IEEE Control Systems Society Education and Outreach @ UTSA

Day #2

Line Following Robot, More Sensors and programming, Parallel parking

This handout can also be found on this weblink: http://tiny.cc/ieee_day2

Day 2, Session 1: 9:30 AM – 12:00 PM

Task 1: Line Following Robot

Motivation: Automated Guided Vehicles (AGV) are used in manufacturing facility and warehouses to move equipment, people, and material. These AGV's follow predefined lines marked on the floor to navigate.

Goal: In this lab, you will build and program a line following mobile robot that can go from a predefined start to a predefined end point in the given time. You will be evaluated based on how well you can follow the given line in a set amount of time.

Building an autonomous (not tele-operated) mobile robot: Build a mobile robot that can turn and incorporate the color sensor that will enable the robot to see the line. Feel free to reuse the design you used earlier. Here is an example mobile robot but feel free to use your own design or customize this one:
http://aux.coe.utsa.edu/ pab/info/lego/lego_vehicle.pdf (5.4 MB)

Tasks

1. Your robot should use only the color sensor for this task. No other sensors are allowed.
2. Your robot needs to follow the black continuous line at all times. We will also keep a track of the time from start to end. HINT: Here is a tutorial on programming a line following robot: https://youtu.be/ODAGVeeDagk
3. One person from each team will place the robot in the orientation of her/his choice at the start point (which will be clearly marked). When the TA/instructor says, 'Ready-Set-Go', the team member will press a button on the brick to get the robot moving. Your time will start when the TA/instructor says 'Go'. Your robot has to follow the line from start to end.
4. If your robot does not reach the finish (end of the line) you will get zero points.
5. If you robot does reach the finish (end of line) then your score will be computed using the formula, Score = 100 - T, where T is the time taken by the robot from start to finish in seconds.
6. You will have three attempts to improve your scores.

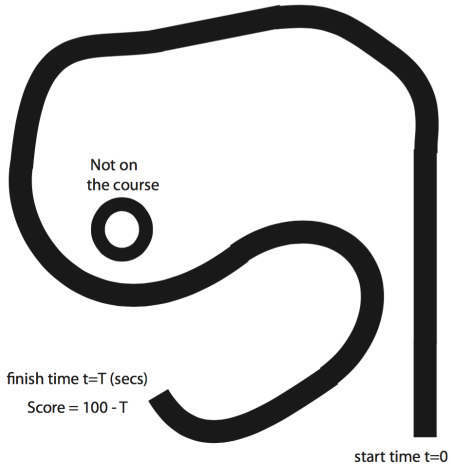

Figure 1: The course for line following robot

NOTE: The TA/instructors decision is final when making a judgement on the interpretation of any of these rules.

Day 2, Session 2: 1:00 PM – 3:00 PM

Complete the post-camp survey

IMPORTANT: Please complete this short post-camp survey. Each student should complete the survey independently. https://goo.gl/ewvxPC

Task 2: Distance measurement

Programming infrared sensor

Program the infrared sensor so that it is able to measure the distance and display it on the brick. The TA will check the program by moving an object close to the infrared sensor and checking the value displayed by the brick.

Programming ultrasonic sensor

Program the ultrasonic sensor so that it is able to measure the distance and display it on the brick. The TA will check the program by moving an object close to the infrared sensor and checking the value displayed by the brick. By default there is no ultrasonic programming block in the software. Use the instruction on this webpage to install the ultrasonic block:
http://robotsquare.com/2014/06/25/tutorial-gyro-ultrasonic-sensor-ev3-home-edition/

Programming gyro sensor

Program the brick so that when the gyro sensor is rotated by a given angle, it will display the angle on the brick. You might find this useful
http://robotsquare.com/2014/06/25/tutorial-gyro-ultrasonic-sensor-ev3-home-edition/. Ask the TA for an angle chart. The TA will test you by rotating the gyro by a known angle and checking the value displayed by the brick.

Task 3: Parallel Parking

Motivation: In future, autonomous cars are expected to replace human drivers. One aspect of autonomous driving is to parallel park the car. Here is an animated gif showing parallel parking.

Goal: In this lab, you will build and program a robotic car to parallel park in a given amount of time. You will be graded based on how well you can parallel park in the set amount of time.

