Matlab Script for Sensor Data Analysis

The following script is used for plotting and refining the parts of datasets that we have chosen for representing the movements of the wrist in correspondence with two different sections of the track, in particular a straight and a curve.

Contents

For loop to analize in a sequence the selected experimental data sets

We only have considered 9 files of the overall provided beacause we chose only the most regular tracks.

```
files = dir('*.mat');
for file = files'
```

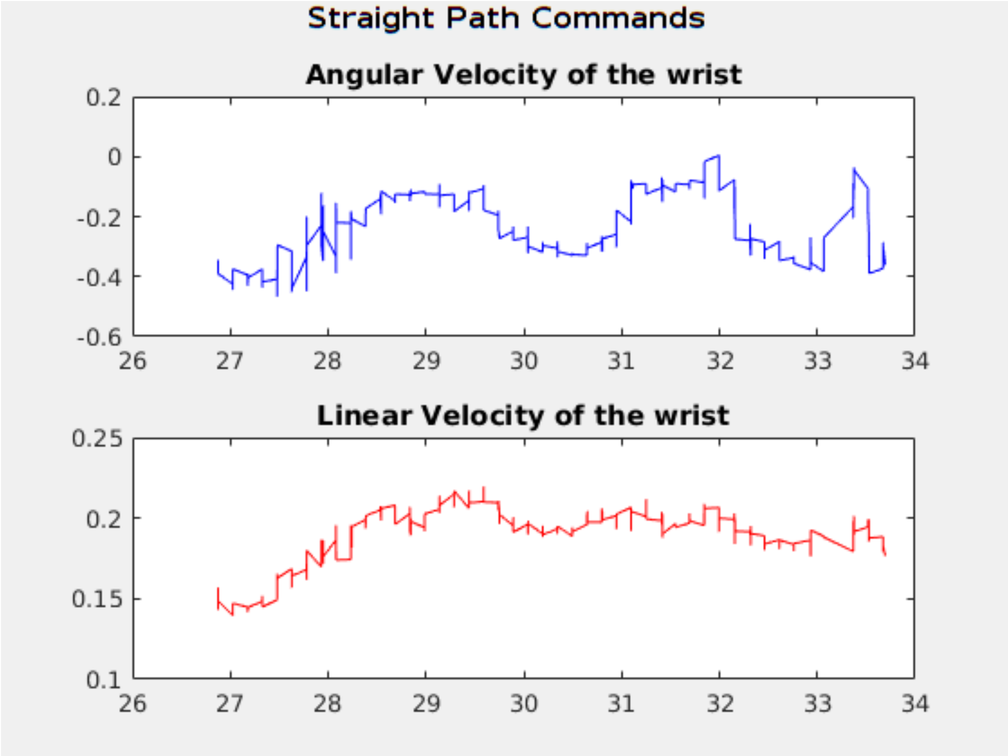
```
    filename = load(file.name);
```

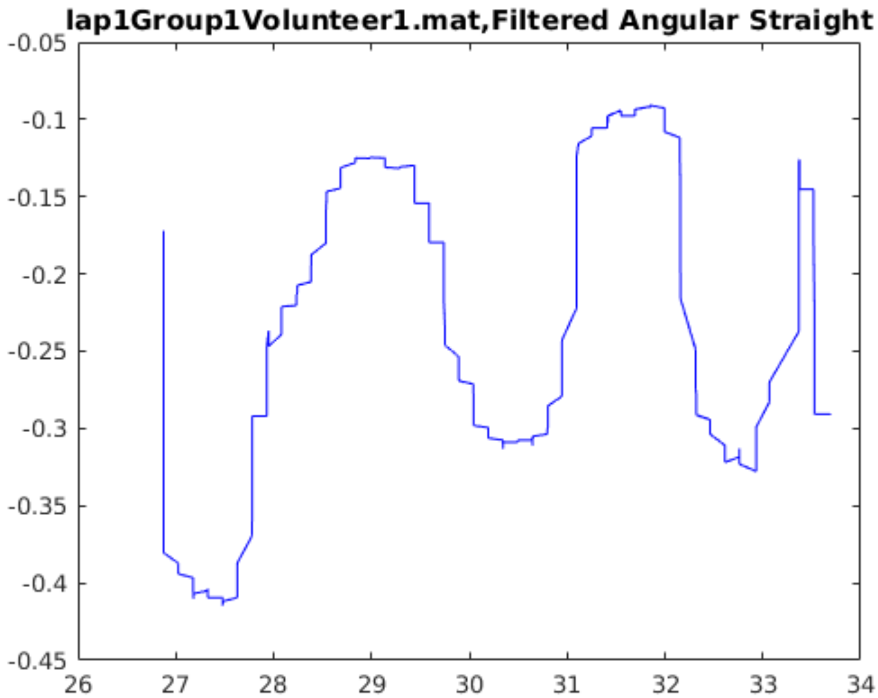
Plots of the behaviour of the driver's wrist in different conditions of motion

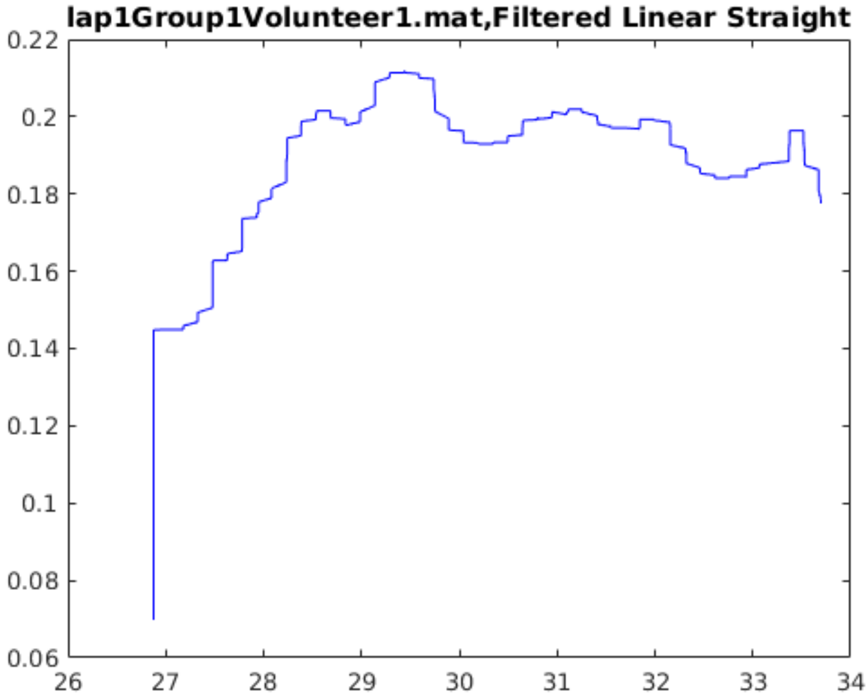
Now we are evaluating the time range in which the robot is moving along an approximate straight line and in this range we provide plots of the motions registered from the smartwatch. This loop is used to save into arrays, for each data structure, the Linear and Angular velocities for different parts of the track.

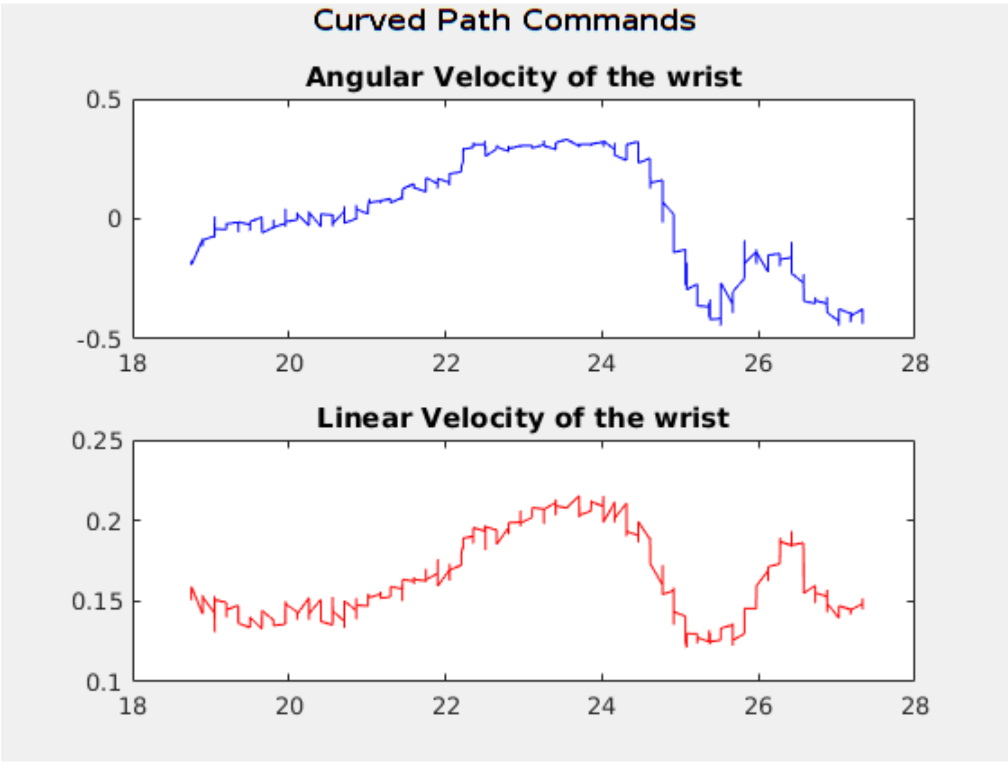
```
time_rettilineo = zeros(300,1);
a_vel_z_rettilineo = zeros(300,1);
l_vel_x_rettilineo = zeros(300,1);
for i = 1:1:300 % This is the approximate range of values which define a straight path
   time_rettilineo(i) = filename.dataCommand.time(1075+i);
   a_vel_z_rettilineo(i) = filename.dataCommand.a_vel_z(1075+i);
   l_vel_x_rettilineo(i) = filename.dataCommand.l_vel_x(1075+i);
end

f = figure;
p = uipanel('Parent',f,'BorderType','none');
p.Title = 'Straight Path Commands';
p.TitlePosition = 'centertop';
p.FontSize = 12;
p.FontWeight = 'bold';
sub1 = subplot(2,1,1,'Parent',p);
plot(sub1,time_rettilineo,a_vel_z_rettilineo,'color','b','DisplayName','AngVel_Z_rettilineo');
title('Angular Velocity of the wrist');
sub2 = subplot(2,1,2,'Parent',p);
plot(sub2,time_rettilineo,l_vel_x_rettilineo,'color','r','DisplayName','LinVel_X_rettilineo');
title('Linear Velocity of the wrist');

% Here we are using a Median Filter to cut off undesidered values from the
% plots
figure
a_vel_z_filtered = medfilt1(a_vel_z_rettilineo,20);
plot(time_rettilineo,a_vel_z_filtered,'color','b','DisplayName','AngVel_Z_filtered');
title(strcat(file.name,',Filtered Angular Straight'))
figure
l_vel_x_filtered = medfilt1(l_vel_x_rettilineo,20);
```

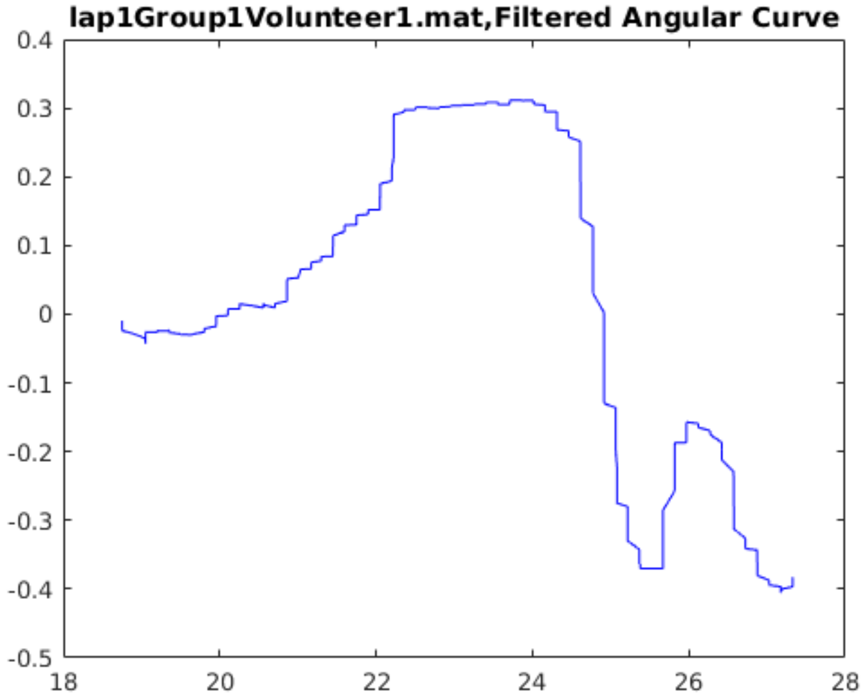
```
plot(time_rettilineo,l_vel_x_filtered,'color','b','DisplayName','LinVel_X_filtered');
title(strcat(file.name,',Filtered Linear Straight'))

% Now we evaluate Smartwatch Data on a curve instead of a straight motion
% This loop is used to save into arrays, for each data structure,
% the Linear and Angular velocities for different parts of the track.
% We took as example the range for the very first track, 'lap1_group1
% volunteer_1'.
% To evaluate together all .mat files, we had to find two 'common ranges'
% which approximately contain for each file a STRAIGHT section and a CURVE
% section.
time_curve = zeros(350,1);
a_vel_z_curve = zeros(350,1);
l_vel_x_curve = zeros(350,1);
for i = 1:1:350 % This is the approximate range of values which define a straight path
   time_curve(i) = filename.dataCommand.time(750+i);
   a_vel_z_curve(i) = filename.dataCommand.a_vel_z(750+i);
   l_vel_x_curve(i) = filename.dataCommand.l_vel_x(750+i);
end

f = figure;
p = uipanel('Parent',f,'BorderType','none');
p.Title = 'Curved Path Commands';
p.TitlePosition = 'centertop';
p.FontSize = 12;
p.FontWeight = 'bold';
sub1 = subplot(2,1,1,'Parent',p);
plot(sub1,time_curve,a_vel_z_curve,'color','b','DisplayName','AngVel_Z_curve');
title('Angular Velocity of the wrist');
sub2 = subplot(2,1,2,'Parent',p);
plot(sub2,time_curve,l_vel_x_curve,'color','r','DisplayName','LinVel_X_curve');
title('Linear Velocity of the wrist');

% Here we are using a Median Filter to cut off undesidered values from the
% plots
figure
a_vel_z_filtered = medfilt1(a_vel_z_curve,20);
plot(time_curve,a_vel_z_filtered,'color','b','DisplayName','AngAcc_Z_filtered');
title(strcat(file.name,',Filtered Angular Curve'))
figure
l_vel_x_filtered = medfilt1(l_vel_x_curve,20);
plot(time_curve,l_vel_x_filtered,'color','b','DisplayName','LinAcc_X_filtered');
title(strcat(file.name,',Filtered Linear Curve'))
```

