

**Biomedical Robotics**  
**EMG data analysis assignment 1**

**Soft Deadline: October 20<sup>th</sup>**

**Group 5**

**Names:** Syed Hasan Shozab Abidi, Divya Noemi Urquijo, Muhammad Ali Haider Dar, Farzin Sarvari

**EMG data preprocessing**

- 1) Load the EMG file EMG\_data.mat  
( $F_s=1000\text{Hz}$ ; 1<sup>st</sup> row Events: 1='Cue'; 2='Go'; 2<sup>nd</sup> row EMG signal Right Biceps; 3<sup>rd</sup> row: Triceps)
- 2) For each muscle implement the following steps:
  - a. Filter (band pass 30-450 Hz) advise FIR filter, recover phase delay 2 with 'filtfilt'.
  - b. rectify
  - c. compute the envelop of the muscle signals (low pass 3-6 Hz)
  - d. down-sample the signal
- 3) Load the motion data kinematic.mat  
( $F_s=100\text{Hz}$ ; 1<sup>st</sup> row Time points; 2<sup>nd</sup> row Events 1 STOP, 2 CUE, 3 GO, 4 TARGET, 8 longer than target; 3<sup>rd</sup> row x cursor, 4<sup>th</sup> row y cursor; 5<sup>th</sup> row x target; 6<sup>th</sup> y target)
- 4) Considering the experimental design (see below); extract EMG and Motion Data of the first set of movements; the first and last sets of force field; the first set of washout

set	1	2	3	4	5		6	7	8	9	10	11	12
Epoch_start	1	97	193	289	385		481	577	673	769	865	961	1057
Epoch_end	96	192	288	384	480		576	672	768	864	960	1056	1152
Condition	NF	NF	NF	NF	NF		FF	FF	FF	FF	FF	WA	WA

Each set contains 96 movements (48 out and 48 back movements). NF= No Force; FF=Force Field; WA=Washout. Remember: each movement has a Cue and a Go events which help you segmenting into sets

**Questions:**

**1. Why the down sampling is computed at the end of the EMG processing?**

**Ans1.** Down sampling on EMG data was done to save the data processing time. If the sampling rate is higher than the more data will be collected in a given unit of time which burden the storage facilities and later stretch the processing time. According to a study conducted by Dr Patrick Li [1], it is possible to use a lower sampling rate for the recognition of multiple classes of arm movements by slightly compromising on the classification accuracy. Down sampling a sampled signal on 1-kHz sampling rate to 500 Hz can save around 50% of the storing memory and reduce 50% of the data processing without significantly losing the quality of the data.

**2. When the muscle activation starts with respect to the movement (see motion signal)?**

**Ans2.** As per the provided data the muscle activation starts approximately 1.4 seconds before the movement.

**3. Which differences can you detect between the sets with and without the application of the force field?**

**Ans.** The first set of movements exposed to force field i.e. Set 6, were quite distorted as compared to previously recorded movements which were not exposed to force field i.e. Set 1. However, the movements got stabilized after some time in force field which can be seen in movements of Set 10. Once the force field exposure ended, there was an increase in distortion again in movements which can be seen in Set 11 during the washout.

The final folder of the assignment must be named Group\_# and it must contain:

The Matlab code with comments and generating the following figures for each muscle and each of the 4 sets you extracted (tip: subplots are easier to understand and follow):

- EMG raw signal with on top the filtered signal plotted with a different color.
- EMG rectified with on top the Envelope plotted with a different color.
- The movement signal X and Y in time
- The xy movements signal together with the targets
- this pdf files filled out

Please, do not put additional files in the final folder

**Reference:**

1. Li, Patrick & Li, Yaonan & Yu, Long & Geng, Yanjuan. (2011). Conditioning and Sampling Issues of EMG Signals in Motion Recognition of Multifunctional Myoelectric Prostheses. Annals of biomedical engineering. 39. 1779-87. 10.1007/s10439-011-0265-x.