Texas Workforce Commission, Girl CodeRunner @ UTSA

This handout is also available on this weblink: https://tiny.cc/twc_day2

Introduction to LEGO Mindstorms, Sensors, Motors
Challenge 1: Robot racing
Challenge 2: Line Following Robot

Time: 9 AM to 10:15 AM

Task 0: Understanding whats in the box given to you

Welcome to the 2nd day of this 5-day camp! Today we will learn robotics and create robots that follow lines and race against each other.

PRIZES: All girls who attend at least 4 out of 5 days will win a prize and a certificate. To get the prize and certificate, you will need to be present on the 5th day. You will also get tickets for completing the activities on each of the days. At the end, we will put all tickets in the box (only if you have attended 4 out of 5 days) and draw out two tickets for a grand prize — chromebook (a laptop/tablet). Note that getting more tickets improves your chances of winning the grand prize.

Open internet explore or any other browse and go to "google.com". Now search for "what does a robotics engineer do". Next, open YouTube and find at least three useful applications of robotics. Discuss with your team.
Assignment 0: Call and discuss with the student assistant.

The equipment given to you includes:

- **Boxes:** 1 LEGO Core set. Information about parts is here https://education.lego.com/en-us/products/lego-mindstorms-education-ev3-core-set-/5003400 (If the link is dead search for LEGO Core Set). See Figures 1.
- **Computer:** 1 NXT Brick and 1 USB cable to connect brick to your computer.
- **Actuators:** 2 large motors and 1 medium size motor.
- **Sensors:** 1 Color sensor, 1 Gyro sensor, 1 Ultrasonic Sensor, 1 Infraredsensor, 1 Touch Sensor, Cables to connect sensors to bricks
- **Battery:** 1 Rechargeable battery and charger

Question: Can you identify the different sensors and motors in Fig. 1 (bottom picture)?
HINT: Look at this link: http://www.lego.com/en-us/mindstorms/products/mindstorms-ev3-31313 (If the link does not work for LEGO Mindstorms EV3).

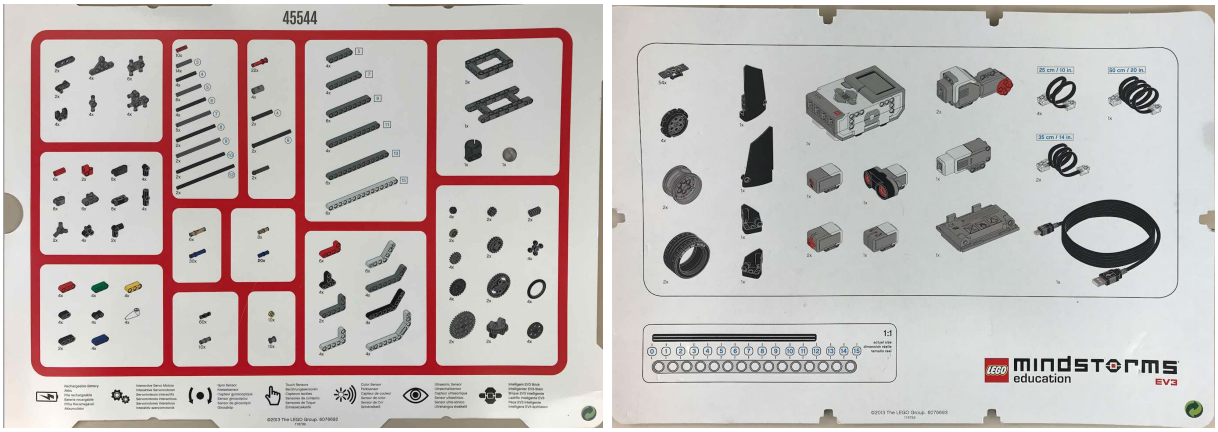

Figure 1: This picture shows descriptions of components in the boxes.

Task 1: Introduction to brick programing, sensors, and motors

Brick programming

This video shows how to write a basic program that plays a sound using the brick.
Video: https://youtu.be/81hctQt6Cp8 (Duration: 4 min 29 sec)
Assignment 1: Follow the video and show your work to the student assistant.

Programming color sensor

Program the brick so that when the color sensor is shown one of the three colors; red, green, and blue; it is displayed on the brick. The student assistant will test the program by showing one of the three colors to the color sensor. Ask the student assistant to give you the color chart (For the student instructor: The link to the colors is here: https://coderunners2019.github.io/lego_colors1.pdf)
Assignment 2: Follow the video and show your work to the student assistant.

