An Efficient Automated Technique and Smartphone Application for Epilepsy Seizure Detection Using EEG signals

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Abstract- Epilepsy is a neurological disorder disease that affects the central nervous system of the human brain that can disrupt the activity of the nervous cells in the brain which will result in unusual behavior that can lead to loss of consciousness called epileptic seizure that can endanger the life of the patient. Therefore, automated epilepsy seizure detection is the solution to the limitation and time consuming of manual epilepsy monitoring and detection using EEG signals. Thus, using MATLAB R2014b, we developed a technique for epilepsy seizure detection using EEG signals, and we achieved an accuracy of 97%. For our main contribution, we developed an Android-based smartphone application for monitoring epilepsy detection based on the classification results of the EEG signal. A notification will be sent to the patient, doctors, and family members when an epilepsy seizure occurs. Once the EEG signal is classified as epileptic, the App will display a visual notification indicating that Epileptic Seizure has been detected. Moreover, it will trigger an alarm and send a message notification to all associated phone numbers. The main goal of our research is to develop an APP that will read the signal from the brain through a Bluetooth device, and process the signal on the APP to determine if it is normal or abnormal.

Introduction

Epilepsy is one of the most commonly known neurological disorder that affects at least fifty million people around the globe, and each year there are approximately 2.4 million people diagnosed with epilepsy mainly in developing countries. [1]. Epilepsy seizure occurs when the human brain starts producing signals four times larger than the normal signals that the brain would normally produce, resulting in unexpected and sudden electrical discharges in a group of brain cells. [2]. Today the smartphone based applications are being used for solving human real life problems. And these applications in the health sciences play a vital role for improving the ways of treatment by introducing most promising methods. Therefore, there is a need for developing an efficient smart phone application that can monitor the behavior of an epileptic patient as well as sending an immediate update to the care takers. [3].

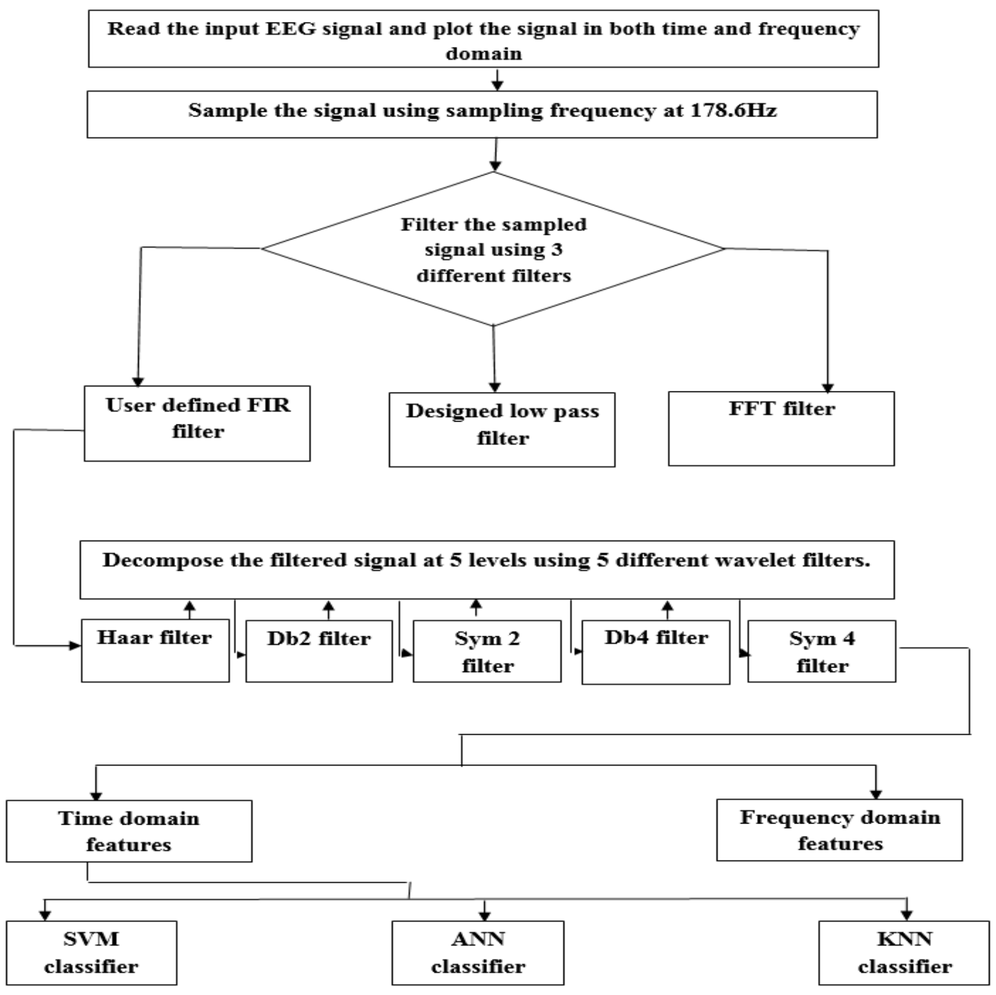
Results

Percentage using Band-bower feature	Classifiers		
	ANN	SVM	K-NN
20% testing and 80% Training	90.97%	89.89%	92.92%
30% testing and 70% Training	88.41%	89.99%	91.60%
40% testing and 60% Training	89.01%	88.27%	90.42%
50% testing and 50% Training	86.21%	88.27%	89.23%

