Final Project

Task

In the final project, you will enable the BlueROV to fully autonomously execute an inspection task. The main part will be a path planning algorithm.

The goal is to move through a given series of *viewpoints* where the robot's camera inspects a certain point of interest. Each viewpoint is defined by a position (x, y) and a yaw angle. The robot will hold a constant depth z. In order to complete the inspection, a viewpoint must be held for a certain amount of time. Moreover, the environment will contain *obstacles* which you will need to avoid. The task is done when the BlueROV has visited all viewpoints on a collision-free path through the environment.

Finally, during a live demo event in February, you will be able to benchmark your algorithm using a given, unknown scenario.

What you will be given

Download the template package following our documentation:

https://hippocampusrobotics.github.io/fav_docs/assignments/final_project.html.

- You can assume the localization to be given. However, keep in mind that in the real world, the localization will be imperfect.
- We provide you with 3 different scenarios. Each scenario consists of a list of viewpoints and obstacle(s) defined by their corner points. You could also try other obstacle/viewpoint definitions by adding scenarios yourself.
- We provide you with an occupancy grid map that automatically includes all given obstacles. You can change the discretization.
- We provide you with a (dumb) baseline solution including a path planner, a path follower, and controllers. Of course, you can use your own controllers instead.

Approach

1. You should start with the implementation of a smarter path planning algorithm. The baseline approach does not include any obstacle avoidance and will fail for all scenarios but scenario 1. It simply connects the viewpoints by straight lines, failing if an obstacle is in the way.
   You will need to consider obstacles. For a start, you can look at each segment between viewpoints separately. We have added an empty function for A* (`compute_a_star_segment()`) within the template. However, RRT/RRT* would also be a good solution.
2. Currently, our dumb baseline path following algorithm first moves the robot to the viewpoint and then turns it to the desired orientation. Things to improve include *(but are not limited to)*:
   - Controlling the orientation while moving towards the viewpoint.
   - Subsampling the path segments to get a finer resolution for the path follower than the resolution of the occupancy grid map. This way, the transition between the setpoints of a given path is smoother.
   - Considering other approaches than *Pure Pursuit* for the path follower.
   - Considering the vehicle's velocity. When close to a viewpoint or an obstacle, it might be beneficial to reduce the speed for the sake of accuracy.
3. Finally, you are not obliged to approach the viewpoints in the given order.

Lab Experiments

As in real-life, resources (time) are limited. We can only offer limited time at the lab. Keep in mind that almost everything can and *should* be tested extensively in simulation. You will get 5 hours of experimental time that you can use in a flexible way and break down into 2 to 4 sessions.

Presentation and Video

1. **The pitch video clip:** Record a 1 minute video clip pitching your project idea, your approach and your findings. There are many video editing tools out there, *DaVinci Resolve* is a good and free software for this task. The video should contain a title 'slide' including the following information: the class name "Simulation and Design of Mechatronic Systems WS 2023/24", "Final Project", and your group name. Optionally, feel free to include your names/pictures, too.
2. **The presentation:** Prepare a 10 minute presentation covering your overall project. In particular, prepare one slide where you list how each group member contributed to the individual work packages. Additionally, reflect on your team's organization and spirit. Use the Powerpoint template provided to you via Slack. Following your presentation, we will have a discussion about your approach and findings. This part will take approx. 10-15 minutes.

Final Submission

The name of your submissions should follow the format: `project_video_groupX.mp4` and `project_slides_groupX.pdf`.

Submit your slides and video clip via Slack.

Deadline Final Project Submission: 01.02.2025, 23:59 CET

Final Group Presentation incl. Live Demo: TBD