Programming motors

The video shows you how to make a motor move. At the end of this video you will be able to control the speed (magnitude and duration), and also control the angle of spin.
Video: https://youtu.be/liKa_I55ADM (Duration: 4 min 58 sec).
Assignment3: Follow the video and show your work to the student assistant.

Time: 10:30 AM to 11:45 AM

Task 2: Robot racing

Develop a mobile car

1. Build the car shown here: https://youtu.be/HsLqiShzP0k or use the booklet provided to you in the box (Duration 2 min 42 sec).

2. Program the car to move in the following fashion: (1) move straight for 2 seconds; (2) take a 90 turn to the right; (3) move straight for 2 seconds; (4) come to a stop. *HINT:* See the tutorial here. https://youtu.be/8C01X72_Xfk (Duration: 3 min 29 sec). Write your team's name on a piece of paper and stick it on the car, somewhere on the top, such that when we make a video of your car with the camera pointing down, it is easy to distinguish your car.

Assignment 4: Follow the video and show your work to the student assistant.

Reacting to sensor measurements

The next task is a race that will be played by all teams together as shown in Fig. 2. The goal is to program your car to move from start to end as shown. The moment the TA says "Go" you will press a button on the brick initiating your car to move in a straight line towards the a black line as shown. The car which comes to a complete stop on the black line (color sensor on the car should be above the black line) first will be declared a winner.

Assignment 5: Contact the student assistant once you are ready to race.

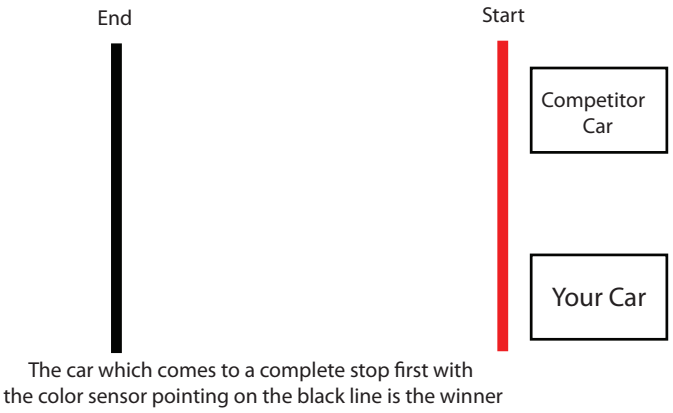

Figure 2: Car racing conceptual diagram.

Time: 12:30 PM to 1:45 PM

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.

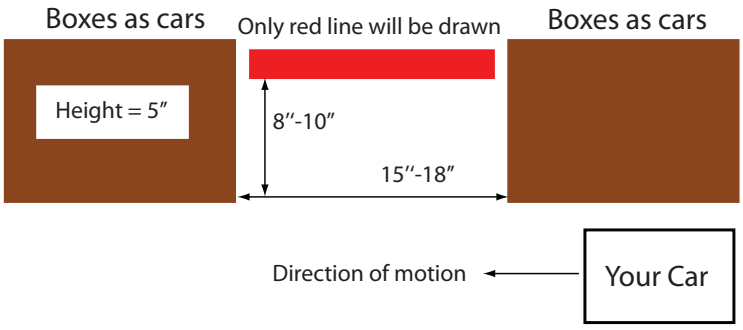

Figure 3: Course with dimensions. The actual distance, breadth and width, between parked cars will be decided on grading day. But it will be within the dimension range specified above.

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 3 shows the course and figure 4 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 4. 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.
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.

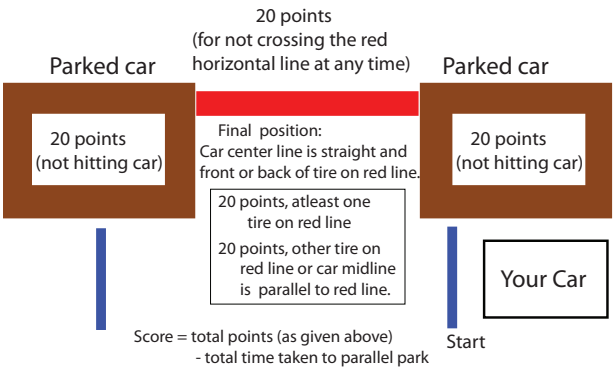

Figure 4: Explanation of grading for the lab.

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.

Assignment 6: Contact the student assistant once you are ready.

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 is in Task 1. Please hand over the box to the teaching assistant.