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% Question 1

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% Note:

% Insert your question 1 codes in this m-file. Hints and extra information

% are provided in this m-file as comments. The code to read image and

% create subplots are given below. Include your plotting code after each of

% the subplot() fucntion. Fill in your solutions where indicated by "...".

%% Part a

% ======

% Latitudinal Acceleration is the acceleration along the north-south/vertical axis.

% Longitudinal Acceleration is the acceleration along the east-west/horizontal axis.

% The Latitudinal Acceleration and Longitudinal Acceleration is measured with respect to the starting point of the track

%

% Lateral G is the acceleration created when a vehicle corners that tends to push a vehicle sideways.

% Accelerating/Braking G is associated to throttle input and brake input.

% The Lateral G and Accelerating/Braking G is measured with respect to the race car.

%% Import data from text file.

% Importing the race\_data file into matlab

filename = 'race\_data.dat';

% Opening the file in read only mode

file\_id = fopen(filename ,'r');

% Importing the data under corresponding variables

% time = race time

% A\_long = Longitudinal acceleration

% A\_lat = Latitudinal acceleration

% G\_ab = Forward acceleration and Braking acceleration

% G\_lat = Lateral G-force acceleration

values = importdata('race\_data.dat');

time=values.data(:,1);

A\_long=values.data(:,2) ;

A\_lat=values.data(:,3);

G\_ab=values.data(:,4) ;

G\_lat=values.data(:,5);

%% Plotting the graphs in one plot

% Creating a new figure window to subplot

figure

% Plotting time vs Longitudinal acceleration and holding on to the graph

plot(time,A\_long,'r-')

hold on

% Plotting time vs Latitudinal acceleration and holding on to the graph

plot(time,A\_lat,'b-')

hold on

% Plotting time vs Lateral G-force acceleration and holding on to the graph

plot(time,G\_lat,'k-')

hold on

% Plotting time vs Forward acceleration and Braking acceleration and holding on to the graph

plot(time,G\_ab,'g-')

hold on

% Labelling the x and y axis as time and acceleration

xlabel('time (s)');

ylabel('acceleration/G(m/s-2)');

% Adding a title to the plot

title('Acceleration vs Time Plot');

% Adding a legend to the plot

legend('Longitudinal Acceleration','Latitudinal Acceleration','Lateral G-force Acceleration','Forward and Braking G-force Acceleration','location','Northeast');

%% Verifying that the acceleration values are between -1.5 and 1.5

% Calculating the maximum and minimum Latitudinal acceleration

max\_A\_lat = max(A\_lat);

min\_A\_lat = min(A\_lat);

% Calculating the maximum and minimum Longitudinal acceleration

max\_A\_long = max(A\_long);

min\_A\_long = min(A\_long);

% Calculating the maximum and minimum Lateral G-force acceleration

max\_G\_lat = max(G\_lat);

min\_G\_lat = min(G\_lat);

% Calculating the maximum and minimum Forward acceleration and Braking acceleration

max\_G\_ab = max(G\_ab);

min\_G\_ab = min(G\_ab);

% Calculating the maximum and minimum time

time\_max = max(time);

time\_min = min(time);

% Using fprintf to output all the maximum and minimum values to the command window

fprintf('Q1a) The range of Latitudinal Acceleration is %g to %g \n',max\_A\_lat,min\_A\_lat)

fprintf(' The range of Longitudinal Acceleration is %g to %g \n',max\_A\_long,min\_A\_long)

fprintf(' The range of Lateral G-force Acceleration is %g to %g \n',max\_G\_lat,min\_G\_lat)

fprintf(' The range of Forward and Braking G-force Acceleration is %g to %g \n\n',max\_G\_ab,min\_G\_ab)

fprintf(' The range of Time is %g to %g \n',time\_min,time\_max)

% Verifying that all the acceleration values are between -1.5 to 1.5 and time is within the range 1 to 180

fprintf(' Therefore we can verify that all the accelerations are within the range 1.5 to -1.5 and the time is between 0 and 180\n\n')

% Pausing the command until key press before starting next part

pause

%% Part b

% ======

% Google map reference of The Glen : http://share.traqmate.com/tracks/united-states/new-york/watkins-glen-international-the-glen/5848#info

%% Intergrating the A\_lat and A\_long to get V\_lat and V\_long

V\_long = cumtrapz(A\_long);