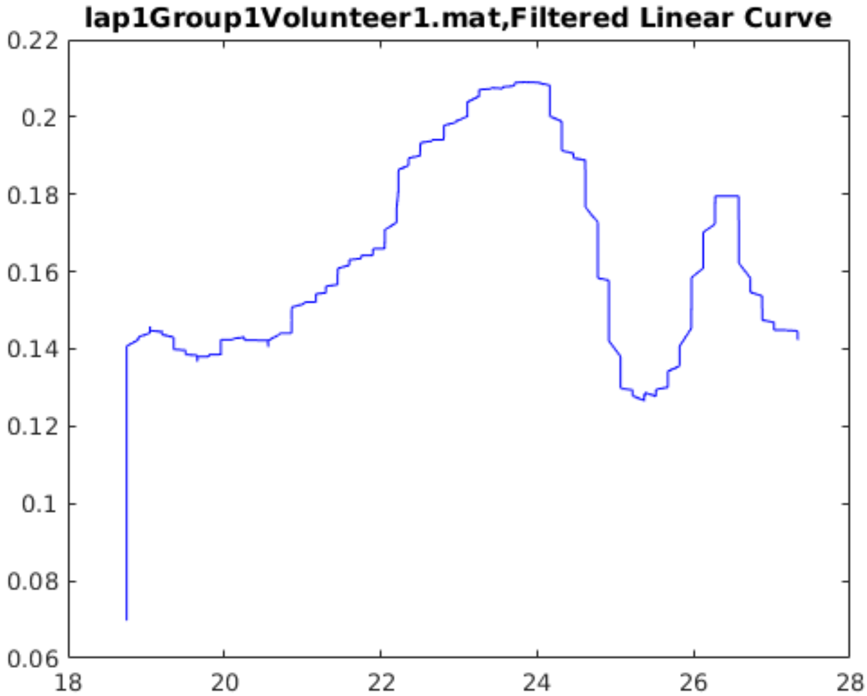

Straight Path Commands
Angular Velocity of the wrist
Linear Velocity of the wrist
0.2
0
-0.2
-0.4
-0.6
26
27
28
29
30
31
32
33
34
0.25
0.2
0.15
0.1

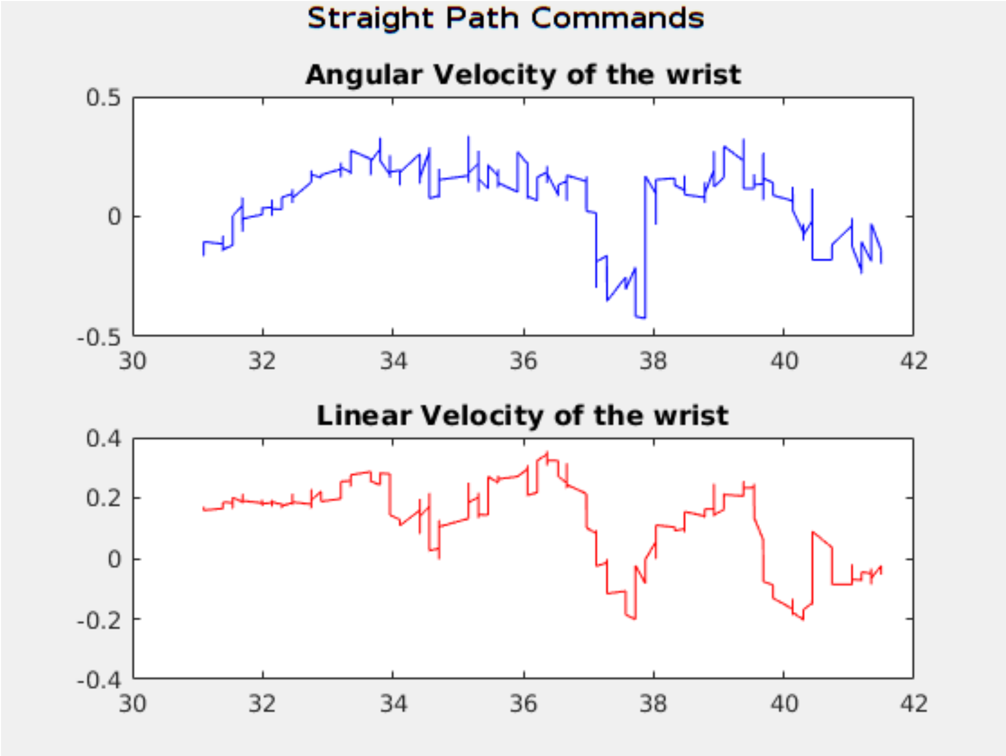

lap1Group1Volunteer1.mat,Filtered Angular Straight
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
-0.4
-0.45
26
27
28
29
30
31
32
33
34

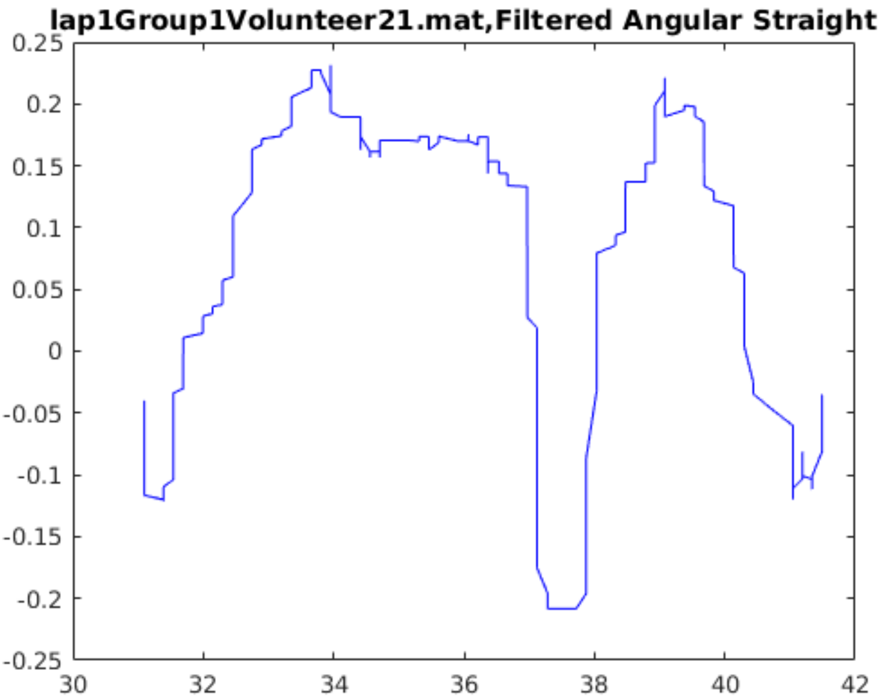

lap1Group1Volunteer1.mat,Filtered Linear Straight
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
26
27
28
29
30
31
32
33
34

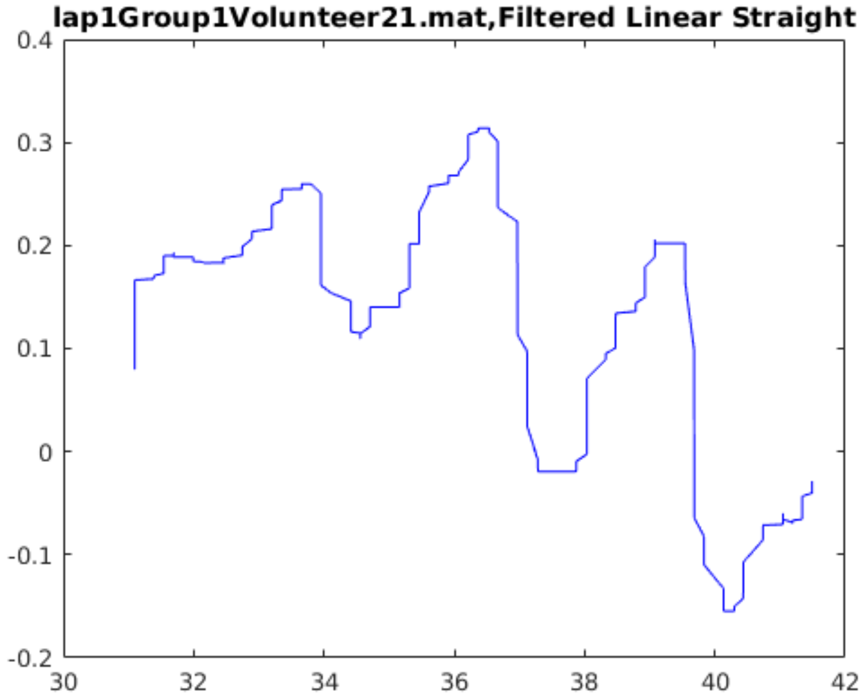

Curved Path Commands
Angular Velocity of the wrist
0.5
0
-0.5
18
20
22
24
26
28
Linear Velocity of the wrist
0.25
0.2
0.15
0.1
18
20
22
24
26
28

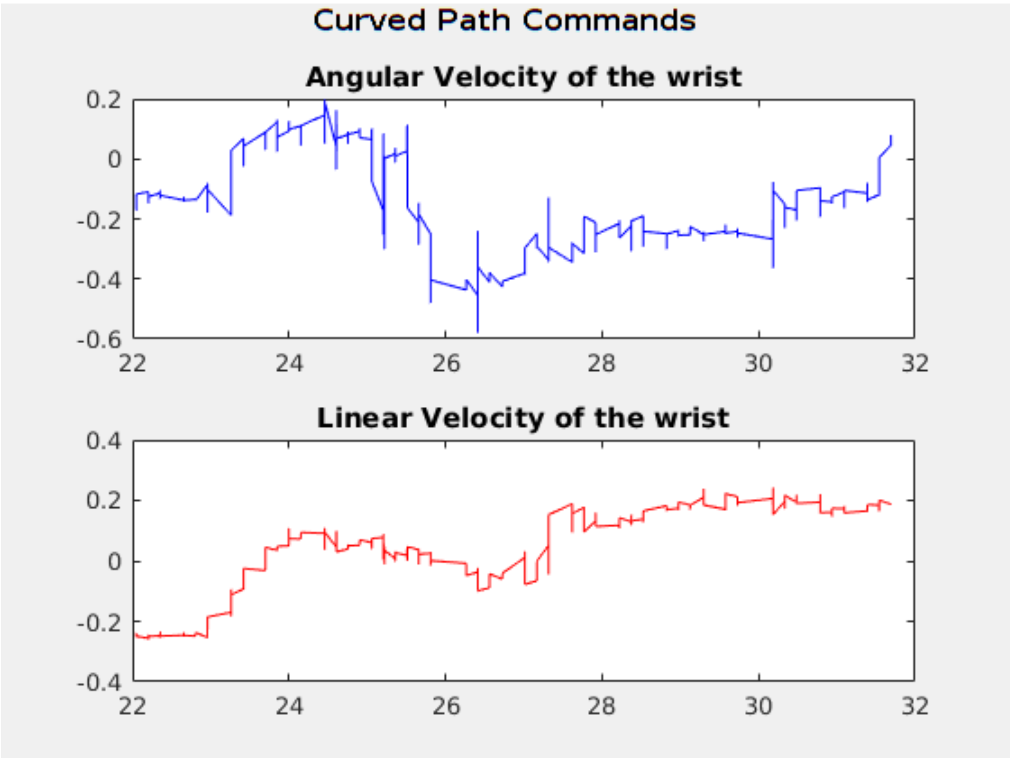

lap1Group1Volunteer1.mat,Filtered Angular Curve
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
18
20
22
24
26
28

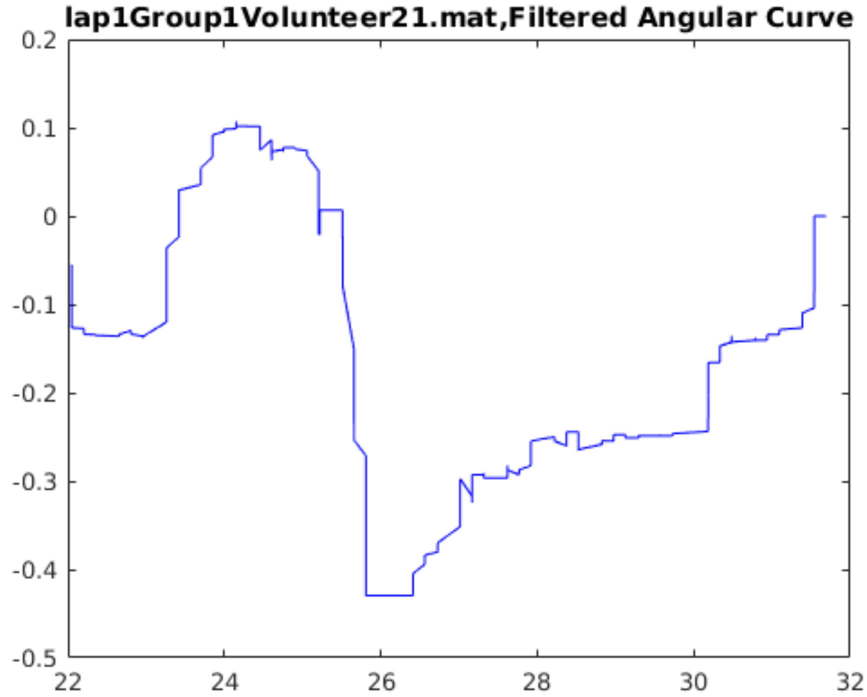

lap1Group1Volunteer1.mat,Filtered Linear Curve
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
18
20
22
24
26
28

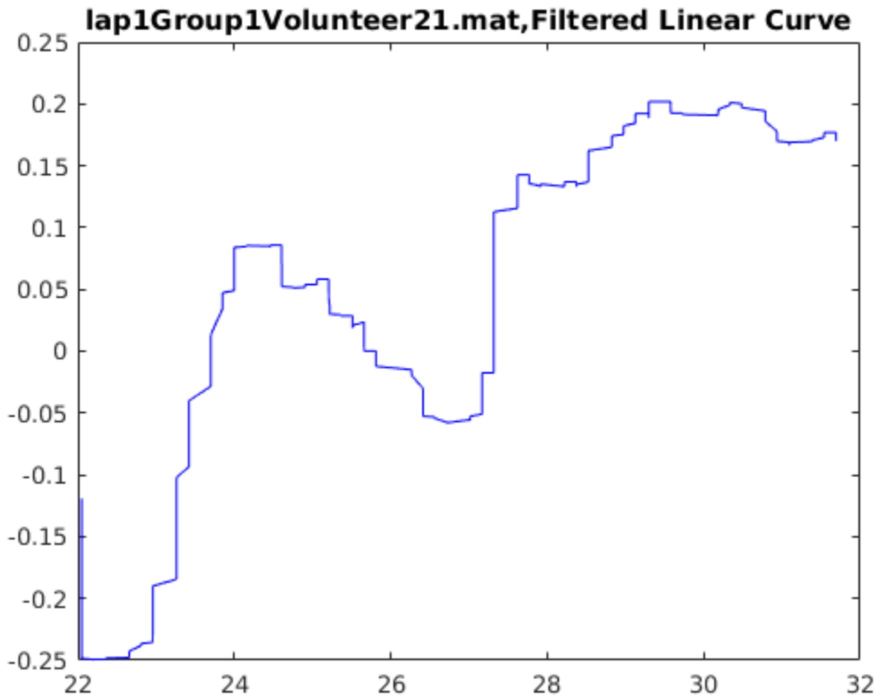

Straight Path Commands
Angular Velocity of the wrist
Linear Velocity of the wrist

