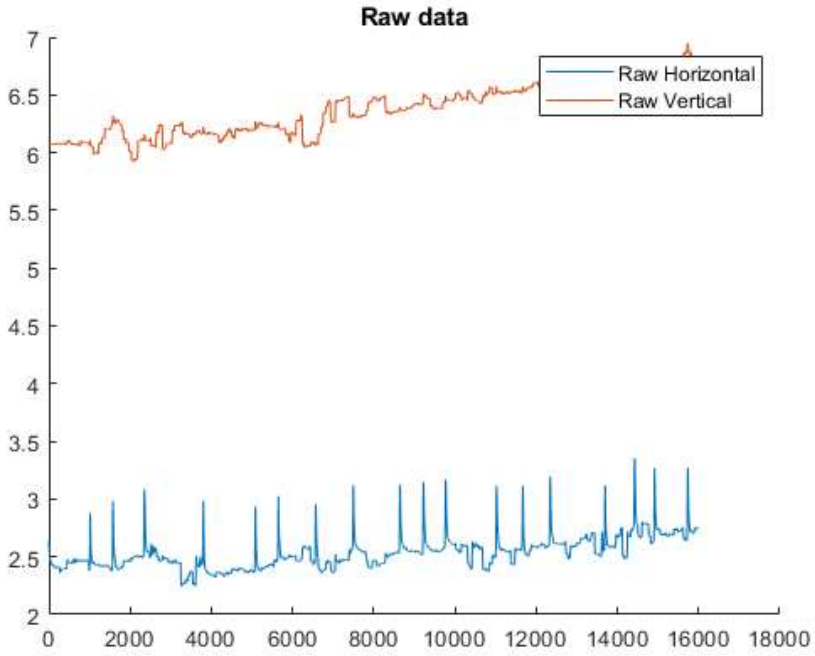
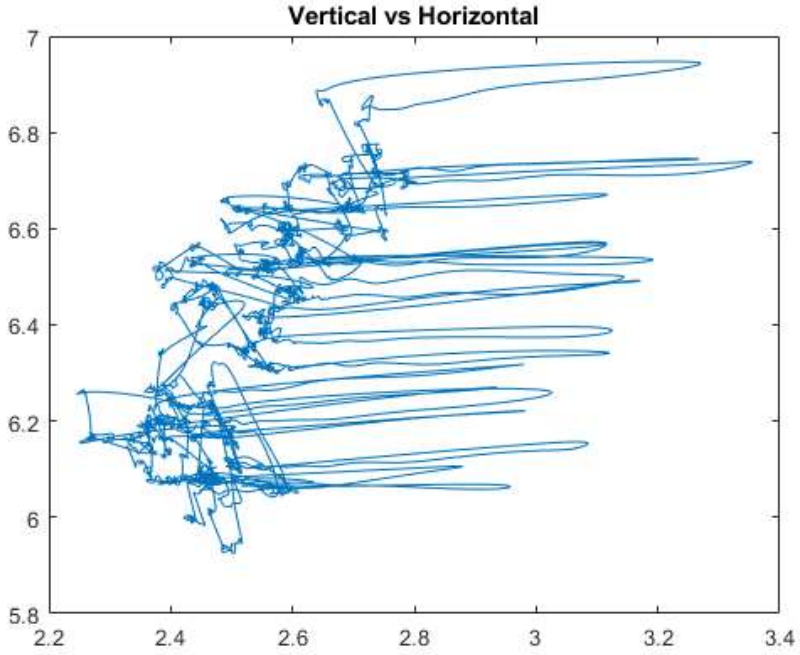
Contents


```
clc
clear all
close all
```

Load and display data

```
load('D:\University\Khaje\Semester 1\کنترل سیستم های عصبی عضلانی\Assignment 3\data.mat')

Raw_Horizontal = data.B;
Raw_Vertical = data.A;

figure(1)
hold on
plot(1:length(Raw_Horizontal) , Raw_Horizontal);
plot(1:length(Raw_Vertical) , Raw_Vertical);
title('Raw data')
legend('Raw Horizontal', 'Raw Vertical')

figure(2)
plot(Raw_Horizontal , Raw_Vertical)
title('Vertical vs Horizontal')
```

