e_t

March 14, 2023

[ ]:

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import math
import time
import sys
import os
from scipy.signal import savgol_filter
from scipy.interpolate import interp1d
from tqdm import tqdm
sys.path.append(os.path.join(os.getcwd(), "..", ".."))
from support.omniwheel_calculation import *
from datetime import datetime
from support.pd_support import *
from support.calculations_support import *
from support.ar_calculations import *
from numba import njit
import polars as pl
from scipy.signal import find_peaks
from scipy.signal import peak_widths
from scipy.signal import peak_prominences
from support.imu_calculations import *
```

[ ]:

```
_parent_folder = "encoder_validation"
_folder_name = "sk28_et_0"
_base_pth = os.path.dirname(os.getcwd())
_base_pth = os.path.join(_base_pth, "..","recording_programs", "test_data",␣
 ↪_parent_folder)
_base_pth
```

[ ]:

```
'c:\\Users\\CMC\\Documents\\openposelibs\\pose\\armbo\\simulation\\..\\recording
_programs\\test_data\\encoder_validation'
```

[ ]:

```
_sk_df = pd.read_csv(os.path.join(_base_pth, _folder_name, "imu01.csv"))
_sk_df["rust_time"] = _sk_df["rust_time"].apply(lambda x: datetime.
 ↪fromtimestamp(x))
# set zero
_sk_df.rename(columns={"rust_time": "time", "e_fr":"e_t"}, inplace=True)
```

```
_sk_df = set_zero(_sk_df, column_name = ["e_t", "e_rr", "e_rl"])
# rename columns
_sk_df["e_t"] =  -_sk_df["e_t"]

_sk_df
```

```
[ ]:                          sys_time                       time    e_t  e_fl  \
     0     2023-03-10 18:10:02.698311 2023-03-10 18:10:02.698669      0     0
     1     2023-03-10 18:10:02.922034 2023-03-10 18:10:02.922161      0     0
     2     2023-03-10 18:10:02.922530 2023-03-10 18:10:02.922627      0     0
     3     2023-03-10 18:10:02.923026 2023-03-10 18:10:02.923140      0     0
     4     2023-03-10 18:10:02.923522 2023-03-10 18:10:02.923549      0     0
     …                              …                          …     …   …
     4955  2023-03-10 18:10:56.556070 2023-03-10 18:10:56.556546  98149     0
     4956  2023-03-10 18:10:56.567161 2023-03-10 18:10:56.567520  98149     0
     4957  2023-03-10 18:10:56.578076 2023-03-10 18:10:56.578307  98149     0
     4958  2023-03-10 18:10:56.588802 2023-03-10 18:10:56.589101  98149     0
     4959  2023-03-10 18:10:56.600110 2023-03-10 18:10:56.600137  98149     0

           e_rr  e_rl                            rtc     mils  sync        ax  \
     0        0     0  2023-03-10 11.40.01.000000 PM  1153034     0 -0.889648
     1        0     0  2023-03-10 11.40.01.000000 PM  1153045     0 -0.890137
     2        0     0  2023-03-10 11.40.01.000000 PM  1153056     0 -0.890625
     3        0     0  2023-03-10 11.40.01.000000 PM  1153067     0 -0.888184
     4        0     0  2023-03-10 11.40.01.000000 PM  1153078     0 -0.888184
     …     …    …                              …        …     …       …
     4955     0    -1  2023-03-10 11.40.55.000000 PM  1206890     0 -0.888672
     4956     0    -1  2023-03-10 11.40.55.000000 PM  1206901     0 -0.888672
     4957     0    -1  2023-03-10 11.40.55.000000 PM  1206912     0 -0.891602
     4958     0    -1  2023-03-10 11.40.55.000000 PM  1206923     0 -0.888184
     4959     0    -1  2023-03-10 11.40.55.000000 PM  1206934     0 -0.891602

