Python MU Editing User Manual

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This program can be used for decomposition of HD-EMG signals. After the decomposition the motor units are visualised and manual editing can be applied. This program an manual is based on the open-source MUEdit program [1, 2]

1 When to use

Manual editing is an essential part of the motor unit decomposition workflow. After decomposition, every motor unit needs to be visually inspected as the decomposition algorithm is not perfect [2].

2 How to use

2.1 Installation

Firstly, the program needs to be installed as explained in the Readme file of the repository.

2.2 Data types

The current supported data types are .poly5 files for decomposition mode and Open-HDEMG style .json files for editing mode. To switch between modes, edit the `MODE` variable in the main file.

2.3 The GUI

When a decomposed file is loaded, the GUI will show up (see figure 1). The plot at the top shows the instantaneous discharge rates along with the silhouette value of the current pulse train, this is calculated by using the time between two consecutive firings. The plot at the bottom shows the pulse train, with the detected peaks shown as well as the number of the current motor unit.

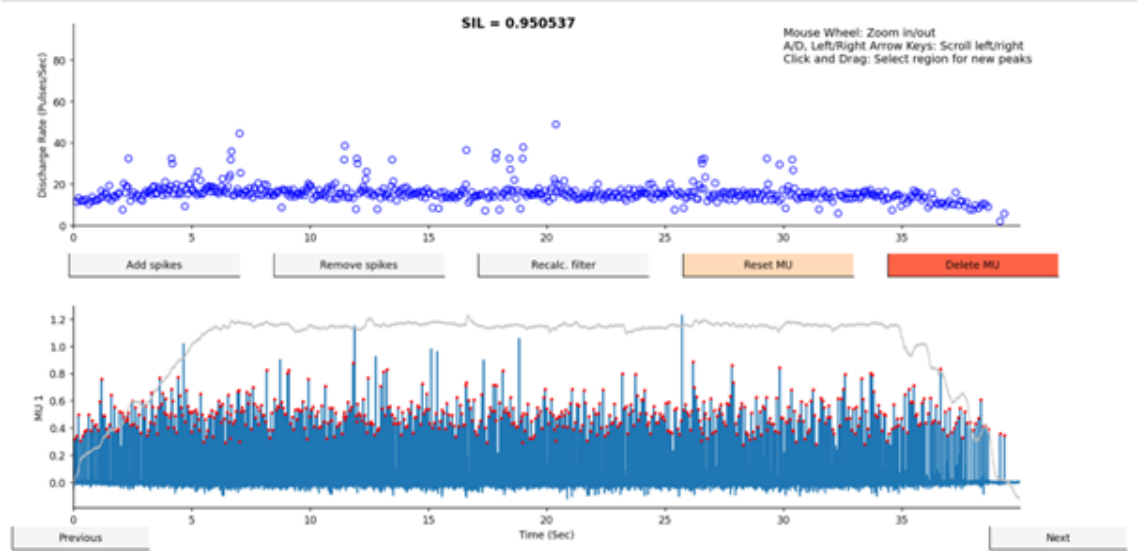

Figure 1: GUI of the software.

Multiple buttons can be pressed in the GUI:

- Previous/next: go to previous/next motor unit
- Add/remove spikes: this button enables a rectangle selector in the bottom plot. Selecting a peak will result in this peak being added to/removed from the list of peaks and the discharge rate at the top plot will change accordingly.
- Recalc. filter: This button will recalculate the motor unit filter for the current motor unit. It only takes into account the current window, the pulse train outside of this window is unaffected.
- Reset MU: Reset current motor unit to the original. Can be used if MU editing is not giving intended results.
- Delete MU: If the user deems the current MU unreliable, this button can be pressed to delete this motor unit.
- Zooming/scrolling: The mouse wheel and the key buttons can be used to zoom/scroll.

2.4 Editing

To edit a motor unit follow the following steps in order [2, 3, 4]:

1. Identify a window of about 3s containing false positives. A good way of doing this is by looking at the discharge rate in the top plot. If you see clear peaks in discharge rates you know the algorithm has made an error and incorrectly added a peak
2. In this window, remove all spikes of lower quality using the 'Remove spikes' button and press the 'Recalc. filter' button. If there are still unwanted spikes in this window after recalculating the filter, repeat.
3. Continue doing this for all windows of interest until no false positives remain.

4. The same has to be done for false negatives, i.e. peaks that incorrectly have not been selected. Again, this can be made easier by looking for valleys in the top plot of discharge rates.

5. Repeat this process for all motor units.

After this, the discharge rate plot should look smooth without very apparent peaks/valleys. To note: removing or adding a peak is always followed by pressing the 'Recalc. filter button', **never** add/remove peaks without recalculating to avoid bias.
To save the edition, simply close the GUI and the file will be saved in your measurements folder with '_edited' appended. The file is an OpenHDEMG style .json file.

