Master/Bachelor Thesis – Semester Project

3D Tracking of Deformable Linear Objects with Multi-sensory Integration

Background

Manipulation of deformable linear objects (DLOs) such as cables is a crucial and widespread step in various industrial manufacturing processes. Unlike rigid bodies, the high-dimensional and nonlinear behavior of DLOs introduces difficulties in accurate modeling and real-time state estimation[1]. The lack of reliable perception methods severely hinders the existing robotic cable manipulation systems to achieve human-comparable performances. The focus in existing deformable linear object (DLO) perception research has centered on visual methodologies which capture the global shape of DLOs[2][3][4]. During manipulation, though, vision-based perception is challenged by frequent occlusions from human or robot arms. In contrast, force/torque sensors on robot wrist[5] and tactile sensors on gripper tips[6] offer local insights into DLO’s shape as well as its tension and contact force when manipulated by the robot. The integration of F/T and tactile information into visual perception will hopefully improve the tracking accuracy and robustness.

Your Tasks

In this project, you will develop a multi-sensory perception system to track the 3D shape of Deformable Linear Objects (DLOs) during robotic manipulation. Specifically, your task will include:

1. learn existing approach in visual perception and modeling of DLO,
2. track DLO status using individual F/T and tactile information,
3. fuse multi-sensory data with visual perception to update the DLO model in simulation during manipulation.

Requirement

• Basic knowledge of computer vision;
• At least six-month working time;
• Python and C++ (optional) programming experiences;
• Working experience with Robot Operating Systems (ROS) and/or Nvidea Isaac Sim will be a plus.

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