Wearable Sensor-Based EEG Signals Automatic Medical Support System For Epileptic Seizure Detection

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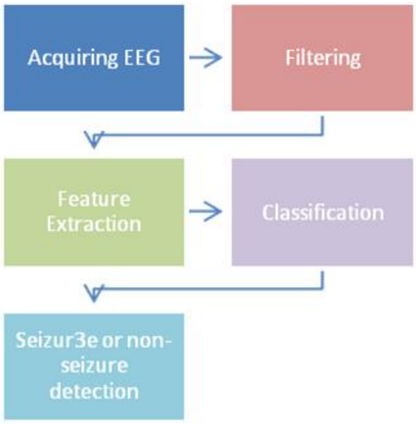
Abstract- *Epilepsy is a brain disorder characterized by a persistent predisposition to cause seizures. It is one of the most common neuropathy affecting people of all ages. Diagnosis of epilepsy is based primarily on clinical evidence supporting investigations including electroencephalography (EEG), neuroimaging, predominantly magnetic resonance imaging (MRI), electrocardiography (ECG) etiology, and epilepsy syndrome. It is done. The method of classifying and proactively classifying seizures can be used for the most appropriate and effective treatment. Wired hospital systems are not suitable for long-term home seizure detection systems. To meet this need, we will compare the performance of wearable devices based on EEG recording (EEG) with the ECG of the hospital using existing seizure detection algorithms. The algorithm classifies seizures based on rhythmic skeletal muscle moments (EEG). Each channel of both seizures and normal EEG data was divided into 256 sample frames. Higher-order statistical features of variance, skewness, kurtosis, and entropy were then calculated for each EEG segment. The important non-linear and non-Gaussian characteristics exhibited by many medical signals facilitate the selection of these parameters. After feature extraction, the classification was performed using a linear classifier. The proposed method was able to detect epileptic seizures with an accuracy of 97.75%. The algorithms used in this proposed method are multi-domain and non-linear analysis. The seizure detection and proposed classification algorithms are trained in a previously recorded independent data set of epilepsy patients. describes the high-level architecture of the system and its implementation based on cloud computing. Considering traditional measurement methods, the detection system proposed in this document may represent an alternative solution, enabling rapid response and support that can save lives in many situations. As a result, the reviewing process shows that there are many research articles that have covered wearable seizure detection systems that based on body signals. The more effective monitoring and detection seizure system is the system that uses multi-body signals, is highly comfortable and has low power consumption.*

I. INTRODUCTION

“Seizure" is a general term that refers to a sudden malfunction in the brain that causes someone to collapse, convulse, or have another temporary disturbance of normal brain function, often with a loss or change in consciousness. Most seizures are caused by abnormal electrical discharges in the brain or by fainting (decrease in blood flow to the brain). Some seizures may be the result of another medical problem, such as low blood sugar, infection, a head injury, accidental poisoning, or drug overdose. When seizures occur more than once or over and over, it may indicate the ongoing condition epilepsy. An epileptic seizure, occasionally referred to as a fit, is defined as a transient symptom of "abnormal excessive or synchronous neuronal activity in the brain"**.** For patients with medically intractable epilepsy, there have been few effective alternatives to respective surgery, a destructive, irreversible treatment. A strategy receiving increased attention is using interracial spike patterns and continuous EEG measurements from epileptic patients to predict and ultimately control seizure activity via chemical or electrical control systems. Though in many cases, epilepsy can be controlled purely by medications, in some cases surgical removal of the Epileptic part of the brain may be carried out. Newer methods where parts of the brain are electrically stimulated to avoid the onset of seizure are being developed. Automatic detection of seizures forms an integral part of such methods. Automatic seizure detection is an important aspect of long term epilepsy monitoring. This paper proposes a method based on the multi domain and non-linear analysis of EEG signal and extract the features for seizure detection. The proposed method was able to detect epileptic seizures with an accuracy of 97.75%.

II. PROPOSED METHOD

The proposed method consists of the following steps:



The wearable device consists of sensors which acquires the EEG signals from the brain .Later , the EEG signals are pre-processed using the filters because the EEG signals have noises at its nature and the next step is to extract the feature and classify the features to detect whether the patient is affected with seizure or not. The device may consist of IOT peripherals which compares the EEG signals with hospital ECG signals using an existing seizure detection algorithm.

ACQUIRING EEG SIGNALS:

- Electroencephalography (EEG) is the recording of electrical activity along the scalp produced by the firing of neurons within the brain.
- In clinical contexts, EEG refers to the recording of the brain's spontaneous electrical activity over a short period of time, usually 20–40 minutes, as recorded from multiple electrodes placed on the scalp.
- The EEG spectrum contains some characteristic waveforms that fall primarily within four frequency bands
  - delta (<4 Hz)
  - theta (4—8 Hz)
  - alpha(8—13 Hz)
  - beta (13—30 Hz)

The data used are a subset of the both healthy and epileptic subjects. The complete data set consists of each containing 100 single channel EEG segments. These segments were selected and cut out from continuous multi-channel EEG recordings after visual inspection for artifacts, e.g., due to muscle activity or eye movements.