                 ay        az        gx        gy        gz          mx  \
     0     0.197266 -0.107910 -0.183105 -0.061035  1.525879  783.969849
     1     0.197266 -0.105957 -0.122070 -0.061035  1.525879  789.364136
     2     0.196289 -0.105469 -0.061035 -0.122070  1.586914  787.566040
     3     0.198730 -0.104980 -0.183105 -0.061035  1.586914  760.594604
     4     0.196289 -0.108887 -0.183105 -0.122070  1.525879  785.767944
     …          …       …       …       …       …          …
     4955  0.204102 -0.101562 -0.244141 -0.061035  1.525879  792.960327
     4956  0.203613 -0.102051 -0.183105 -0.183105  1.586914  789.364136
     4957  0.203125 -0.103516 -0.122070  0.000000  1.464844  778.575562
     4958  0.203125 -0.105469 -0.122070 -0.244141  1.525879  774.979370
     4959  0.202637 -0.105469 -0.122070 -0.183105  1.464844  774.979370

                   my          mz
```

```
0     213.663010 -72.322121
1     204.760376 -87.819710
2     220.785110 -75.766022
3     201.199326 -80.931892
4     194.077225 -70.600166
…            …          …
4955  197.638275 -70.600166
4956  201.199326 -63.712341
4957  204.760376 -84.375801
4958  204.760376 -80.931892
4959  204.760376 -74.044067

[4960 rows x 18 columns]
```

[ ]:

```python
# type in marker details
_xm = get_marker_name(1)
_zm = get_marker_name(3)
_om = get_marker_name(2)
```

[ ]:

```python
_mocap_df, st_time = read_rigid_body_csv(os.path.join(_base_pth, _folder_name.
  ↪split("_")[0] ,_folder_name + ".csv"))
_mocap_df = add_datetime_col(_mocap_df, st_time, "seconds")
```

[ ]:

```python
# This cell is optimized to run faster using polars

# calculate rotation matrix from xvec, zvec, org
_m_df = _mocap_df.copy()
_m_df = pl.from_pandas(_m_df)

_rotmat_i = []
for i in tqdm(range(len(_m_df))):

    _x_vec = _m_df[[_xm["x"], _xm["y"], _xm["z"]]][i, :].to_numpy().T
    _z_vec = _m_df[[_zm["x"], _zm["y"], _zm["z"]]][i, :].to_numpy().T
    _org = _m_df[[_om["x"], _om["y"], _om["z"]]][i, :].to_numpy().T

    _rotmat_i.append(calculate_rotmat(_x_vec, _z_vec, _org))
# calculating del rotmat for mc
_del_r = []
for i in tqdm(range(len(_rotmat_i))):
    _del_r.append(_rotmat_i[i].T@_rotmat_i[0])

# calculating angle for mc
_theta_x = []
_theta_y = []
_theta_z = []
```

```
for i in tqdm(_del_r):
    _theta_x.append(np.arctan2(i[2,1], i[2,2]))
    _theta_y.append(np.arctan2(-i[2,0], np.sqrt(i[2,1]**2 + i[2,2]**2)))
    _theta_z.append(np.arctan2(i[1,0], i[0,0]))

_theta_x = np.array(_theta_x)
_theta_y = np.array(_theta_y)
_theta_z = np.array(_theta_z)

