HFOVIS: an Open-source Semi-automatic Detector and Viewer of High Frequency Oscillations

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High frequency oscillations (HFOs) in the 80-500 Hz band have been implicated in attention[1], memory formation[2], and normal neurodevelopment [3]. Pathologic HFOs have been identified as a biomarker of epileptogenic cortex in the surgical treatment of epilepsy[4]. Visual detection of HFOs is a time-consuming task, particularly with long, multi-channel electrocorticographic (ECoG) recordings. Multiple automated HFO detection methods have been described which are time-saving[5,6], however automated HFO detection methods to date have high false detection rates that limit their utility for research and clinical applications. A recent study found automated HFO detectors to have high false detection rates ranging as high as 66 to 77%[7]. Thus, the accurate use of HFO automatic detection algorithms in research and clinical use requires supervision by an expert (e.g. neurologist) to visually inspect results. There is a paucity of visualization tools that allows for the detection, efficient navigation, and analysis of HFOs in large EEG datasets. We present HFOVIS, an open-source semi-automated HFO detector and viewer built on a Matlab (Mathworks) Graphical User Interface (GUI). It allows the user to semi-automatically detect HFOs using a commonly used method[7]. In addition, the GUI has a heatmap view that allows for the multichannel visual inspection of HFOs over the entire duration of the study (Figure 1). This method quickly reveals segments of data with high HFO rates, which the user can explore further by clicking to examine in more detail. This provides a convenient 'drill-down' navigation technique for efficient visual analysis of HFOs within large, multi-channel EEG datasets. The GUI also contains an HFO verification module utilizing FIR filter and the complex Morlet wavelet that allows a trained EEG reader to efficiently review putative HFO events (Figure 2). We have developed the GUI to be open-source and extensible. Thus, we expect it to evolve into a beneficial clinical tool for research purposes and the treatment of epilepsy and other neuropsychiatric disorders.

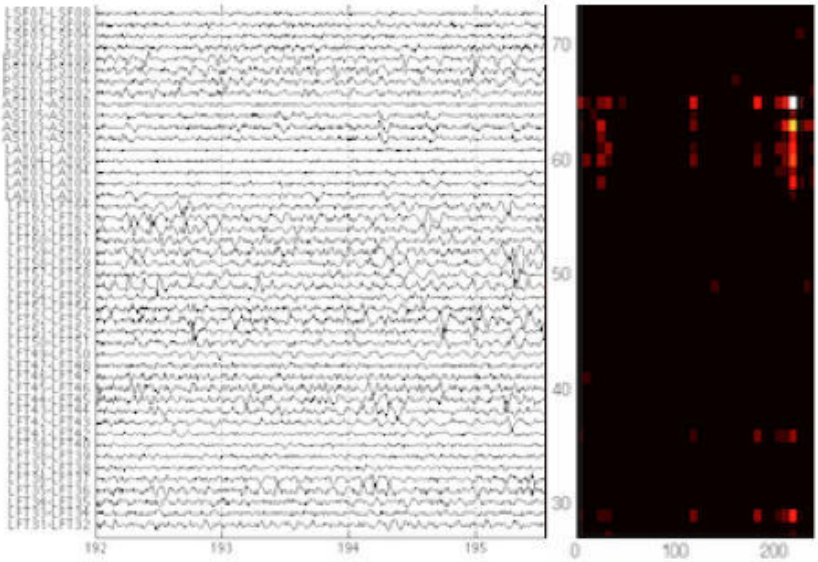

Figure 1. Sample ECoG data and HFO rate from a 10-min sample shown on heatmap

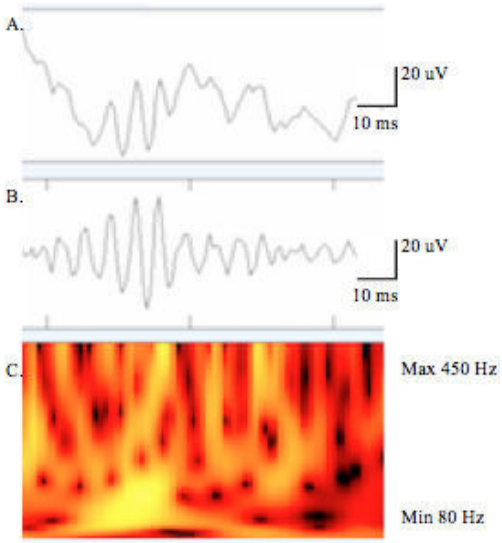

Figure 2. A. Unfiltered data B. FIR filtered data C. Morlet Wavelet

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