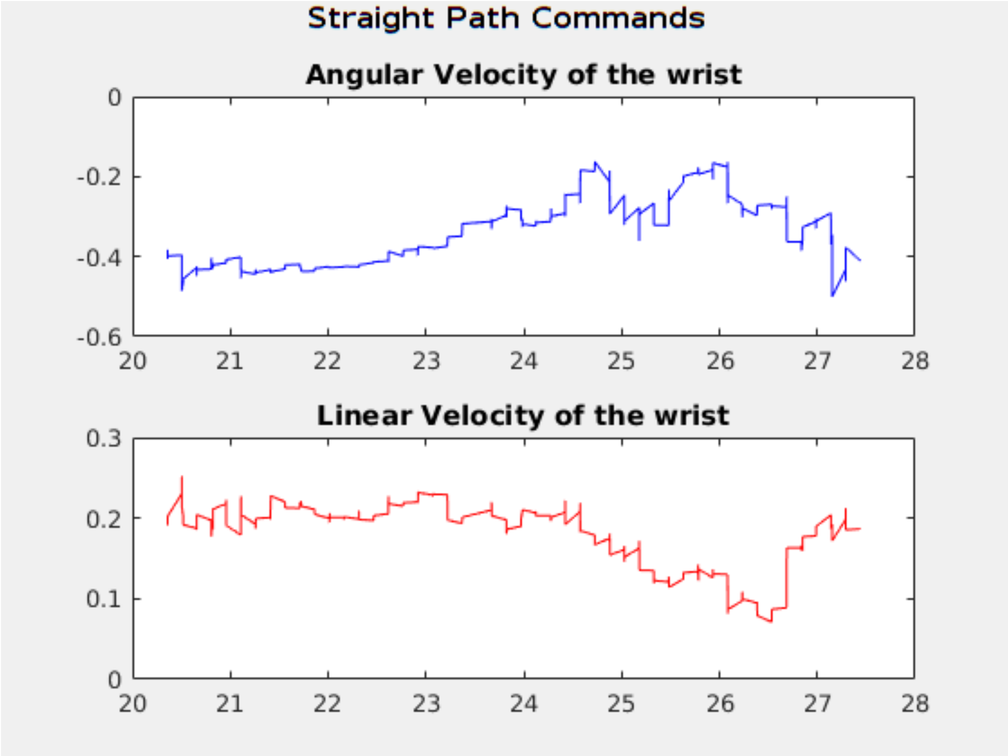

lap1Group1Volunteer21.mat,Filtered Angular Straight

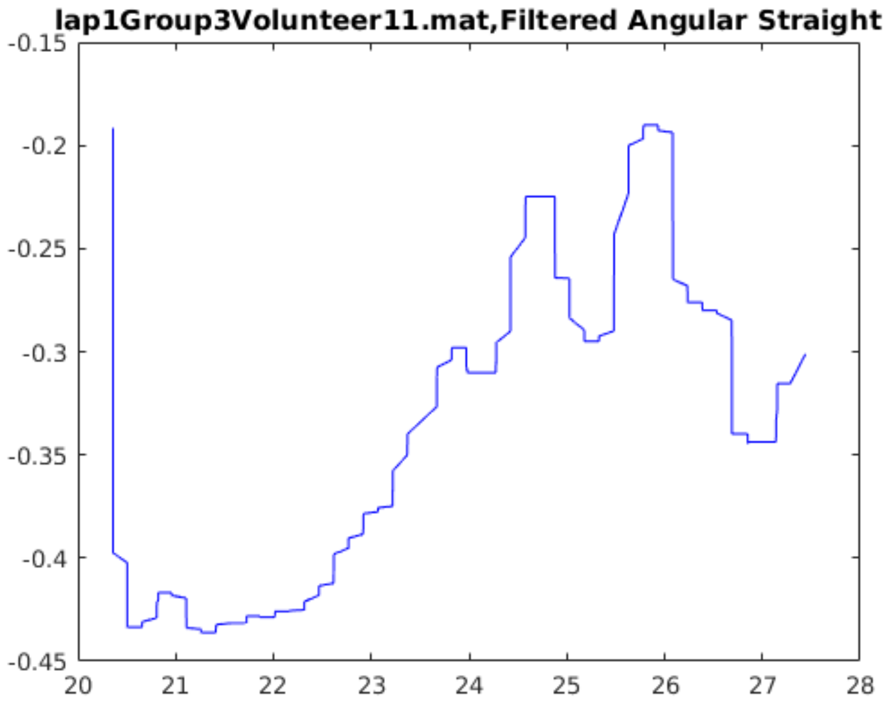

lap1Group1Volunteer21.mat,Filtered Linear Straight
0.4
0.3
0.2
0.1
0
-0.1
-0.2
30
32
34
36
38
40
42

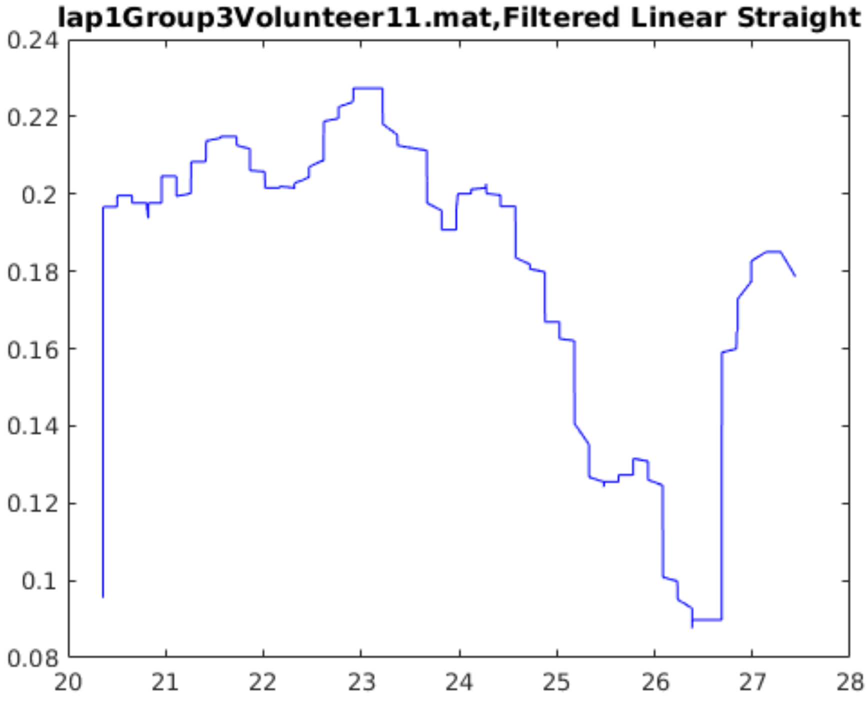

Curved Path Commands
Angular Velocity of the wrist
0.2
0
-0.2
-0.4
-0.6
22
24
26
28
30
32
Linear Velocity of the wrist
0.4
0.2
0
-0.2
-0.4
22
24
26
28
30
32

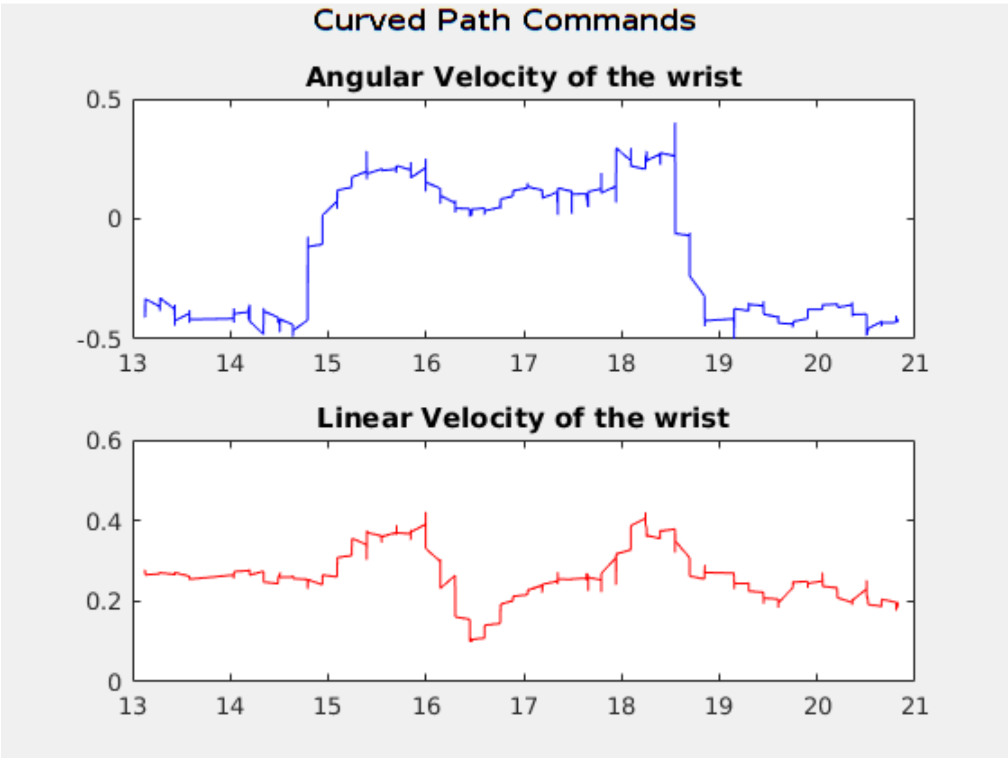

lap1Group1Volunteer21.mat,Filtered Angular Curve
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
22
24
26
28
30
32

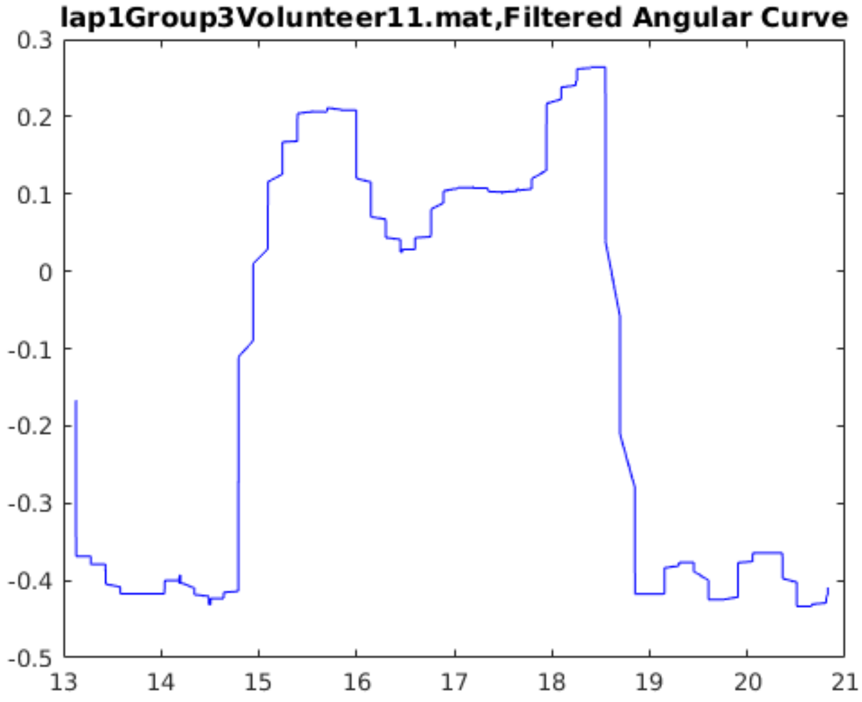

lap1Group1Volunteer21.mat,Filtered Linear Curve
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
22
24
26
28
30
32

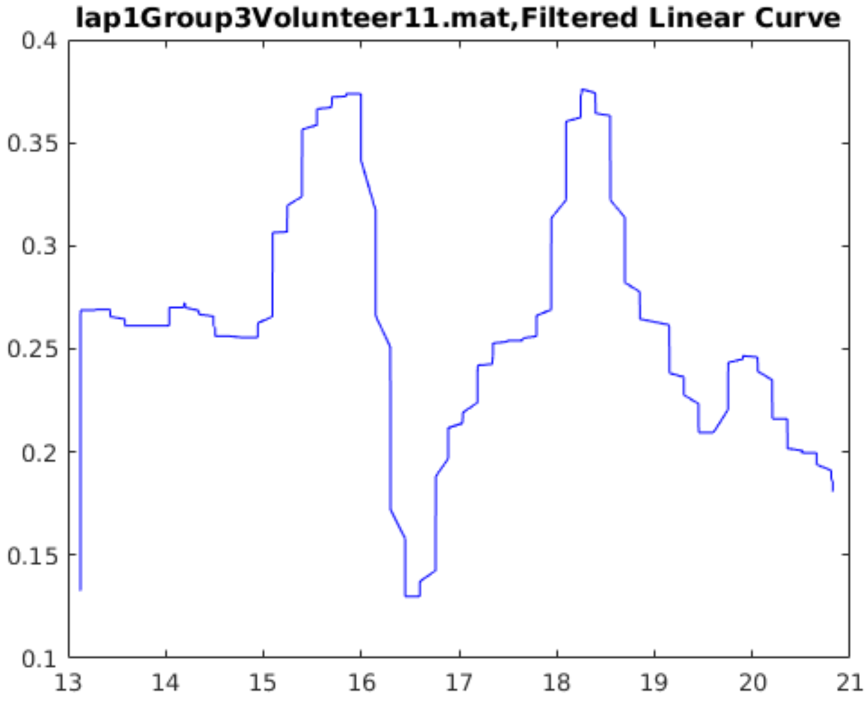

Straight Path Commands
Angular Velocity of the wrist
0
-0.2
-0.4
-0.6
20
21
22
23
24
25
26
27
28
Linear Velocity of the wrist
0.3
0.2
0.1
0
20
21
22
23
24
25
26
27
28

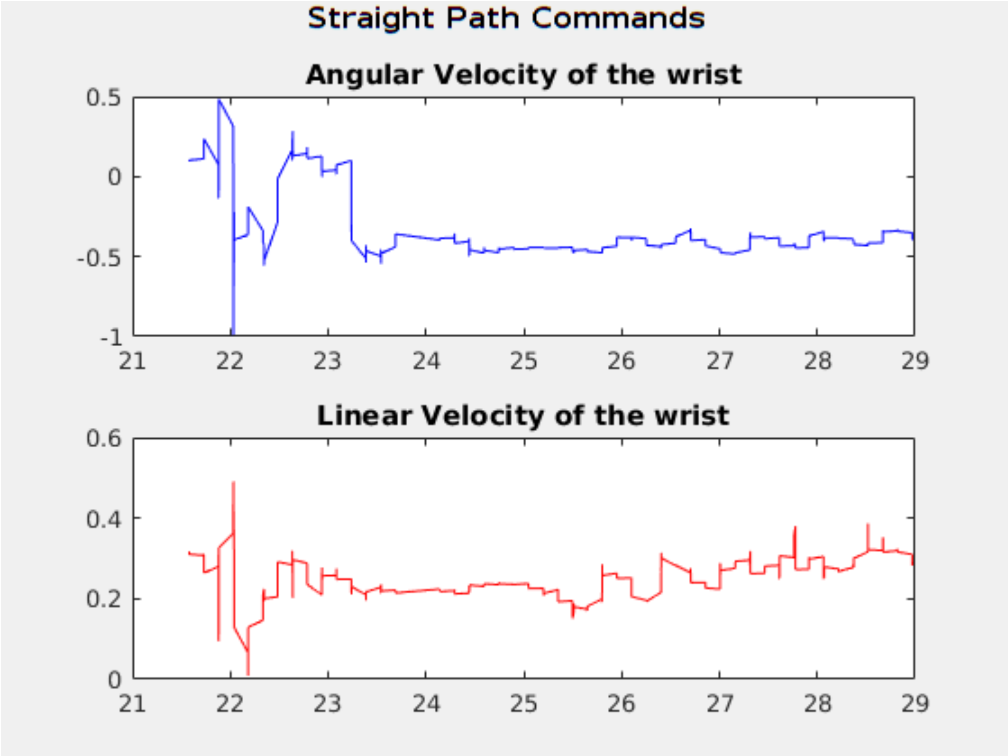

lap1Group3Volunteer11.mat,Filtered Angular Straight
-0.15
-0.2
-0.25
-0.3
-0.35
-0.4
-0.45
20
21
22
23
24
25
26
27
28

