DetectRotations

January 13, 2022

1 Define the libraries

[99]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from matplotlib.backends.backend_pdf import PdfPages
from datetime import timedelta
from scipy import signal
```

2 Define the functions

[100]:

```
def␣
 ↪PlotData(Begin,Duration,Mistake,OncourtFrame,OncourtVideo,Time,Data1,Data2,Figuur,player,df
 ↪

    #Define starting en stopping positions for the CSV data
    Start = int((((OncourtFrame - OncourtVideo)*100) + Begin/10) - Mistake*100)
    Stop = int(Start + Duration*100)

    WheelRotationspeed = Data1[Start:Stop]
    FrameRotationspeed = Data2[Start:Stop]
    Timestamp = Time[Start:Stop]

   # ----------------------------------------------------------------------
        #LowPass Filter

    #Lowpass filter design for rotation and wheelspeed to improve accuracy of␣
 ↪code (Butterworth filter)
    Order = 5
    cutoff_freq = 1.5
    sampling_freq = 100
    sampling_duration = Duration

    normalized_cutoff_freq = 2 * cutoff_freq / sampling_freq
    numerator_coeffs, denominator_coeffs = signal.butter(Order,␣
↪normalized_cutoff_freq)

    filtered_WheelRotationspeed = signal.lfilter(numerator_coeffs,␣
↪denominator_coeffs, WheelRotationspeed)
    filtered_FrameRotationspeed = signal.lfilter(numerator_coeffs,␣
↪denominator_coeffs, FrameRotationspeed)


   # -----------------------------------------------------------------------
        #Operations I have to do for user story

    #Play with different operations to see clearer patterns
    Sub = filtered_WheelRotationspeed + filtered_FrameRotationspeed


    #I'm finally not using conv1 nor Conv_temp
    Conv1 = filtered_FrameRotationspeed / filtered_WheelRotationspeed
    #I set the var below as Conv_temp beause i want to try new calculations
    Conv_temp =␣
↪(abs(filtered_FrameRotationspeed)+abs(filtered_WheelRotationspeed))/
↪filtered_WheelRotationspeed



    #Conv2 is the one im using finally
    Conv2 = (abs(filtered_FrameRotationspeed)+abs(filtered_WheelRotationspeed))/
↪filtered_WheelRotationspeed




    #Diff = arr[i+1] - arr[i]
    number = 8#this variable is for me to only change one number instead of␣
↪various parameters 1by1
    DiffFrame = np.diff(filtered_FrameRotationspeed,n=number)
    DiffFrame = np.insert(DiffFrame,[0]*number,0)#insert 0 to make the sizes␣
↪match
    #print(DiffFrame)

    DiffWheel = np.diff(filtered_WheelRotationspeed,n=3)
    DiffWheel = np.insert(DiffWheel,[0]*3,0)

    Multi = filtered_WheelRotationspeed + filtered_FrameRotationspeed
    #same as conv but doesn´t see use
```

```
 # -----------------------------------------------------------------------

   #Visualize operations done (lower row of the subplot)
   fig, ax = plt.subplots(2,2)

   ax[1,1].plot(Timestamp,Conv2,'r')
   ax[1,0].plot(Timestamp,abs(DiffFrame),'b')

  # -----------------------------------------------------------------------


   #Set all data into a datafram including Sub, Conv1->Conv, DiffFrame,␣
↪DiffWheel
   Data = pd.DataFrame({'Time':Timestamp,'WheelRotationspeed':
↪filtered_WheelRotationspeed,
                        'FrameRotationspeed':filtered_FrameRotationspeed,
                        'Sub':Sub ,'Conv':Conv1,'Conv2':Conv2, 'DiffFrame':
↪DiffFrame, 'DiffWheel':DiffWheel},
                       columns=['Time',␣
↪'WheelRotationspeed','FrameRotationspeed','Sub','Conv',␣
↪'Conv2','DiffFrame','DiffWheel'])

   # -----------------------------------------------------------------------


   #Convert data into chunks of n/100 of a second
   n = 50  #chunk row size
   Data_chunks = [Data[i:i+n] for i in range(0,Data.shape[0],n)]
   #when printing the data chunks we see that it prints in sets of 1.5k values
   #those which are divided in sets of 50, this is why we get when asking for␣
↪max values
   #30 values per iteration


   #Search for the sprints
   Startsprint = []
   Stopsprint = []
   Sprinting = False
   Stop = True

#--------------------------------------------------------------------------------------------

   #  Detect Sprints

   #Use Sub en Conv to detect sprints
   for chunks in Data_chunks:
        if abs(chunks['Conv'].max()) < 3 and chunks['Sub'].mean() > 300 and␣
↪Sprinting == False:
            Startsprint.append(chunks['Time'].min())
            Sprinting = True
            Stop = False
        elif abs(chunks['Conv'].max() < 3) and chunks['Sub'].mean() > 300:
            Sprinting = True
            Stop = False
        elif Stop == False:
            Stopsprint.append(chunks['Time'].min())
            Sprinting = False
            Stop = True


