Learning Cartesian Trajectory Following

MSc. Project Proposal at the Autonomous Multi-Robots Lab, Cognitive Robotics, TU Delft

Brief description:

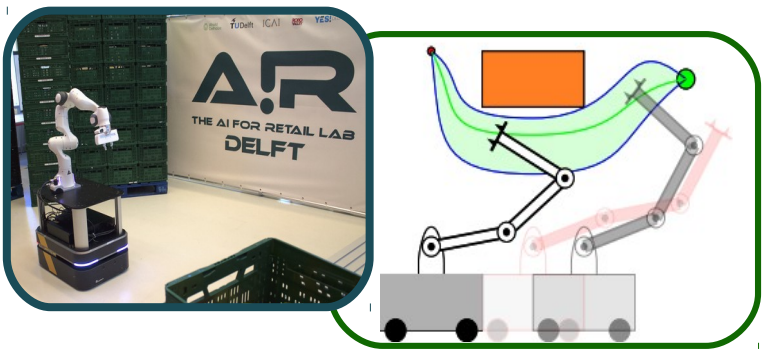
Mobile manipulators offer a wide range of possible capabilities and applications: restocking shelves, transporting objects and cleaning up to name a few examples from retail environments. But, their long operational times for simple tasks limits the effectiveness in most environments. Thakar et al. have shown that operational time for mobile manipulation is reduced when arm motion and locomotion happen simultaneously [1]. We focus in this project on coupled motion planning methods to further exploit mobile manipulators.

In dynamic environments, motion planning is usually divided into two sequenced steps: generation of a global path and execution of this path by a local planner. In the classical approach, global paths are represented as a sequence of configurations [2]. As mobile manipulators are characterized by a high number degrees of freedom, this representation implies that the kinematic redundancy is solved in the global planning process. The local planner cannot exploit the redundancy any longer as it is restricted to one specific sequence of configurations. We propose to express global paths as splines in the Cartesian workspace to overcome this shortcoming, see right figure.

Various approaches to local planning under the assumption of global path expressed in the workspace are possible : model predictive control, operational space control, reinforcement learning. Model predictive control can be used to imitate operational space control but keeping the predictive character to avoid obstacles and include longer time horizons. But, model predictive control schemes lack enough computational speed to cope with real-time constraints. In this project, we propose to combine optimal control policies with the speed of reinforcement learning. Specifically, we aim at training a mobile manipulator for spline trajectory following based on the policy provided by an model predictive agent. An open-AI environment will be available and will be used during this project. Final results should prove the feasibility on a real mobile manipulator.

Desired qualities:

- Motivated and independent
- Good problem solving skills
- Interest and preferably experience RL
- Experience in python programming
- Preferably Experience OpenAI Gym



Start Date: September 2021

For further questions or to apply, please contact M.Spahn <m.spahn@tudelft.nl>. When applying, please provide a short motivation, up to date CV, a transcript of your current degree program and intended start date.

Group information: http://www.autonomousrobots.nl/

References:

[1] S. Thakar, P. Rajendran, A. M. Kabir, and S. K. Gupta, “Manipulator Motion Planning for Part Pickup and Transport Operations From a Moving Base”, 2020

[2] Z. Kingston, M. Moll, and L. E. Kavraki, “Exploring implicit spaces for constrained sampling-based planning”, 2019