V\_lat = cumtrapz(A\_lat);

%% Intergrating the A\_lat and A\_long to get V\_lat and V\_long

d\_lat = cumtrapz(V\_lat);

d\_long= cumtrapz(V\_long);

%% Plotting the map and the track image side by side

% Creating a new figure window to subplot

figure

% Subplot for google map track image

subplot(1,2,1)

% Importing the track\_map.pmng to mathlab

track = imread('track\_map.png');

% Displaying the image

imshow(track)

% Adding title for the image

title('Satellite image of "The Glen" from Google Maps');

% Subplot for the race car displacement

subplot(1,2,2)

% Plotting the Latitudinal distance vs Longitudinal distance

plot(d\_long,d\_lat)

%Labeling the axis and adding a title

xlabel('Longitudinal Distance (m)');

ylabel('Latitudinal Distance (m)');

title('Latitudinal Distance vs Longitudinal Distance');

% Pausing the command until key press before starting next part

pause

%% Part c

% ======

% The lateral Gs are above zero at left turning corners and

% are below zero at right turning corners. You are required to manually

% find a negative threshold value (increment of 0.1) where all points below this value

% identifies the right turning corners correctly. You are also required to

% find a positive threshold value (increment of 0.1) where all points above this value

% identifies the left turning corners correctly.

%% Sorting the left turning and right turning values and plotting the graph

% Creating a new figure window to subplot (\*\*\*Changing the default figure size so that all the data points can be seen clearly\*\*\*)

FigHandle = figure('position',[100,100,1049,895]);

% Subplot for lateral Gs

subplot(1,2,1)

% Turning thresholds

threshold\_lr = 0.2;

% Data rows (indices a.k.a. \_idx) that are outside the thresholds

% These contain data from the time when the vehicle is turning

% Plot everything

% Using a for loop to plot the graph

for i = 1:length(G\_lat)

if (G\_lat(i)> threshold\_lr)

plot(time(i),G\_lat(i),'b.') % Plotting the values greater than the threshiold value as blue dots

hold on % Holding on to the graph

else if(G\_lat(i) < -threshold\_lr)

plot(time(i),G\_lat(i),'y.') % Plotting the values less than the threshiold value as yellow dots

hold on % Holding on to the graph

end

end

end

%Labeling the axis and adding a title

xlabel('Time (s)');

ylabel('Lateral G-force Acceleration (ms-2)');

title('Time vs Lateral G-force Acceleration');

%Adding a legend

lege = zeros(2,1);

lege(1) = plot(NaN,NaN,'b.','markersize',25);

lege(2) = plot(NaN,NaN,'y.','markersize',25);

legend(lege,'Left Turns','Right Turns');

% Turning on the grid

grid on

%% Plotting the left and right turns on the race track

% Subplot for left and right turns on the race track

subplot(1,2,2);

% Plot race track as in Part (b) earlier

% Plotting the race track line in a black solid line

plot(d\_long,d\_lat,'k-')

% Holding on to the previous graph

hold on;

% Only plot left and right turn displacements using the \_idx variables

% Also setting markers

% Using a for loop to plot the points on the track

for i = 1:length(G\_lat)

if (G\_lat(i)> threshold\_lr)

plot(d\_long(i),d\_lat(i),'b.','markersize',25) % Plotting the values as blue 25 markersize dots

hold on % Holding on to the graph

else if(G\_lat(i) < -threshold\_lr)

plot(d\_long(i),d\_lat(i),'y.','markersize',25)% Plotting the values as yellow 25 markersize dots

hold on % Holding on to the graph

end

end

end

%Adding a legend

lege = zeros(3,1);

lege(1) = plot(NaN,NaN,'k-');

lege(2) = plot(NaN,NaN,'b.','markersize',25);

lege(3) = plot(NaN,NaN,'y.','markersize',25);

legend(lege,'Race Track','Left Turns','Right Turns');

hold off; % Release plot

%Labeling the axis and adding a title

xlabel('Longitudinal Distance (m)');

ylabel('Latitudinal Distance (m)');

title('Left and Right Turning Points');

% Printing thresholds

% Diplaying the threshold values used in determining the left and right turns

fprintf('Q1c) The Threshold use to find the turns are %g and %g\n',-threshold\_lr,threshold\_lr)

% Pausing the command until key press before starting next part

pause

%% Part d

% ======

% The accelerating/braking Gs are above zero when braking and are below

% zero when accelerating. You are required to manually find a negative

% threshold value (increment of 0.1) where all points below this value identifies the braking

% zones correctly. You are also required to find a positive threshold value (increment of 0.1)

% where all points above this value identifies the accelerating zones correctly.