  # ------------------------------------------------------------------------

    #Detect rotation

    #Use wheelrotation, framerotation and conv to detect rotations
    Startrotate = []
    Stoprotate = []
    Rotate = False
    Stop = True

    count = 0


    #try adding operations instead of diffframe
    for chunks in Data_chunks:
        if abs(chunks['FrameRotationspeed'].max()) > 75 and abs(chunks['Conv2'].
↪mean()) > 1.15 and count!=29 and Rotate == False:
            #this condition count!=29 is to make sure that it doesn't start a␣
↪rotation in the last
            #point of the graph because that way it would never enc

            Startrotate.append(chunks['Time'].min())
            Rotate = True
            Stop = False
        elif abs(chunks['FrameRotationspeed'].max()) > 75 and␣
↪abs(chunks['Conv2'].mean()) > 1.15 and count == 29 and Rotate == True:
        #this comes due to the need of matching sizes (between startsprint and␣
↪stopsprint), as in one fast defense
        #theres a rotation that never ends in the plot, so I'm forcing it (had␣
↪to add Rotate == True so that this condition only
        #happens when a rotation has started before the last point of the graph)
```

```
            Stoprotate.append(chunks['Time'].min())
            Rotate = False
            Stop = True
        elif abs(chunks['FrameRotationspeed'].max()) > 75 and␣
↪abs(chunks['Conv2'].mean()) > 1.15:#si abs menor que num sigue siendo␣
↪rotation
            #Rotate =True is implicit
            Rotate = True
            Stop = False
        elif Stop == False :#Rotate==True and the previous conditions aren´t␣
↪met, thats implicit
            Stoprotate.append(chunks['Time'].min())
            Rotate = False
            Stop = True



        count +=1

    # -----------------------------------------------------------------------

    #Pop small sprints out

    #Filter Sprints by lenght, if length is below 2 delete sprint
    Deleted = 0

    if len(Startsprint) > len(Stopsprint):
        Startsprint.pop(-1)

    if len(Startsprint) == len(Stopsprint):
        for i in range(0,len(Startsprint)-1):
            if (Stopsprint[i-Deleted] - Startsprint[i-Deleted]) < 2:
                Startsprint.pop(i-Deleted)
                Stopsprint.pop(i-Deleted)
                Deleted = Deleted + 1


   # -----------------------------------------------------------------------


    #Plot graph
    ax[0,0].
↪plot(Timestamp,WheelRotationspeed,'r',Timestamp,FrameRotationspeed,'b')
    ax[0,1].
↪plot(Timestamp,WheelRotationspeed,'r',Timestamp,FrameRotationspeed,'b')
    #ROJO -> WheelRotationSpeed
    #AZUL -> FrameRotationSpeed

  # -----------------------------------------------------------------------

    #Plot the vertical lines in plot 1
    for Start in Startsprint:
        ax[0,0].axvline(x=Start, color = 'g')
    for Stop in Stopsprint:
        ax[0,0].axvline(x=Stop, color = 'm')
    #ax[0,0].legend(['Wheel Rotation Speed','Frame Rotation Speed'])
    ax[0,0].set_xlabel('Time (sec)')
    ax[0,0].set_title("Fast Defence " + str(Figuur) + ", " + str(player) + ",␣
↪Video Time = "
                      + str(timedelta(seconds=(int(Begin/1000)-Mistake))))

    #Plot the vertical lines in plot 2
    for Start in Startrotate:
        ax[0,1].axvline(x=Start, color = 'g')
    for Stop in Stoprotate:
        ax[0,1].axvline(x=Stop, color = 'm')

    ArrayStartRotate.append(Startrotate)
    ArrayStopRotate.append(Stoprotate)
```

[ ]:

```

```

3 Visualize the data

3.0.1 Define player and match

[101]:

```
Player = 9
Game = 2
```

3.0.2 Insert data player

[102]:

```
df_Player = pd.read_csv('matrix_Player_' + str(Player) + '_game_' + str(Game) +␣
↪'.csv')
df_Player.columns =␣
↪['frAcc','frRoAcc','frDispl','frRoAng','frSpeed','timeLine','frameRotationalSpeedX','frameR
df_Action = pd.read_csv('Ned_DUI_Game_' + str(Game) + '.csv')
df_Player
```

```
[102]:            frAcc  frRoAcc  frDispl  frRoAng   frSpeed  timeLine  \
       0       0.000000      0.0      0.0  0.00000  0.000000      0.01
       1       0.000000      0.0      0.0  0.00000  0.000000      0.02
       2       0.000000      0.0      0.0  0.00000  0.000000      0.03
       3       0.000000      0.0      0.0  0.00000  0.000000      0.04
       4       0.000000      0.0      0.0  0.00000  0.000000      0.05
       …            …       …       …        …         …
       754220 -0.030424   4981.9   6585.3 -0.11980 -0.001860   7542.20
       754221  0.062668   4981.9   6585.3 -0.11723 -0.002164   7542.20
       754222  0.019899   4981.9   6585.2 -0.13407 -0.001537   7542.20
       754223       NaN      NaN      NaN      NaN       NaN       NaN
       754224       NaN      NaN      NaN      NaN       NaN       NaN