To get an idea of what an effect editing can have on the discharge rate plot, see figure 2.

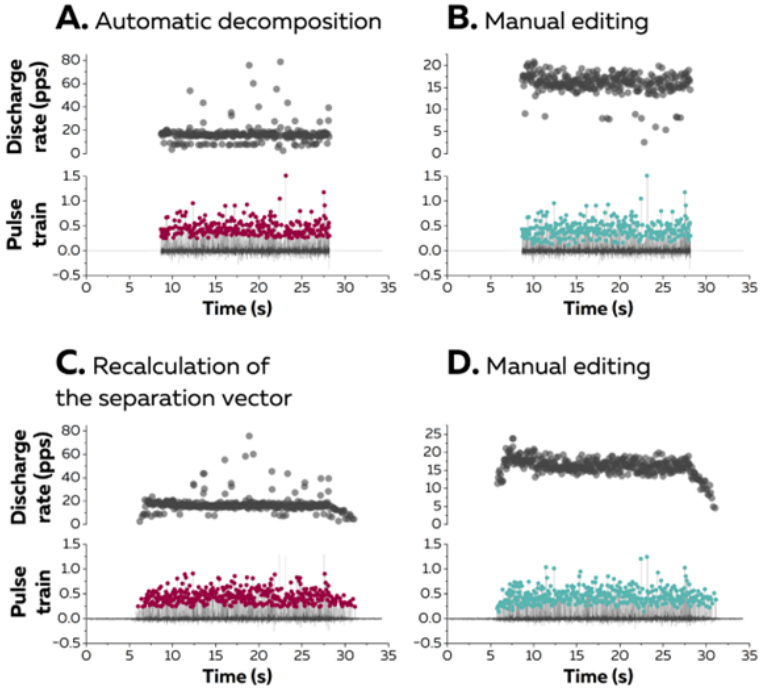

Figure 2: Effect of motor unit editing. In A. the before is seen. In B. the outlier at the top are removed. In C. the filter is recalculated. In D. the final result is shown after a couple iterations of editing and recalculating. As can be seen, the discharge plot is much smoother than in A [2].

3 Decomposition

Above workflow is for when a .json file is loaded with the decomposition part already finished. However, the software is also capable of this decomposition. By running the program in 'decompose' mode and selecting a .poly5 file from the measurements folder, the decomposition will start.

3.1 Parameters

There are multiple parameters to adjust in this program:

- Rejected channels: this parameter determines which channels do not get taken into account during the decomposition. You can reject channels in the GUI that shows up after selecting your file. This is done by clicking on the respective channel name.
- To filter: depending on whether your signal has been filtered you can adjust this parameter. To do this, in the init function of `EMG_Decomposition.py` set either a 0 or a 1 where the `offline_EMG` class is instantiated.
- In the init function in `EMG_classes.py`:
  - Number of iterations of the BSS algorithm
  - Number of extended channels used in the algorithm
  - Duplicate threshold: value between 0-1 which represent percentage of firings that need to overlap for the algorithm to see as duplicates
  - Covariance threshold: Threshold that determines below what value the covariance of interspike intervals has to be for the filter to be accepted
  - Silhouette threshold: Threshold that determines above what value the silhouette value has to be for the filter to be accepted
  - There are more parameters representing different functionalities of MUEdit in matlab, but a lot of these have a TO-DO next to them saying they are untested. Advisable is to leave these as is for now.

After the decomposition, the file will be saved and the program will go into editing mode.

References

[1] Simon Avrillon and Michael Uren Hub. *MUedit: a step-by-step user manual*. 2024

. [2] Simon Avrillon et al. "Tutorial on MUedit: An open-source software for identifying and analysing the discharge timing of motor units from electromyographic signals". In: *Journal of electromyography and kinesiology : official journal of the International Society of Electrophysiological Kinesiology* 77 (Aug. 2024). ISSN: 1873-5711. DOI: 10.1016/J.JELEKIN.2024.102886. URL: https://pubmed.ncbi.nlm.nih.gov/38761514/.

[3] A. Del Vecchio et al. "Tutorial: Analysis of motor unit discharge characteristics from high-density surface EMG signals". In: *Journal of Electromyography and Kinesiology* 53 (Aug. 2020), p. 102426. ISSN: 1050-6411. DOI: 10.1016/J.JELEKIN.2020.102426.

[4] François Hug et al. "Analysis of motor unit spike trains estimated from high-density surface electromyography is highly reliable across operators". In: *Journal of Electromyography and Kinesiology* 58 (June 2021), p. 102548. ISSN: 1050-6411. DOI: 10.1016/J.JELEKIN.2021.102548.