Phase 3 Lab Exercise #1

INSTRUCTIONS

Complete the exercises below and upload them to Canvas as a single MATLAB script file using the naming convention "ENGR131_21S_P3_Lab##_abc123.m", replacing abc123 with your Case ID, and ## with the two-digit lab number.

For example, if Dr. Williams were submitting this lab, it would be ENGR131_21S_P3_Lab01_mrw8.m

For your script, please perform the following:

1. Separate each question into separate, runnable sections using the "%%" comment notation.
2. You may use the code and notes from class, the textbook, MATLAB's documentation, and anything you find using Google to solve these problems.
3. Use comments as appropriate to indicate your thoughts and how your code works (or is supposed to work). This is 5 points (9%) of your grade.

ARDUINO PROTOCOL

This lab will be simulating recording the light from two different "cities" using the Arduino circuit your built in Phase 2 Lab 1. You will need to have your Arduino set up to do the following:

- Measure the light shining on the photoresistor
- Map it to a value from 0 to 255
- Send the data out to Matlab via serial communication (9600 baud).

To simulate the day/night cycle for each city, use a flashlight (or similar) to "sweep" over the photoresistor in a circle as shown in Figure 1. Move fast enough that you get 4 to 6 passes over the sensor in 10 seconds. For the second city, place a tissue or similar translucent material over the photoresistor and repeat.

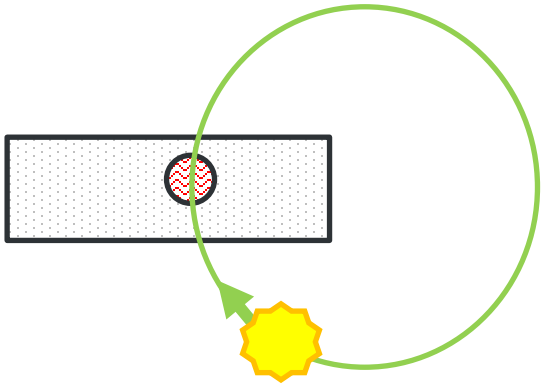


Fig 1. Diagram of how to pass the center of the flashlight beam over the photoresistor.

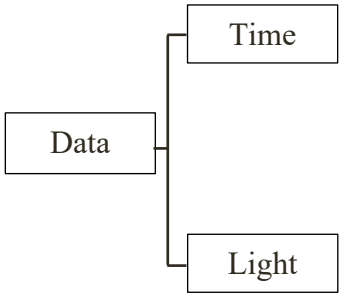
QUESTIONS

There are 4 questions for this lab, each builds on the previous question, so do not clear between each section.

1. COLLECT DATA (15 PTS)

The first step in our analysis of the light recorded in two different cities is to collect two sets of light data and save it to a structure. Do this by:

A. Writing a function that implements a loop to collect a set amount of data. The function should use the serial object, the recording time, and the iteration (city number) as input arguments and return an N x 2 array with the time in the first column and the recorded light level in the second. (4 pts). Include in this function outputs to the Command Window noting the starting and stopping of the recording.
B. Write a script that performs the following:
    a. Sets the recording time and the number of recordings to make.
    b. Create an empty structure with fields called Time and Light (2 pts)
    c. Creates a serial port object and waits for 2 second while the Arduino reboots
    d. Use a loop to record the light from each "city". This loop should:
        i. Call the function created in 1.A
        ii. Trim off the first 10 samples (to account for noise)
        iii. Normalize the time such that that starting time value is 0 (2 pts).
        iv. Normalize the light data such that it goes from 0 to 100 instead of 0 to 255 (2 pts).
        v. Save the data to the structure from 1.B.b with each city's data as a separate row in the structure (Figure 2, 5 pts).
    e. Clear the serial object.



(a)

Fields	Time	Light
1	1958x1 dou...	1958x1 dou...
2	3815x1 dou...	3815x1 dou...

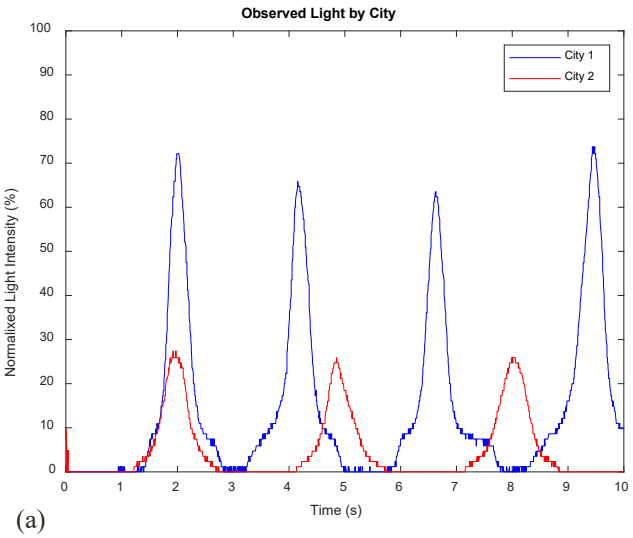
(b)

Fig 1. Diagram of data structure with fields to record the time and light intensity (a) and a screen capture of the variable in the Workspace explorer (b).