# converting them to degrees
_theta_x = np.rad2deg(_theta_x)
_theta_y = np.rad2deg(_theta_y)
_theta_z = np.rad2deg(_theta_z)
```

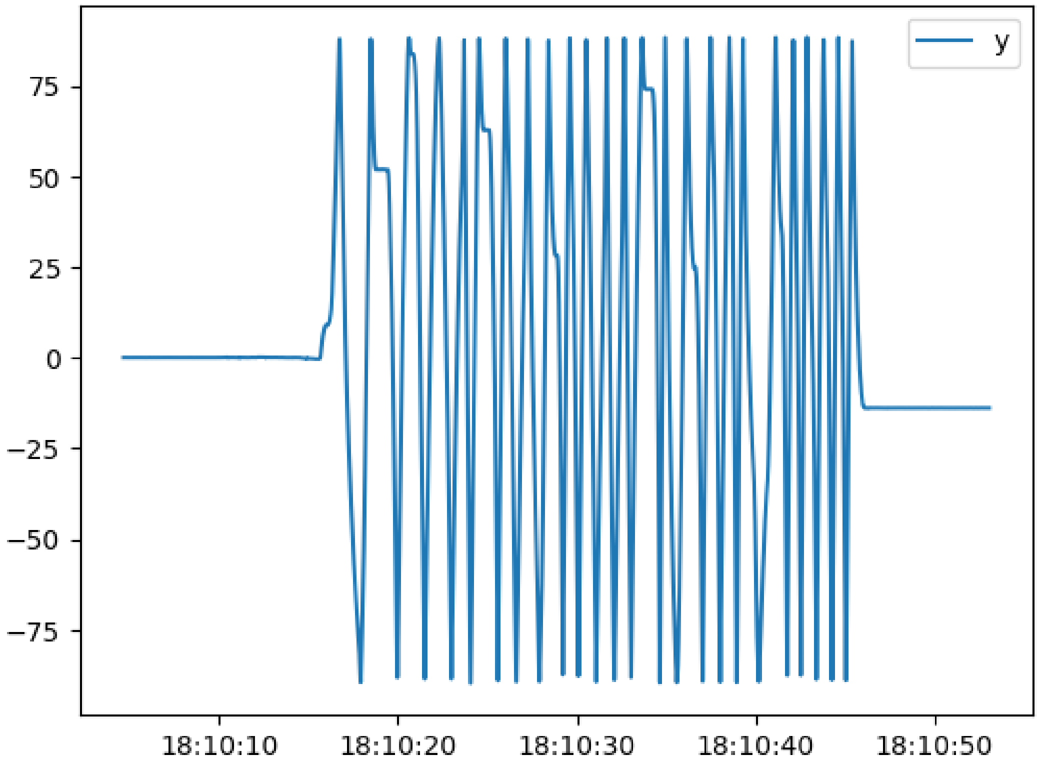
```
100%|      | 4839/4839 [00:02<00:00, 1953.56it/s]
100%|      | 4839/4839 [00:00<00:00, 390259.72it/s]
100%|      | 4839/4839 [00:00<00:00, 120447.44it/s]
```

[ ]:

```
# plt.plot(_m_df["time"][1000:2000], _theta_x[1000:2000], label="x")

