Name(s)

Jiaju Liu

Project Number

S0820

Project Title

A Novel Approach for Understanding Early-Stage Epileptogenesis via Nonlinear Manifold Learning

Abstract

Objectives

High-frequency oscillations (HFOS) in EEG data are thought to be promising biomarkers of epileptogenesis. Instead of examining data from patients living with epilepsy, EEG data were analyzed from patients in the early stages of post-traumatic epileptogenesis. The goal of my study was to analyze large amounts of EEG data in a fully automatic, computationally efficient way and provide a meaningful clustering of the data in which points embedded to the same cluster have similar local geometries.

Methods

Five patients were analyzed, each with 12 hours of scalp EEG data obtained within 48 hours of initial brain trauma. Data was downloaded from the University of Southern California Laboratory of NeuroImaging. After downloading, the data were preprocessed with a surface Laplacian and IIR filter. Events of interest were identified with an energy-based approach. Finally, Unsupervised Diffusion Component Analysis was performed to cluster the data and detect relevant patterns.

Results

A total of 6,384 HFOs were detected and 79.94% were embedded near the origin of the graph. Upon visual inspection of the clusters formed, the cluster at the origin was composed of short spike artifact while clusters further away contained genuine HFOs.

Conclusions

Although no predictions may be made regarding whether the patients will develop epilepsy, the program outputs high-frequency waveforms and the embedded graph provides a guide to further visual inspection. Rather than examining thousands of events generated by existing HFO detectors in the literature, the nonlinear embedding allows epileptologists to only examine a few events in each cluster. In addition, the program was able to detect HFOs in scalp EEG which has been seldom used for HFO detection.

Summary Statement

I coded a fully automatic, computationally efficient program that detects and clusters high-frequency waveforms in noisy scalp EEG data which show potential as biomarkers of epileptogenesis.

Help Received

I was pointed towards manifold learning and given a paper on USC's overall plan for finding a biomarker of epileptogenesis. From there, I self studied Fourier Analysis, graph theory, learned MATLAB, proposed, and wrote my code by myself. My mentor registered me for an account to access EEG data and for cloud