               frameRotationalSpeedX  frameRotationalSpeedY  frameRotationalSpeedZ  \
       0                         NaN                    NaN                    NaN
       1                         NaN                    NaN                    NaN
       2                         NaN                    NaN                    NaN
       3                         NaN                    NaN                    NaN
       4                         NaN                    NaN                    NaN
       …                           …                      …                      …
       754220                0.97222                 2.4578               -0.98778
       754221                0.91000                 2.5480               -1.05000
       754222                0.92400                 2.6320               -1.05000
       754223                0.96444                 2.5200               -1.01890
       754224                0.88375                 2.5200               -0.93625

               wheelRotationalSpeedX  wheelRotationalSpeedY  wheelRotationalSpeedZ  \
       0                         NaN                    NaN                    NaN
       1                         NaN                    NaN                    NaN
       2                         NaN                    NaN                    NaN
       3                         NaN                    NaN                    NaN
       4                         NaN                    NaN                    NaN
       …                           …                      …                      …
       754220              -0.000000                  4.690                  2.730
       754221              -0.056000                  4.494                  2.597
       754222               0.070000                  4.620                  2.660
       754223               0.070000                  4.620                  2.660
       754224               0.081667                  4.585                  2.625

               frRoSpeed
       0         0.00000
       1         0.00000
       2         0.00000
       3         0.00000
       4         0.00000
       …             …
       754220    0.25656
```

```
754221   -1.68370
754222        NaN
754223        NaN
754224        NaN

[754225 rows x 13 columns]
```

4 Define boundaries

4.1 Get timestamps from CSV

```
[103]: df_Action_Player = df_Action.loc[df_Action["Players Group Box"] == ("Player " +␣
        ↪str(Player))]
       df_Action_Player_Fast_defence = df_Action_Player.loc[df_Action_Player["Player"]␣
        ↪== "Fast defence"]#.iloc[::-1]
       Timestamp = df_Action_Player_Fast_defence.Position.to_numpy()
       print(len(Timestamp))
       Timestamp
```

```
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```

```
[103]: array([ 103920,  282560,  321160,  436840,  509000,  575680,  639320,
               989320, 2495800, 2774320, 4401320])
```

