University West
Department of Engineering

Project 3

MOBILE ROBOTS

Author
SOLOMON GUGSA

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Contents

0.1 Introduction

The goal with this Lab is to find an object in a maze automatically. This also includes testing of the robot navigation in unknown environment as given in the gazebo lunch files. The layout of this report lists questions from the main lab document followed by answer and practical discussions that arises during the lab work.

0.2 Task 1

Given a world in Gazebo*, move in the maze without collision?

0.2.1 Grade-Level 1

Perform navigation in Gazebo using MAT-LAB?

A simple navigation Mat-lab-application is used to navigate through the maze. This is done using a probabilistic road map developed in prior labs with few modifications inorder to accommodate obstacle avoidance.The idea behind PRM algorithm is basically, to explore feasible paths around a number of obstacles located in the map. This could be done using mobileRobotPRM object in mat-lab. This app requires a start and a goal position and it then calculates an optimized path towards goal position. The robot movement is controlled using the defined mat-lab application followed by a map builder using Hectors' method. The map then exported to mat-lab thorough ros-bag. It's important to note that Occupancy-Map is modified to fit the original map recorded in Rvis. This is due to the color miss-match created when using original occupancy-grid. The result shows the robot controlled using a simple mat-lab application by publishing twist, message in cmdvel topics and reading pose and velocity from Odom topic in real-time. Way-points are defined using the predetermined path created in PRM. Two Matlab-solution is provided for this task in-which the first one is navigation through Operator node and the other is automatic navigation with collusion avoidance. The latter is presented below as follows:-

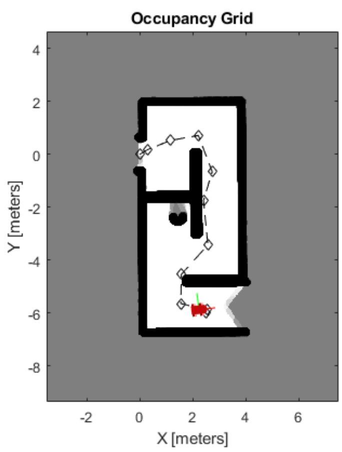

Figure 1: PRM-Path on inflated Map

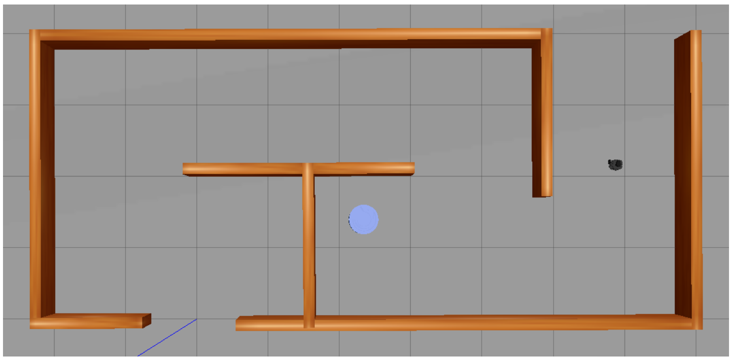

Figure 2: Destination Confirmation on Gazebo-World

0.2.2 Grade Level-2

Grade level II: Solve the maze without creating a map first?

The following algorithm defines a real-time autonomous navigation throughout the map avoiding obstacles along its real-time trajectory. This algorithm defines a route for the robot to observe and avoid possible obstruction, or a wall along a random path and without a map. The logic behind the algorithm is basically, follow a steps of approximate guessing by reading scan ranges in five different direction-i.e., left, right, and front-right, front-left Comparing defined ranges with sensor readings provides an insight to where the robot is located as well as its surroundings. The following flow chart shows steps of the algorithm as follows:

The idea behind the road-map in figure 2 is basically simpler than it's presented in the flowchart figure 3, However, both yields identical results. The idea is to read-out 360 range samples from the laser and defined region of interest according to desire range coverage. The turtle-bot is publishing 360 samples of readings from laser readings in-which it represents between -180 (the very left) degree and +180 (the very right) degree view of turtle-bot. Regions are then divided into five categories: 0 - 71 (right), 72 - 143 (front-right), 144 - 216 (front), 217 - 289 (front-left) and 290 - 360 (Left). The maximum distance to detect objects is set to 3.5 m. For instance, if any objects detects between the robot and max distance value, it is considered a close-by object relative to the robot. To avoid reading a value of inf, region are considered only if they're explicitly minimum out of ranges in that group and it should also be minimum out of max-distance of 3.5 meter. Find snapshot of python-script results in figure 5. The script is also attached with this document.

