IEEE Control Systems Society Education and Outreach @ UTSA

Day #2

More Sensors and programming, Parallel parking

1. Angle measurement: 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/. The TA will test you by rotating the gyro by a known angle and and checking the value displayed by the brick. The angle chart for testing is here: http://aux.coe.utsa.edu/∼pab/info/lego/lego_angles1.pdf **(10 points)**.
2. Distance measurement: 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 ultrasonic sensor and checking the value displayed by the brick. **(10 points)**

Motivation: In future, autonomous cars are expected to replace human drivers. One aspect of autonomous driving is to parallel park the car [1]. 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 either use your imagination or use designs from the internet. There are lots of ideas on YouTube. Here is an example mobile robot but feel free to use your own design or custom this one: http://aux.coe.utsa.edu/ pab/info/lego/lego_vehicle.pdf (5.4 MB)

Practise Task:

1. The figure 1 shows the course and figure 2 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.
2. You are free to use any number of sensors provided in the LEGO box given to you, but cannot borrow sensors from other groups.
3. Tele-operation (remote controlling the car) is not allowed. The robot needs to be autonomous (by itself).

[1] Imagine this happening one day: you hop off your car to attend school while the car (autonomously) figures out where and how to park.

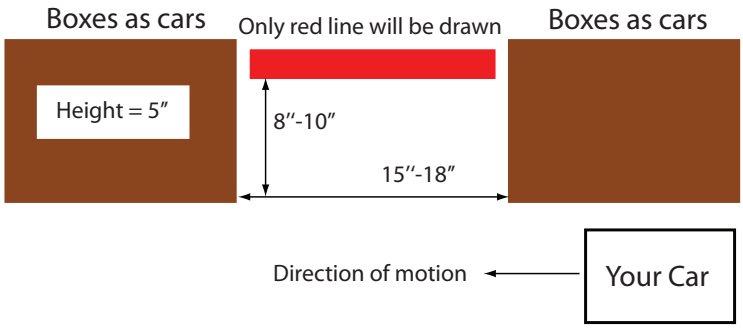

Figure 1: Course with dimensions. The actual distance, breadth and width, between parked cars will be decided on grading day. But it will be within the dimension range specified above.

Scoring (100 points as given below) One person from each team will place the robot at the start line as shown in the figure 2. 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. 20 points: As long as you drive and pull yourself parallel to the car near the intermediate point and then reverse to start the parking maneuver. If you do not do this maneuver then you will get zero points for the rest of the lab.

2. 10 x 3 = 30 points: For: (1) not hitting the front car; (2) not hitting the rear car; (3) not crossing the horizontal red line.

3. 20 points: In the final stopping position, one tire is on the red line. It is fine to be partially on the line.

4. 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

5. 10 points: For parallel parking in under 30 seconds.

Here is a parking red line for testing (print on letter size paper):
http://aux.coe.utsa.edu/ pab/info/lego/lego_park_line.pdf.

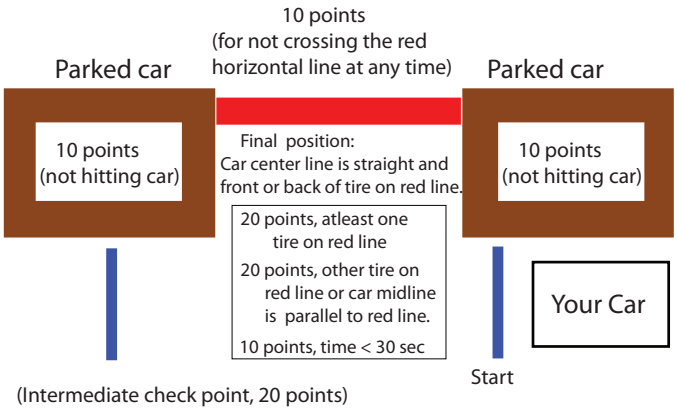

Figure 2: Explanation of grading for the lab.