Developing Pre-processing Filtering Methods for Electrophysiology Recordings

Esther Bedoyan[1,2], Jay Reddy[1], and Maysam Chamanzar[1,2]

[1]Department of Electrical and Computer Engineering, Carnegie Mellon University (CMU), [2]Center for Neural Basis of Cognition, CMU

Current Neural Data Analysis Pipeline

- **Electrophysiology (ephys) recordings can contain non-biological signals**, such as 1) artifacts caused by motion or stimulation and 2) electrical interference, that are picked up by recording amplifiers.
- **Artifacts can be misclassified as spikes, and background noise can be conflated with a spike waveform**, degrading the performance of spike-sorting algorithms and subsequent data analysis.
- To attempt to reject non-neuronal signals, current spike-sorting frameworks use band-pass filters in the spike band (300 Hz - 7 kHz) and targeted filters (i.e. 60 Hz mains electricity). However, these **current methods are unable to filter out interfering signals that fall within the spike band or adapt to the noise environment of a specific experimental context.**
- To address this issue, **I explore a new adaptive filtering technique that isolates biological signals from electronic interference** (i.e., 60 Hz mains noise, switching power supplies, etc..) by isolating and removing narrowband peaks in the frequency domain.

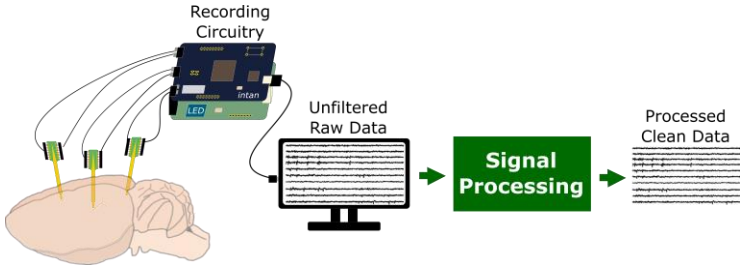

Fig 1. Schematic of Recording and Signal Processing Pipeline

Noise Removal Method using Frequency Domain

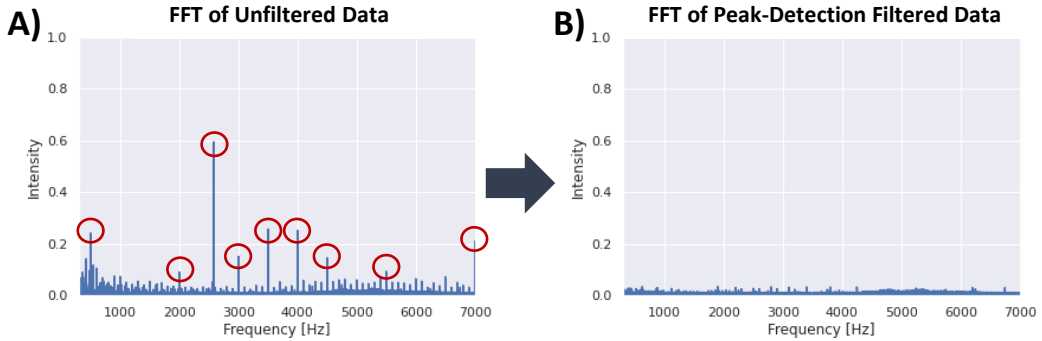

Fig 2. Peak-detection of FFT plot used to removed noise bands. Fast Fourier Transform (FFT) plots of unfiltered (A) and peak-detection filtered data (B). All harmonics of 60Hz and frequency peaks (some of which are circled in red) above a spike prominence of 0.035 are removed using a notch-filter (bandwidth = 5Hz).

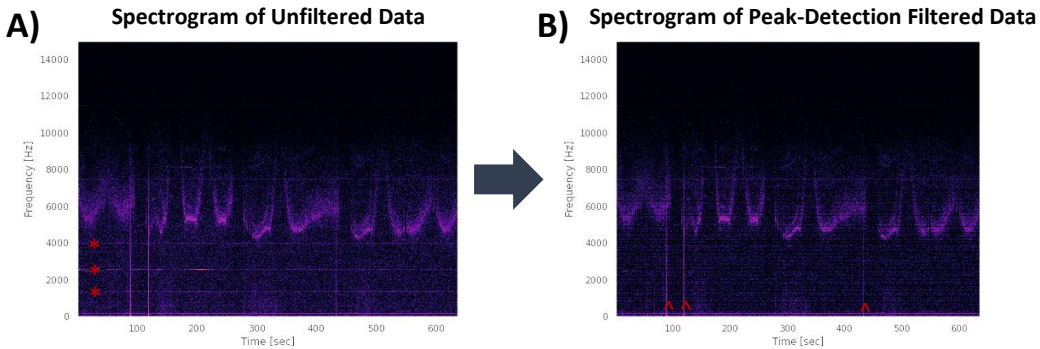

Fig 3. Filtering technique is restricted to the frequency domain. Spectrogram of unfiltered (A) and peak-detection filtered data (B). Horizontal noise bands (some of which are denoted with *) present in (A) are removed, however artifacts visible in the time-domain (^) are untouched.

Filtered Waveform Results

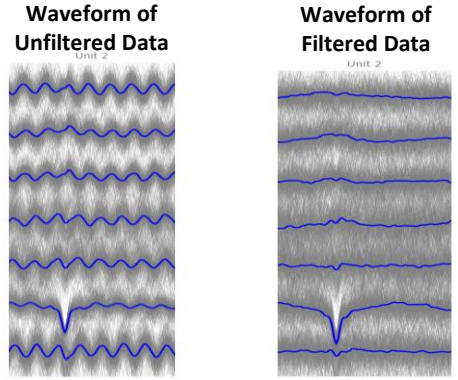

Fig 4. Unit waveform comparison of pre- and post-filtered ephys recording. High-frequency sinusoidal interference is removed.

Next Steps: Wavelet Analysis

- Explore filtering methods using wavelet-based analysis - allows for simultaneous filtering methods in the time and frequency domain.
- Wavelet-based filtering has the potential for better-targeted artifact removal

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