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Early Detection System for Epileptic Seizures By Using Machine Learning

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***Abstract-** An epileptic seizure is considered the most conspicuous neurological disorder nowadays that can distress to all ages, people.Around 6 decades million people all over the world are travail from epilepsy.Electroencephalograph (EEG) signals are most commonly used for the analysis and detection ofseizures.As EEG signal contains anenormous amount of clatterartifact-included information, so many researchers are trying to support automatic structures for completefeature extraction. This paper provides areview of popular seizure detection methods and performance analysis of the proposed K-Nearest neighbor (KNN), Support Vector Machine(SVM), and Regional Neural Network(RNN) algorithms.*

***Keywords:** Epilepsy, Electroencephalograph EEG, Seizures, Feature extraction.*

I -INTRODUCTION

An epileptic seizure is a crucial nervous system disorder in which brain functioning becomes abnormal, unusual behavior, sensation, and sometimes loss of awareness. Seizure symptoms can vary widely, if a person has one or more strokes of seizures then that person is diagnosed with epilepsy unless the seizures are caused by some known medical conditions.Non-epileptic seizures may happen because of several reasons including brain tumor or, stroke, head injury, and birth defects. Electroencephalography (EEG) is the recording of the electrical activity of the brain. It is taken through several electrodes fitted on the scalp[1].

An epileptic patientsignals exhibit in two states of abnormal activities namely interictaland ictal. Epilepsy can be revealed by conventional methods by well-trained and experienced neurophysiologists by inspection of long durations of EEG signals; this is timewasting, monotonous, and is not foolproof. Hence, to overcome these problem, a computer-aided detection of epileptic EEG signals can be utilized[2].

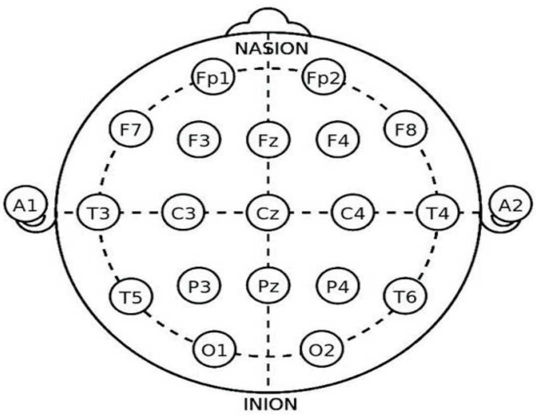

Fig .1 Electrode placement for EEG signal

The electrical waves of the brain mainly have a small amplitude (approximately 100 microvolt) capture from electrode placement over a scalfshown in fig.1 and the range of frequency from 004 Hz to 80 Hz. In an EEG

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signal five sub-bands: delta (0.5-4 Hz), theta (4-8 Hz), alpha (8- 12 Hz), beta (13-30 Hz), and gamma (30-60 Hz) are decomposed [3 and4]. Extracting the features considers the finestrepresentation of the EEG signals. These are imperative for automated seizure detection analysis. The main objective of Feature extraction is to capture the evocativeappearancesunseen in EEG signals, which closely dominates the final c1assification accuracy. According to the study, use of early detection system for epilepsy seizures is possible. There is scope for early detection of epilepsy seizures. So as to get prior intimation to the patient or his concern to take the necessary precaution.

II-LITERATURE REVIEW

Review of literature: Review of literature in five categories:

a)Neural network-based approach.b) Wavelet-based methods.c) Fourier transform-based approach.d) Classifier-based techniques.

This literature review contains the majorcontributions from different researchers in AutomatedDiagnostic System for Epilepsy Diseasefield [4].

A]Neural network-based approaches

A warning system for epileptic seizures developed by Sam et al. (1975) works on pattern recognition principles. They created a compact-sized device for patients that use to provide advance cautioning related to any forthcoming seizure.

An automated detection system for the epileptic presented by Christopher et al. (1999)formed activity of EEG signals and the results were tested over recorded data of 43 patients. The proposed technique was centered on a popular artificial neural network (ANN) approach that is based ona self-organizing feature map (SOFM). It worked like a novel classifier and was used to assign possibilities to the incoming epileptic form discharges. It was a multistage detection system with SOFM, mimetic and fuzzy logic as three major stages where the fuzzy logic was introduced to extract three-dimensionalappropriate information during the detection process.