PRE-PROCESSING SIGNALS:

The EEG data used has already gone through the pre-processing steps. All the EEG data signals were cut out from continuous multichannel EEG recordings after visual inspection for artifacts due to muscle activity or eye movement. All EEG signals were recorded with the same 128-channel amplifier system, using an average common reference. The data were sampled at 173.61 samples per second and digitized using 12 bit resolution. A band-pass filter having a pass band of 0.53–40 Hz (12 dB/oct) was used to select the EEG signal of desired band.

FEATURE IDENTIFICATION:

Acquired EEG data was grouped in frames of 256 data points. The data is classified based on the statistical distribution obtained from the histogram. The distinguishing features between the signal features are:

- The deviation from the mean value is large for the seizure case, is highly skewed.
- The skew value for the seizure is large
- The peak value of the distribution for seizure is almost doubles that of the normal.

It is logical to use variance, skewness and kurtosis as three features for detection of seizure. During seizure the EEG signal will exhibit some rhythmicity . So the lower degree of randomness is expected for the seizure data than the normal. Thus entropy also used to distinguish between the two classes.

FEATURE EXTRACTION:

The different features extracted for the signal analysis are

Mean:

Mean is the expected value of a random variable. For a data set, the mean is the sum of the values divided by the number of values. The mean of a discrete random variable x is given by taking the product of each possible value of x and its probability P(x), and then adding all these products together, giving

$$\mu = \sum xP(x)$$

Variance:

The variance of a random variable or sample is a measure of statistical dispersion and is a way to capture its scale or degree of being spread out.

$$\mathbf{Var(X) = E[(X - \mu)2]}$$

Standard deviation:

Standard deviation of a statistical population, data set, or probability distribution is the square root of its variance.

$$\sigma = \sqrt{\mathrm{E}[(X-\mu)^2]}.$$

Skew:

Skewness is the measure of asymmetry of a probability distribution function. It is the third standardized moment, γ1 and is defined as:

$$\gamma_1 = \mu_3 / \sigma^3$$

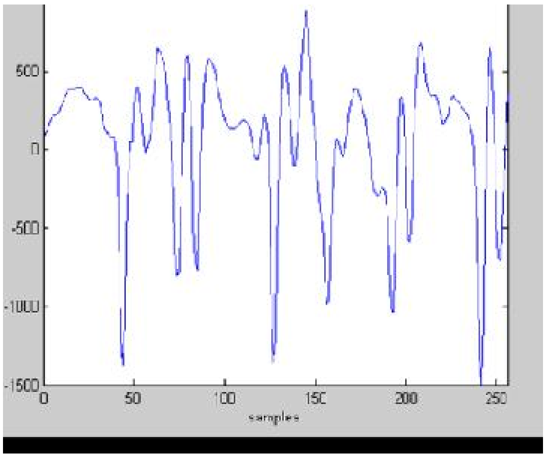
where μ_3 is the third moment about the mean and σ is the standard deviation.

Kurtosis:

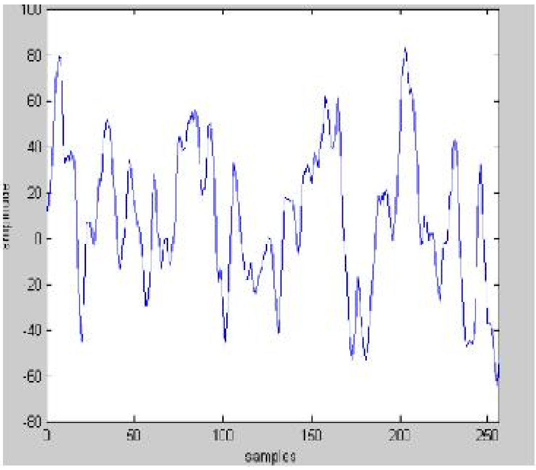
Kurtosis is the degree of "peakness" of a real valued random variable. Higher kurtosis means more of the variance is due to infrequent extreme deviations, as opposed to frequent modestly sized deviations. Kurtosis is the fourth standardized moment, γ2 and is defined as:

$$\gamma_2 = \mu_4 / \sigma^4$$

where µ4 is the fourth moment about the mean and σ is the standard deviation.



EEG OF SEIZURE PATIENT



EEG OF NORMAL PATIENT

ALGORITHM:

The epileptic activity in EEG signals using multi-domain and nonlinear analysis will improve the performance of EEG epileptic seizure detection .

