CMPE 434 INTRODUCTION TO ROBOTICS

LAB #3 "Calibration"

Sensors are the robot's means of observing the environment. In order to get the best results you have to perform sensor calibration. This can be done by actually measuring the quantity reported by the sensor and plotting the result to see if there is a deviation from the expected linear relationship. The sensor's response may also depend on the environment, e.g. a distance measuring sensor may report different results for the same actual distance for different surfaces, so you should also check to see if this is the case. In order to get a meaningful result you are going to repeat the experiments multiple times and report the average.

In the first part of this lab you are going to calibrate the light - color, ultrasound, and gyro sensors of the Lego robot. In the second part you will establish the relation between the motor speeds applied and the linear and rotational motion observed.

Things to do:

1. In this lab, use the robot you built for LAB #1.
2. **Sensor Calibration**
    - For each sensor do the following
    - Fit only the sensor to be calibrated to the robot.
    - Write a java code to return and display on the LCD screen the sensor measurement.
    - **Ultrasonic sensor:** for obstacle in {wall cardboard box, robot box} do the following:
        (a) For distance measurements, place the robot {1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 40, 50} cm away from the obstacle record the value returned from the sensor.
        (b) Repeat the experiment 5 times.
        (c) Compute the average and standard deviation. Plot the recorded data. (We will see a line for the data and for true values)
        (d) Finally, you will fit a line ($Y = aX + b$) to the data using linear regression and plot the fitted line on the plot from previous item.

- **Light - Color sensor:** for different pieces of papers in different colors
  (a) Place the paper in front of the sensor at an appropriate distance (1-3cm)
  (b) Record the (Ambient and RGB) value returned from the sensor under different lighting conditions (i.e. dark and light)
  (c) Repeat the process 5 times.
  (d) Compute the average and the standard deviation for each color and lighting conditions for ambient and RGB values (RGB separately) (i.e. blue-light, red-dark). Plot the data.
- **Gyro Sensor:**
  (a) Rotate the robot {0,45,90,135,180,225,270,315} degree and record the measurement of the sensor
  (b) Repeat the process 5 times.
  (c) Compute the average and standard deviation and plot the data.

3. **Motor Calibration**

- Write a code to set the speeds of the two motors to the desired values
- **Linear Motion:**
  (a) Mark a starting line. For each measurement put the robot on the starting line. Give the same speed to both of the motors to obtain a linear motion. For speed in {100, 200, 300, 400, 500, 1000, 1500, 3000, 5000} do the following:
  (b) Run the robot for 5 seconds, measure the distance traveled.
  (c) Repeat the experiment 5 times.
  (d) Compute the average and standard deviation. Plot the data.
  (e) Comment on the effect of the acceleration on the distance traveled.
- **Rotational Motion:**
  (a) Mark a starting line. For each measurement put the robot exactly parallel to the starting line. Give the speed to motors, but rotate one of the motor in forward direction and the other backward direction. For speed in {25, 50, 75, 100, 125, 150, 200, 250, 300, 350} do the following:
  (b) Run the robot for 5 seconds, measure the turn angle.

(c) Repeat the experiment 5 times.

(d) Compute the average and standard deviation. Plot the data.

(e) Comment on the effect of the acceleration of the motor.