Cairo University
Faculty of Engineering
Computer Engineering

CMP 4021
Cognitive Robotics
Project

Project Document

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1) Overview

This project aims to apply the concepts of cognitive robotics to implement **multi-robot exploration** and **map merging** using known initial poses, and then apply it on **Gazebo** and **RViz** simulation tools using a real-life robot model in a realistic environment. Each robot starts from an initial known pose to explore the surrounding environment and build a map given noisy motion and sensor models. Maps from different robots are aggregated and merged into a single map.

kol robot by3ml al map bt3to lwa7do akno m4 4ayf ba2i al maps we fel a5er bngm3 al maps de m3 b3d

al initial positions of the robots are known ...

we need to handle al noise in the motion model

fe noise fe sensor readings

2) Robot Requirements

ROS includes a large set of real-life robot models with a variety of sensors. You are allowed to use one or several robot models for implementing your multi-robot exploration system. **Keep in mind that you are allowed to use any proximity sensor**. Some good suggestions of robot models inside ROS are:

- SUMMIT-XL: https://robots.ros.org/summit-xl/
- TurtleBot: http://wiki.ros.org/Robots/TurtleBot

don't use cameras as sensors

you are free to build your own the environment but confirm the complexity of the environment.

3) System Requirements

You are required to create your own world file for an environment that is complex enough to test your system. Your environment should be large and complex enough to test multiple robots. **You will need to share your environment with the TA to confirm the level of complexity.**

The goal is to implement a multi-robot exploration system, where the initial pose of each robot is known. Each robot should build its own part of the map, then map parts from different robots are aggregated and merged into a single complete map. The system should operate on three or more robots. **You are allowed to use pre-implemented modules and open-source code, however you MUST understand the details of your submitted code.**

The code modules are listed as follows: fe packages le kol al modules

a) **Robot navigation (exploration):** The robot should not be controlled by the user. It should operate autonomously exploring its surroundings with a noisy motion model.
b) **Sensor reading and incorporation:** Readings from sensors (laser, odometry …, etc) at each time step should be processed and fused together. Note that you must assume a noisy sensor model.
c) **Mapping with known initial poses:** The robot should build parts of the map, in which it navigates, assuming that the initial pose (position + orientation) is known.
d) **Map aggregation and merging:** Parts of the map from different robots should be aggregated and merged together into a single map covering the whole world.

4) [Optional] Research Contribution

Teams are allowed to propose a novel solution for the multi-robot navigation and map merging. Your proposed solution can modify one or more modules from the ones listed above. Moreover, you are allowed to use other sensors and robot models, under the condition of the novelty of the idea. **You will mainly be working on implementing, validating and publishing your idea as a conference paper. In case of completion, the team will receive a bonus of 25% of the project grade (5 marks).**

- Related schedule:
    - Interested teams have to send their proposals by **4/11/2023**.
    - The initial paper draft should be submitted by **2/12/2023**.
    - The final paper (after the instructor's review) should be submitted by **16/12/2023**.

5) Deliverables

- Your designed world map (should be confirmed ahead of submission).
- Your code containing all mentioned modules (along with build and launch files).
- A document containing your system design (used modules) and sample visualizations of your outputs using three or more robots.
- The deadline for environment map confirmation is **2/12/2023**.
- The deadline for submission is **23/12/2023**.
- Total grade: **20 marks**.