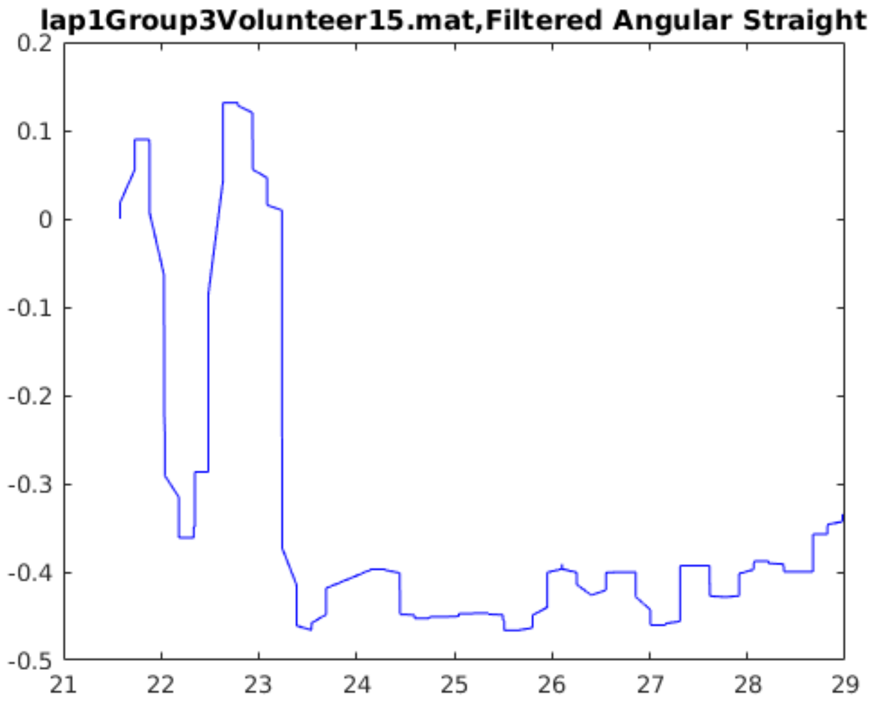

lap1Group3Volunteer11.mat,Filtered Linear Straight
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
20
21
22
23
24
25
26
27
28

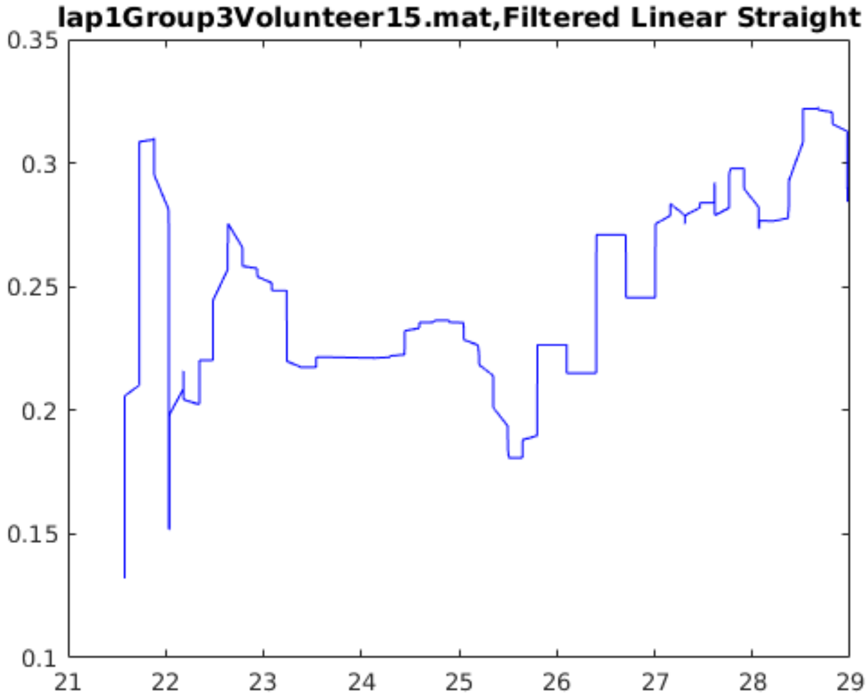

Curved Path Commands
Angular Velocity of the wrist
0.5
0
-0.5
13
14
15
16
17
18
19
20
21
Linear Velocity of the wrist
0.6
0.4
0.2
0
13
14
15
16
17
18
19
20
21

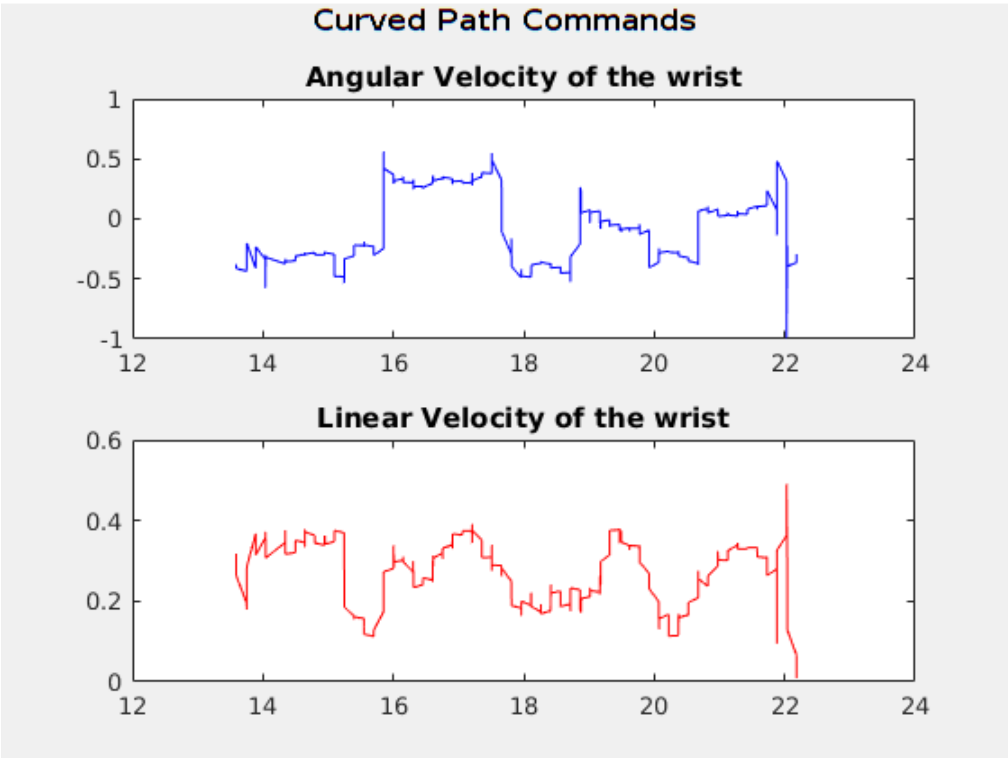

lap1Group3Volunteer11.mat,Filtered Angular Curve
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
13 14 15 16 17 18 19 20 21

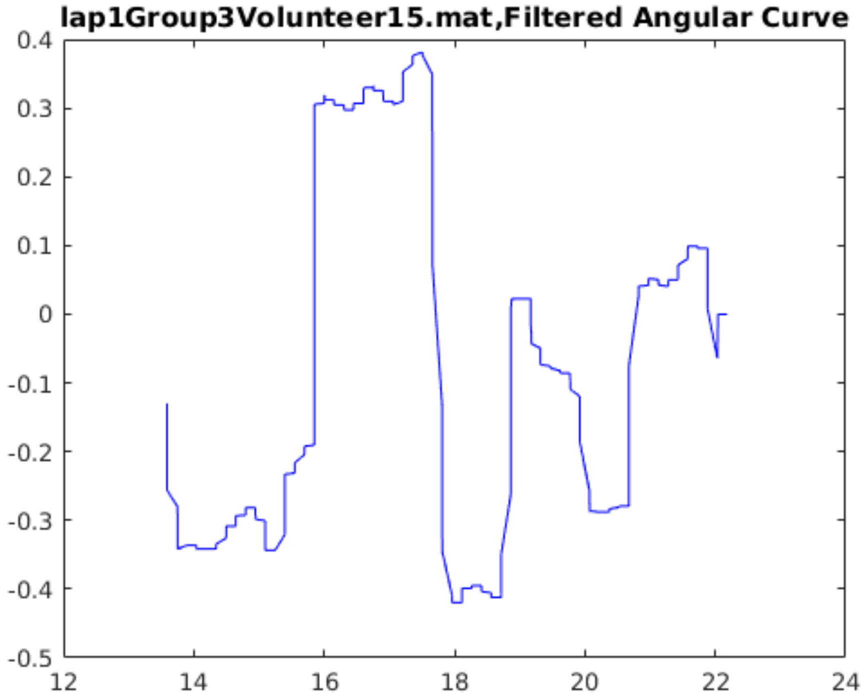

lap1Group3Volunteer11.mat,Filtered Linear Curve
0.4
0.35
0.3
0.25
0.2
0.15
0.1
13 14 15 16 17 18 19 20 21

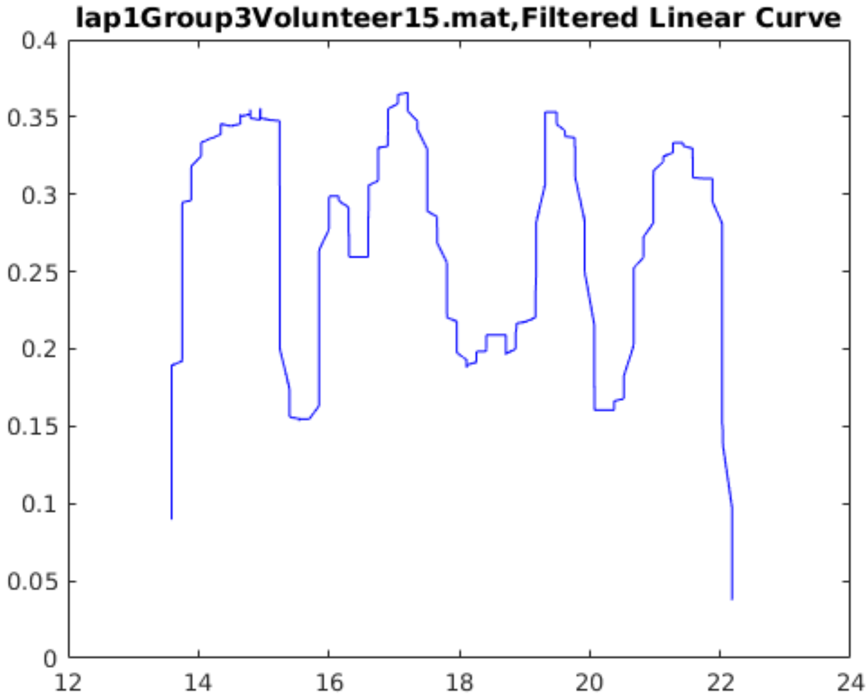

Straight Path Commands
Angular Velocity of the wrist
0.5
0
-0.5
-1
21
22
23
24
25
26
27
28
29
Linear Velocity of the wrist
0.6
0.4
0.2
0
21
22
23
24
25
26
27
28
29

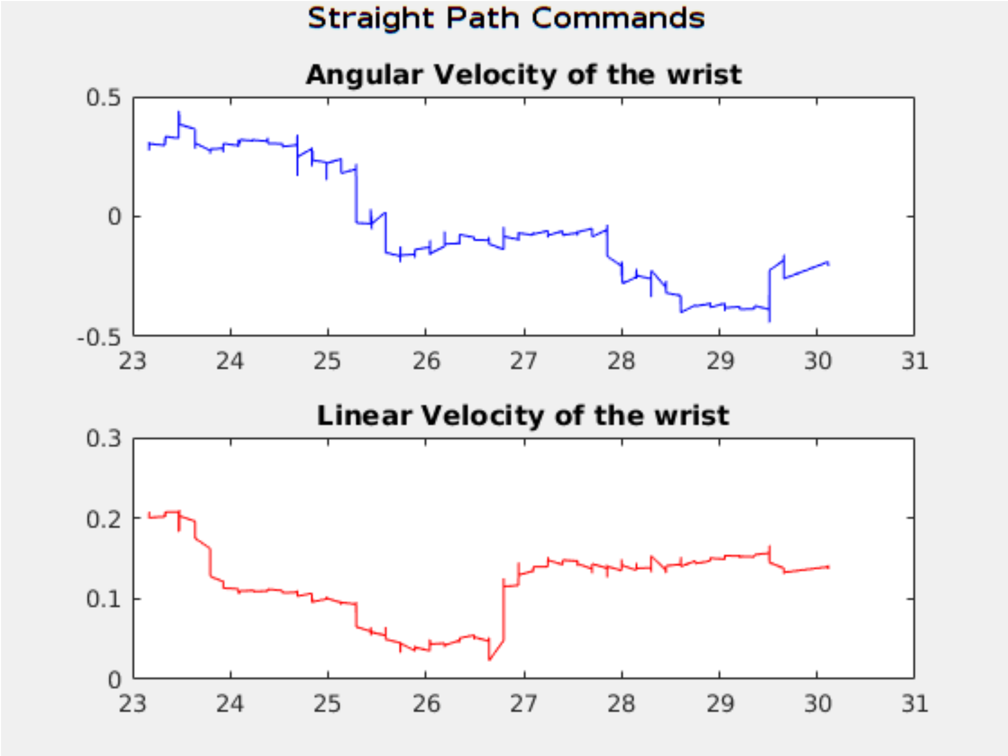

lap1Group3Volunteer15.mat,Filtered Angular Straight
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
21
22
23
24
25
26
27
28
29

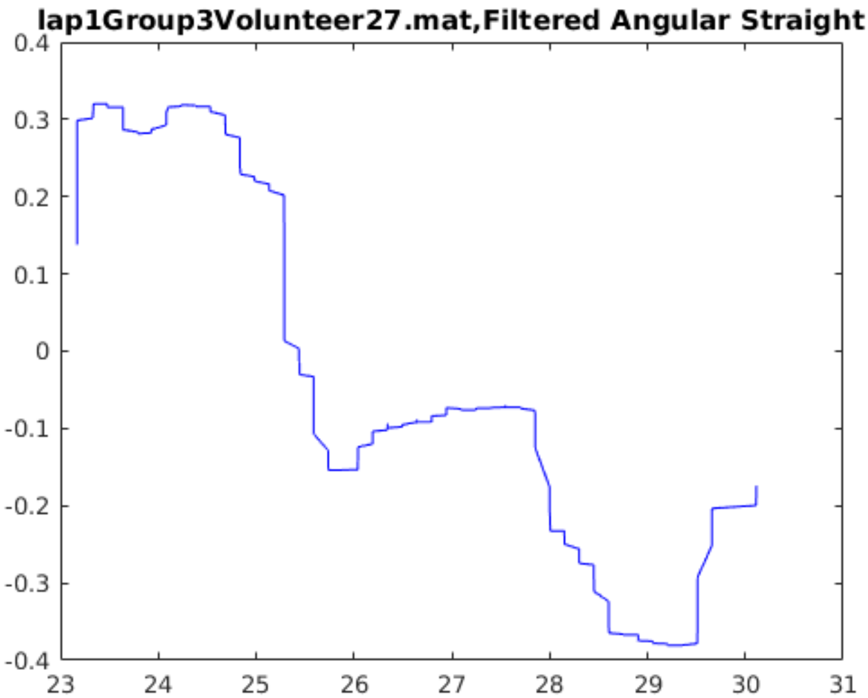

lap1Group3Volunteer15.mat,Filtered Linear Straight
0.35
0.3
0.25
0.2
0.15
0.1
21
22
23
24
25
26
27
28
29