plt.plot(_m_df["time"], _theta_y, label="y")
# plt.plot(_m_df["time"][1000:2000], _theta_z[1000:2000], label="z")
# change angle to 0 to 360
plt.legend()
# max(_theta_z)
```

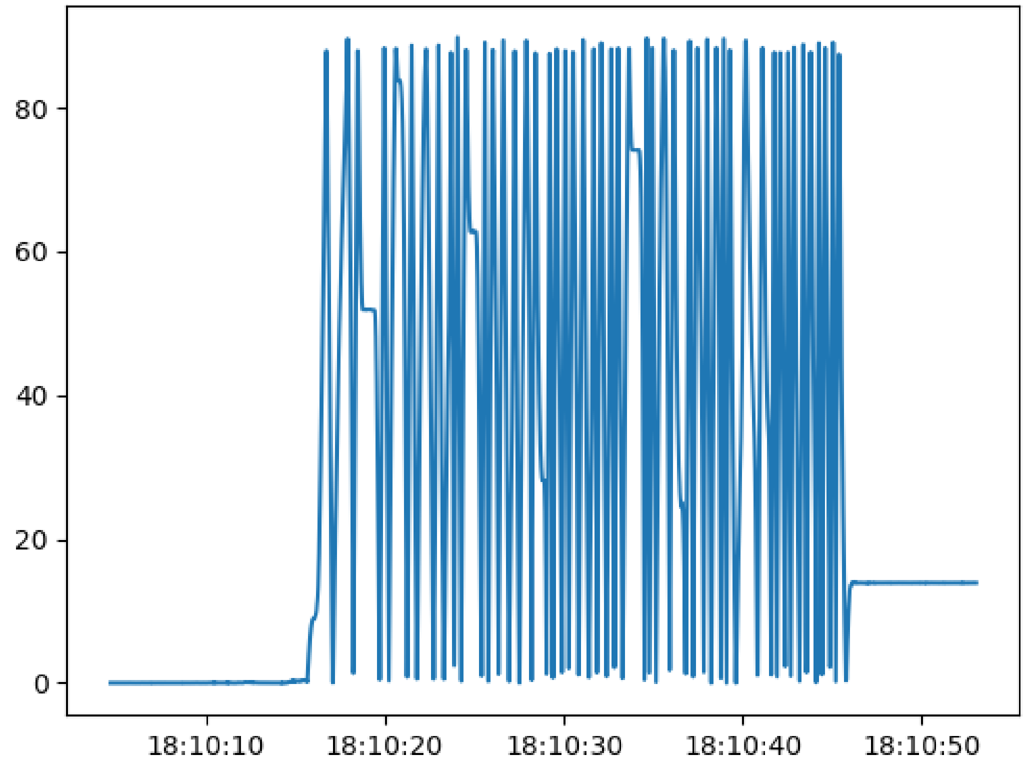
[ ]:

```
<matplotlib.legend.Legend at 0x1fab9140488>
```



```
[ ]: # convert to absolute angle
     _theta_y_abs = []
     for idx, value in enumerate(_theta_y):
         _theta_y_abs.append(value)
         if value < 0:
             value = abs(value)
             # print(idx)
             _theta_y_abs[idx] = value
         else:
             value = value
             _theta_y_abs[idx] = value


     plt.plot(_m_df["time"], _theta_y_abs, label="y")
```

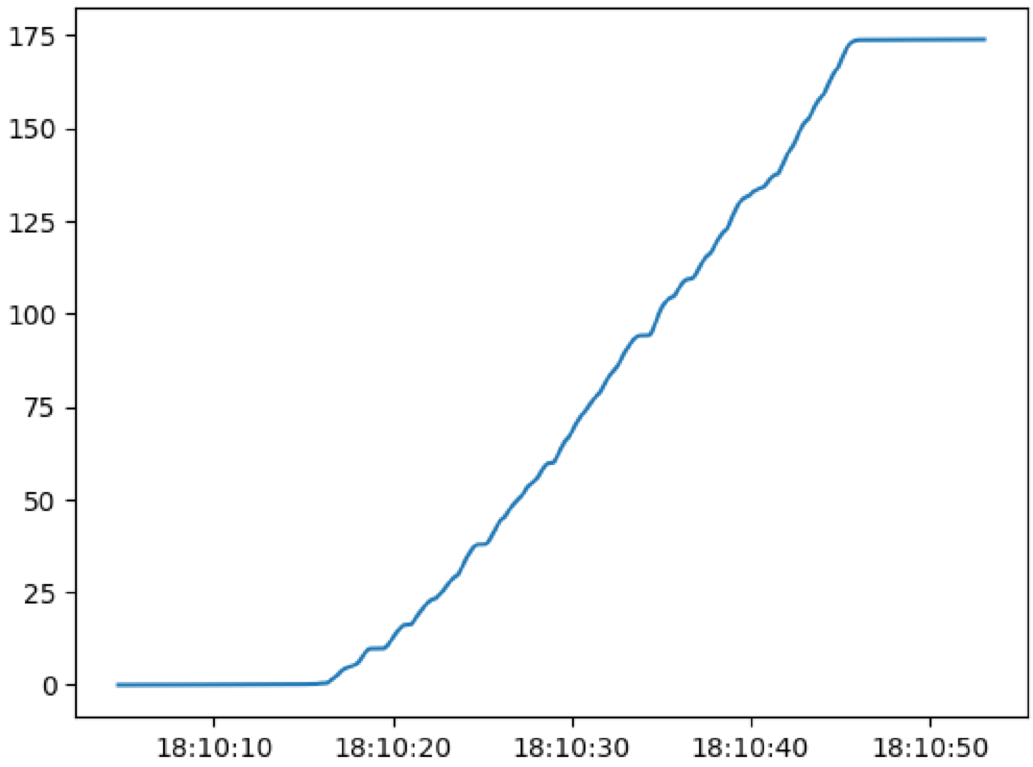
```
[ ]: [<matplotlib.lines.Line2D at 0x1fa9ec8f348>]
```



