Position: Master 2 internship or final course project (PFE)
Duration: 6 months
Location: Nano-Innov, 2 Bd Thomas Gobert, 91120 Palaiseau, France
Contact: Eric LUCET (eric.lucet@cea.fr), Kai ZHANG (kai.zhang@cea.fr)

Obstacle rearrangement for navigation tasks

When navigating in an environment under partial or noisy observation, a wheeled mobile robot with pick-and-place capabilities (e.g. autonomous forklift) should avoid collision with various obstacles, including static obstacles (walls) and dynamic obstacles (humans). Besides, there is another type of obstacle, named movable obstacles, with which the robot could interact. These movable obstacles, such as bags, bottles, chairs, boxes, or doors, are commonly encountered in various environments. The objective of this internship is to develop a task and motion planner specifically designed for the reorganization of obstacles. This planner will enable the robot to create a clear path by rearranging these obstacles and successfully reach its intended destination, as shown in Fig. 1.

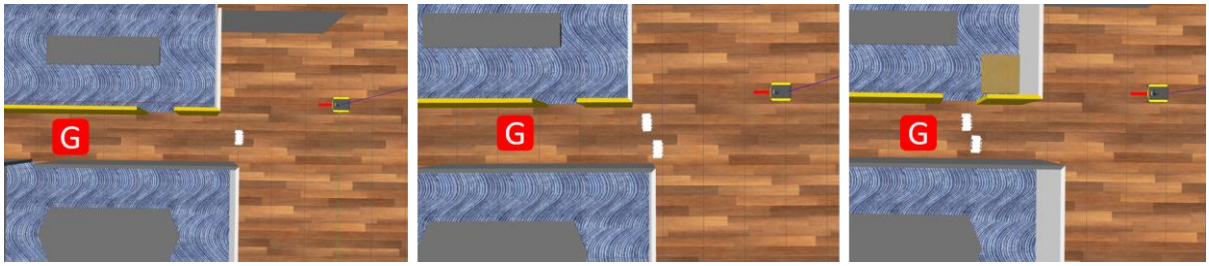

Figure 1. Different cases where white movable obstacles block the path to G red area

The existing path planning algorithms usually propose a detour for the robot to bypass these movable obstacles. However, in some cases, it is indispensable to remove the obstacles before finding a feasible path to the goal. For example, when the robot has to enter a room with a closed door, it must open it to complete its task.

Some task planners are proposed to solve the problems and a review paper can be found at [1]. The robot is ordered to move the obstacle to clear the path. However, few of them consider the position of stocking the obstacles. In [2], the social cost and navigation distance are taken into account when predicting a stock region. The method is limited to the case with only one obstacle and the stock region does not consider the orientation of the obstacle.

When dealing with multiple obstacles, it is important to determine the identity and order of manipulating obstacles under the constraints of environment. Besides, some obstacles are difficult to manipulate due to their shape or weight. Therefore, by implementing a priority prediction module, the robot could adjust the manipulation order, enhancing its success rate in reaching the goal.

The objectives of this internship include three aspects:

1. Develop a stock region proposal method for multiple obstacles with consideration of obstacle orientation based on the baseline method in [2].
2. Design a priority prediction module to find the order of manipulation.
3. Evaluate the performance in simulation and then real testing. Write a scientific paper on the methods.

Profile of the candidate

- Knowledge in robotics: modeling and control, reinforcement learning
- Skills on Python and C++ under ROS Gazebo
- Fluency in English

The CEA internship salary is between 700-1400 euros per month.

Applications should be sent by e-mail to Eric Lucet (eric.lucet@cea.fr) and Kai Zhang(kai.zhang@cea.fr) and should include a detailed CV and a letter of motivation, as well as the grades.

Bibliography

[1] Kai Zhang, Eric Lucet, Julien Alexandre Dit Sandretto, Selma Kchir, and David Filliat. "Task and motion planning methods: applications and limitations." In 19th International Conference on Informatics in Control, Automation and Robotics ICINCO 2022), pp. 476-483. SCITEPRESS-Science and Technology Publications, 2022.

[2] Kai Zhang, Eric Lucet, Julien Alexandre Dit Sandretto, and David Filliat. "Navigation among movable obstacles using machine learning based total time cost optimization." In IROS 2023-IEEE/RSJ International Conference on Intelligent Robots and Systems, 2023.