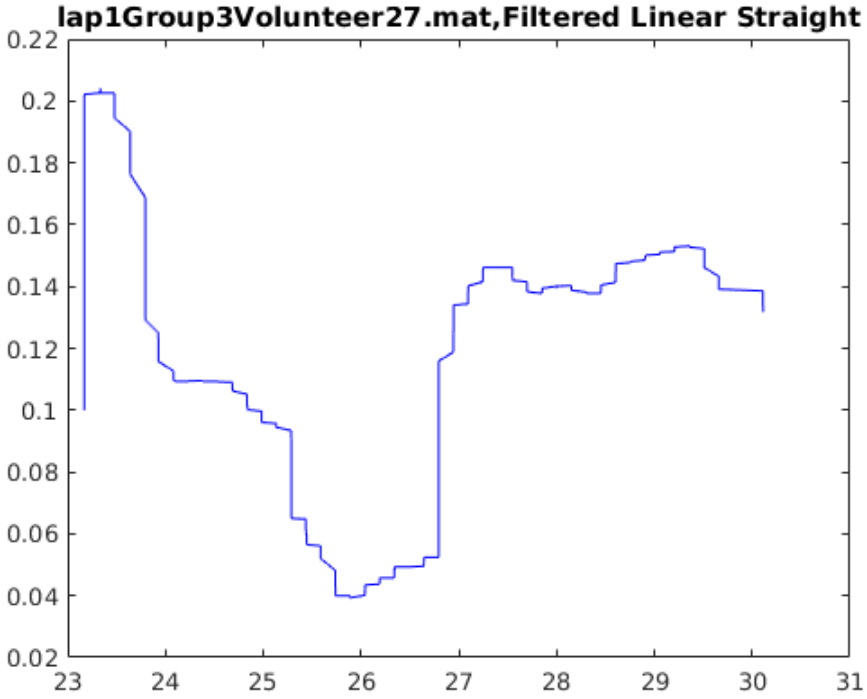

Curved Path Commands
Angular Velocity of the wrist
1
0.5
0
-0.5
-1
12
14
16
18
20
22
24
Linear Velocity of the wrist
0.6
0.4
0.2
0
12
14
16
18
20
22
24

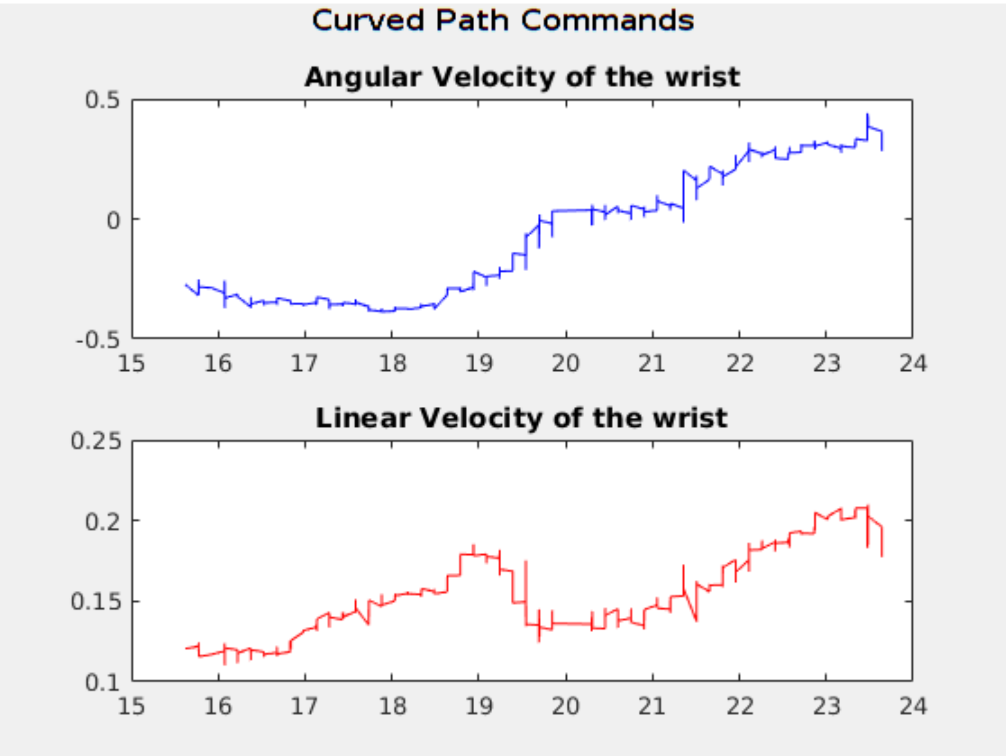

lap1Group3Volunteer15.mat,Filtered Angular Curve
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
12
14
16
18
20
22
24

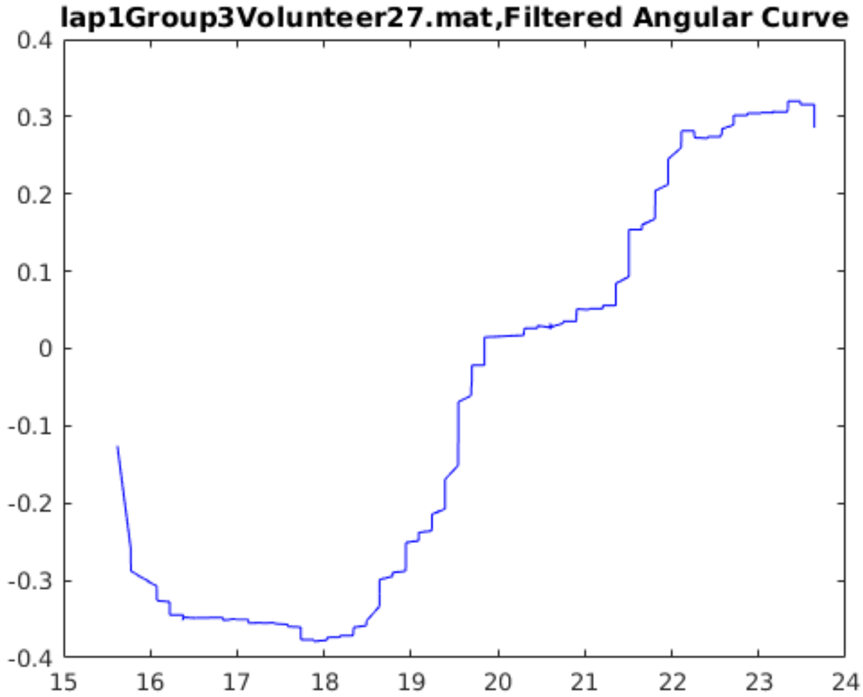

lap1Group3Volunteer15.mat,Filtered Linear Curve
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
12
14
16
18
20
22
24

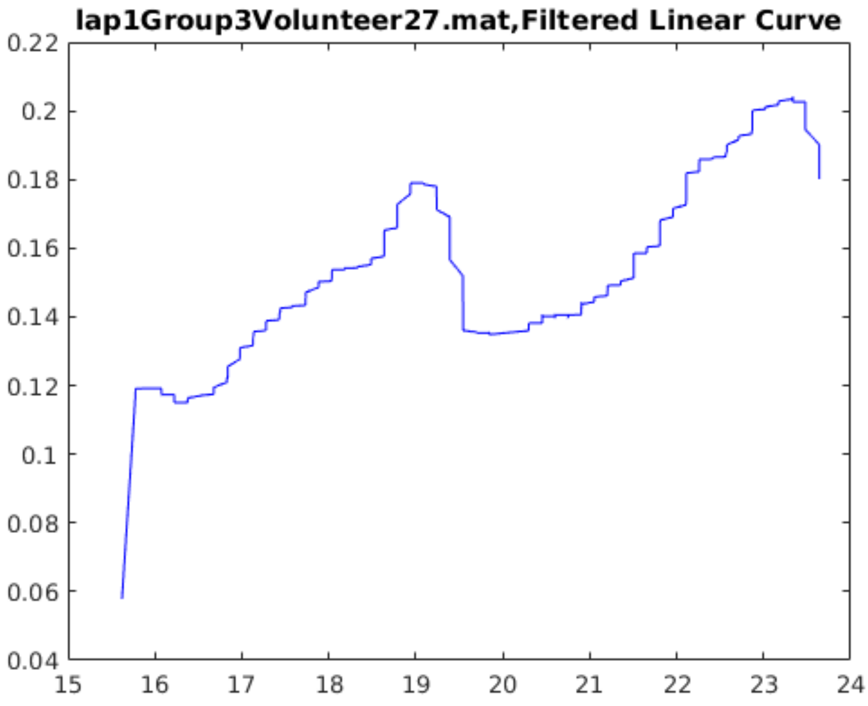

Straight Path Commands
Angular Velocity of the wrist
Linear Velocity of the wrist

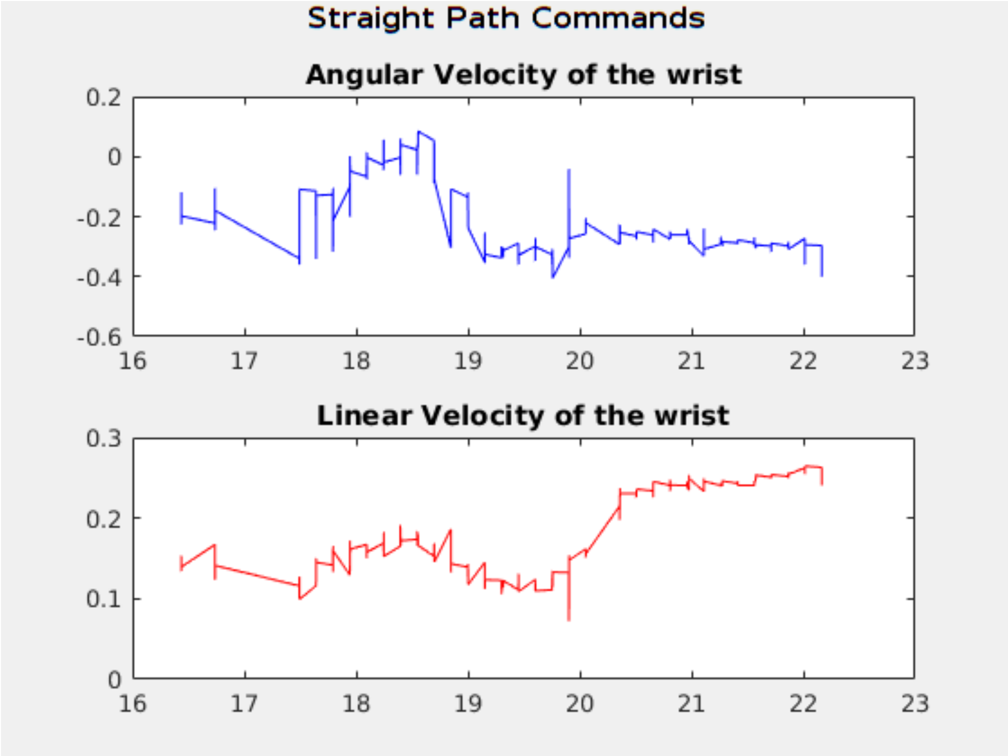

lap1Group3Volunteer27.mat,Filtered Angular Straight

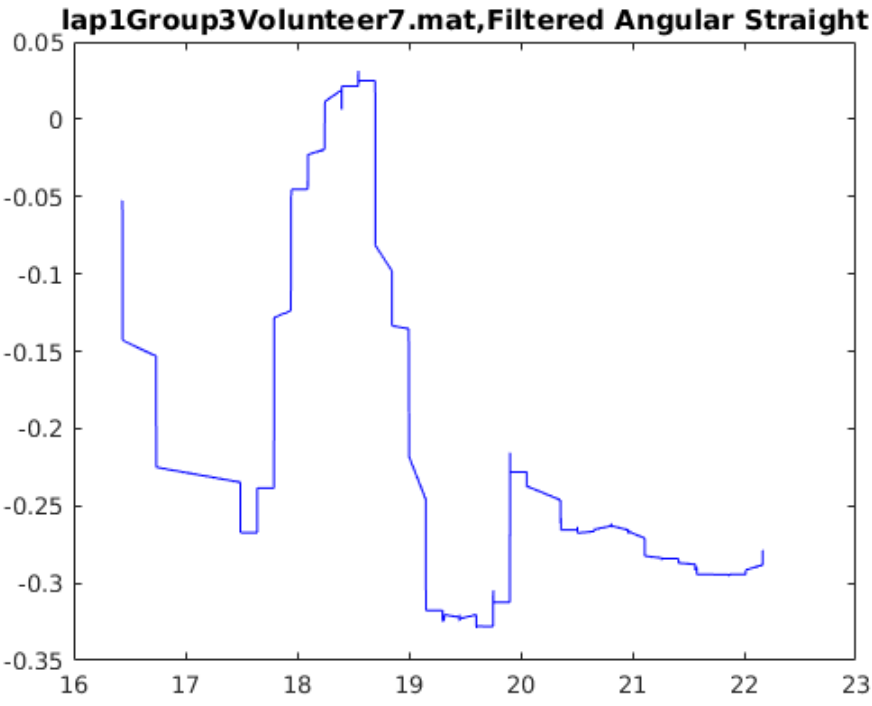

lap1Group3Volunteer27.mat,Filtered Linear Straight
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
23
24
25
26
27
28
29
30
31

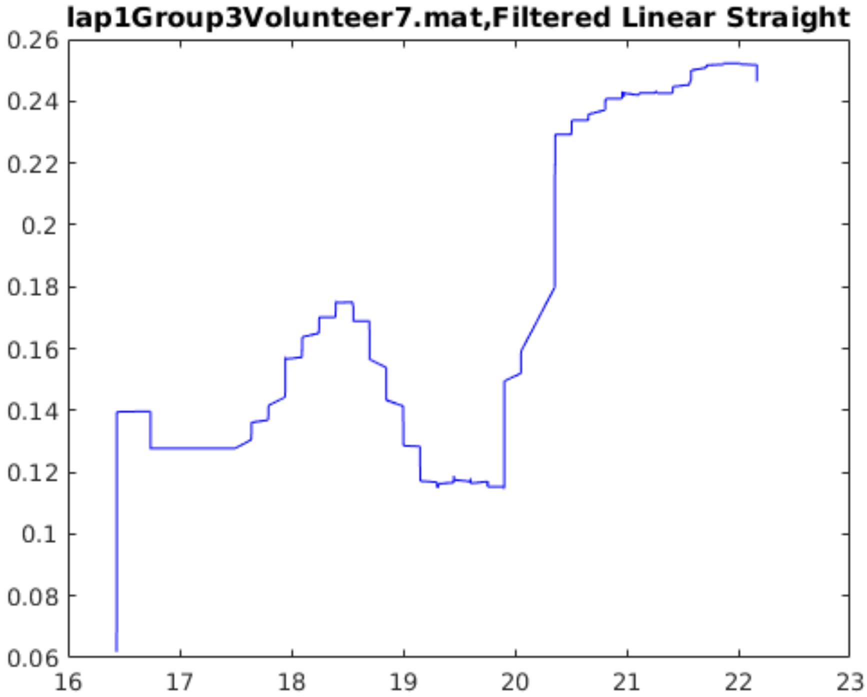

Curved Path Commands
Angular Velocity of the wrist
0.5
0
-0.5
15
16
17
18
19
20
21
22
23
24
Linear Velocity of the wrist
0.25
0.2
0.15
0.1
15
16
17
18
19
20
21
22
23
24