```
[ ]: theta_df = pd.DataFrame({"time": _m_df["time"], "theta_y": _theta_y})
     theta_df["diff"] = abs(theta_df["theta_y"].diff())
     # replace nan with 0
     theta_df["diff"].fillna(0, inplace=True)
     # integrate angle
     df, _ = get_orientation(theta_df, "diff")
```

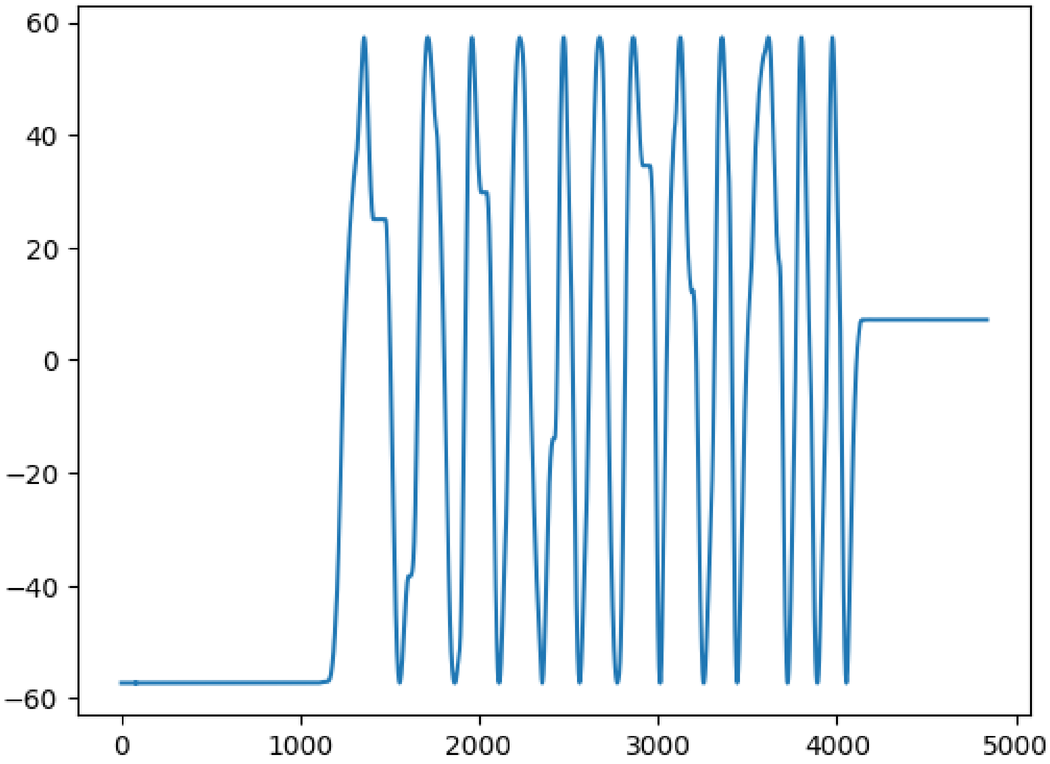
```
[ ]: plt.plot(df["time"], df["theta"], label="y")
```

