# Term Project – Fall 2023
# EMG Decomposition/Spike Sorting

Phase I: Due Date – Nov. 14, 2023

Phase II: Due date – Dec. 17, 2023

Each student must individually finish the term project about EMG/spike decomposition method. ***The project includes an aspect of competition, three projects with the best decomposition performance will be recognized from the class and proper credits will be awarded accordingly.***

The project will be carried out and accordingly evaluated in two phases.

1. **Phase I** - is the background preparation including 1) reviewing/digesting major key papers about EMG recording and understanding its signal characteristics; 2) understanding the basic module flow of the decomposition method using machine learning techniques (see appendix - flow chart). Thus you are assigned to prepare a technical report that documents your systematic knowledge about EMG and its decomposition nature. The report should be less than 10 pages**.**

2. **Phase II** – is the implementation including 1) MATLAB codes for each individual building module; 2) integration of the overall modules (NOTE: the MATLAB codes must be organized as sections so that individual section could be executed and tested with MATLAB); 2) testing of the method with a given set of recorded EMG waveforms; 3) final term project report and codes.

Two small segments of real EMG signals are uploaded to the course portal for your practice. Final long segment of EMG recordings will be released for your tested in late November.

**Phase I Report** – is for the background preparation including

a. Reviewing/digesting major key papers about EMG recording and understanding its signal characteristics – literature search for several key papers other than the one given by the class; EMG - signal basics, signal amplitude and bandwidth, templates, applications. Availability of the state-of-art and open source software packages? Availability of the benchmark for EMG decomposition?

b. Understanding the basic module flow of the decomposition method using machine learning techniques (see attached flow chart). What mathematical techniques and signal processing tools are expected in your project phase II?

**c.** The report should be less than 10 pages**.**

**Phase II - Final Term project grading criteria**

I. MATLAB code (400 points)
   1) Each section will be graded individually according to the accomplishment
   2) The codes must be organized as specific sections by "%%". Sections must include
      a. Input file (50 points)
      b. Filter signal (50 points)
      c. Detect spikes (50 points)
      d. Align spikes (50 points)
      e. Extract features (50 points)
      f. Cluster spikes (50 points)
      g. Classify spikes (50 points)
      h. Analysis (50 points)
   3) Detailed comments are required in all sections
   4) Each section has to be able to be a) executed individually and b) generate the input/output figures. The figures have to be well titled.
   5) Sufficient comment in code will seriously impact the grading
   6) **Grading criteria for each section: CORRECT execution (40 points), readability (10 points)**
   7) The beginning of the first section "Input file" should be as follows:

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```
%% Inputfile
M= csvread('EMG_example_2_fs_2k.csv');
%read in csv file time= M(:,1); % first
column is the time series
fs= (time(2)-time(1))^-1; % calculate the
sample frequency channel_number= size(M,2)-
1; % num of channels in the database for
i=1:channel_number,
    figure('Color',[1 1 1]);plot(time,M(:,i+1));
    %plot each channel str= sprintf('Channel
    %d',i);
```

```
    xlabel('seconds');title(str);xlim([time(1) time(size(time,1))]); % label
and title eachplots end
channel_select= 1; % select channel for testing. channel_select<=
channel_number test_input= M(:,channel_select+1); % test_input will go
through all the individual sections
```

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**Note:**

1. The test file and channel can be randomly assigned for grading evaluation.
2. For *EMG_example_1_90s_fs_2k.csv*, you will have to type in the sample rate fs=2000 and arrange the time series accordingly.

II. Report (100 points)

1) Use ***PowerPoint format***
2) Introduction/Method description (20 points)
3) Results and figures of 8 building section for 3 test databases (40 points)
4) Discussion of the results of each section and conclusion (40 points)
5) Avoid long and tedious description and focus at important points

III. Bonus (Each up to 100 points)

1) Advanced features/analysis methods, and extensions
2) Outstanding performance
3) Best 3 projects of the class