The wavelet threshold method is to be applied to remove noise components from the EEG signal prior to EEG signal feature extraction .

Dimensionality reduction algorithm of the principle component analysis (PCA),along with the feature ranking method of analysis of variance(ANOVA),will be applied to eliminate irrelevant or redundant features, which may deteriorate the classification performance in the original high –dimensional features space .

MULTI-DOMAIN ANALYSIS:

In multi-domain, multiple features are extracted from the time domain, frequency domain, rational domain, time-frequency domain using non-linear analysis.

NON-LINEAR ANALYSIS:

Non-linear electrical function of nerve cells in brain are monitored by EEG signals. Non-linear analysis is used to analyze and extract the non-linear feature for epileptic seizure diagnosis.

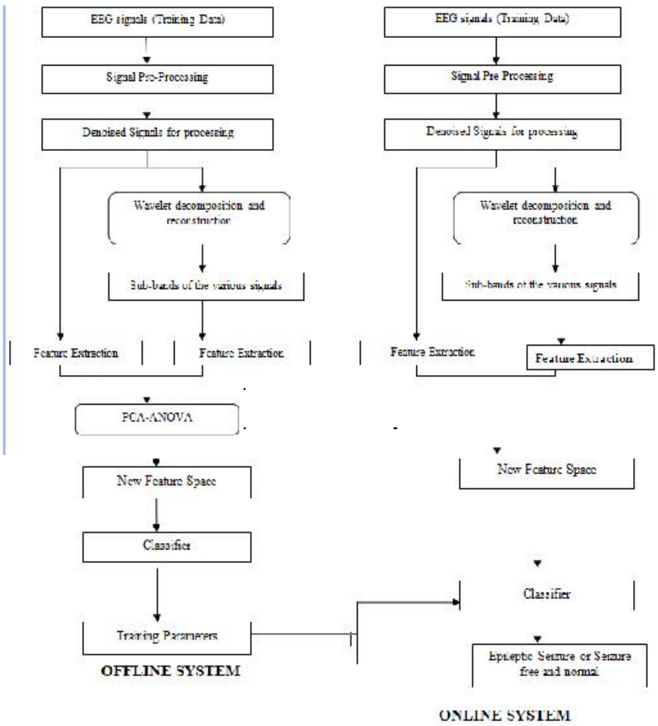
WAVELET DECOMPOSITION:

In order to extract the individual EEG sub-bands, a wavelet filter is employed. Wavelet transform has the advantages of time-frequency localization, multi-rate filtering, and scale-space analysis . Wavelet transform uses a variable window size over the length of the signal, which

allows the wavelet to be stretched or compressed depending on the frequency of the signal. This results in excellent feature extraction from non-stationary signals such as EEG signals. In this research, the discrete wavelet transform (DWT), based on dyadic (powers of 2) scales and positions, is used to make the algorithm computationally very efficient without compromising accuracy. The EEG signal is decomposed into progressively finer details by means of multi-resolution analysis using complementary low-pass and high-pass filters.

Wavelet is a oscillating function localized in both frequency and time domain. In wavelet analysis the signal is decomposed into single function called wavelet