4.1.1 Sychronize

Times consist of the oncourt times in the video and the oncourt frames in Matlab

```
[104]: df_Sync = pd.read_csv('Sync_match_' + str(Game) + '.csv')
       df_Sync_Player = df_Sync.loc[df_Sync["Player"] == Player]
       Times = df_Sync_Player[["Video","Matlab"]].to_numpy()
       Times[0][1]
```

```
[104]: 2412.5
```

```
[105]: Error = [6,6,6,4,6,6,6,6,6,8,8]
       print(len(Error))
```

```
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```
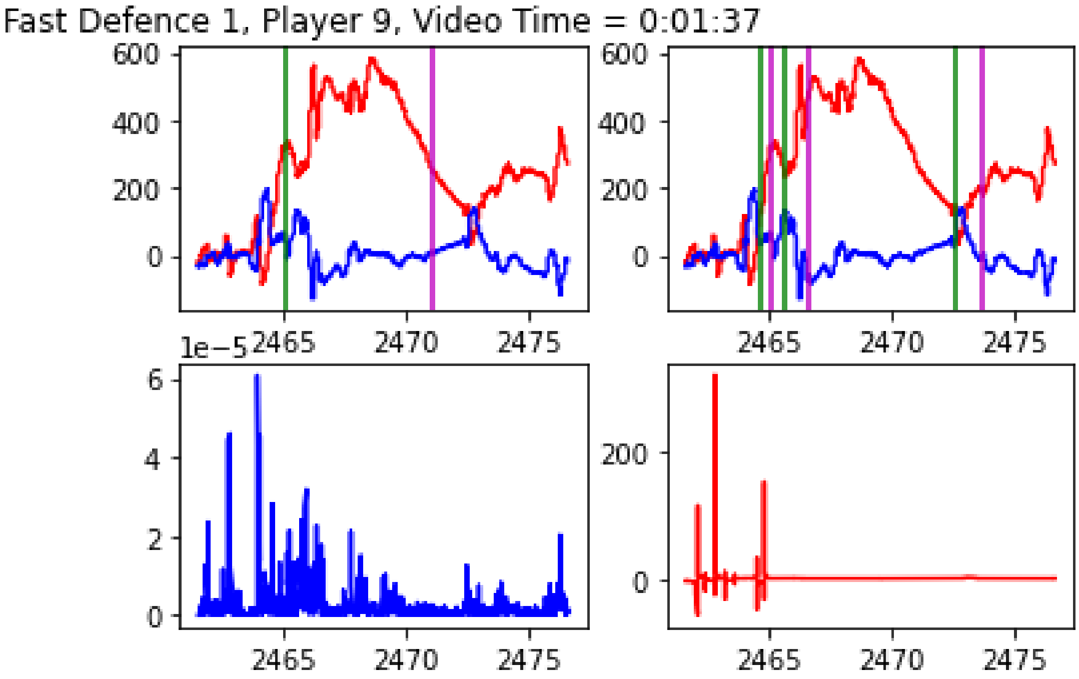
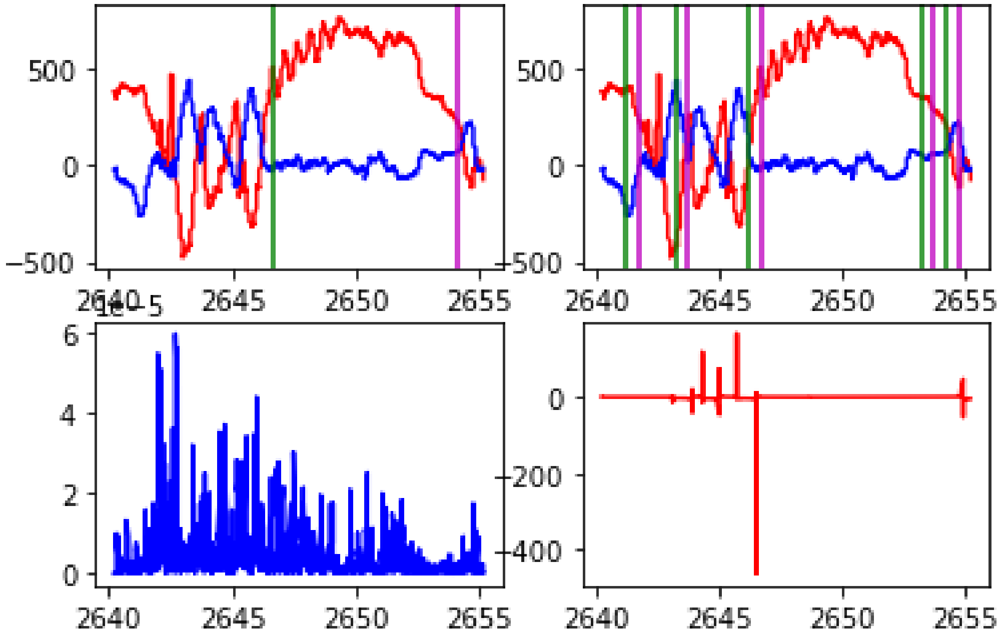

4.1.2 Visualize

[106]:

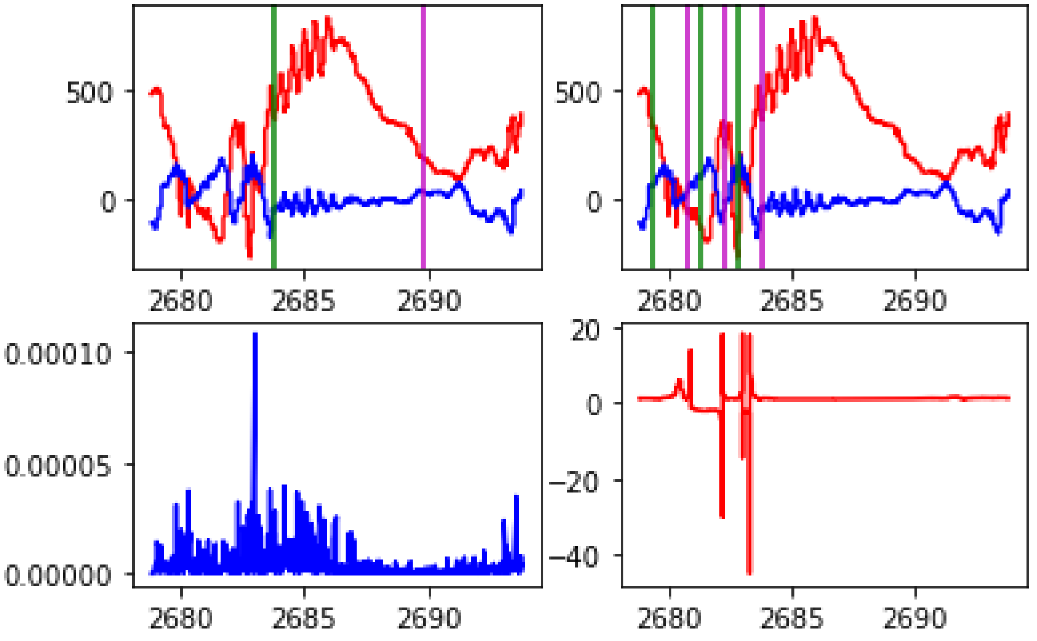
```
Quator = 0;
count = 0
ArrayStartRotate = []
ArrayStopRotate = []
for i in range(0,len(Timestamp)):#this loop happens 7 times
    if Quator < (len(Times)-1):
        if Timestamp[i] >= (Times[Quator+1][0] * 1000):
            Quator = Quator + 1
    PlotData(Timestamp[i], 15, Error[i], Times[Quator][1], Times[Quator][0],␣
 ↪df_Player.timeLine.to_numpy(),