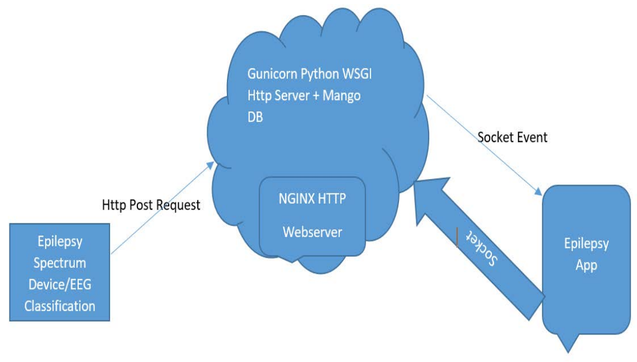
Percentage using Maximum-Minimum feature	Classifiers		
	ANN	SVM	K-NN
20% testing and 80% Training	95.38%	94.13%	98.61%
30% testing and 70% Training	95.65%	94.57%	97.7%
40% testing and 60% Training	95.97%	93.27%	96.54%
50% testing and 50% Training	96.1%	93.18%	95.06%

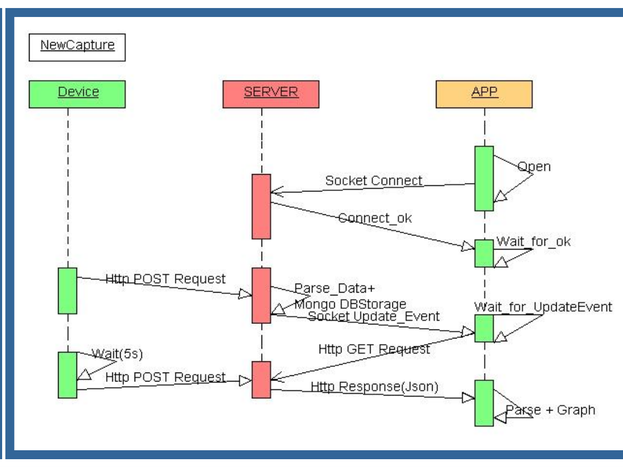
Percentage using Crest Range feature	Classifiers		
	ANN	SVM	K-NN
20% testing and 80% Training	94.89%	95.34%	97.92%
30% testing and 70% Training	95.52%	93.56%	97.93%
40% testing and 60% Training	94.20%	94.73%	96.54%
50% testing and 50% Training	95.03%	94.92%	95.68%

Proposed Method

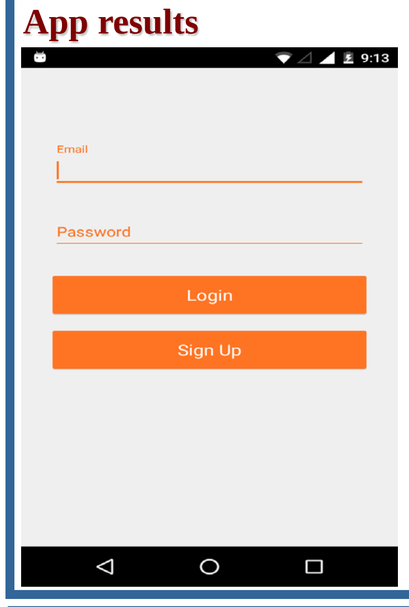


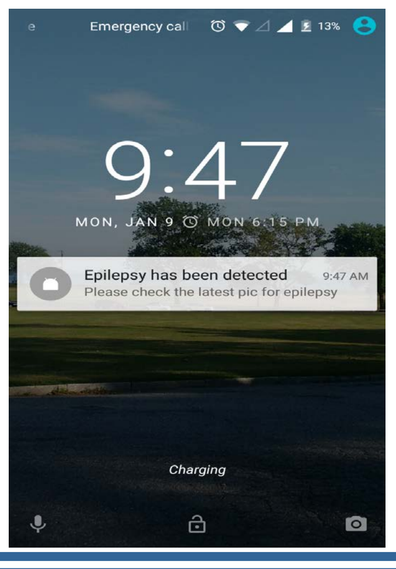
Smartphone App Development





App results





During the registration process the app keeps track of the users who needs to be notified with the alarm when there is a new epilepsy seizure detected. Upon classification completion, an alarm will be triggered should an epilepsy seizure detected.

Newly introduced techniques

1- In the decomposing stage, we processed the N level decomposition with different wavelet filters at each stage so that the frequency responses may vary at each level.

2- Crest Range: (designed feature)
Initially, we detected the peaks of the signal using findpeaks function in MATLAB. Then we calculate the crest factor of the signal.

Crest factor = (Peak to peak of the signal) / (RMS value of the signal)

RMS value of the signal = $\sqrt{\frac{1}{T}\int_0^{133} x^2(t)\,dt}$

This crest factor is added to the amplitude range in order to get the crest range of the given signal.

Conclusion

We have presented an efficient method of epilepsy seizure detection. We have used an EEG data set that is publicly available from the University of Bonn in Germany; then we have eliminated the noise and artifacts of the signal by applying three different filters, and in the next step we decomposed the signal using wavelet analysis. Furthermore, out of many features extracted three features were selected for the classification procedure. Among those three features is one newly designed feature that is Crest Range. In the final stage three of the mostly used learning machines in epilepsy classification namely ANN, K-NN and SVM were used for training and testing the extracted feature we have achieved the best accuracy when using K-NN classifier. Then, we develop an APP that monitors the behavior of epileptic patients based on EEG processing and classification. The APP is connected to the classification procedure through the sever, and updates the results instantly whenever a new signal is processed. Upon classification completion, an alarm will be triggered should an epilepsy seizure detected.

References

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