Lab 4

MATLAB Functions and Graphing

Objectives:
- Gain familiarity with MATLAB functions
- Learn MATLAB graphing operations and formatting

Files Provided:
- datalog1.csv
- datalog2.csv
- datalog3.csv
- datalog4.csv
- datalog5.csv
- datalog6.csv
- datalog7.csv
- readdatalog.m

Assignment:

Implement each part below as a function in a single MATLAB m-file that accepts the log file name as the only input. Thus, each file must be independently executable, i.e. you must not need to execute one file to generate data for another part. You may make a copy of readdatalog.m and modify it. Each part refers to processing data from the 7-column data log files. Your functions must also return useful "help" comments to explain their operation. Note that the first comment block in a function file is automatically returned when you enter "help *function_name*" in the command window.

1.

a. Implement the difference equation below to calculate the acceleration of the vehicle. Determine the value for the constant A so that the output is in units of g's (32 ft/sec^2) given that measured speed is in mph. Create a fully labeled line graph (i.e. using the plot() function) that graphs the acceleration vs. time in the upper third of the figure window (use subplot (3,1,1)).

$$acc[n] = A\frac{speed[n] - speed[n-1]}{time[n] - time[n-1]}\ given\ initial\ condition\ acc[0] = 0$$

b. Hopefully, the graph from part 1 is alarming. You should see spikes of acceleration far beyond 1g, which is not remotely realistic for the passenger sedan being recorded. The issue is that speed is reported in the data log as an integer, and the transition between two values for speed occur in consecutive readings a few hundredths of a second apart. Let's attempt a simple moving window filter for speed. Implement the difference equation below, then use the resulting filtered velocity to repeat part 1. Create a fully labeled line graph (i.e. using the plot() function) that graphs the new acceleration (i.e. acc_{filter}) vs. time in the middle third of the figure window (subplot (3,1,2)).

$$speed_{filter}[n] = \frac{speed[n] + speed[n-1] \ldots + speed[n-31]}{32}$$

$$given\ the\ initial\ conditions$$

$$\begin{gathered} speed_{filter}[0] = speed[0] \\ speed_{filter}[1] = speed[1] \\ \ldots \\ speed_{filter}[30] = speed[30] \end{gathered}$$

c. To see how much difference the filter makes, calculate the percent difference of the values using the difference equation below. Create a fully labeled line graph (i.e. using the plot() function) that graphs the error vs. time in the lower third of the figure window (subplot (3,1,3)).

$$perdiff[n] = \left| \frac{acc[n] - acc_{filter}[n]}{acc_{filter}[n]} \right|$$

The Figure window with all three of the plots from parts a, b, and c is a deliverable.

d. The function must return the acc array and the acc_{filter} arrays as the two outputs.

2. There is information in the log file that may be used to determine a second measure of velocity. The log file contains both the engine RPM and the current gear. Using the gear ratios and information about the car's tires, this may be used to calculate velocity. Calculate this velocity based on the following difference equation. Assume 245/40R18 tires with a diameter of 25 inches.

$$speed_{calc}[n] = \frac{RPM[n] * \frac{60min}{s} * \pi * diameter_{tire}}{\frac{5280ft}{mile} * \frac{12in}{ft} * \frac{25.6mm}{in} * ratio(gear[n]) * finalRatio}$$

given

First Gear Ratio (:1)	3.45
Second Gear Ratio (:1)	1.95
Third Gear Ratio (:1)	1.30
Fourth Gear Ratio (:1)	0.97
Fifth Gear Ratio (:1)	0.78
Sixth Gear Ratio (:1)	0.67

Final Drive Axle Ratio (:1) 4.11

While this calculation seems to give more precision that the measured integer speed, there are a few issues. First, examination of the log files show that the selected gear is not sampled as often as it is transmitted in a message (meaning the CAN messages may still show the shifter being in 5th gear for a while after it has been moved to neutral). The recorded data also does not show when the clutch is pressed and the engine is disconnected from the wheels, in which case the car is effectively in neutral even though the shifter is in gear. Finally, when the messages do correctly indicate that the car is in neutral (gear 0), it may still be rolling down the road, and there is no ratio for gear 0.

The last issue mentioned above, not being able to calculate the speed while in gear 0, is the only one we will actively try to fix for now. For each sample point n for the calculated speed, use the raw measured integer speed if the vehicle is in gear 0, and use the calculation above if gear is 1 to 6.

Show this new calculated speed by creating three fully labeled plots in a single figure window. The upper plot must be the raw measured integer speed from the data log. The middle plot must be the calculated speed. The lower plot must be the difference between the upper two. The function must also output the array of calculated speeds as the only output.

3. The log file does not show distance traveled. The distance in miles may be calculated from the difference equation below, given that speed is in miles/hour and time is in seconds.

$$distance[n] = distance[n-1] + 0.5speed[n] + 0.5speed[n-1] * \frac{(time[n] - time[n-1])}{3600\ sec/hr}$$

$$given\ initial\ condition\ distance[0] = 0$$

Calculate these values and create a fully labeled plot of distance vs. time, doing so twice. First, use the measured integer speed, and second, use the calculated speed from part 4. Both graphs must be on the same full-figure plot (i.e one set of axis with two plotted lines). Make sure to add a legend to show which line represents which data. The function must also return both arrays as the two outputs.

Hint: Start with the same file used for part 4 to calculate the velocity from the data log, then add the new equation and replace the graphs.

Deliverables:

Upload an electronic copy of the deliverables to Canvas per the lab submission requirements. Please note: **<u>ALL</u>** deliverables must be present in the single PDF report, and the m-file and the figure window must also be included as separate files with logical names.

- 3 m-files
- 2 figure windows from each of part 1, part 2, and part 3, using your selection of any 2 of the 7 data logs

Scoring:
10 points – Compliance with Submission Guidelines
30 points – Part 1
30 points – Part 2
30 points – Part 3