RBE 3002 Unified Robotics IV: Navigation

Lab Assignment #4: Mobile Robot Path Planning

Introduction

In this lab, you will extend your A* path planning implementation to work with real map data and program the Turtlebot to follow the planned path. This lab is to be done in groups of 3.

Objectives

Upon successful completion of this lab, you will be able to:

1. Use the expand obstacles within the cost map published when gmapping is launched or apply an obstacle expansion algorithm to the map to enable safe navigation of the environment.
2. Plan a path for a mobile robot to navigate through this environment.
3. Program the robot to drive along the planned path.
4. Use replanning to avoid obstacles in the robot's path.

Pre-Lab

None.

Lab Work

1. **Leveraging your code from labs 2 and 3, implement a function (or functions) that will drive the robot along the entire A* planned path**. Begin by using a static map. You won't be able to drive very far, so start by planning simple goals. For example, place the goal two meters in front of the robot.
2. **Implement obstacle expansion**. We now want to start working with real maps generated from the sensor data. Look at the other maps provided. As in the class examples, these maps have imperfections, such as gaps in the walls. Write code to expand the obstacles in your occupancy grid so that the robot does not attempt to drive through such gaps. Either write your own node or implement a solution from the existing topics.
3. **Implement re-planning.** Hopefully, you should only have to make a few changes to your code to handle re-planning using the expanded map. It is most likely that you will need to optimize the grid size for you're A* search to improve execution time. Display your optimized map with A* path in RVIZ. In order to increase the effectiveness of the map and path updates, break the algorithms you're implementing into multiple nodes and helper functions. This should also make implementation of the final project easier.
4. **Update f(n).** Once you are able to plan a path with the main map, try subscribing to the other map topics published by a TurtleBot running GMapping. The robot publishes a number of other maps besides"/maps". For example,the GMapping code publishes both a local and global cost map on the "/move_base/local_costmap/costmap" topic. Update your heuristic or cost function so that the robot avoids the high cost paths. Keep in mind, your heuristic should never *overestimate* the actual path cost. When using the simulator the cost map is not the same as on the real robot. The real robot will publish a cost map that will have a reference frame based off the robots location. The

simulators cost maps are generated from the map whereas the real turtlebots cost map is generated by the sensor.

5. **Obstacle avoidance.** To test that obstacle expansion and avoidance works, again set the goal 2 meters in front of the robot but place a small obstacle (be sure it's tall enough to be seen by the Kinect) in the robot's path after the robot starts driving. We recommend placing the object after your first waypoint but before the goal. Once the obstacle is sensed and the map is updated, the robot should re-plan and drive around it before reaching the goal.

Deliverables and Deadlines

Please submit:

1. Copy of the sign-off sheet
2. Compressed folder containing your package (e.g. jdoe_lab4.zip).
3. A brief report describing your implementation, including
    a. a screenshot of the updated interface,
    b. a description of what occupancy grid size you used and why,
    c. a description of your updated heuristic function.

    If you were unable to complete the entire lab, you should describe what parts work, which do not and what problems you encountered. The complete document should not exceed 2 typed pages.

4. If you used external sample code other than the packages listed in this lab document, please also submit a document called References.txt that lists all such sources, as well as a very brief description of what you used from each one.

RBE3002 Lab4: Mobile Robot Path Planning

Name: _____

Name: _____

Name: _____

Lab Sign-offs

TASK	SIGNED BY	DATE/TIME
Display Expand obstacles on your own topic		
Display Optimize map with A* path		
Display re-planning using updated heuristic		
Show obstacle avoidance		

Grading Rubric

[100 points] All pre-lab and in-lab procedures are completed and demonstrated prior to the deadline. All deliverables and sign-off sheet are submitted on time. The code is well commented and structured.