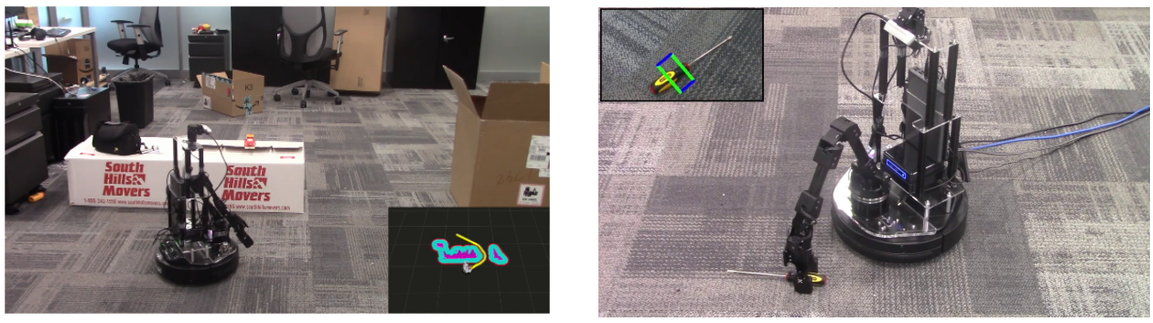
Master Thesis @ DTG

Autonomous Mobile Robot Manipulation and Grasping

Premises - In the last decade, autonomous robotics is increasingly becoming an attractive research branch characterized by a peculiar mixture of theoretical issues to be solved and technological challenges to be faced. Its multidisciplinary nature constitutes the key aspect to solve complex tasks wherein any robot is typically required to dynamically interact and exchange information both with other systems and the environment. Arising from the classical theory of systems control and largely exploiting the paradigms of multi-agent systems and communication networks, autonomous robotics represents an innovative and effective technology in several applications coping with transportation, manipulation and grasping tasks (see, e.g., [1, 2, 3, 4]). Along this direction, recent advances in the field of artificial intelligence also applied to computer vision have allowed autonomous robots to become an essential element of Industry 4.0. In smart factories, these are particularly employed to monitor the activities navigating in the environment and to accomplish autonomous and/or cooperative object transportation, manipulation and grasping (Figure 1).



(a) (b)

Figure 1: (a) example of mobile robot performing a navigation and mapping task, (b) example of mobile robot performing a manipulation and grasping task.

Thesis Focus - The main objective of the thesis consists in performing an object picking task with an autonomous mobile manipulator, i.e. the LoCoBot (http://www.locobot.org/), through the design and development of all the software infrastructures needed to accomplish the required manipulation and grasping task. In particular, the thesis work will focus on the study of the software libraries given by the robotic-arm's producer and their integration to develop new functions for arm manipulation and hand grasping [5]. To improve the physical interactions with the environment, it is possible to account for the vision capabilities of the LoCoBot and to expoit its rgb-depth camera to localize the object of interest in the 3D space (extra). The whole solution will be developed and tested in simulation, and on the real robot.

Detailed Objectives - The thesis will evolve through the fulfill of (all/some) the following steps:

- study of the existing literature related to contact-aware sensing and control;
- study of the software libraries given by the robot producer;
- *manipulation task*: control of the end-effector pose (motion planning, trajectory following, impact avoidance [6]);
- *grasping task*: control of object picking maneuver [3, 4];
- (extra) study of the literature devoted of object detection [7];
- (extra) implementation of an effective object detection strategy;
- (extra) definition of the optimal end-effector pose for the grasping task.

Expected and To-Be-Acquired Skills - From the methodological point of view, the proposed work deals with rigid-bodies dynamics and control theory, end-effector arm control, physical analysis of the grasping actions. In addition, it involves ROS as operative system, simulations in C++/Python environments, laboratory activities. The extra part might include machine learning and deep learning algorithms for the object detection.

Contact - Giulia Michieletto & Riccardo Fantinel
Department of Management and Engineering, University of Padova,
Stradella S. Nicola 3, 36100 Vicenza, Italy
giulia.michieletto@unipd.it, riccardo.fantinel@gmail.com

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