Proposing a Cloud Computing System for Automatic Detection of Epileptic Seizures by Artificial Intelligent

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Introduction

•Epilepsy is defined by the occurrence of at least two recurrent epileptic seizures in less than 24 hours.

•Epilepsy affects about three million Americans and is one of the common nationwide neurological disorders.

•Public knowledge of epilepsy is limited and most of the time people do not know how to react when someone is having a seizure attack in urban areas.

•Developing an artificial intelligent system for detection and monitoring epileptic seizures in EEG would greatly assist clinical care.

•By new telecommunication technology and cloud based pervasive computing, Quality of Life (QoL) of epileptic patients can be improved by precise on-line seizure detection.

•In this study, for ubiquitous real-time seizure detection, monitoring, and alarming a cloud based platform as a service is proposed for urban places.

Subjects

To evaluate the proposed technique, a clinical dataset of eight patients with temporal and extratemporal lobe epilepsy have been used which was jointly developed by the University of Pennsylvania and the Mayo Clinic, sponsored by the American Epilepsy Society. The iEEG's were recorded in depth electrodes implanted along anterior-posterior axis of the hippocampus, and in subdural electrode grids in various locations.

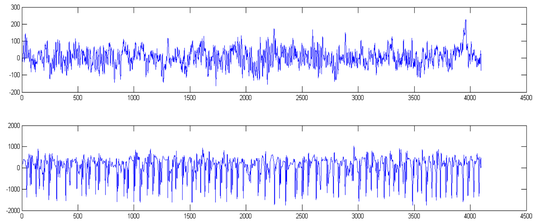

Figure 1: Comparing EEG segments of Normal (above) and Seizure (down). The horizontal line is Time (sec) and the vertical line is Amplitude (micro V).

Methods

•The proposed system for automatic seizure detection is designed to be performed in the cloud with pervasive computing and emergency aiding abilities.

•By non-invasive small wearable devices, EEG's are recorded in mobile patients and are sent to a cloud by communication devices such as smartphones.

•In our proposed solution we leverage the cloud computing to exploit its massive storage capacity and strong computational resources to provide on-line epileptic seizure detection.

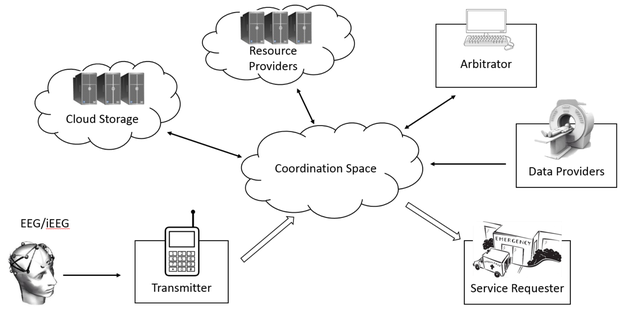

Figure 2: Cloud computing framework enabling pervasive healthcare. In this study, we leverage the advantages of cloud computing and propose a ubiquitous cloud based seizure detection framework to increase the sensitivity of the system while decreasing the error rate.

•Cloud computing provides a simple way to access storage, databases, and computational resources over the internet. This growing area of IT services offers ubiquitous access with the potential to increase agility with lower costs.

•Informative components of epileptic seizures are extracted in cloud area. A new feature reduction method is developed using Infinite Independent Component Analysis.

•After preparing feature vectors, Support Vector Machines (SVM's) are classified in each subspace to normal and epileptic patterns. Then, majority voting is used for aggregating of each SVM's output.

•Finally by the detection onset of epileptic seizures, a notification is sent to the closest medical emergency centers.

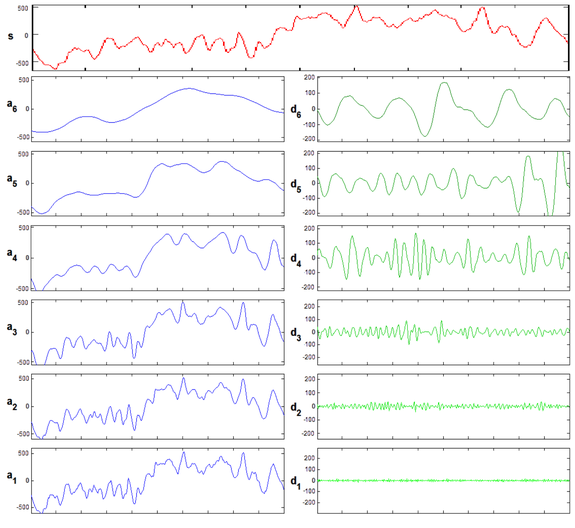

Figure 3: Cloud Synthesized signal for One second seizure data (ictal) segment: S, 6 levels of approximation coefficient: a1-a6 (Left side), 6 levels of detail coefficients: d1-d6 (Right side). The X axis is labeled in samples. Scale 4-6 of detail coefficients represent seizure activity.

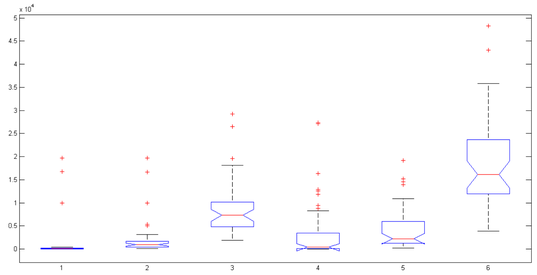

Figure 4:Graphical depiction of extracted features. Variance, power and sum of absolute value for normal and seizure groups are shown by 1 to 6, respectively. Outliers are plotted by a plus sign.

Results

Using leave-one-out cross validation on epileptic EEG segments recorded at sample rate 173.61 HZ and band-pass filtered on 0.53-40 HZ (12 dB/oct), sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of our method were 90%, 91.7%, 90%, 91.7% and 90.9% respectively.

Discussion

•The proposed low computational-complexity framework makes decisions based on the EEG patterns with clinical significance to provide high sensitivity and low false detection service.

•The pervasive framework implemented as a cloud based service and it has advantages of cloud computing, such as performing a framework as real-time.

•Therefore, there is a possibility of sending an emergency request with the location of patient to a nearby hospital or emergency center using cloud servers and global position system (GPS) after seizure detection.

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