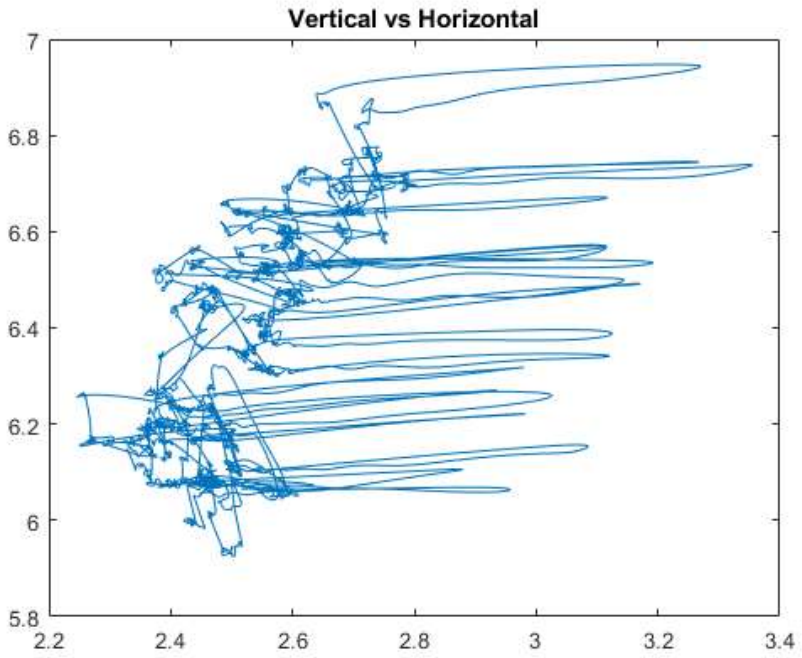


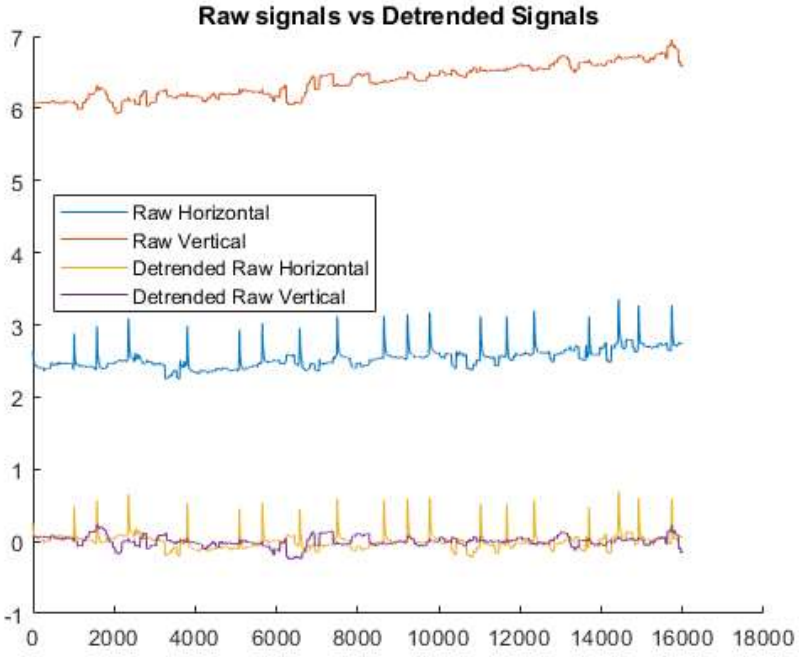


Detrend data and plot Signals

Question 1

```
Detrended_Raw_Horizontal = detrend(Raw_Horizontal);
Detrended_Raw_Vertical = detrend(Raw_Vertical);

figure(3)
title('Raw signals vs Detrended Signals')
hold on
plot(1:length(Raw_Horizontal) , Raw_Horizontal);
plot(1:length(Raw_Vertical) , Raw_Vertical);
plot(1:length(Detrended_Raw_Horizontal) , Detrended_Raw_Horizontal);
plot(1:length(Detrended_Raw_Vertical), Detrended_Raw_Vertical);
legend('Raw Horizontal', 'Raw Vertical' , 'Detrended Raw Horizontal' ,'Detrended Raw Vertical' , 'Location','best')
```