Note that the model .sdf for turtle-bot-burger is alos modified to adjust flexibility during the scan. See the following figure 6. This is due to easy one-way navigation of the robot. Thus, the span is only limited to -180 degree left and +180 degree right.

[1]

[1]

1. Kavraki, L.E., P. Svestka, J.-C. Latombe, and M.H. Overmars. "Probabilistic roadmaps for path planning in high-dimensional configuration spaces," IEEE Transactions on Robotics and Automation. Vol. 12, No. 4, Aug 1996 pp. 566—580. https://se.mathworks.com/help/robotics/ug/probabilistic-roadmaps-prm.html

2. Copyright 2014-2019 The MathWorks, Inc. https://se.mathworks.com/help/robotics/ug/path-

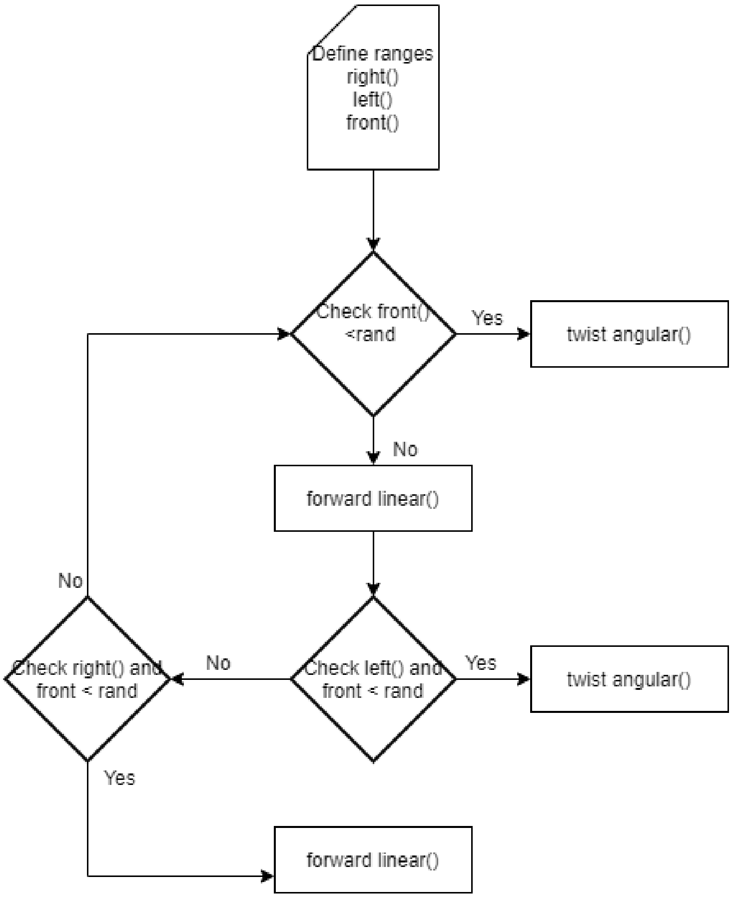

Figure 3: Collusion Avoidance steps without a Map

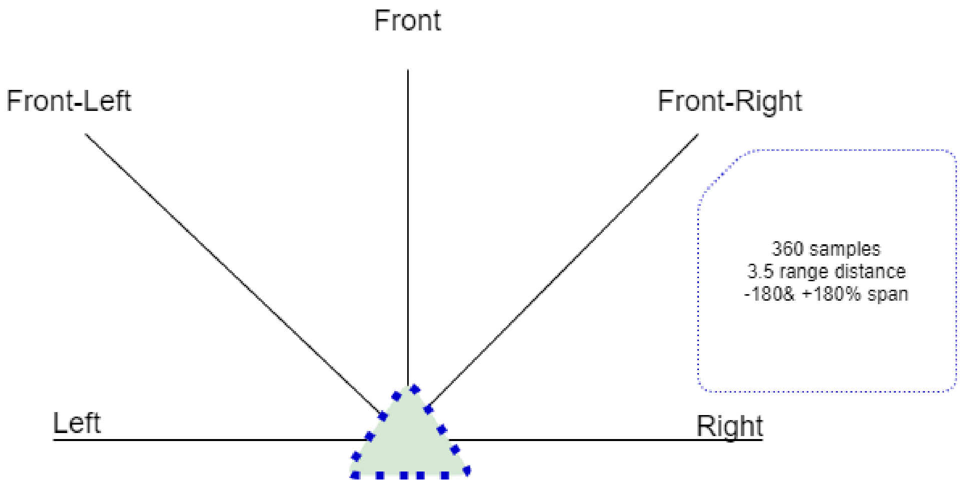

Figure 4: Road-Map

following-for-differential-drive-robot.html

```
File  Edit  View  Search  Terminal  Help
user@ubuntu:~/Desktop/PY$ python auto.py
[INFO] [1612125851.765795, 2534.427000]: Front-Right Collusion
[INFO] [1612125852.036921, 2534.627000]: Front-Right Collusion
[INFO] [1612125852.317322, 2534.829000]: Front-left and Front-right Collusiong
[INFO] [1612125852.589354, 2535.028000]: Front-Right Collusion
[INFO] [1612125852.867821, 2535.226000]: Front-Right Collusion
[INFO] [1612125853.163986, 2535.428000]: Front-Right Collusion
[INFO] [1612125853.457759, 2535.626000]: Front-Right Collusion
[INFO] [1612125853.739235, 2535.827000]: Front-Right Collusion
[INFO] [1612125854.040338, 2536.029000]: Front and Front-right Collusion
[INFO] [1612125854.319645, 2536.229000]: Front and Front-right Collusion
[INFO] [1612125854.645948, 2536.429000]: Front and Front-right Collusion
[INFO] [1612125854.944667, 2536.625000]: Front and Front-right Collusion
[INFO] [1612125855.235807, 2536.830000]: Front and Front-right Collusion
[INFO] [1612125855.558826, 2537.031000]: Front and Front-right Collusion
[INFO] [1612125855.818772, 2537.231000]: Front and Front-left and front-right Collusion
[INFO] [1612125856.109265, 2537.430000]: Front and Front-left and front-right Collusion
[INFO] [1612125856.384863, 2537.633000]: Front and Front-left and front-right Collusion