2. Plotting Data From a Data Structure (10 pts)

In a new section, create a script that:

A. Plots the light intensity for each city Fig 3a (3 pts)
B. Plots histograms of these data sets as shown in Fig 3b. (4 pts)
    a. *Hint: adjust the xlimits to go from 5 to 100 and the ylimits to go from 0 to the maximum observed on the graph. This will better represent the actual light data without all the 0's when the light isn't shining on the photoresistor.*
C. With appropriate labeling (3 pts)



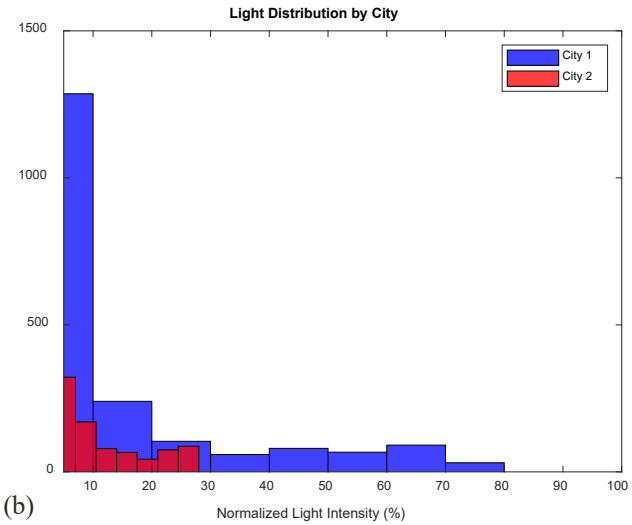


Fig 1. Plot of simulated light intensity on two cities (a) and the distribution of intensities by city (b).

3. Computing and Displaying Statistics (15 pts)

Recreate Table 1 by performing the following in a new section:

A. Compute the statistics on the data for each city (5 pts).
B. Create the table (5 pts) shown in Table 1. For the table, use the 'VariableName' property of the table command to set the column labels.
C. Perform a paired t-test on the two sets of light intensities and report back to the workspace the p-value as well as whether or not the two populations are statistically different (p<=0.05) using an if-else to test the condition (5 pts).

	City 1	City 2
Mean	13.965	2.6437
Std Dev	19.249	5.8603
Median	7.451	0
Max	73.725	27.451
Min	0	0
5th PCTL	0	0
95th PCTL	61.882	18.431

Table 1. Statistics of recorded light intensities by city.

4. Sorting (15 pts)

Sort the data using both a manually coded sort as well as Matlab's sorting. Time each method. Perform this by the following in a separate section:

A. Create a function to sort data using the selection sort algorithm discussed in class (8 pts).
B. Sort each data set and place the results in a nested data structure where each field is separated into manual and Matlab sorted values (Fig 2a, 2 pts).
C. Time each sort using the tic and toc commands. After both cities and both methods of sorting you should have a 2x2 matrix of times where each column is the time for one type of sort (2 pts).
D. Plot the sorted data as shown in Fig 2b. If your sort function is working properly, the data sets should overlap each other for each gender's heights (2 pts). *Hint: You may have to zoom in to see it*.
E. Report the average time for the manual and Matlab sorts to the Command Window.

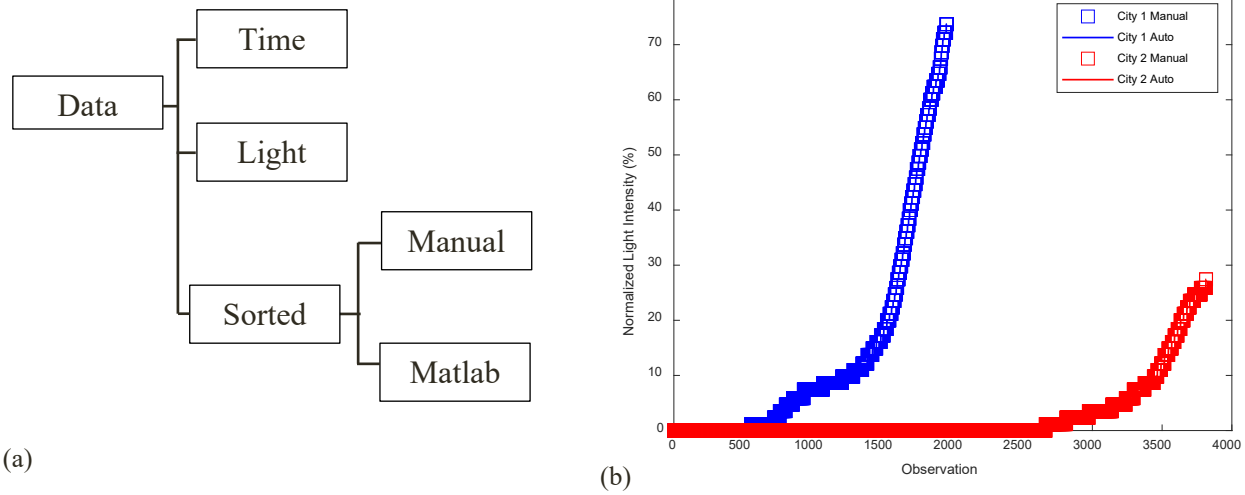


Fig 2.Diagram of data structure including sorted data (a) and plot of sorted light intensities by city using manual and Matlab's built-in sort functions

Revision	Description	Date
A	Original Document	3/26/2021