Elpi: facilitating the annotation and review of High Frequency Oscillations

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Introduction

The use of HFO as biomarkers of neurological disorders is often challenged by the subjectivity and time-demand that characterizes the visual annotation process. Current EEG software packages lack functionalities that allow: filtering at higher frequencies, generating spectrograms, placing annotations that are channel specific. We have developed an EEG App that facilitates the annotation of EEG patterns and fills in the missing software gap in the process of visually marking HFO, as well as validating automatically detected HFO.

Methods

The presented system allows annotating channel-specific events of variable duration by using the mouse to draw a rectangle over the EEG pattern. Each annotation can be edited by clicking on it and other annotation characteristics such as color and channel-specificity are customizable. Two EEG panels can be displayed and individually filtered. A Morlet-Wavelet-Spectrogram can be displayed to analyze the frequency components of selected channels (Fig.1). The presented App also generates a noise map in gray scale that synchronizes with the EEG review panels, which allows quickly screening the EEG for high noise sections. Other features include customizable panel sizes, keeping memory of last session settings, autosave mode and the generation of tabular reports amongst others:

- Synchronized dual panels with independent FIR filters and window-lengths
- Intuitive and fast scrolling through signals
- Synchronized wavelet analysis
- Customizable band-pass and notch filters
- Channel-wide and channel-specific annotations of variable duration
- Compatible with common file formats (Persyst, Natus, EDF, EEGLAB, etc.)
- Exporting of clips in EDF format

Results

The developed App has been used to annotate HFO on the scalp EEG of over 70 patients. In total, over 10000 events have been visually marked, spanning over 100 hours of scalp EEG. Additionally, over 8000 automatic HFO detections were validated and 170000 were discarded as artifacts using Elpi.

Conclusions

The developed App has been used to annotate HFO on the scalp EEG of over 70 patients. In total, over 10000 events have been visually marked, spanning over 100 hours of scalp EEG. Additionally, over 8000 automatic HFO detections were validated and 170000 were discarded as artifacts using Elpi.

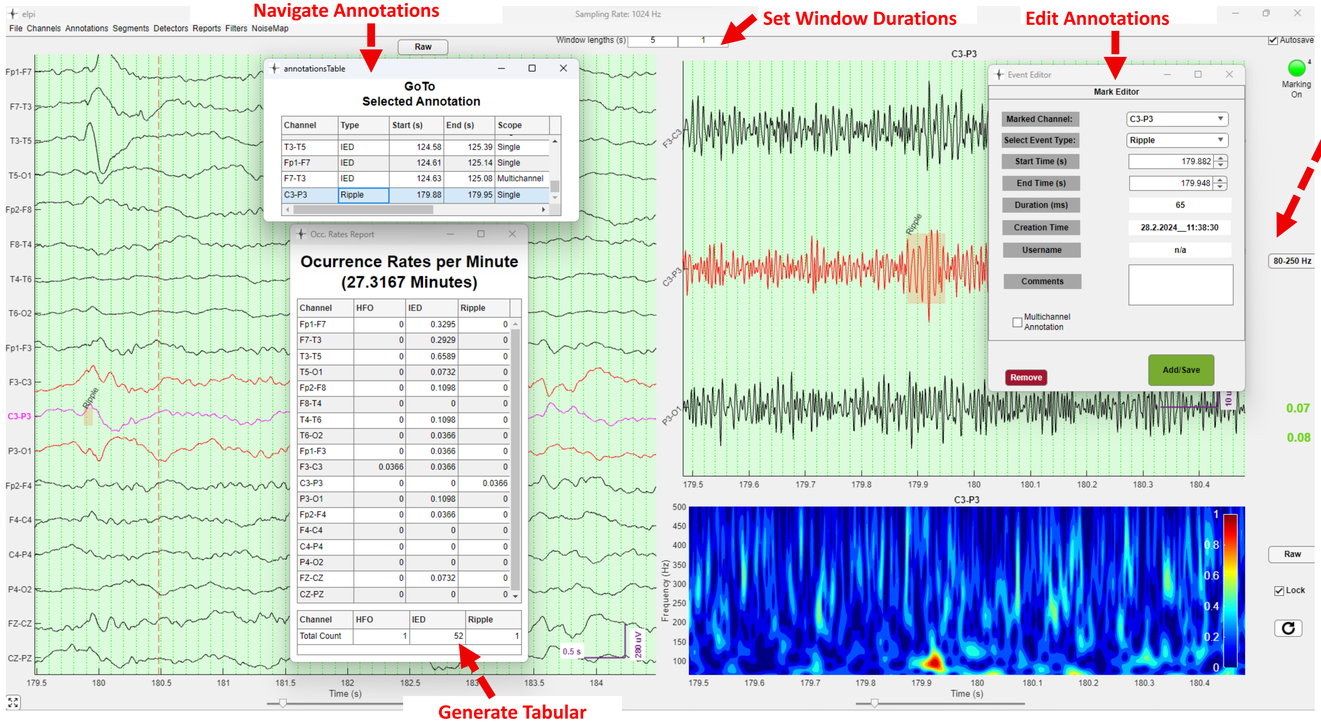

Fig.1) Elpi allows placing channel-specific or channel-wide annotations on both the intracranial and scalp EEG. The tool provides two review panels with individual filtering and a Spectrogram panel that facilitates the recognition of artifacts stemming from fast transients. The annotations can be navigated by clicking on the floating window displayed in the figure. A report containing the occurrence rate from each annotation type can be generated automatically and provides the information needed to explore which brain regions present the highest biomarker activity.

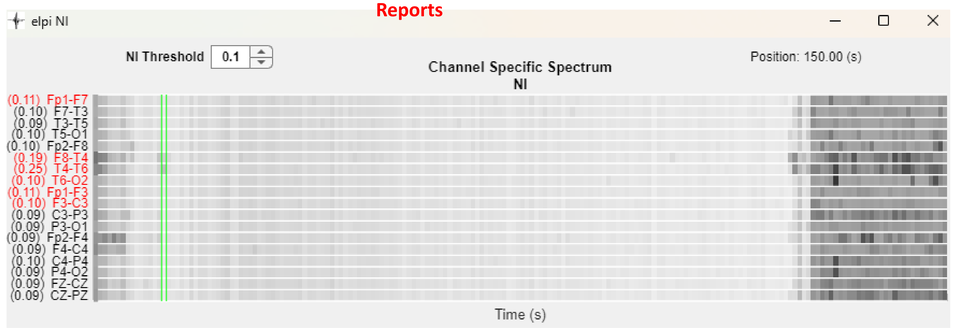

Fig.2) The Noise Index (NI) map in gray scale is synchronized with the EEG. The NI provides a value between 0 and 1 according to:

i. Deviation from an ideal spectrum.
ii. The deviation from the channel average spectrum.
iii. The residuals when modelling the spectrum

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