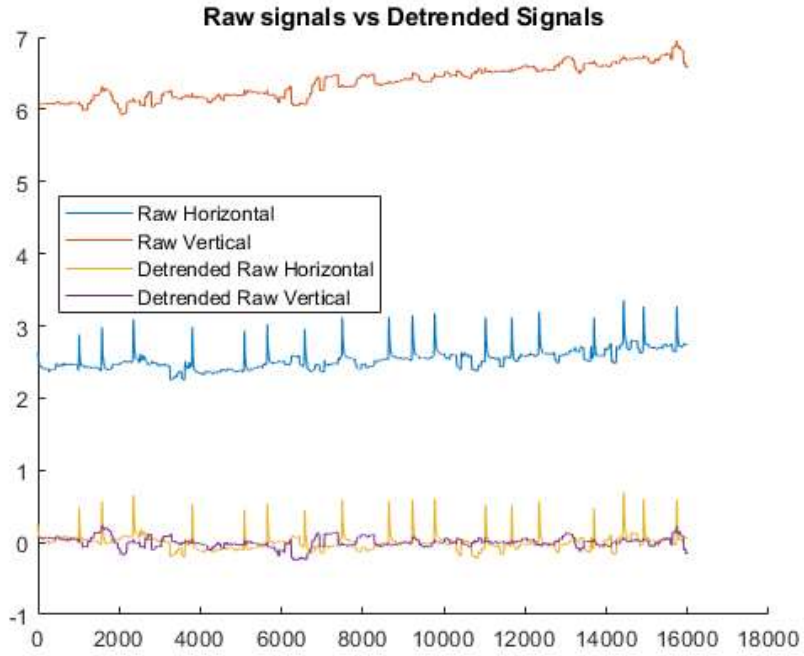
Finding Blink,Fixation and Saccade

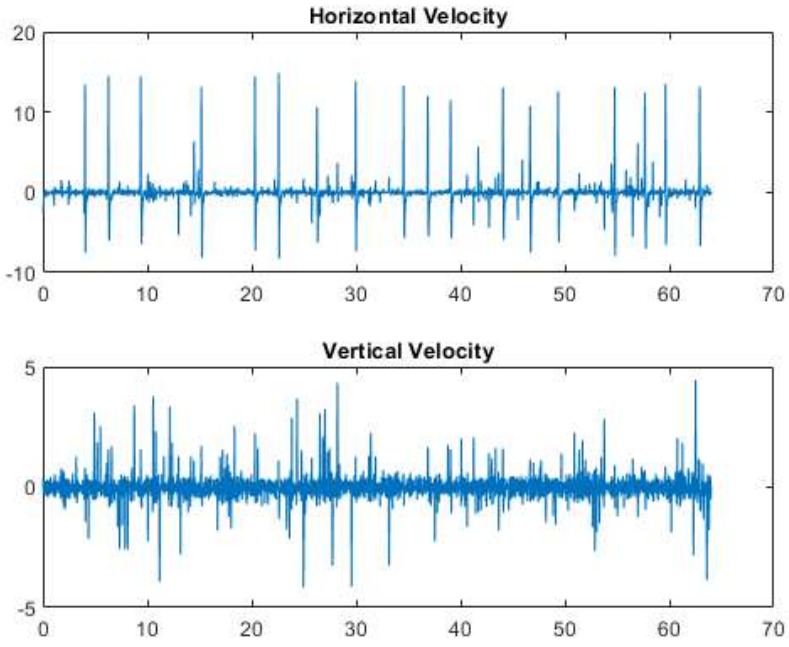
Question 2

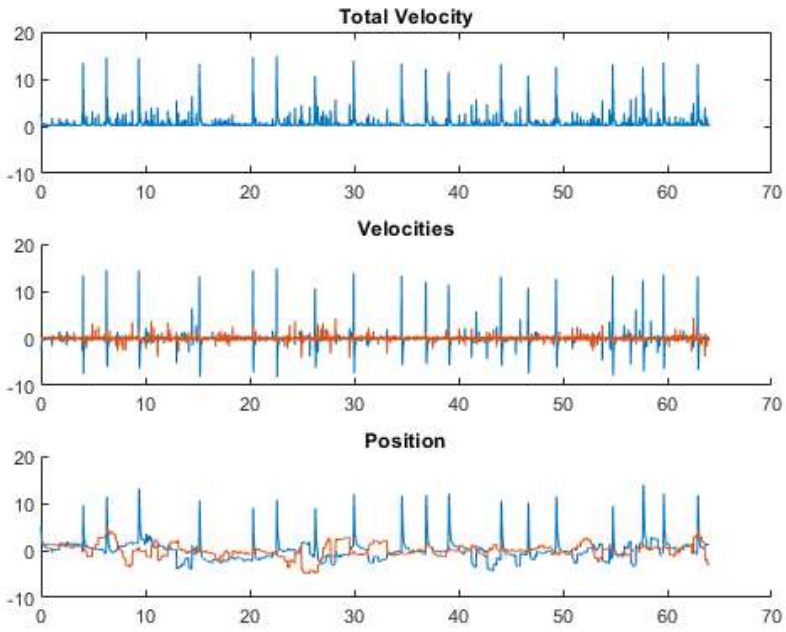
```
%assuming sample rate is 250 Hz
time = (1:length(Raw_Horizontal))/250;
velH = diff(Detrended_Raw_Horizontal)./diff(time);
velV = diff(Detrended_Raw_Vertical)./diff(time);
figure(4)
subplot(2,1,1)
plot(time , [velH , 0])
title('Horizontal Velocity')
subplot(2,1,2)
plot(time , [velV , 0])
title('Vertical Velocity')
```

```
Velocity = sqrt(velH.^2 + velV.^2);
figure(5)
axe1 = subplot(3,1,1)

plot(time , [Velocity , 0])
title('Total Velocity')
axe2 = subplot(3,1,2)
title('Velocities')
hold on
plot(time , [velH , 0])
plot(time , [velV , 0])

axe3 = subplot(3,1,3)
title('Position')
hold on
plot(time , Detrended_Raw_Horizontal*20);
plot(time, Detrended_Raw_Vertical*20);
% plot(velV,velH)
linkaxes([axe1 , axe2 , axe3])
```

```
axe1 =

  Axes with properties:

            XLim: [0 1]
            YLim: [0 1]
          XScale: 'linear'
          YScale: 'linear'
    GridLineStyle: '-'
         Position: [0.1300 0.7093 0.7750 0.2157]
            Units: 'normalized'

  Use GET to show all properties


axe2 =

  Axes with properties:

            XLim: [0 1]
            YLim: [0 1]
          XScale: 'linear'
          YScale: 'linear'
    GridLineStyle: '-'
         Position: [0.1300 0.4096 0.7750 0.2157]
            Units: 'normalized'

  Use GET to show all properties


axe3 =

  Axes with properties:

            XLim: [0 1]
            YLim: [0 1]
          XScale: 'linear'
          YScale: 'linear'
    GridLineStyle: '-'
         Position: [0.1300 0.1100 0.7750 0.2157]
            Units: 'normalized'

  Use GET to show all properties
```


Raw signals vs Detrended Signals
Raw Horizontal
Raw Vertical
Detrended Raw Horizontal
Detrended Raw Vertical
7
6
5
4
3
2
1
0
-1
0
2000
4000
6000
8000
10000
12000
14000
16000
18000


Horizontal Velocity
20
10
0
-10
0
10
20
30
40
50
60
70
Vertical Velocity
5
0
-5
0
10
20
30
40
50
60
70