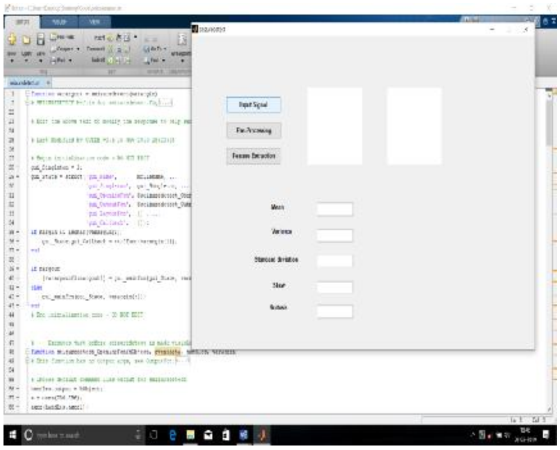
III. FLOWCHART



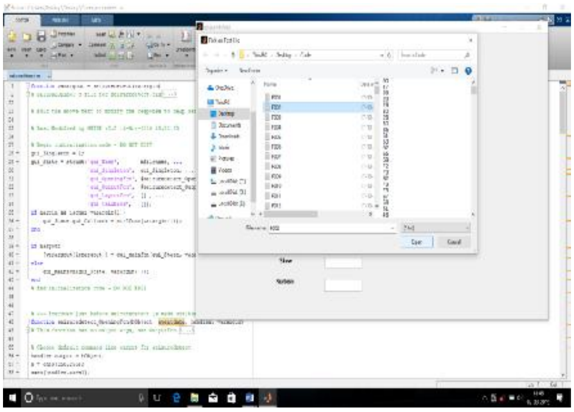
IV. CONCLUSION

Epilepsy is the deadly disease due to neurological disorder which produces different type of seizures. EEG is most suitable method for monitoring, diagnosing nervous disorders. Manual detection of seizure become time consuming and less accuracy .The proposed system provides automatic detection of seizure for better performance. Performance enhancement is due to feature extractions are done using multi-domain and non-linear analysis. People with epilepsy will live an insecure life. Sudden immediate death (SUDEP) condition may arises if patients are alone. To decrease the mortality rate and to overcome this risky situation,automatic detection of seizure will be applied on real time basis using sensors. It will provide immediate alert to caretakers once seizure was detected. This proposed framework able to detect seizure with accuracy of 97.75%.It will be efficient and reliable one and patients will live a securable life.

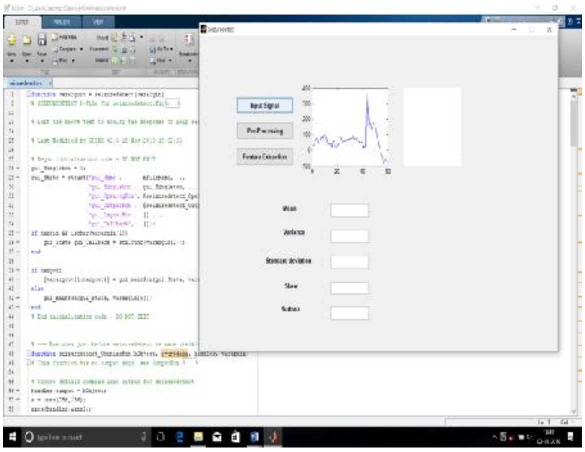
V. OUTPUT



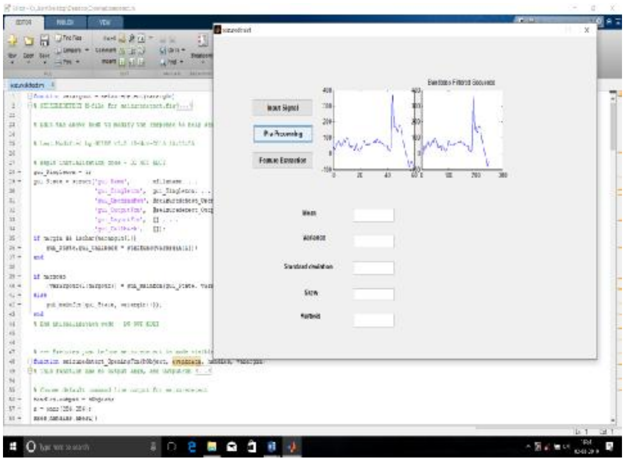
MATLAB



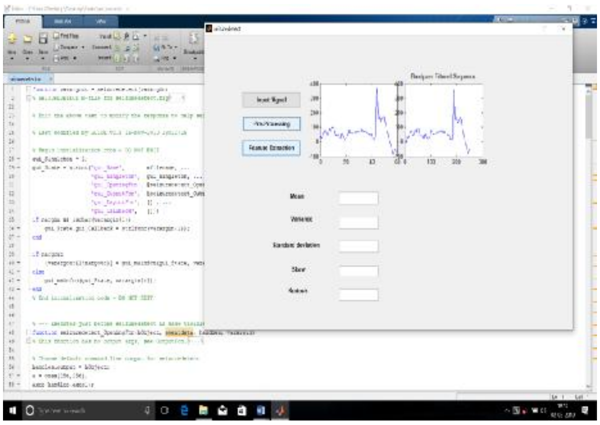
INPUT SIGNAL SELECTION



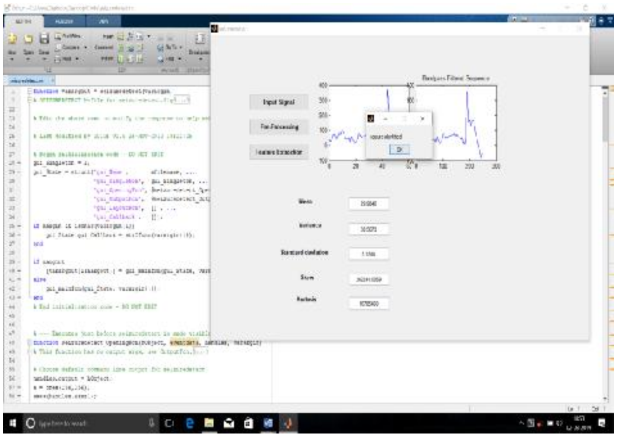
INPUT SIGNAL



PRE-PROCESSED SIGNAL



FEATURE EXTRACTED SIGNAL



FINAL OUTPUT

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