              df_Player.wheelRotationalSpeedX.to_numpy(),
              df_Player.frameRotationalSpeedZ.to_numpy(),
              i+1,('Player ' + str(Player)),df_Action, ArrayStartRotate,␣
 ↪ArrayStopRotate)
```



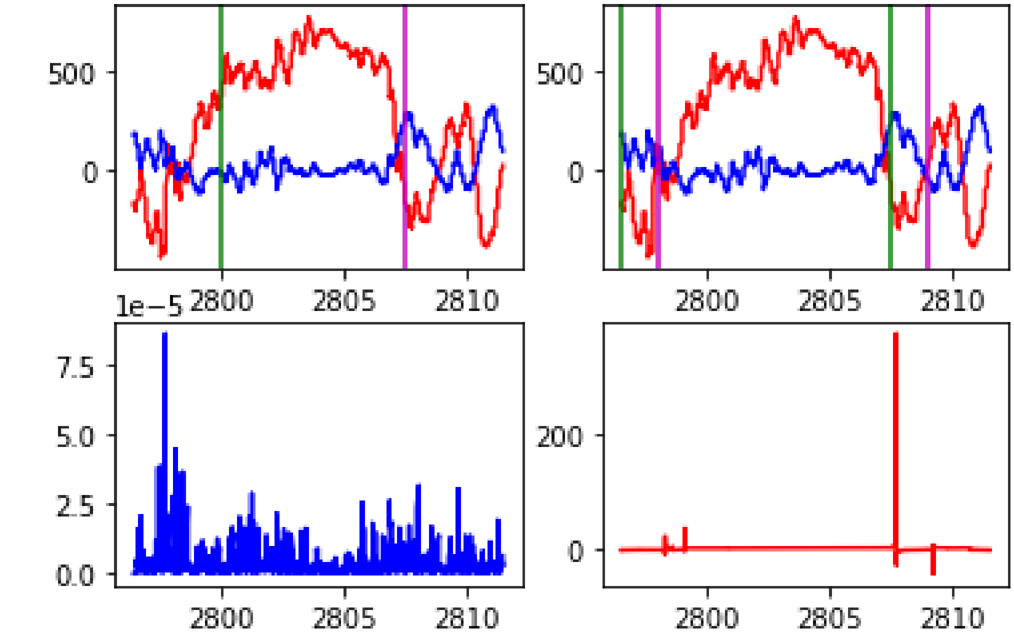
Fast Defence 2, Player 9, Video Time = 0:04:36



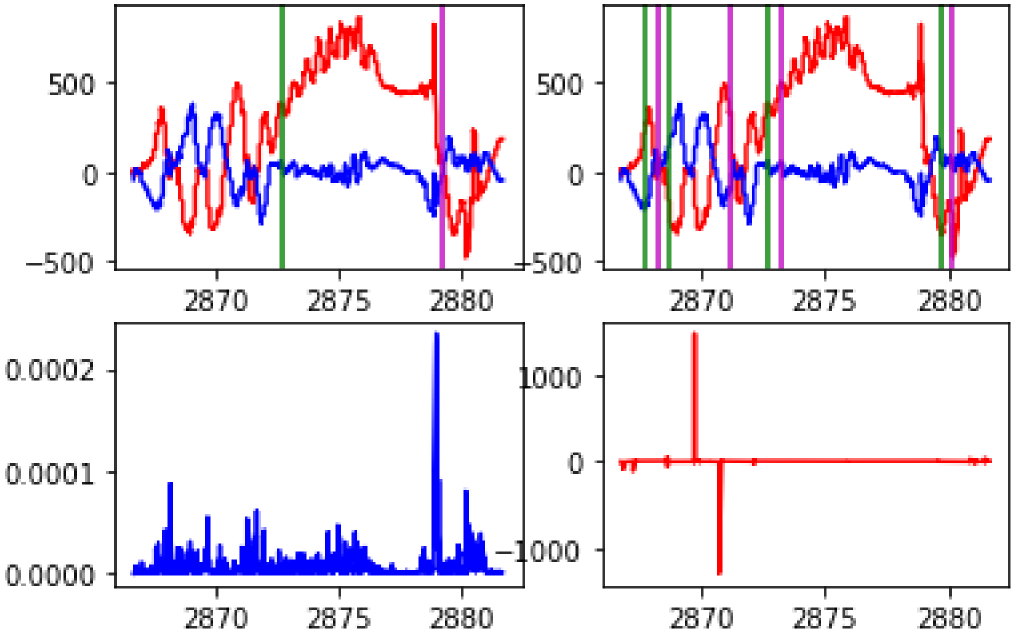
Fast Defence 3, Player 9, Video Time = 0:05:15



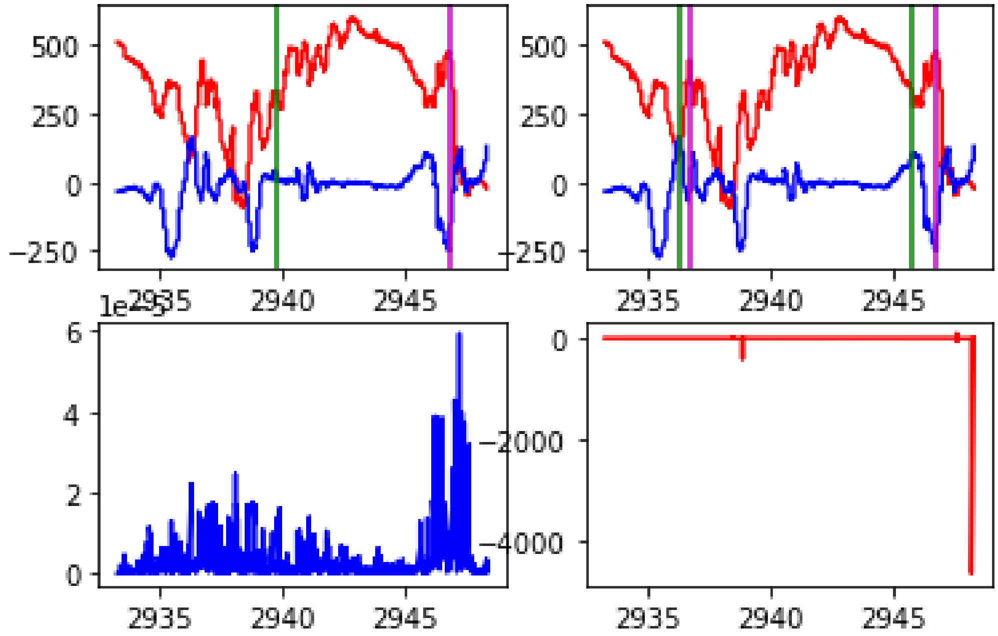
Fast Defence 4, Player 9, Video Time = 0:07:12