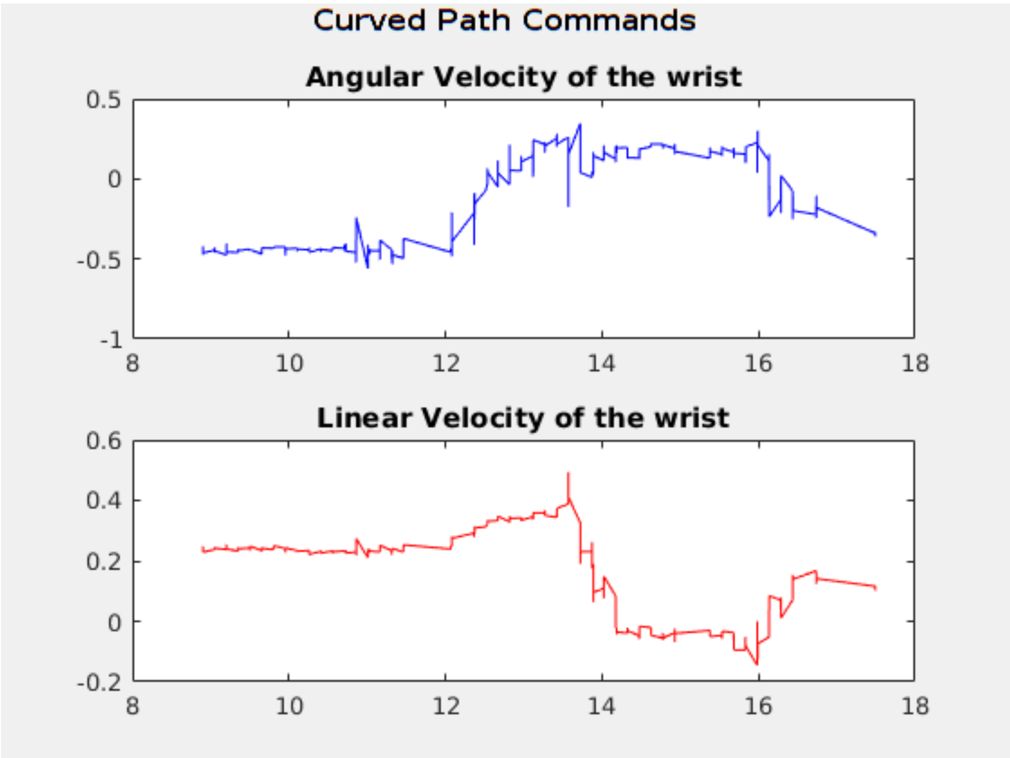

lap1Group3Volunteer27.mat,Filtered Angular Curve
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
15
16
17
18
19
20
21
22
23
24

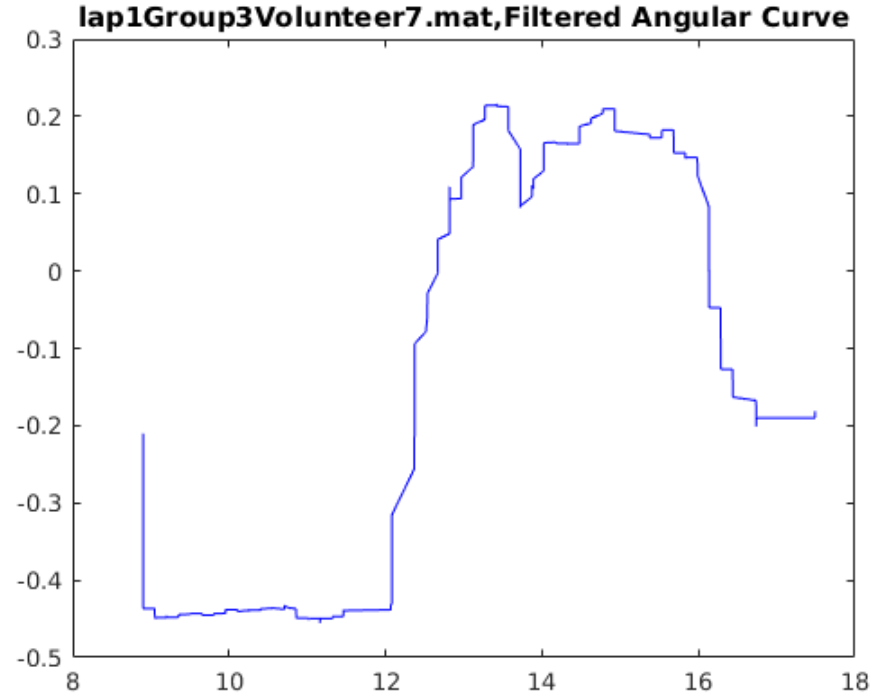

lap1Group3Volunteer27.mat,Filtered Linear Curve
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
15
16
17
18
19
20
21
22
23
24

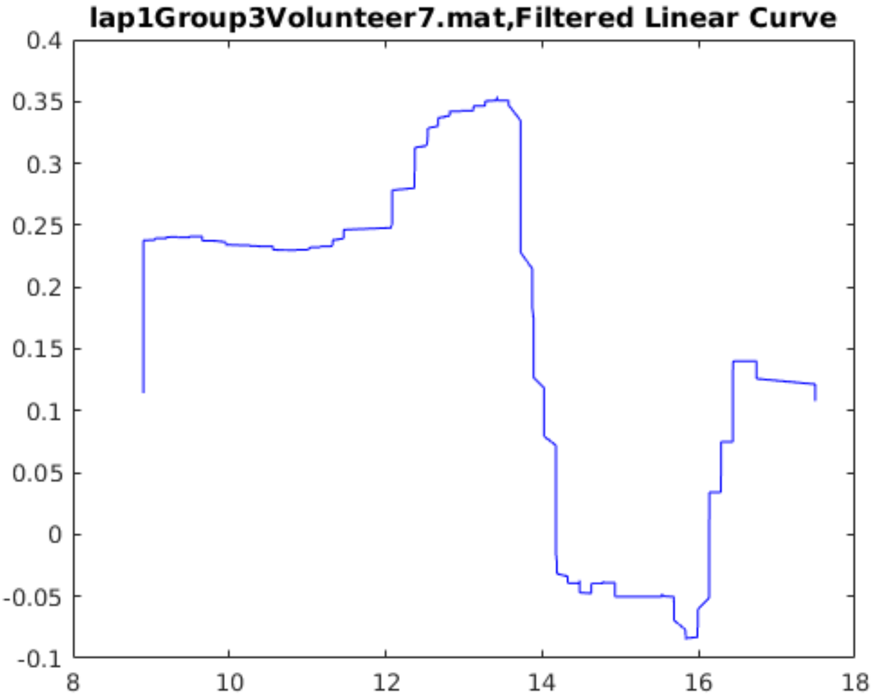

Straight Path Commands
Angular Velocity of the wrist
0.2
0
-0.2
-0.4
-0.6
16
17
18
19
20
21
22
23
Linear Velocity of the wrist
0.3
0.2
0.1
0
16
17
18
19
20
21
22
23

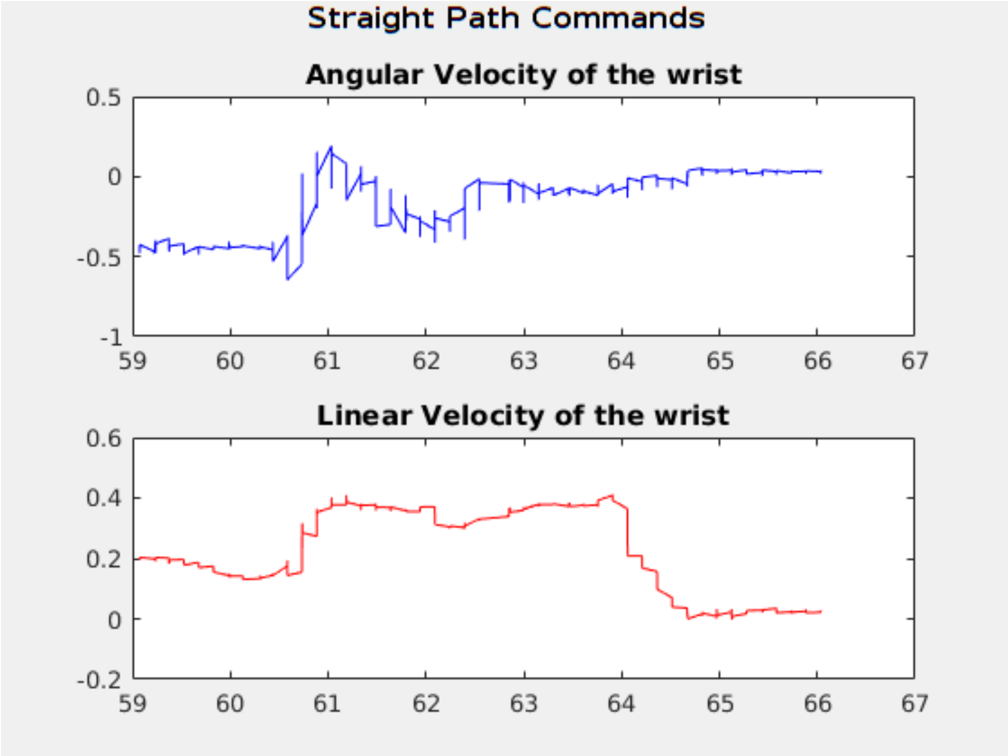

lap1Group3Volunteer7.mat,Filtered Angular Straight
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
16
17
18
19
20
21
22
23

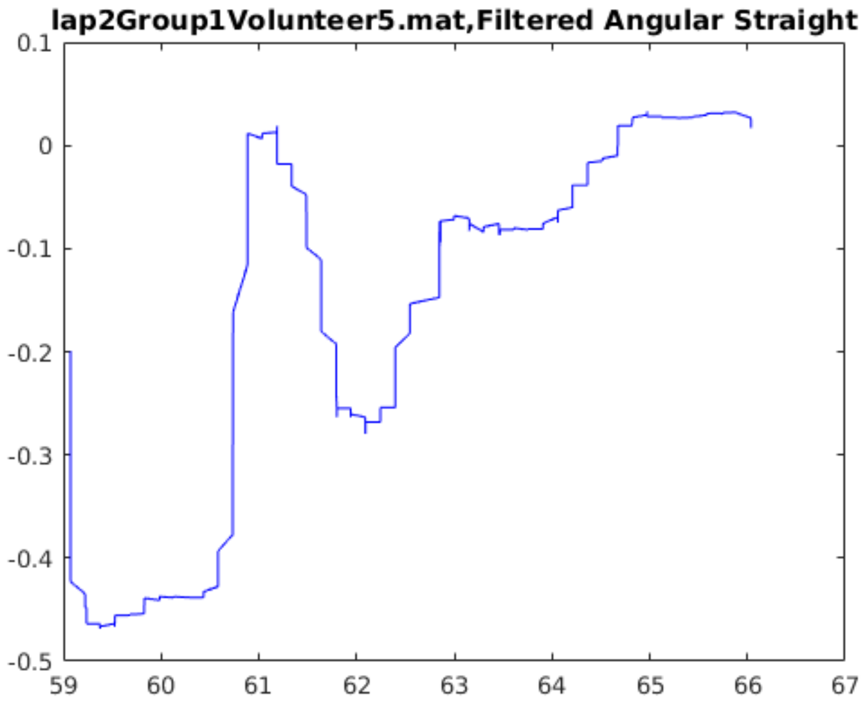

lap1Group3Volunteer7.mat,Filtered Linear Straight
0.26
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
16
17
18
19
20
21
22
23

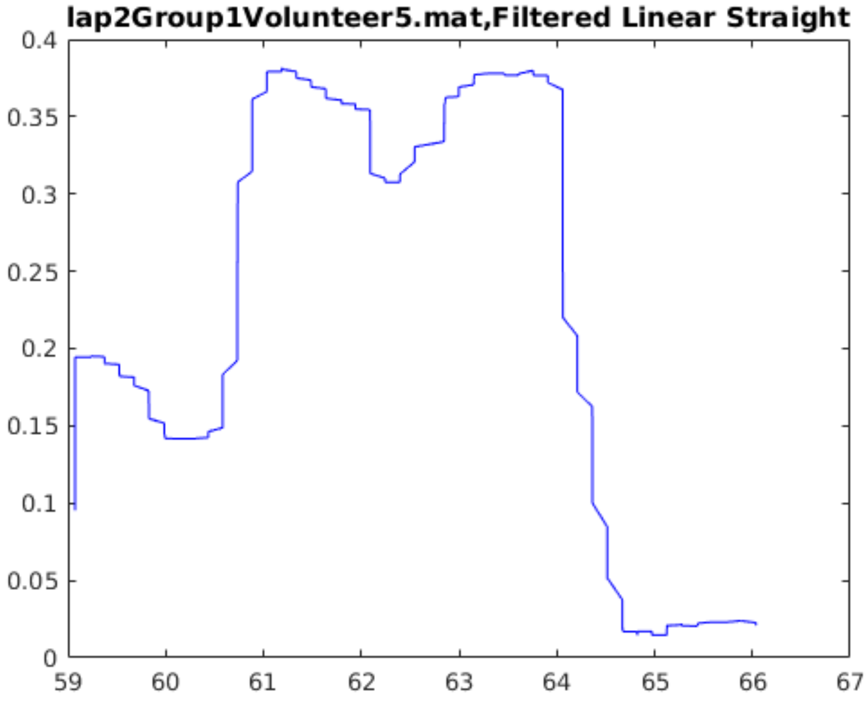

Curved Path Commands
Angular Velocity of the wrist
0.5
0
-0.5
-1
8
10
12
14
16
18
Linear Velocity of the wrist
0.6
0.4
0.2
0
-0.2
8
10
12
14
16
18

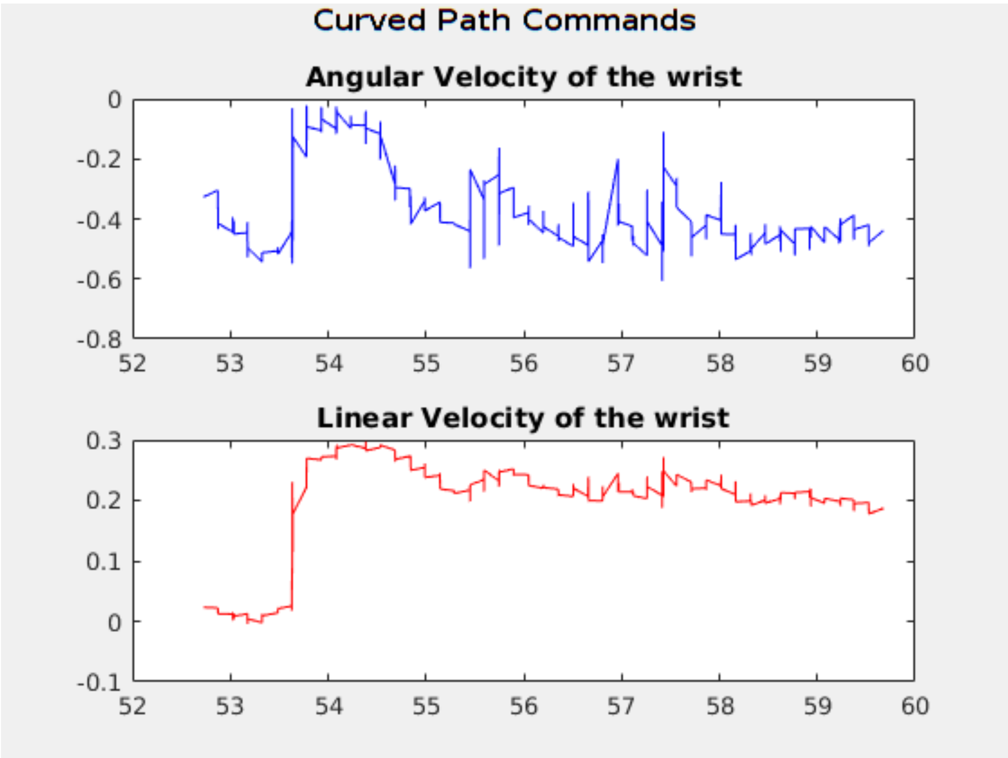

lap1Group3Volunteer7.mat,Filtered Angular Curve
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
8
10
12
14
16
18

