



Lab 7

Map Making

Reading: *Ch. 4 of text*

(Demonstration due in class on **Thursday**)

(Code and Memo due in Moodle drop box by midnight on **Sunday at midnight**)

Read this entire lab procedure before coming to lab.

Purpose: The purpose of this lab is to use range sensors on a mobile robot to create an occupancy grid or topological map. The mapping task involves the creation of a hybrid topological and metric map of the robot’s world by using sensor feedback and an exploration algorithm.

Objectives: At the conclusion of this lab, the student should be able to:

- Use sensor data to create an occupancy grid or topological map of the robot’s world
- Create a world model that the robot can use for navigation

Equipment: Base Robot
Range sensors
LCD Screen

LAB PROCEDURE

Part 1 - Build the world model

1. In this exercise, you will build a map of the 6’ x 6’ test arena by using a cover algorithm and sensor feedback. The robot should be able to use the created map to plan a path from a start position to a goal location. Try to reuse as much code as possible from prior labs once the map has been created to simplify the path planning and execution.
2. Note that mapping will be tricky because of odometry error, sensor error, and other sources of error. A completely accurate map would require localization to reduce the uncertainty of position. However, this



would require SLAM which is difficult to implement. Therefore, using only the robot’s sensor data and odometry try to create the best world model possible.

3. You can use teleoperation, wander, cover, wall following or any other motion algorithms to move the robot through the environment. One possible technique is to create a generalized Voronoi diagram or follow center behavior to efficiently explore the environment. Use the robot’s pushbuttons to start the motion algorithm.
4. Then, use Histogrammic in motion mapping (HIMM) to identify objects in the environment. Although your textbook states that this algorithm was created for a sonar sensor, it is reasonable to use it for the primary axis of the IR sensor. For this method when the cell value exceeds some threshold it is coded as occupied or used to create a topological map. You do not have to use this technique you have the flexibility of selecting your own technique to create the model. Devise a mechanism to display the map created on the LCD after the motion completes.
5. Alternately, you can create an occupancy grid with 0’s and 1’s based upon the free and occupied space. Figure 1 provides an example of using a Generalized Voronoi Graph (GVG) and HIMM to create a world map.

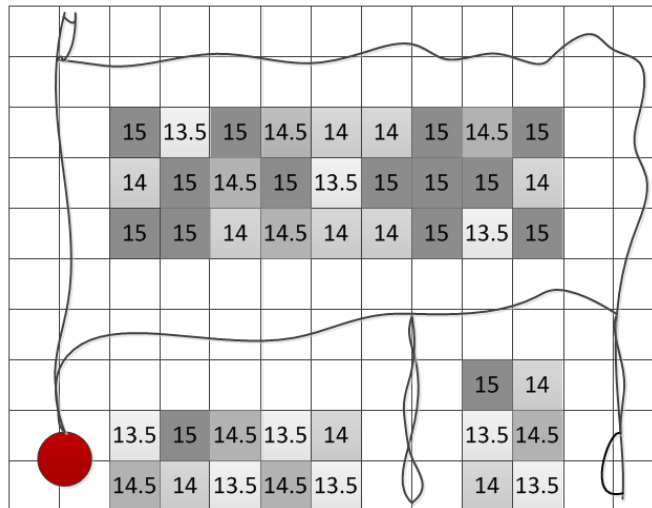


Figure 1: GVG with HIMM

6. You should show the robot’s state on the LCD as it creates the world map. In addition, upon completion of the motion algorithm, the robot should display the world map on the LCD.

Part 2 - Navigation using the robot’s model

1. Once the robot has created the map, it should be able to use this map to create a path from a start position to a goal location. Similar to Lab 6, you will be given a start position and goal location and the robot then plans a path to the goal.



2. You will be graded on the ability to generate the map, the accuracy and detail in the map and how well the robot is able to use your world map to plan a path to a goal location while avoiding obstacles.

Demonstration:

This week's demonstration will involve showing the world model created by the robot on the LCD and then using that model to plan a path and follow the path from a given start point to goal point.

Bring your robot fully charged to class on Thursday for the demonstration. Note that you always must re-flash the factory firmware and plug in the AC adapter in order for the robot to charge. Alternately, you can put the robot battery in the RC car battery charger. Note that this is a fast charger and will not last as long as the outlet charge.

See prior labs for information on the program, memo, submission requirements and grading rubric.

Submission Requirements:

You must submit you properly commented code as a zipped folder of the C file and the lab memo in a zipped folder by **11:59 pm on Sunday** to the Moodle Course Drop box. Your code should be modular with functions and classes in order to make it more readable. You should use the push buttons, buzzers and LCD to command the robot and indicate the robot state during program execution.