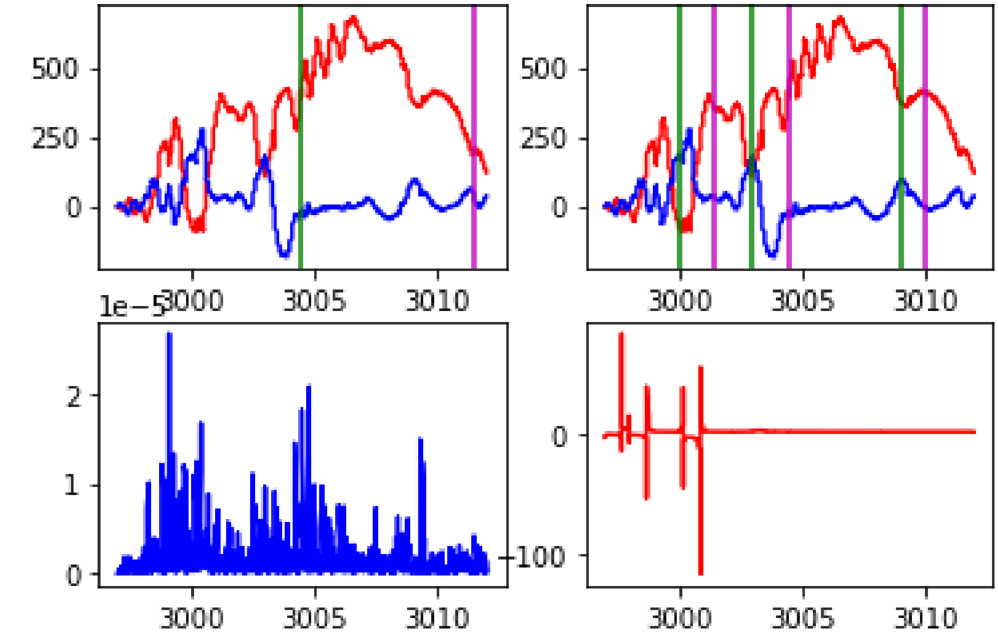
Fast Defence 5, Player 9, Video Time = 0:08:23



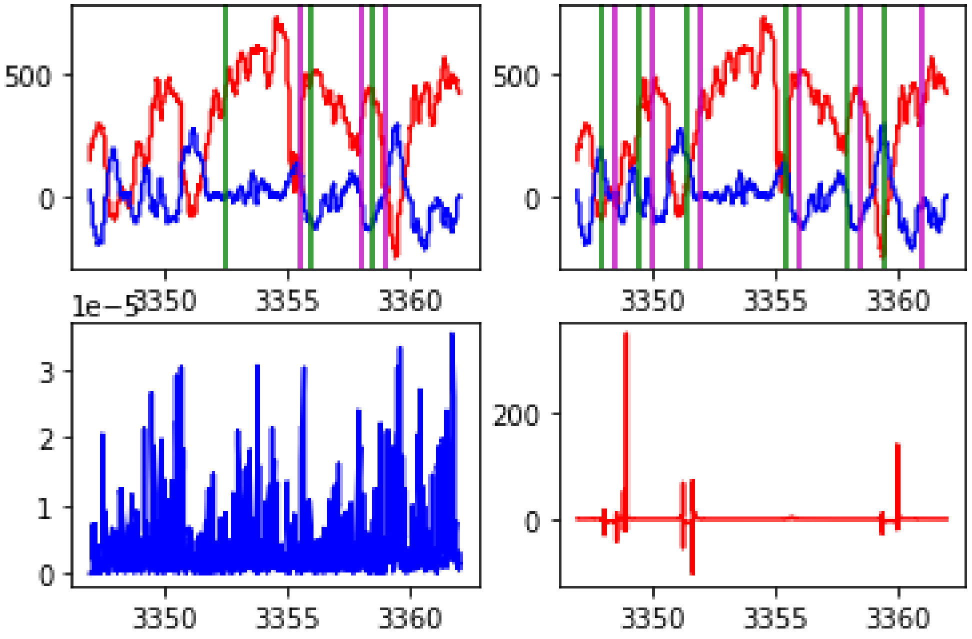
Fast Defence 6, Player 9, Video Time = 0:09:29



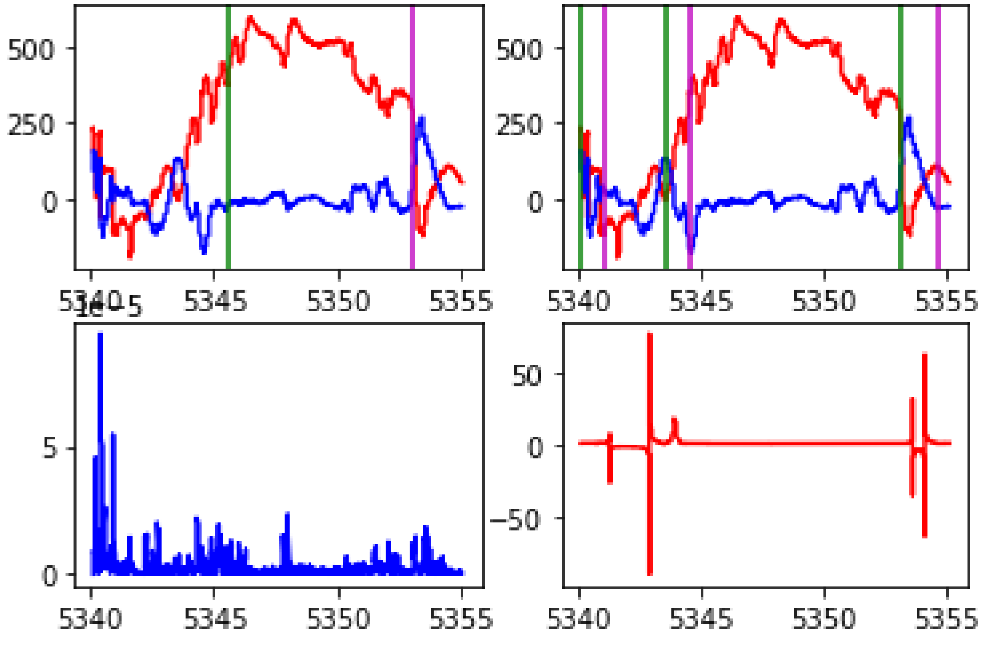
Fast Defence 7, Player 9, Video Time = 0:10:33

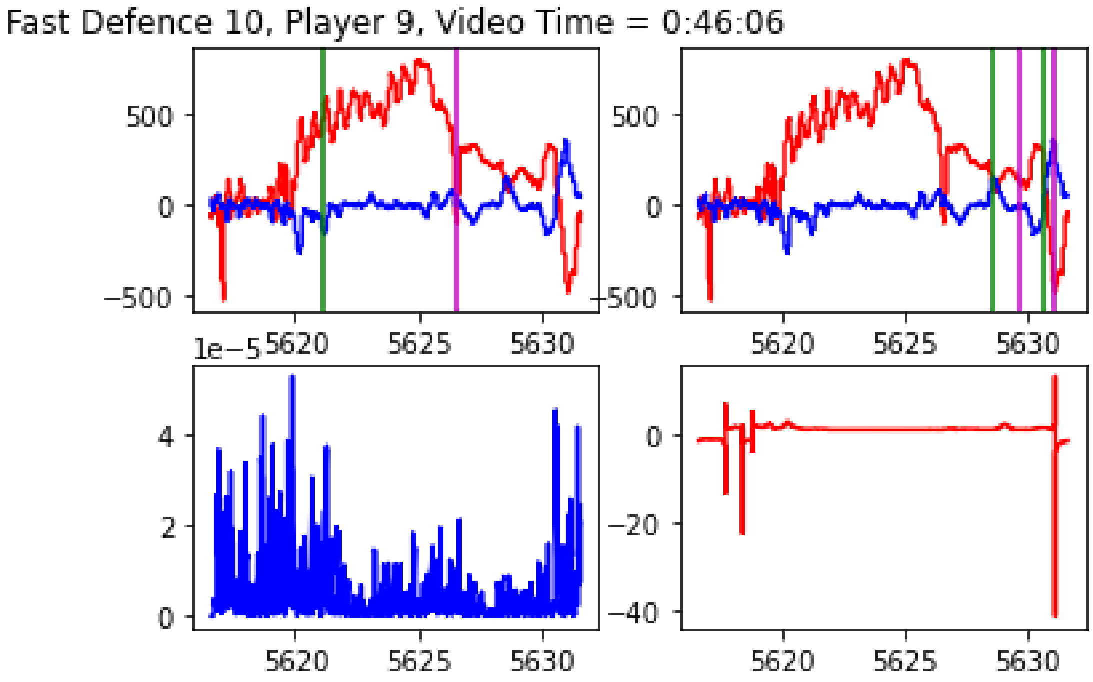


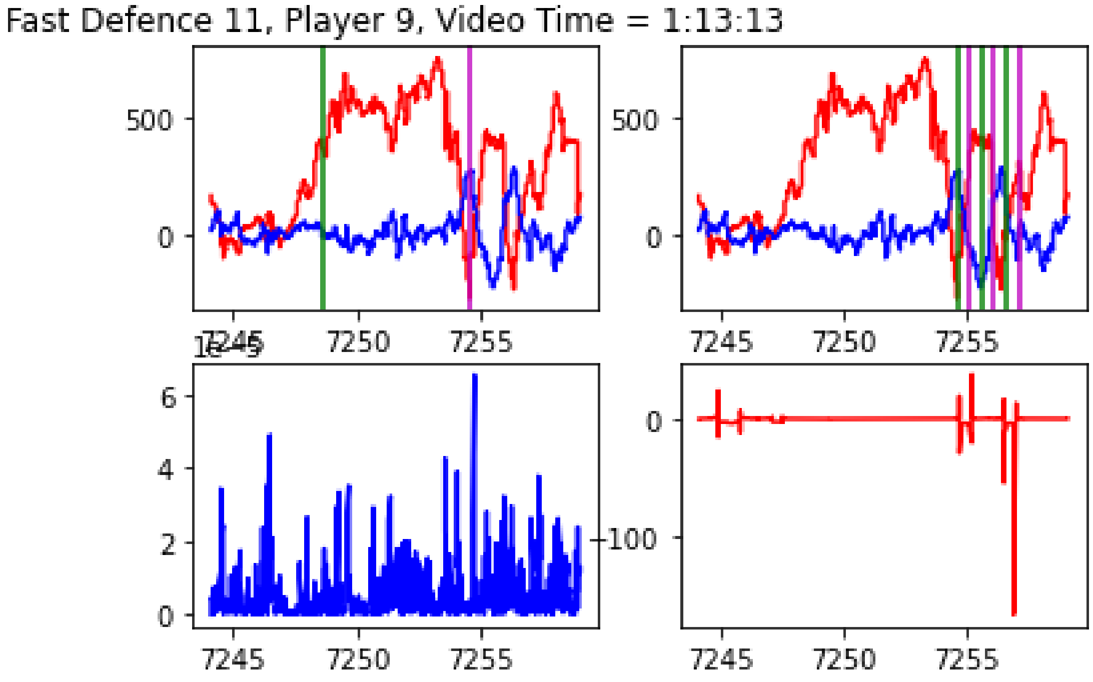
Fast Defence 8, Player 9, Video Time = 0:16:23



Fast Defence 9, Player 9, Video Time = 0:41:29







[107]:
```
Startrotate =[]
Stoprotate = []
```

