Epileptic Seizure Detection Through Machine Learning Classification of Heart Rate Variability Features

Affecting over fifty million people worldwide, epilepsy is a common neurological disorder in which recurrent, unprovoked seizures occur due to abnormal electrical brain activity. The ultimate goal of a seizure detection algorithm is to prevent traumas from occurring during epileptic episodes, ensuring patient safety. Ongoing research has utilized heart rate variability (HRV) analysis, which looks at the time variation between consecutive heartbeats. We developed software which conditioned electrocardiogram (ECG) data of epilepsy patients to remove outliers and ectopic beats. The software then extracted HRV time, frequency, and Poincaré plot features over three-minute intervals, which were detrended using a cut off rate to provide a clear distinction between seizure and nonseizure signals. To facilitate accurate comparisons across features, each feature was normalized to be on a scale between -1 and 1, and seizure and nonseizure intervals were evaluated to determine significant distinctions. We determined that the average NN-interval, standard deviation of NN-interval, mean heart rate, standard deviation of heart rate, and very low frequency features significantly change during seizures. Using Support Vector Machine (SVM) Classifiers over 10,000 trials, our algorithm was able to detect seizures with an accuracy rate of 86.04%. Since many everyday technologies such as electronic watches already collect ECG data, HRV analysis could offer an easily accessible method of epileptic seizure detection.