Building an autonomous (not tele-operated) robotic car: Build a robotic car that can turn and incorporate a sensors that will enable the robot to localize relative to other cars and localize with respect to the curb shown in red (see figures). Keep in mind the dimensions of the spacing, width, breadth, and height, while building the robot and incorporating the sensors. Feel free to reuse the design you used earlier. Here is an example mobile robot but feel free to use your own design or customize this one:
http://aux.coe.utsa.edu/ pab/info/lego/lego_vehicle.pdf (5.4 MB)

Overview: The figure 2 shows the course and figure 3 gives more information about grading. The brown rectangles are parked cars and the red horizontal line between the cars is the reference line that you will be able to use for localization. You may use the LEGO box to replace the parked car. The car should parallel park similar to the animation shown here:
https://en.wikipedia.org/wiki/File:ParallelParkingAnimation.gif. In particular, note that the car first pulls parallel to the front car, then drives in reverse, and then starts turning to initiate parking. You need to do similar maneuver or you will get no credit for the lab.You are free to use any number of sensors provided in the LEGO box given to you, but cannot borrow sensors from other groups.

Scoring One person from each team will place the robot at the start line as shown in the figure 3. When the TA/instructor says, 'Ready-Set-Go', the team member will press a button on the brick to get the robot moving. Your time will start when the TA/instructor says 'Go'. **Your robot should come to a complete stop when it thinks it has parallel parked itself. The robot should also blink the red led on the programmable brick. We will stop the time once we see red light.** The grading rubric is as follows:

1. If you do not follow the parallel parking convention (see notes above) then your score will be zero for that particular attempt.

2. T_1 = 20 x 3 = 60 points: For: (1) not hitting the front car; (2) not hitting the rear car; (3) not crossing the horizontal red line.

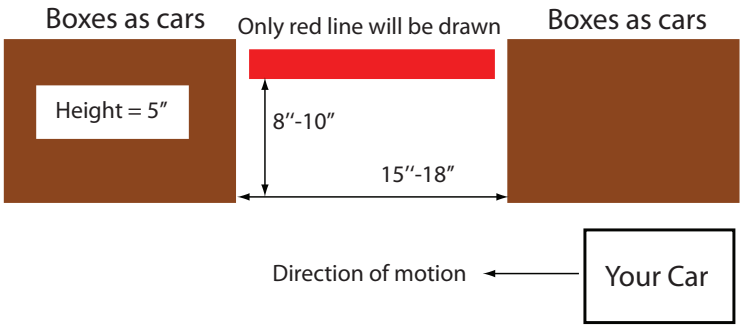

Figure 2: Course with dimensions. The actual distance, breadth and width, between parked cars will be decided on grading day. But it will be within the dimension range specified above.

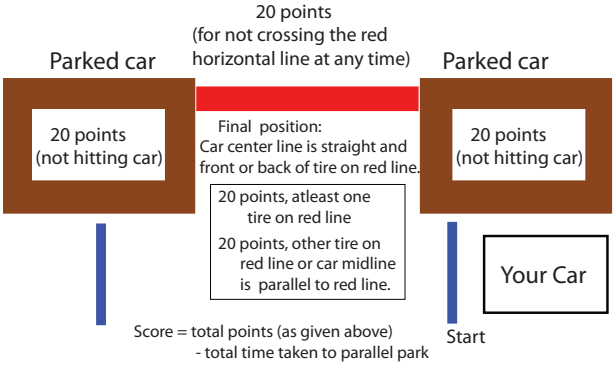

Figure 3: Explanation of grading for the lab.

3. $T_2 = 20$ points: In the final stopping position, **at least one tire is on the red line**. It is fine to be partially on the line.

4. $T_3 = 20$ points: In the final stopping position, **the orientation of the midline of the car is parallel to the horizontal red line**. To check alignment on a four wheeled car, we will check to see if the front/back tires on one side of the car are on the red line. If you use a single castor wheel then we will check to see if the orientation of the midline is within $\pm$ 5 degrees of the red line (this is left to the discretion of the teaching assistant)

5. Final score = $T_1 + T_2 + T_3$ - Total time taken (in seconds).

6. You will have three attempts to improve your scores.

NOTE: The TA/instructors decision is final when making a judgement on the interpretation of any of these rules.

Packing up

Please dis-assemble the robot and put contents in the correct location in the box. Please ensure that parts, sensors, motors, brick, **cables**, **usb cables** are returned to the box. The complete list is in the handout for yesterday which can be found here: http://tiny.cc/ieee_day1. Please hand over the box to the teaching assistant.