasks from the NIST board.

Requirements

Basic knowledge of control theory and robotics, as well as programming experience in Matlab and/or Python are required.

References

[1] Sanchez, Jose, et al. "Robotic manipulation and sensing of deformable objects in domestic and industrial applications: a survey." The International Journal of Robotics Research 37.7 (2018).
[2] Kimble Kenneth, et al. "Benchmarking protocols for evaluating small parts robotic assembly systems." IEEE Robotics and Automation Letters (2020).

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