Master thesis proposal

Deformable Linear Object Manipulation

Rope Manipulation

Flexible Cable Manipulation


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Background

In recent years, there has been a growing interest in deformable object grasping and manipulation problems by the robotics community. Deformable objects pose more challenges as compared to rigid objects, since they are harder to model and simulate. Further, they typically require some type of shape estimation, which doesn’t need to be considered for rigid object manipulation. This computer vision problem is an obstacle for dexterous manipulation of deformable objects, especially because they can suffer from self-occlusions. Deformable linear objects (DLOs), are a particularly useful class which includes wires, cables and ropes. They are found in numerous applications, e.g. wire cutting (right figure). Also, rope shaping is a common benchmark for robotic manipulation research (left figure). Both tasks are considered explicit shape control problems, since the DLO has to reach a specific deformation. There are other deformable object manipulation tasks, where the change in shape is not the primary objective, which are instead referred to as implicit shape control problems. An example of this is knotting and threading of DLOs.

Problem description

This project will consist of implementing robotic control to a DLO task. The student will work with ABB’s YuMi in order to solve the manipulation problem. The project provides the student with freedom to choose their own task with guidance from their supervisor. The project will build on previous student work on computer vision for state estimation, in order to track the DLO.

Purpose and aims

We consider a DLO grasped by parallel-jaw grippers. The problem can be formulated as bi-manual manipulation or as single gripper re-grasping. Depending on the problem formulation machine learning algorithms may be applied, e.g. reinforcement learning. The objectives of the project are summarized below:
• Choice of DLO task, based on literature review.
• Derivation of control/planning method for completing the task. The control policy may be analytically derived or learned in simulation and transferred to the real robot (sim-to-real).
• Practical implementation of chosen method with YuMi, using ROS and Python. The final objective is to have a working demonstration with the real robot.

We are searching for: highly motivated students from the master program in Systems, Control and Mechatronics or a student with a similar background Knowledge in Modeling and Control of Mechatronic Systems, basic Learning methods and Computer Vision is required. Programming using Python (or C++) and ROS will be preferred and thus some experience with these tools is a plus.

The master student will: build competences within Robotics, Computer Vision and Robot Control.

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