Spring 2016

Control of Mobile Robotics

CDA4621

Lab 3

Localization

Total: 100 points

Due Date: 4-4-16 by 8am

A. Lab Requirements

The lab requires use of the course robotic hardware ("Robo-Bull-2016") provided to students at no charge for the duration of the course. Required software can be downloaded free of charge from the web. All labs are to be done by teams of two students. Each student is required to submit his or her joint report through CANVAS.

- Hardware Requirements

The "Robo-Bull-2016" (Figure 1) is the main robot hardware used for the course. Note, that the components of the robot are the same as in Lab1.

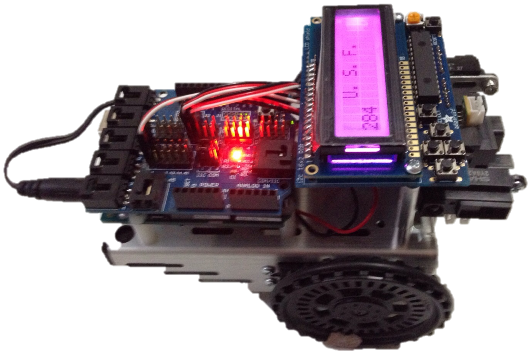


Figure 1: Robo-Bull-2016.

- Software Requirements

Arduino Software (Version 1.6.7 released on Jan 7, 2016)
https://www.arduino.cc/en/Main/Software

B. Task Evaluation

Each individual task is worth a specific number of points where these points are always split 50% between Task Execution and Task Report:

- Task Execution

The robot should execute the task correctly with a video clearly and completely showing the task execution (points will be taken for errors or missing aspects of task execution).

- Task Report

Each task report requires an accompanying document to be uploaded to Canvas together with ALL the files required to run the program in the robot. The task report needs to include ALL the following sections (points will be taken off if anything is missing):

1. Task description.
2. Solution describing the detailed algorithm used to solve the task described in terms of flow charts to describe the logic of the program and block diagrams to describe the various robot components.
3. Video link to different task executions (you should split each task execution as a different video link most preferably in YouTube making sure the video is public to all). Provide at the beginning of each video your name and description of which task is being performed.
4. Description of the code used to program your robot with explanations that clearly relate to the solution previously described.
5. Images taken from the actual robot task execution (at least one image per task).
6. Conclusions where you analyze any issues you encountered when running the task and how these could be improved.

C. Task Description

The goal of this assignment is to develop an algorithm to navigate the complete maze. The robot has to build a map and localize within the map. The same algorithm has to work for the three mazes shown in Figure 2.

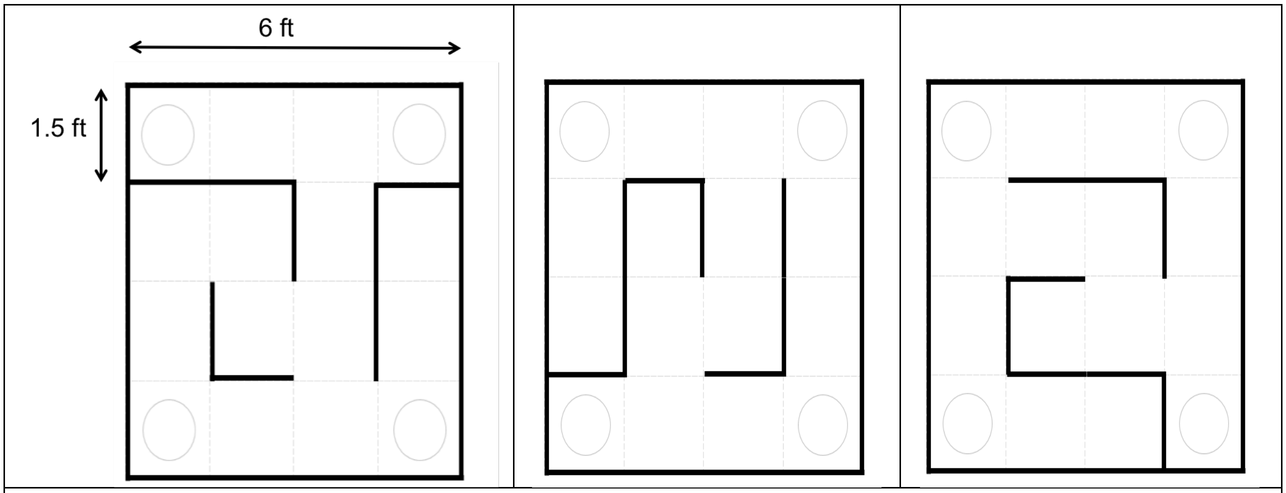


Figure 2. Three different maze configurations (left, center, right). Each maze is 6x6 sq. ft. consisting of a 4x4 non-marked grid cells of 1.5x1.5 sq. ft.

1. Navigation (40 points)

The objective of Task 1 is to develop a program to allow the robot to navigate the full maze. Although the maze does not contain any physical grid marks, the robot is considered to have navigated the full maze when it has passed through each of the 4x4 grid cells at least once. The robot may start to navigate from any of the 4 corner cells pointing in any desired direction. See Figure 3 (a) and (b). The task requires the robot to navigate in a single uninterrupted sequence all grids in each maze at least once without any human or other intervention. The robot may pass through any particular grid multiple times. Note that for this task there is no references to grids.