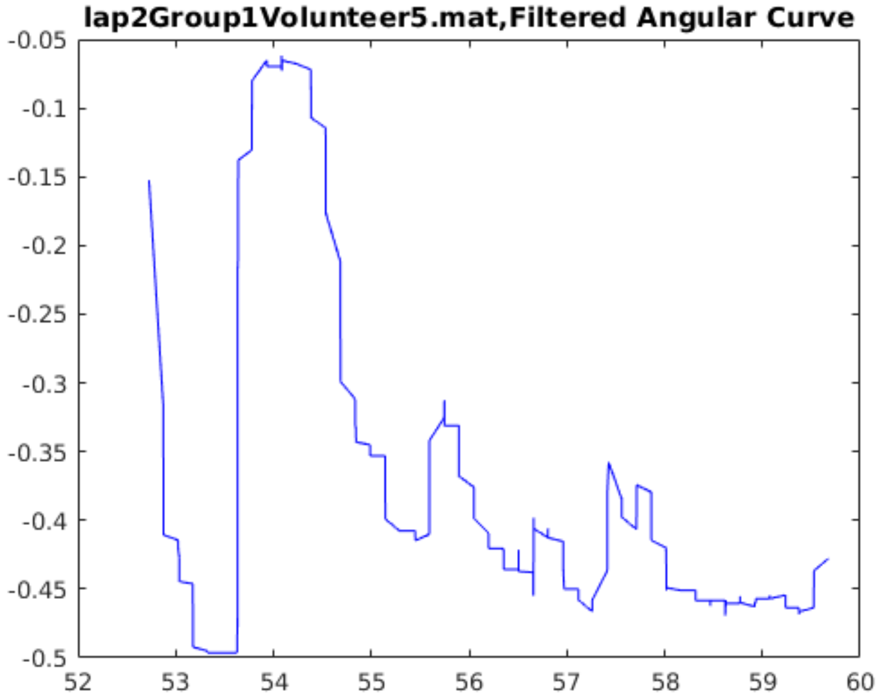

lap1Group3Volunteer7.mat,Filtered Linear Curve
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
8
10
12
14
16
18

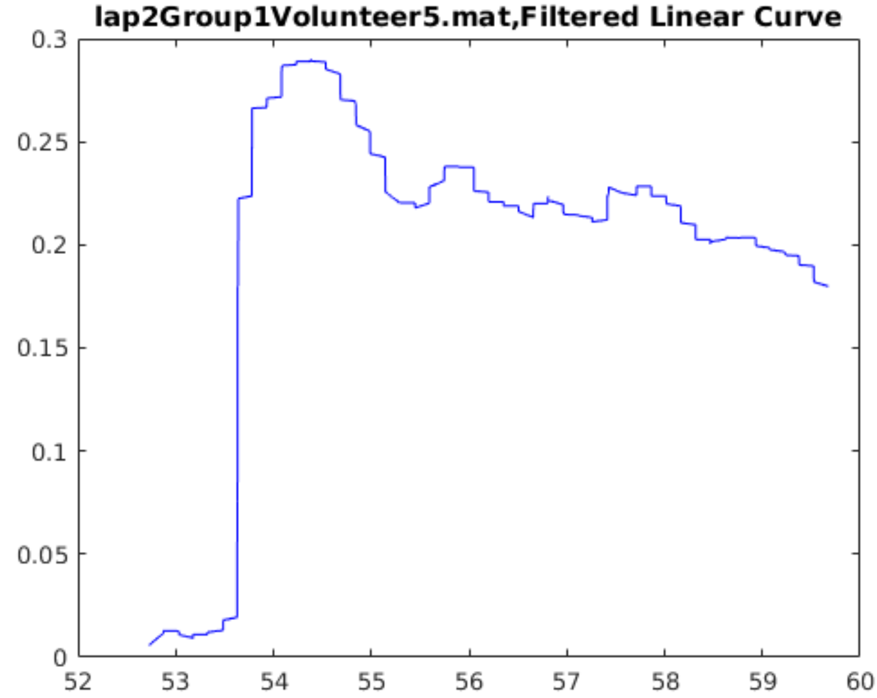

Straight Path Commands
Angular Velocity of the wrist
0.5
0
-0.5
-1
59
60
61
62
63
64
65
66
67
Linear Velocity of the wrist
0.6
0.4
0.2
0
-0.2

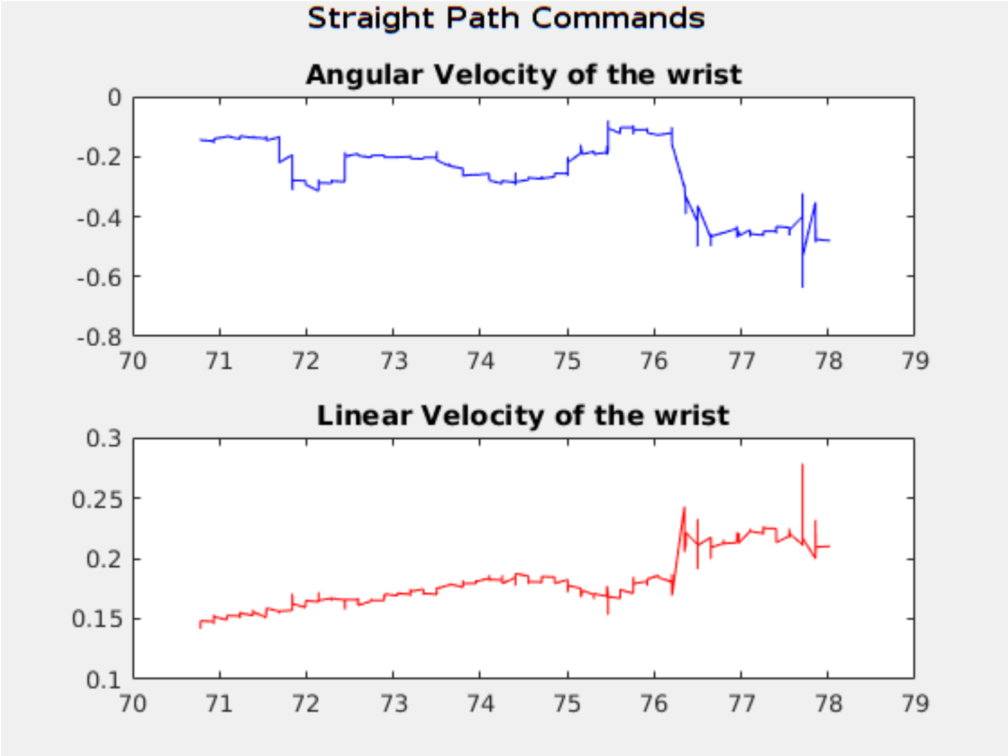

lap2Group1Volunteer5.mat,Filtered Angular Straight
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
59
60
61
62
63
64
65
66
67

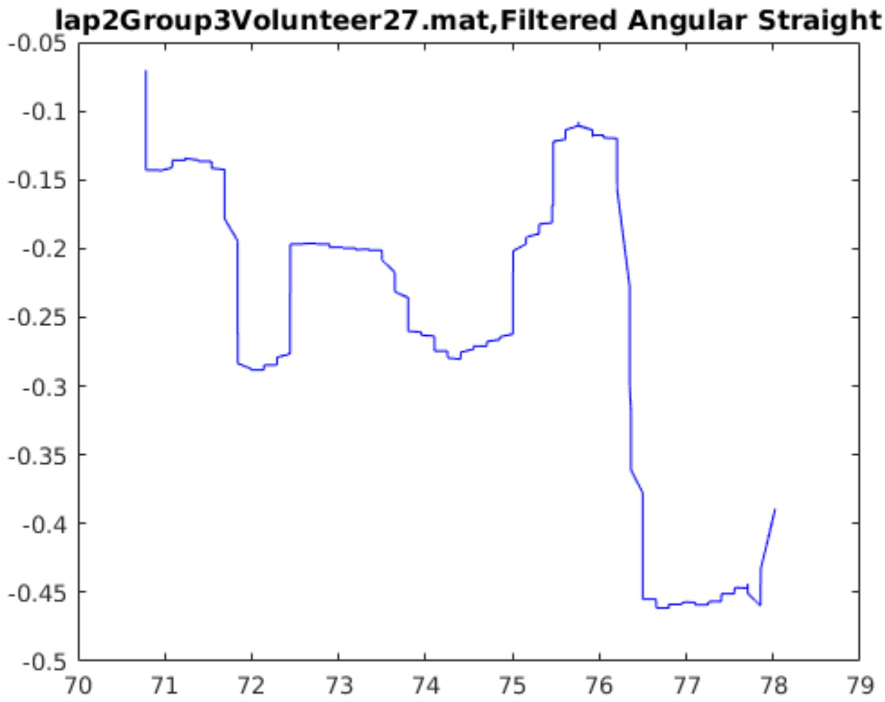

lap2Group1Volunteer5.mat,Filtered Linear Straight
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
59
60
61
62
63
64
65
66
67

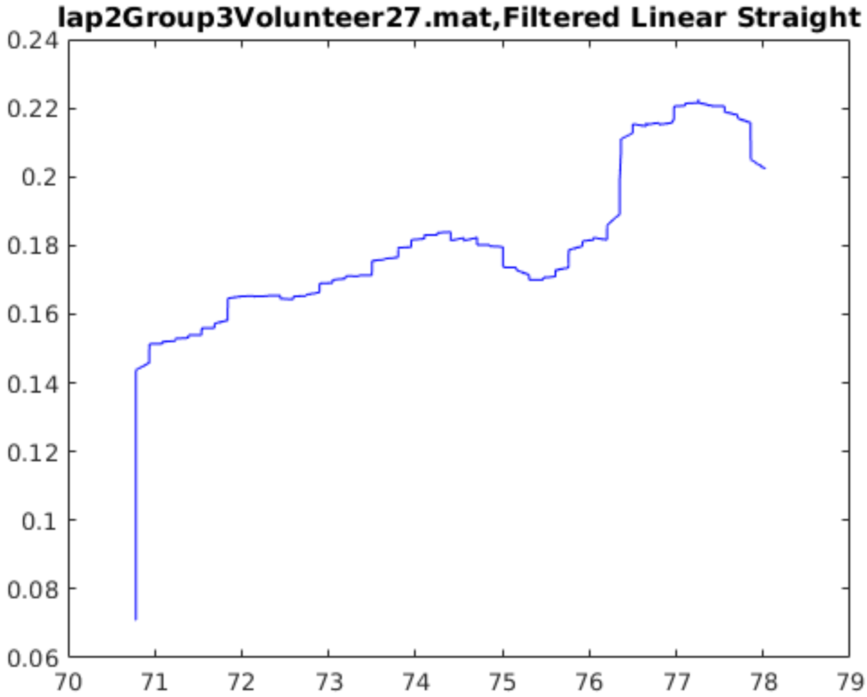

Curved Path Commands
Angular Velocity of the wrist
0
-0.2
-0.4
-0.6
-0.8
52
53
54
55
56
57
58
59
60
Linear Velocity of the wrist
0.3
0.2
0.1
0
-0.1
52
53
54
55
56
57
58
59
60

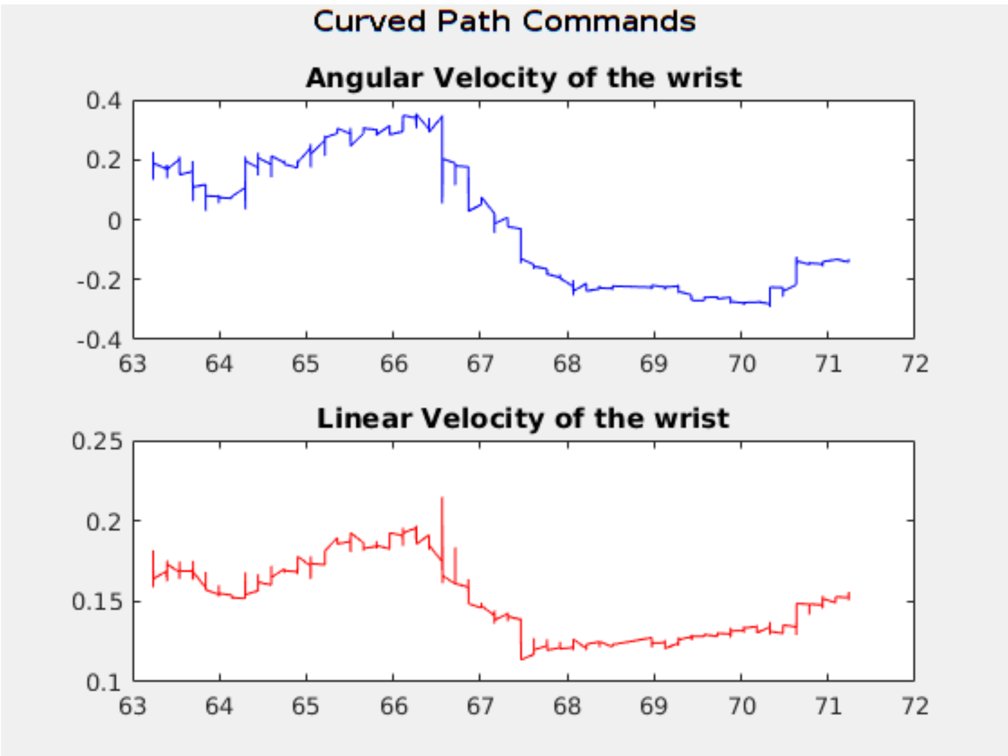

lap2Group1Volunteer5.mat,Filtered Angular Curve
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
-0.4
-0.45
-0.5
52
53
54
55
56
57
58
59
60

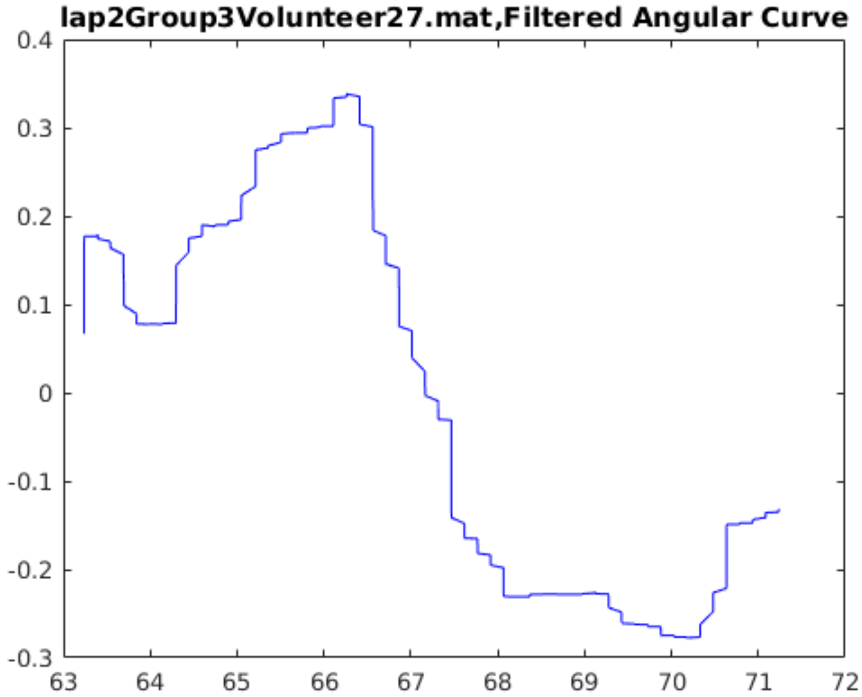

lap2Group1Volunteer5.mat,Filtered Linear Curve
0.3
0.25
0.2
0.15
0.1
0.05
0
52
53
54
55
56
57
58
59
60