```
[ ]: [<matplotlib.lines.Line2D at 0x1fabaa8b108>]
```



```
[ ]: plt.plot(np.rad2deg(_mocap_df.rb_ang_w))
```

```
[ ]: [<matplotlib.lines.Line2D at 0x1fabac6d548>]
```



[ ]:

```
_ang_df = _sk_df[['time', 'e_t']].copy()
```

[ ]:

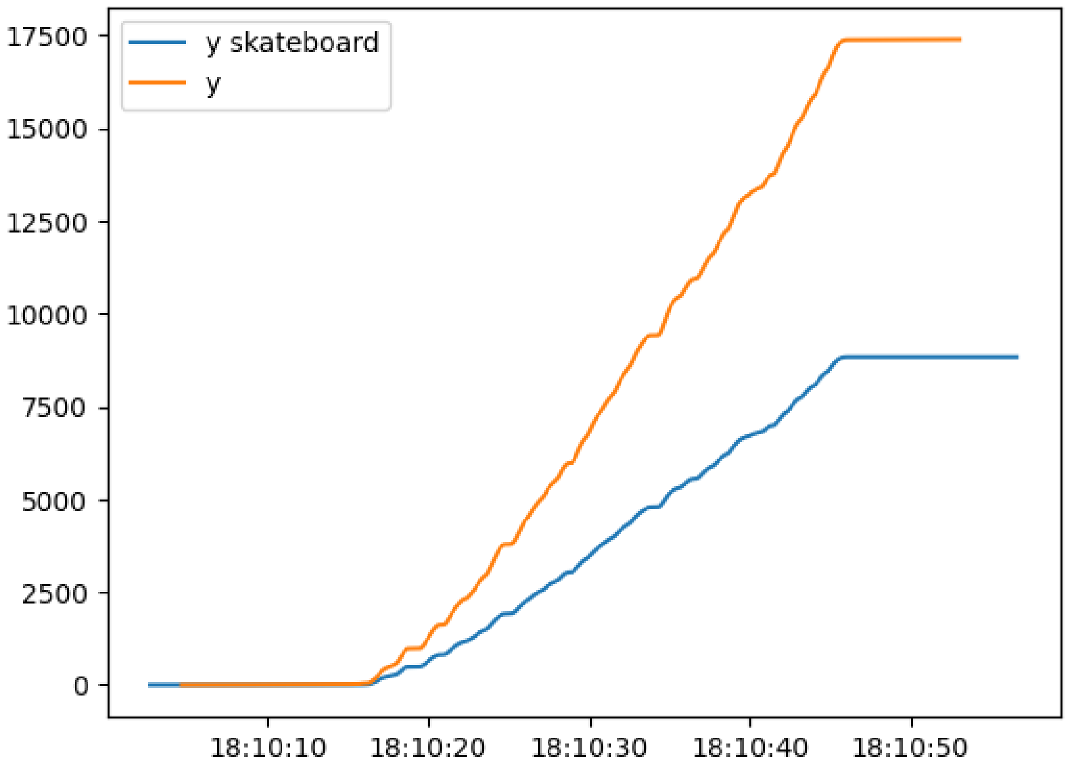
```
_ang_df["ang_y"] = _ang_df["e_t"].apply(lambda x: x*0.09)
# change angle to 0 to 360
# _ang_df["ang_y"] = _ang_df["ang_y"].apply(lambda n: n%360)

# _ang_df["ang_y"] = _ang_df["ang_y"] - _ang_df["ang_y"][0]
```

[ ]:

```
plt.plot(_ang_df["time"], _ang_df["ang_y"], label="y skateboard")
plt.plot(df["time"], df["theta"]*100, label="y")
plt.legend()
```

[ ]:

```
<matplotlib.legend.Legend at 0x1fabafda648>
```


y skateboard
y
17500
15000
12500
10000
7500
5000
2500
0
18:10:10
18:10:20
18:10:30
18:10:40
18:10:50

```
[ ]:
```