Project: HFO (Some Facts)

Fast ripples are considered reliable biomarkers (like interictal EEG spikes).

Allow us to make a definitive diagnosis and localize the area of the brain that needs to be resected with a single test. This would greatly increase the number of patients who would receive and benefit from surgery.

250-500 Hz---Fast Ripples 80-250 Hz (Ripples)

HFOs occur frequently at the time of interictal spikes, but are also found independently

Plain Subdural EEG



80-250 HZ

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250-500 HZ

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Main Objective

- 1. Raw number of fast ripples (FR)/ channel as fast ripples distinguished the seizure onset zone better than ripples.
- 2. Mean duration of FR/channel.
- 3. Graph that include an ANOVA to determine which channels have a statistically significant greater # and duration of FRs.

The results will would provide another tentative quantitative measure to include in the pre-resection analysis.

HFO (ripples and fast ripples) in pediatric patientsHFO in resection cases and correlate it with seizure outcomeHFO in different types of intractable seizure disorders.HFO in pediatric patients in different states/during different tasks

10 minute data segment and do the filtering and FR counting

Project: Interictal Spikes Detection

Objective:

An integrated design that identifies and localizes interictal spikes while automatically removing or discarding the presence of different artifacts such as EMG, EKG, and eye blinks.



Project: Interictal Spikes Detection



Note: Discarding the presence of different artifacts such as EKG is really important in this procedure.

Project: Interictal Spikes Detection



EKG artifact

Project: Interictal Spikes Detection



Several methods for spike detection have been proposed based on single and multichannel approaches:

- Template matching algorithms based on finding events that match previously selected spikes.
- Parametric approaches based on traditional signal processing techniques.
- Neural networks (NNs) techniques.

Project: Seizure Prediction

 This study provides an analysis of trends in EEG activity prior to seizure onset



wso Window of seizure onset

Objectives

- To extract as many parameters as possible from the EEG and statistically analyze their behavior prior to seizure in a search for potential trends.
- To create a model that works regardless of the number of electrodes and their localization by combining intra-electrode features with interelectrode features.

State of the Art in Seizure Prediction

Research devoted to particular features mostly using multichannel EEG data streams:

- Short term maximum Lyapunov exponent
- Residual sub-band wavelet entropy
- Correlation dimension
- Coherence
- Dynamical similarity index
- Accumulated energy
- etc

Current Problem

 Despite patents etc, no method has been implemented that clearly predicts a seizure.

Starting Point: Windowed Features

From each electrode, the following features can be extracted for each time window (1, 2, ... sec):

- The Horth's parameters (activity, mobility and complexity)
- the minimum value
- the maximum value
- the average value
- the standard deviation
- the difference max-min
- the kurtosis
- the skewness
- the signal to noise ratio
- the norm of the SNR components
- the correlation sum
- the spectral power in the different frequency bands (alpha, beta, delta and theta)

Seizure Prediction using coherence



Seizure Prediction - Trend Validation (4)

Mental image:



Project: SSEP

The data only has 2 electrodes, so it would be composed by two columns only.

SSEPs are characterized by the peaks and the valley of the waveform denoted by N and P respectively.

The *P*37 and *N*45 peaks of the bipolar recordings are thus used for the monitoring purposes of the surgical procedure.



Project: SSEP

- SSEP recordings at different stages of the surgical procedure are provided from two bipolar channels, C_3 - C_4 (right and left median nerve stimulation) and C_z - F_z (right or left tibial nerve stimulation) using the international 10-20 system for the positions of the electrodes.
- The SSEP signals are recorded by applying stimuli to the posterior tibial nerve of the right leg.
- <u>The data is recorded at 6400Hz sampling rate with duration of</u> <u>100msec, yielding 640 samples per signal</u>.
- The raw trial signals are band-limited from 10Hz to 1000Hz, and the clinical average is obtained using frequencies between 30Hz and 500Hz.
- One hundred to 250 trials were averaged depending on the signal to noise ratio of the single trials.

SSEP

- The process aims to detect the P37 and N45 peaks in the SSEP signal maintaining a 10% time latency deviation and a 50% peak-to-peak amplitude deviation with a minimum number of trials.
- The choice of 10% and 50% for the time latencies and peakto-peak amplitude is based on generally adopted clinical standards



SSEP



Comparison between the results (C3-C4) of the algorithm using fewer trials (solid line) and the clinical data using 200 trials (dotted line).

The time values on the solid line markers are the time instances of the SSEP selected by clinical experts.

SSEP



Figure shows the consistency in detecting P37 and N45 peak latencies from the CZ-FZ recording (algorithm vs. clinical)