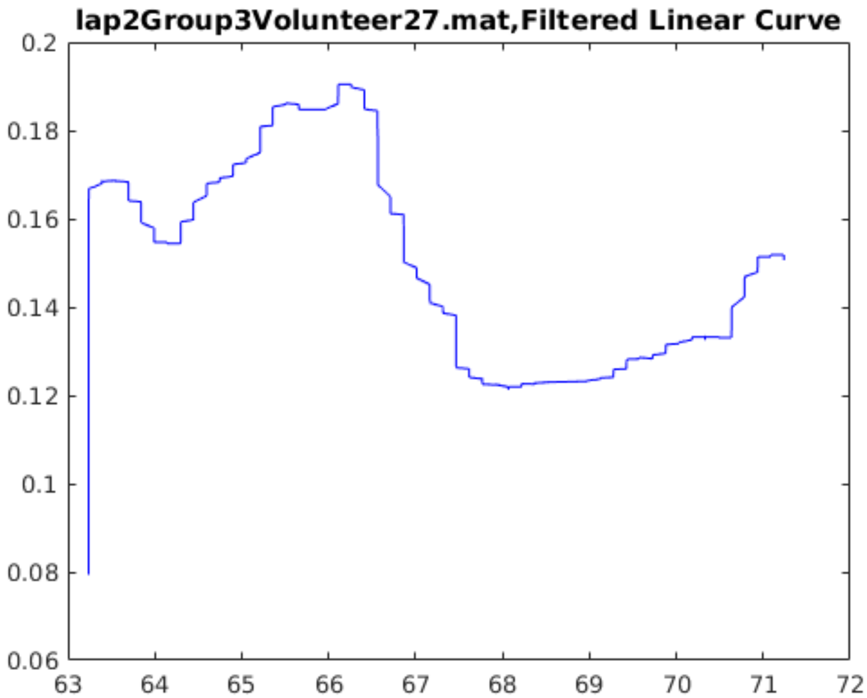

Straight Path Commands
Angular Velocity of the wrist
0
-0.2
-0.4
-0.6
-0.8
70 71 72 73 74 75 76 77 78 79
Linear Velocity of the wrist
0.3
0.25
0.2
0.15
0.1
70 71 72 73 74 75 76 77 78 79

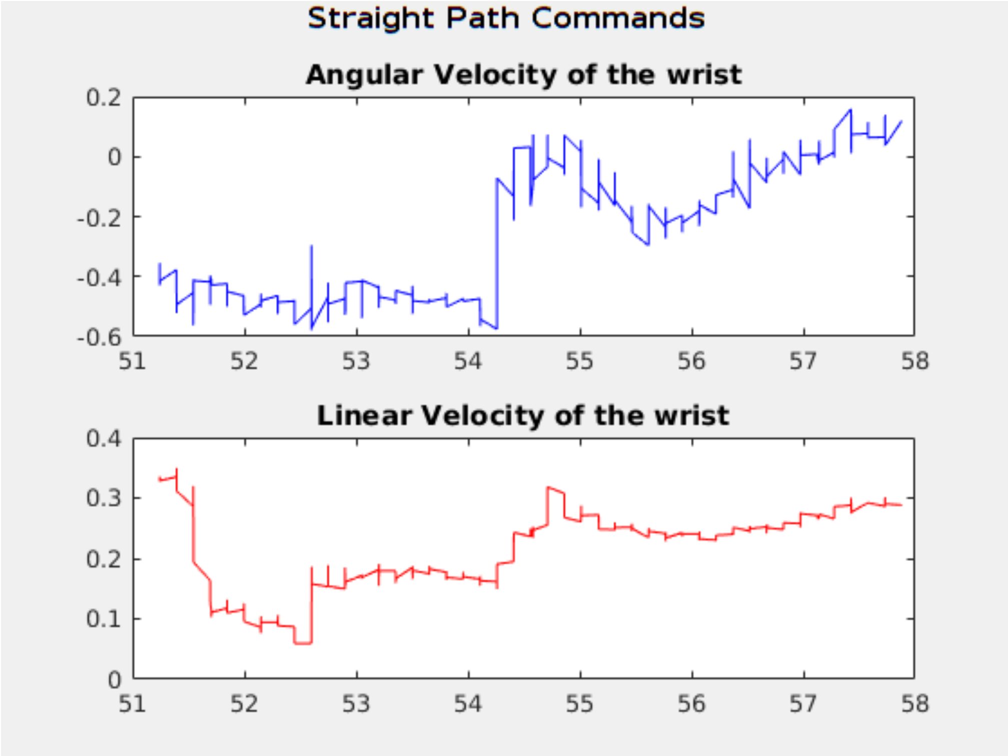

lap2Group3Volunteer27.mat,Filtered Angular Straight
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
-0.4
-0.45
-0.5
70 71 72 73 74 75 76 77 78 79

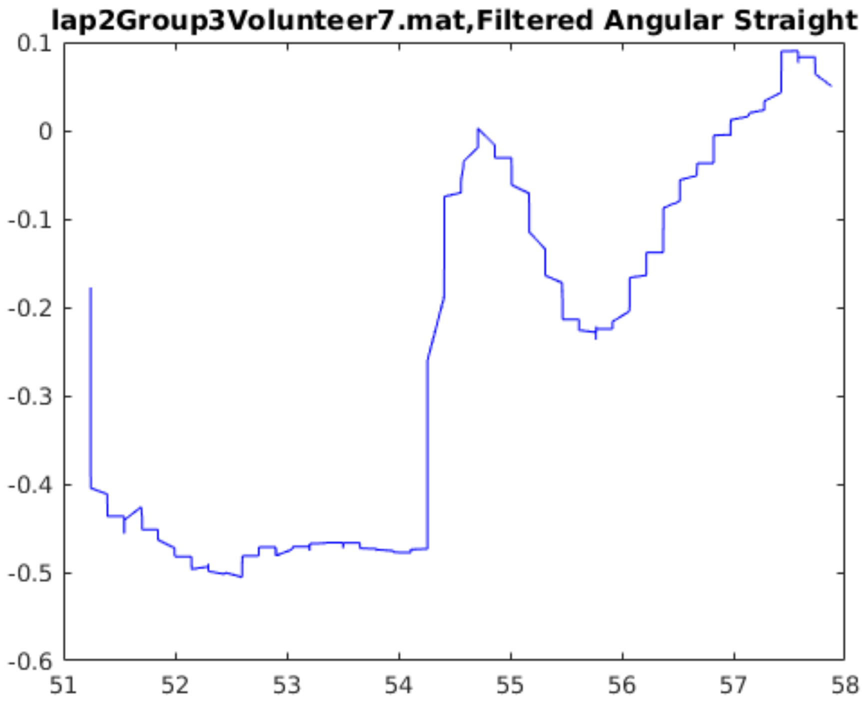

lap2Group3Volunteer27.mat,Filtered Linear Straight
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
70 71 72 73 74 75 76 77 78 79

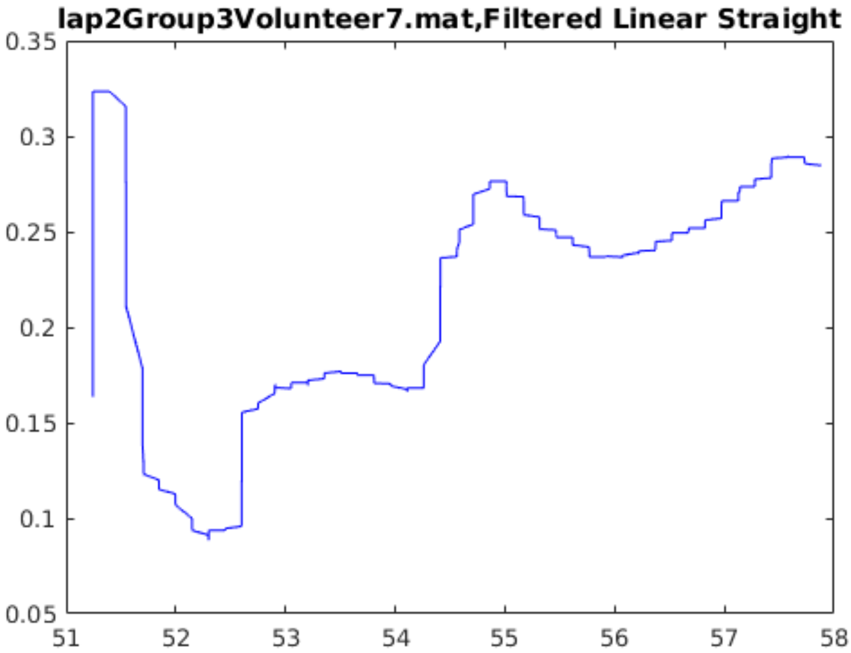

Curved Path Commands
Angular Velocity of the wrist
0.4
0.2
0
-0.2
-0.4
63 64 65 66 67 68 69 70 71 72
Linear Velocity of the wrist
0.25
0.2
0.15
0.1
63 64 65 66 67 68 69 70 71 72

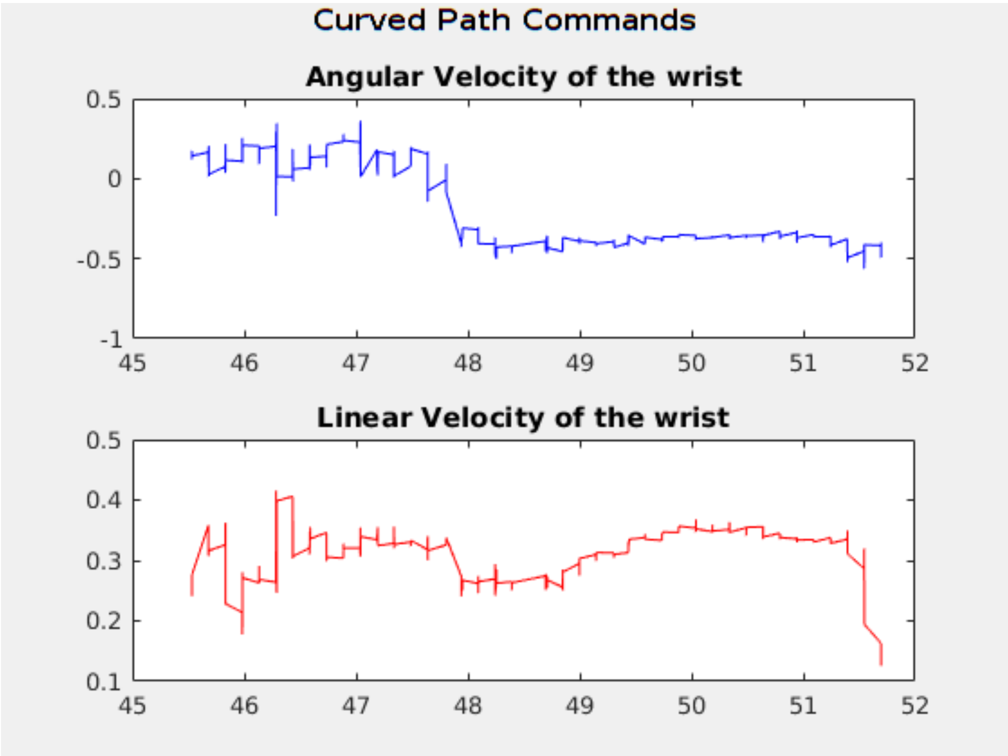

lap2Group3Volunteer27.mat,Filtered Angular Curve
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
63
64
65
66
67
68
69
70
71
72

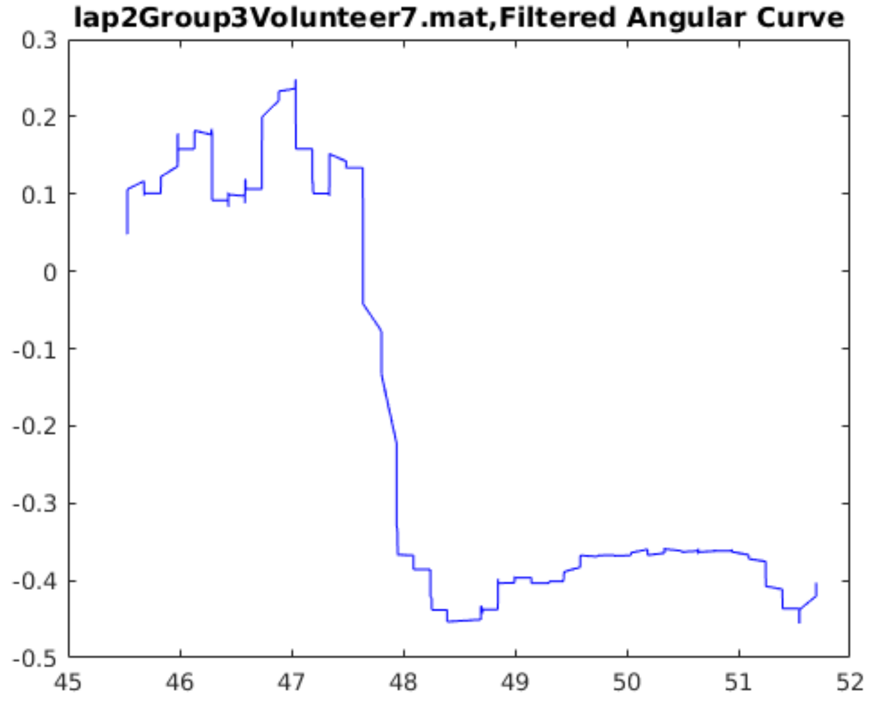

lap2Group3Volunteer27.mat,Filtered Linear Curve
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
63
64
65
66
67
68
69
70
71
72

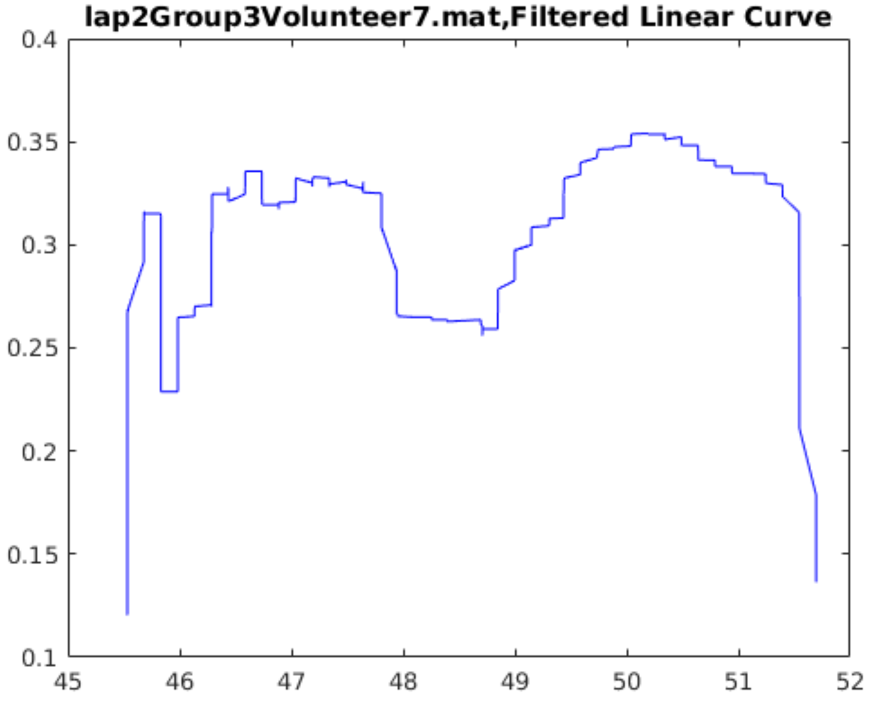

Straight Path Commands
Angular Velocity of the wrist
0.2
0
-0.2
-0.4
-0.6
51 52 53 54 55 56 57 58
Linear Velocity of the wrist
0.4
0.3
0.2
0.1
0
51 52 53 54 55 56 57 58


lap2Group3Volunteer7.mat,Filtered Angular Straight
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
51 52 53 54 55 56 57 58


lap2Group3Volunteer7.mat,Filtered Linear Straight
0.35
0.3
0.25
0.2
0.15
0.1
0.05
51
52
53
54
55
56
57
58


Curved Path Commands
Angular Velocity of the wrist
0.5
0
-0.5
-1
45
46
47
48
49
50
51
52
Linear Velocity of the wrist
0.5
0.4
0.3
0.2
0.1
45
46
47
48
49
50
51
52



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end
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