TÉCNICO LISBOA

Robotics

Spring 2019

Departamento de Engenharia Electrotécnica e de Computadores

2nd lab assignment

Basic navigation strategies for mobile robots

(Due by the week of May 20 - May 24, 2019)

1 Objectives

This lab assignment aims at (i) developing students creativity related to the use of mobile robots, and (ii) having students familiarized with the problems related to sensing, actuating, and controlling the robot to execute a mission in an a priori known environment.

2 Syllabus

Consider a mobile robot, with unicycle kinematics, as the Pioneer DT robots in the lab.

Figure 1: fig:The Pioneer DT robot

The specific objectives for this lab assignment are

1. Make the robot to navigate around the North tower 5th floor, starting from inside the lab and returning to the starting point (blueprint available at the labs section in the course webpage),
2. The robots must detect doors and determine if the are (i) fully open, (ii) half open, or (iii) closed.

   On detection of a fully open door the robot should turn with front pointing towards the door and issue a greeting verbal sound.

   On detection of a half open door the robot should turn with front pointing towards the door and issue an inquiring verbal sound.

   On detection of a closed open door the robot should turn with front pointing towards the door and issue a sentence indicating that the door is closed.

The robot can use navigation aids, namely QR codes to help localization (suggest public domain software such as the Zebra Crossing project, www.zxing.com, you can also check the course webpage, file QR-code.rar),

QR codes can be put around the floor to help the robot navigation but should not be left there permanently. Once they are not being used they must be removed.

The Pioneer XT robot is controlled through an RS232 serial communications line. Connect this line to a laptop computer running Matlab and the robot can be controlled through the functions in Table 1. These functions are available at the course webpage, file matlab_pioneer.rar.

Linear and angular velocities are in mm/s and degrees/s, respectively. Prior to the use of the functions to control the robot ans assess its state, the user must open the serial port for communications using

pioneer_set_controls("serial port object", "linear velocity", "angular velocity arg");
pioneer_read_odometry();
pioneer_read_sonars();

Table 1: Main functions to control the robot and access its state

the function *serial_port_start*. To disconnect the computer from the robot a *serial_port_stop* function must be called.

The laser range finder (LRF) is a Hokuyo URG-04LX that can be connected to a USB port of the same computer used for the navigation. Relevant information on the typical behavior of this LRF can be found in multiple papers namely "Characterization of the Hokuyo URG-04LX Laser Range Finder for Mobile Robot Obstacle Navigation", Yoichi Okubo, Cang Y, Johann Borenstein, 2009 (available at the labs section of the course webpage).

Matlab/Octave functions to get data from the LRF are available at the lab section in the course webpage. Before being able to use the LRF determine the port being used by the connection (in Windows environment should be COM<something>) and change the SetupLidar.m accordingly. Running the SetupLidar function initializes the connection with the LRF.

The function LidarScan is used to get data. Check the script lidar_test_oct for an example on how to use this function and the variable containing the data returned by the LRF.

3 Guidelines

- Calibrate the controls for the robot; in general, due to a number of factors, e.g., wheels of different size, the kinematic model of the robot is not exactly that of a unicycle and an adequate compensating strategy must be used.
- Create a reference trajectory/path in the free workspace that can be used by the robot to navigate between the initial and final point.

  Both the initial and final points should be locate inside the lab.
- Develop a control strategy that generates the linear and angular velocities that will make the robot to follow the path generated in the previous item.
- Check the influence of odometry errors. Eventually, the odometry errors are too big and the execution of the mission can not rely on the odometry data exclusively. Consider using the sonars and/or a laser range finder to help the navigation.

4 Expected outcomes

Students must deliver a zip/rar file containing all the software developed, tests ran, and adequate pdf documentation explaining, clearly, the project and how to use the software.

5 Bonus points

For creative navigation algorithms that include a demonstration of stability.

For detection of other “interesting” events.