% You may verify your threshold values from the velovities graph. Note that

% velocity increases when accelerating and decreases when braking.

%% Sorting the acceleration and braking points and plotting the graph

% Creating a new figure window to subplot (\*\*\*Changing the default figure size so that all the data points can be seen clearly\*\*\*)

FigHandle = figure('position',[100,100,1049,895]);

% Subplot for accelerating/braking Gs

subplot(2,2,1)

% Considered thresholds

threshold\_ab = 0.1;

% Plot everything

% Using a for loop to plot the graph

for i = 1:length(G\_ab)

if (G\_ab(i)> threshold\_ab)

plot(time(i),G\_ab(i),'r.') % Plotting the values as red dots

hold on % Holding on to the graph

else if(G\_ab(i) < -threshold\_ab)

plot(time(i),G\_ab(i),'g.') % Plotting the values as green dots

hold on % Holding on to the graph

end

end

end

%Labeling the axis and adding a title

xlabel('Time (s)');

ylabel('G-force Acceleration (ms-2)');

title('Time vs G-force Acceleration');

%Adding a legend

lege = zeros(2,1);

lege(1) = plot(NaN,NaN,'r.','markersize',25);

lege(2) = plot(NaN,NaN,'g.','markersize',25);

legend(lege,'Braking points','Accelarating points');

% Printing thresholds

fprintf('Q1d) The Threshold use to find the accelerating and braking are %g and %g\n\n',-threshold\_ab,threshold\_ab)

%% Plotting the velocity vs time graph

% Subplot for race car velocity

subplot(2,2,3)

% Velocities

% Calculating the Velocity of the race car

v = abs(sqrt((V\_long).^2+(V\_lat).^2));

% Plotting the velocity of the race car

plot(time,v);

% Turning on the grid

grid on

%Labeling the axis and adding a title

xlabel('Time(s)');

ylabel('Velocity (ms-1)');

title('Velocity vs Time');

%% Plotting the race track and all the left, right, forward and braking points

% Subplot for acccelerating and braking zones on the race track

subplot(2,2,[2,4])

% Plot race track as in Part (b) earlier

% Plotting the race track line in a black solid line

plot(d\_long,d\_lat,'k-')

% Holding on to the previous graph

hold on;

% Turns

% Plotting the turns on the black solid race track line

for i = 1:length(G\_lat)

if (G\_lat(i)> threshold\_lr)

plot(d\_long(i),d\_lat(i),'b.','markersize',25) % Plotting the values as blue 25 markersize dots

hold on % Holding on to the graph

else if(G\_lat(i) < -threshold\_lr)

plot(d\_long(i),d\_lat(i),'y.','markersize',25) % Plotting the values as yellow 25 markersize dots

hold on % Holding on to the graph

end

end

end

% Accel/Brake

% Plotting the accelaration and braking graph

for i = 1:length(G\_ab)

if (G\_ab(i)> threshold\_ab)

plot(d\_long(i),d\_lat(i),'r.') % Plotting the values as red dots

hold on % Holding on to the graph

else if(G\_ab(i) < -threshold\_ab)

plot(d\_long(i),d\_lat(i),'g.') % Plotting the values as green dots

hold on % Holding on to the graph

end

end

end

%Adding a legend

lege = zeros(5,1);

lege(1) = plot(NaN,NaN,'k-');

lege(2) = plot(NaN,NaN,'b.','markersize',25);

lege(3) = plot(NaN,NaN,'y.','markersize',25);

lege(4) = plot(NaN,NaN,'r.','markersize',25);

lege(5) = plot(NaN,NaN,'g.','markersize',25);

legend(lege,'Race Track','Left Turns','Right Turns','Braking Points','Accelarating Points');

hold off; % Release plot

%Labeling the axis and adding a title

xlabel('Longitudinal Distance (m)');

ylabel('Latitudinal Distance (m)');

title('Left, Right, Forward & Braking Points');