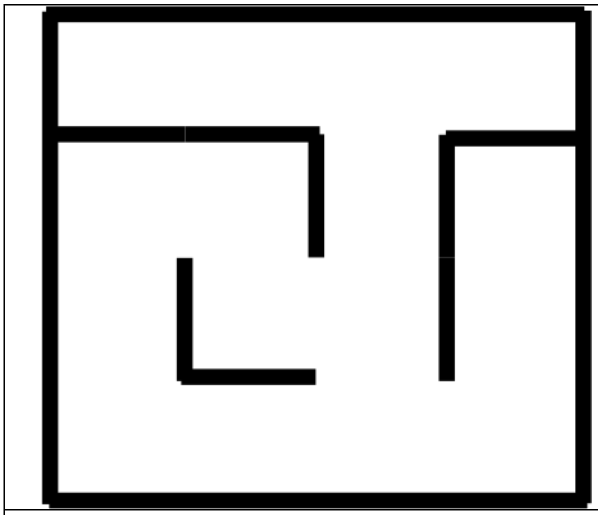


Figure 3. (a) Real Maze

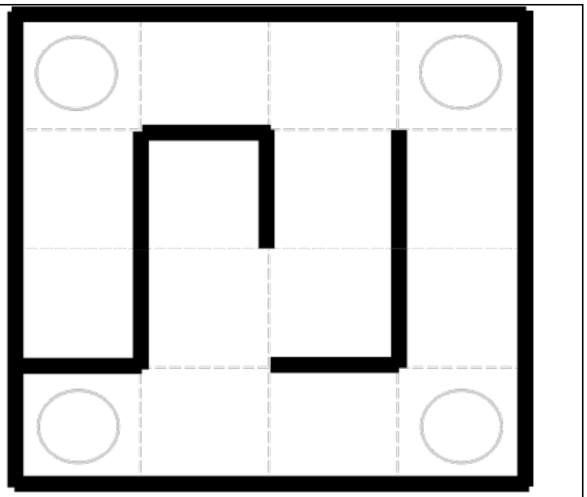


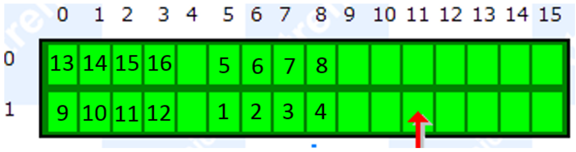
Figure 3. (b) Maze with imaginary grid cells

2. Localization (40 points)

As the robot navigates the maze, it has to localize within a specific grid in the maze. As described in Task 1, the maze is divided into 4x4 imaginary grid cells that can be enumerated from 1 to 16 as shown in Figure 4 (a), with a corresponding location in the grid shown in the LCD in two different columns according to Figure 4 (b). For example, if “0” marks a visited cell and “X” marks a cell not yet visited, then Figure 5(b) shows the LCD display corresponding to the “orange” path followed by the robot in Figure 5(a).

13	14	15	16
9	10	11	12
5	6	7	8
1	2	3	4

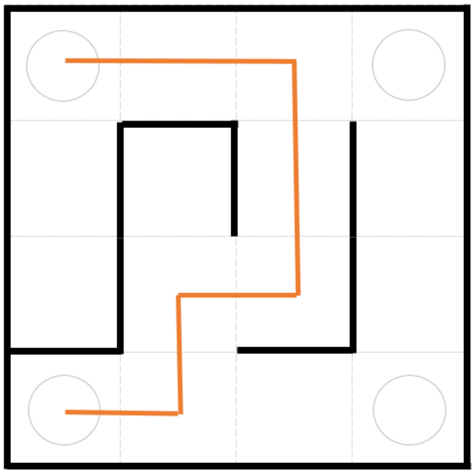
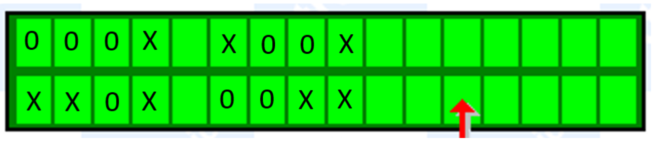
Figure 4. (a) Grid Code



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	13	14	15	16		5	6	7	8							
1	9	10	11	12		1	2	3	4							

Figure 4. (b) Grid Code in LCD

The objective of Task 2 is to provide localization of the robot into the LCD according to Figure 4 as it navigates the full maze. Additionally the LCD display must provide a flashing color each time it changes grid according to the following: (a) Red when moving to a grid that is right, (b) Green when moving to a grid that is left, (c) Blue when moving to a grid that is up, and (d) Yellow when moving to a grid that is down. Single flashes should take place per individual grids. The rest of the time the LCD should show a white background. You may provide additional information in the LCD such as orientation and relative movement corresponding to the 4 different flashing colors.

	 0 0 0 X X 0 0 X X X 0 X 0 0 X X
Figure 5. (a) Path followed by robot	Figure 5. (b) Path shown in LCD

3. Mapping (20 points)

The objective of Task 3 is to provide a final map built by the robot after navigating the complete maze. During navigation, the robot needs to collect the necessary information to rebuild the map of the maze. When navigation is complete, you should connect the robot to a computer by using the provided USB cable in order to download your final maze map. You will need to develop a program that to display the map in the computer screen.