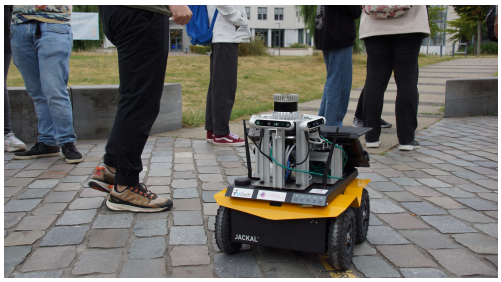
Compliant Mobile Manipulation

MSc. Project (or Student Assistant Position) at Autonomous Multi-Robots Lab, Cognitive Robotics, TU Delft



Brief Description: Autonomous mobile robots increasingly populate complex and dynamic environments shared with humans. In these environments, manipulation skills are often necessary to perform useful tasks such as transporting objects, opening doors, or moving obstacles out of the way. Mobile manipulators combine the strengths of a mobile base with the strengths of manipulators and thus increase the operational space and extend the manipulability.
Existing approaches for mobile manipulation usually decouple the movement of the base and the movement of the manipulator to simplify the control problem. Instead, whole-body motion control refers to planning and controlling all degrees of freedom simultaneously resulting in more effective movements [3, 5].
To operate safely alongside humans, despite e.g. imperfect perception and unmodelled interactions, the mobile manipulator needs to react without damaging the environment or itself. One way of addressing this is to realize compliant whole-body behavior via impedance control [2]. More recent approaches apply learning to transfer compliant manipulation skills from humans to robots [4]. So far active compliance has been mainly addressed in the field of manipulation. Furthermore, impedance control requires force/torque measurements that can not be accessed for the available mobile manipulator.
To this end, the goals are twofold: First, to research compliant whole-body motion control for mobile manipulators. Second, to implement a compliant whole-body motion controller on the available mobile manipulator without relying on torque sensors.
Within this project, the focus is on applying the developed approach to the robot. You will mainly work with a mobile manipulator consisting of a Clearpath Dingo-O base and a Kinova Gen3 lite arm (similar to right image [1]) which will be equipped with Realsense cameras and a Lidar (similar to left image). Doing both the research assignment and thesis within this project is encouraged. Adaptations of the topic can be discussed.

Desired Qualities:

- Motivated and independent
- Good problem-solving skills (especially with the robot)
- Experience with ROS (knowledge of ROS 2 is a plus)
- Experience in Python

Start Date: January 2023 (or later)

For further questions or to apply, please contact Luzia Knoedler (l.knoedler@tudelft.nl). When applying, please provide a short motivation, an up-to-date CV, a transcript of your current degree program and the intended start date.

Group information: www.autonomousrobots.nl

References:

[1] Clearpath. `https://clearpathrobotics.com/`. Accessed: 2022-12-06.

[2] Alexander Dietrich, Kristin Bussmann, Florian Petit, Paul Kotyczka, Christian Ott, Boris Lohmann, and Alin Albu-Schäffer. Whole-body impedance control of wheeled mobile manipulators. *Autonomous Robots*, 40(3):505–517, 2016.

[3] Mayank Mittal, David Hoeller, Farbod Farshidian, Marco Hutter, and Animesh Garg. Articulated object interaction in unknown scenes with whole-body mobile manipulation. *arXiv preprint arXiv:2103.10534*, 2021.

[4] Weiyong Si, Yuan Guan, and Ning Wang. Adaptive compliant skill learning for contact-rich manipulation with human in the loop. *IEEE Robotics and Automation Letters*, 7(3):5834–5841, 2022.

[5] Shantanu Thakar, Pradeep Rajendran, Ariyan M Kabir, and Satyandra K Gupta. Manipulator motion planning for part pickup and transport operations from a moving base. *IEEE Transactions on Automation Science and Engineering*, 2020.