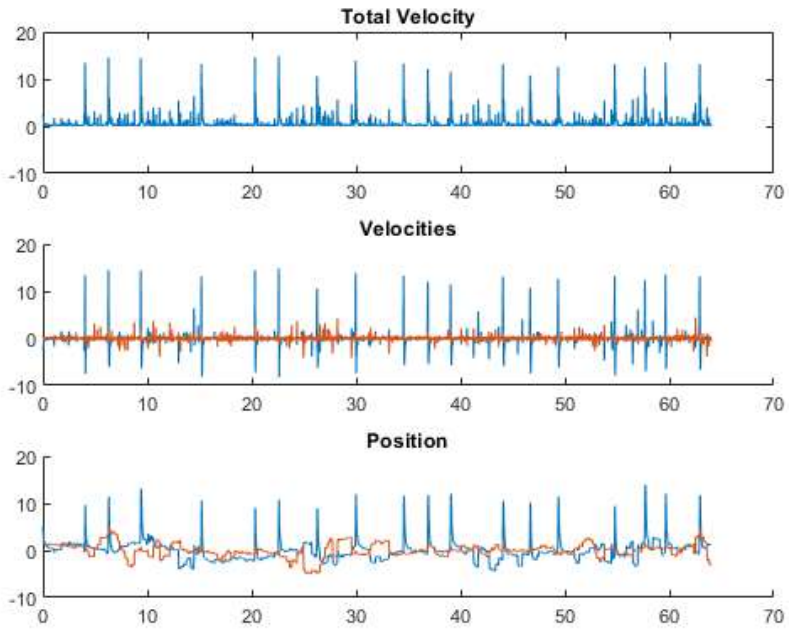


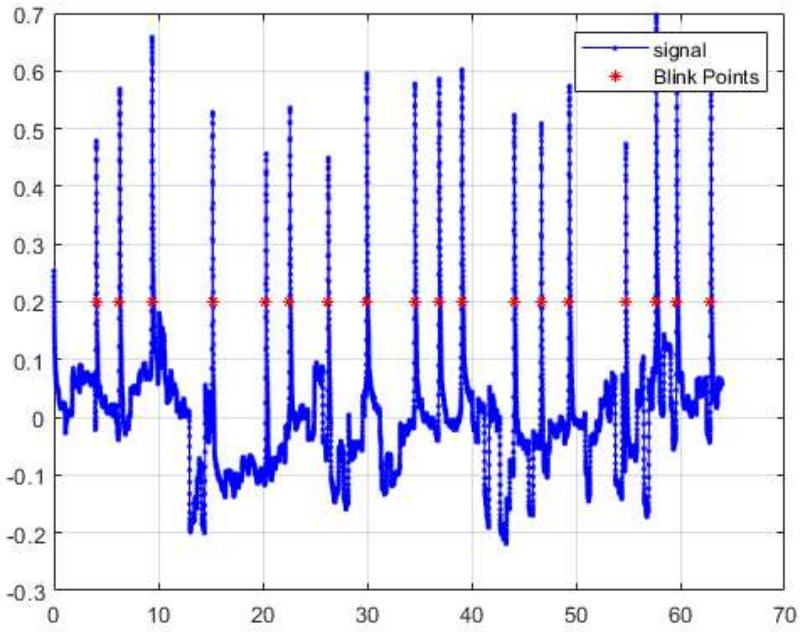
Calculating Blink,Fixation and Saccade frequency

Question 3 Frequency of Blinking

```
Blink_threshold = 0.2;
Blinks = find_zc(time, Detrended_Raw_Horizontal, Blink_threshold);
Blink_Frequency = numel(Blinks)/time(16001)
figure(6)
plot(time, Detrended_Raw_Horizontal, 'b.-', Blinks, Blink_threshold*ones(size(Blinks)), '*r', 'linewidth', 0.5, 'markersize', 5);
grid on
legend('signal', 'Blink Points');
```

```
Blink_Frequency =

    0.2812
```



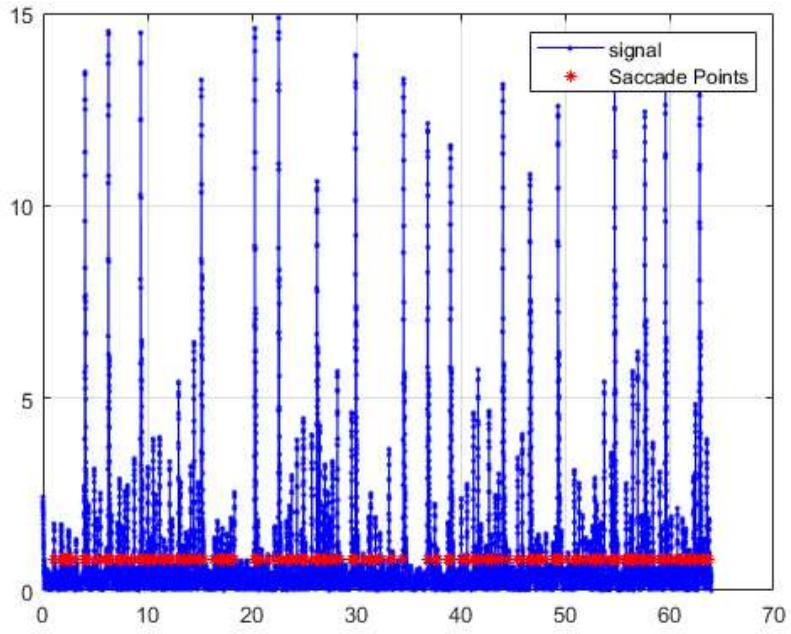


Frequency of Saccade

```
Saccade_threshold = 0.8;
Saccades = find_zc(time, [Velocity,0], Saccade_threshold);
Saccade_Frequency = (numel(Saccades)-(numel(Blinks) * 2))/time(16001)

figure(7)
plot(time, [Velocity,0], 'b.-', Saccades, Saccade_threshold*ones(size(Saccades)), '*r', 'linewidth', 0.5, 'markersize', 5);
grid on
legend('signal', 'Saccade Points');
```

```
Saccade_Frequency =
```

```
    2.8436
```




```
%Frequency of Fixation
Fixation_Frequency = (numel(Saccades)-numel(Blinks)+1)/time(16001)

% function to find zero crossings
function [Zx] = find_zc(x, y, threshold)
    y = y - threshold;
    zci = @(data) find(diff(sign(data)) > 0); % function: returns indices of +ZCs
    ix = zci(y); % find indices of + zero crossings of x
    ZeroX = @(x0, y0, x1, y1) x0 - (y0.*(x0 - x1))./(y0 - y1); % Interpolated x value for Zero-Crossing
    Zx = ZeroX(x(ix), y(ix), x(ix+1), y(ix+1));
end
```

```
Fixation_Frequency =

    3.1404
```

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