EGR 262

Fundamental Circuits Lab

File: N262L10

**Lab # 10**

**Using Infrared (IR) Sensors with the Arduino UNO**

A. **Objectives**

 The objectives of this laboratory are to introduce the student to:

1. Infrared (IR) sensors
2. The QTRSensors Library for the Arduino
3. IR sensor calibration
4. Line following using IR sensors

B. **Materials**

 Robot vehicle that includes:

* Arduino UNO
* Qik 2s9v1 Dual Motor Controller
* 5-AA Battery Pack
* 7805 - 5V Regulator
* Two 580 rpm gearhead motors
* Breadboard

10 kΩ resistor

QTR IR Sensor (digital)

QTR-8RC Sensor Array (digital)

Cables and headers for connecting sensors to the breadboard

C. **Introduction**

 See the ***Presentation for Lab #10*** for more detailed background information.

D. **Pre-Lab Tasks**

1. ***Program 1 – Navigating an oval track using line following***

Write a program to navigate the oval track illustrated on the following page.

* Use the QTRSensor library for the Arduino (download and add to the Arduino/library folder)
* Use the PololuQik library for the Arduino (download and add to the Arduino/library folder)
* You might begin with the program QTR8RCEx1 shown in the lecture nodes. It is a modified version of QTRRCExample found in the QTRSensor library.
* You might use an algorithm similar to the one presented in the lecture notes where outer sensors correspond to sharp turns and inner sensors correspond to more gradual turns (or going straight).
* Include plenty of comments in the program including the usual initial block of comments.
* The track will consist of a 4’ x 8’ piece of plywood with an oval line created using ¾” black electrical tape.

¾” black electrical tape

4’ x 8’ plywood

E. **In-Lab Tasks**

1. **QTR Sensor**
	* Connect a QTR sensor to the breadboard using the cable provided.
	* Wire the QTR sensor as indicated in the lab presentation (using a 10kΩ resistor).
	* Enter the program used to test the QTR sensor.
	* Add a piece of black electrical tape to a white sheet of paper for testing the sensor.
	* Verify that the sensor detects a black line and a white surface.
	* The optimal sensor height for this sensor is 0.25”. Vary the sensor height to determine the height range over which it will operate. Measure the height range with a ruler and recored the results.
	* Demonstrate proper operation to the instructor.
	* Add comments to the program and print a copy for your report.
	* Print a sample output from the computer monitor showing that the sensor detects both the black line and the white surface.
	* Test the sensor over some other surfaces (different colors or materials) and record the results.
2. **Wiring the QTR-8RC sensor array**
	* Add washers to adjust the height of the sensor array so that it is close to 1/8”.
	* Using cables and headers provided, connect the QTR-8RC sensor array to the breadboard.
	* Add wires to connect the 8 sensor inputs, along with LEDON, Vcc, and GND, to the Arduino inputs specified in the lab presentation.
3. **Calibrating and testing the sensors**
	* Use the program QTR8RCEx1 to calibrate and test the sensors (using the same white sheet of paper with black tape used previously).
	* Capture a printout of the output showing the max/min values for each sensor.
	* Also capture a printout of the output showing the values of each sensor as the sensors move over the tape. Verify that the program correctly identifies when each sensor is over the tape.
	* Demonstrate proper operation to the instructor.
4. **Testing Program 1**
	* Download Program 1.
	* Test the robot on the course provided (4’ x 8’ plywood track with a black oval line). Adjust your program until the robot can navigate the course in both directions (CW or CCW).
	* Record the time for the robot to complete one lap (in either direction).
	* Demonstrate the robot on track to the instructor.
	* Print the final program.

F. **Post-Lab Tasks**

1. Discuss the QTR sensors (single sensors):
* Compare the specified sensor height to the measured range of sensor heights.
* Discuss the results of using the sensor over other colors or materials.
1. Discuss the calibration and testing of the QTR-8RC sensor array:
* How difficult was it to calibrate the sensors?
* How good was the program at identifying which sensor was over the line?
1. Discuss the program to navigate the course.
* How difficult was it to adjust the program to navigate the course?
* How many times did you modify the program?
* Once the program was adjusted to complete the course, would the robot navigate it reliably every time?
* Calculate the % of full speed for each motor for each sensor position and show the results in a table.
* If you used a variation to the navigation approach presented in the lab, discuss your approach.

G. **Report**

 A lab report is due 1 week after the date of the experiment. Use the same format as in previous labs.