[INFO] [1612125856.662696, 2537.830000]: Front and Front-left and front-right Collusion
[INFO] [1612125856.942602, 2538.031000]: Front and Front-left and front-right Collusion
[INFO] [1612125857.259125, 2538.230000]: Front and Front-left and front-right Collusion
[INFO] [1612125857.580396, 2538.432000]: Front and Front-left and front-right Collusion
[INFO] [1612125857.836944, 2538.630000]: Front and Front-left and front-right Collusion
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[INFO] [1612125858.417115, 2539.030000]: Front and Front-left Collusion
[INFO] [1612125858.697305, 2539.229000]: Front and Front-left and front-right Collusion
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[INFO] [1612125859.296203, 2539.636000]: Front and Front-left and front-right Collusion
[INFO] [1612125859.552797, 2539.833000]: Front and Front-left Collusion
[INFO] [1612125859.824041, 2540.032000]: Front and Front-left Collusion
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[INFO] [1612125860.394189, 2540.431000]: Front and Front-left and front-right Collusion
[INFO] [1612125860.691231, 2540.631000]: Front and Front-left Collusion
[INFO] [1612125860.991888, 2540.832000]: Front and Front-left Collusion
[INFO] [1612125861.278108, 2541.032000]: Front and Front-left and front-right Collusion
[INFO] [1612125861.565680, 2541.232000]: Front and Front-left and front-right Collusion
[INFO] [1612125861.824780, 2541.431000]: Front and Front-left Collusion
[INFO] [1612125862.097884, 2541.631000]: Front and Front-left Collusion
[INFO] [1612125862.372401, 2541.831000]: Front and Front-left and front-right Collusion
[INFO] [1612125862.652917, 2542.031000]: Front and Front-left and front-right Collusion
[INFO] [1612125862.947854, 2542.232000]: Front and Front-left Collusion
[INFO] [1612125863.225186, 2542.430000]: Front and Front-left Collusion
```

Figure 5: Results

```
<ray>
  <scan>
    <horizontal>
      <samples>360</samples>
      <resolution>1</resolution>
      <min_angle>-1.570796</min_angle>
      <max_angle>1.570796</max_angle>
    </horizontal>
  </scan>
  <range>
    <min>0.120000</min>
    <max>3.5</max>
    <resolution>0.015000</resolution>
  </range>
```

Figure 6: Model Modification