```
for start in ArrayStartRotate:
    for time in start:
        Startrotate.append(time)

for stop in ArrayStopRotate:
    for time in stop:
        Stoprotate.append(time)

print(Startrotate, Stoprotate)

df_Player['Action'] = ""

#There are 9 rotations since the one that doesnt have end
for i  in range(0,len(Startrotate)):
    df_Player['Action'].iloc[int(Startrotate[i]*100-5):
 ↪int(Stoprotate[i]*100-5)] = 1


df_Player.to_csv('matrix_Player_' + str(Player) + '_game_' + str(Game) +␣
 ↪'_Action.csv')
```

```
[2464.6, 2465.6, 2472.6, 2641.2, 2643.2, 2646.2, 2653.2, 2654.2, 2679.3, 2681.3,
2682.8, 2796.5, 2807.5, 2867.7, 2868.7, 2872.7, 2879.7, 2936.3, 2945.8, 3000.0,
3003.0, 3009.0, 3348.0, 3349.5, 3351.5, 3355.5, 3358.0, 3359.5, 5340.1, 5343.6,
5353.1, 5628.6, 5630.6, 7254.6, 7255.6, 7256.6] [2465.1, 2466.6, 2473.6, 2641.7,
2643.7, 2646.7, 2653.7, 2654.7, 2680.8, 2682.3, 2683.8, 2798.0, 2809.0, 2868.2,
2871.2, 2873.2, 2880.2, 2936.8, 2946.8, 3001.5, 3004.5, 3010.0, 3348.5, 3350.0,
3352.0, 3356.0, 3358.5, 3361.0, 5341.1, 5344.6, 5354.6, 5629.6, 5631.1, 7255.1,
7256.1, 7257.1]
```

```
/opt/jupyterhub/anaconda/lib/python3.8/site-
packages/pandas/core/indexing.py:1637: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  self._setitem_single_block(indexer, value, name)
```

[108]:

```
print(len(Stoprotate))

print(len(Startrotate))
```

```
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```

[ ]:

[ ]:

```
```