A technique for automated detection of epileptic waveforms presented be Vivek and Danial (2013) from recorded EEG signals using a multistage-type nonlinear pre-processing filter. They combined with a diagnostic LAMSTART neural network for appropriate input preparation. The system was analyzed for overall performance on the basis of accuracy and miss rate where the practical value for accuracy was 97.2% and for miss rate, it was observed to be 1.6% [6].

Graphical User Interface (GUI) MATLAB - based automated diagnostic system developed by Gamze et al. (2015) developed for the epilepsy disease.Three different methods of ANNs, Cascade, Elman, and Feed Forward Backpropagation classification methods are used. From the attainedresults, it is observed that the proposed method can accomplish accuracy of 98.3% and the GUI-based interface is much easier to use for medical personnel.

A spiking neural network proposed by Shen et al. (2010) where statistics is encoded at different spike intervals. It was observed that traditional gradient descent approach-based learning algorithm usually get stuck in local minima and is not able to converge efficiently when negative synaptic weights were used.

A hybrid combination of particle swarm optimization (PSO) and Backpropagation algorithmtechnologically advanced byNesibe et al. (2015) for improved training of ANN so that epilepsy patients can be diagnosed in a much better. The training and testing are done on seven different PSO equations with less or more variable change so that higher accuracy can be attained. It is observed that PSO trained networks are stable and have the ability of classification even for highly complex EEG waves [8].

A hybrid design for the detection of epilepsy seizures was established by Seema et al. (2012) by combining ANN with PSO technique. This method provided a higher accuracy rate when used with variable network training parameters.

B] Wavelet-based methods

An epileptic seizure event identification over EEG influences studied by Carlos et al.'s (1997) using wavelet analysis. The overall analysis was centered on time localization computational efficiency, and characterization of epileptiform events.

The technique of modulus maximum pair of wavelet transforms by Chen and Niu (2004) for exposure of individuality values of spikes and sharp background activities recorded with EEG signal. After analysis, it was observed that this method is particularly useful for reliable and applicablecredentials of analytical bioelectric states.

A seizure identification system developed by Satchidananda et al. (2013) with the ensemble of outspreadradial basis function networks (RBFNs). For classification,the EEG signals were disintegrated into various sub-bands using DWT and then some basic figures are applied to wavelet magnitudes so that they can be extracted. The exploration was completed over three different types of data sets such as normal, non-epileptic seizure eliminating healthy brains, and seizure segments[9].

A novel algorithm for identification of epileptic features of EEG signals presented by Zainab et al. (2011) that are based on wavelet transform and genetic algorithm (GA). Theprime wavelet basis purpose used to acclimatize spikes of EEG signal and they are designed using GA; after this matched filter method used to identify different spikes that are relatedto the seizure activity of EEG recordings.

C] Fourier transform-based approach

The first solution to the problem of automated epilepsy detection provided by Prior et al. (1973). during their studies on intensive therapy. Wherever patients were monitored for acute anoxic occurrences, it was observed that an automated device used for monitoring EEG activity of brain signals was of great importance.

The analysis of frequencies for epileptic seizures and healthy EEG signals urbanized by Meenakshi et al. (2014)by using the fast Fourier transform technique. They divided recorded EEG signal activities into five different frequency sub bands (α, β, γ, θ, and δ sets). The respective frequencydistribution over FFT was compared to analyze differences between healthy and epileptic signals[10].

D] Classifier based techniques

An epileptic seizure detection algorithm proposed by Saadat and Hossein (2013) with patient-specific features. The nonseizure- and seizure-oriented EEG signals were applied to the system and then discrete Fourier transform and DWT were applied on the following five special frequency sub-bands: δ, α, β, γ, and θ. By using this classifier, it is possible to make latency, specificity, and sensitivity adjustments in model[9 and 10].

An advanced approach for automated detection of epileptic seizures was presented by Sivasanskari et al. (2013) using multilayer perceptron neural network type classifier. A statistical tool named as independent component analysis (ICA) was used for extraction of features[7].

Novel pattern recognition methods presented by Sharmila and Geethanjali (2016) for epilepsy seizure-related abnormalities in EEG signals. The arithmetic features of the signal were derived using DWT coefficients ranging between D3 and D5, whereas for seizure abnormality revealingA5 was used along with naïve Bayes. The K-nearest neighbor classifier was proven to be useful for 14 unique arrangements of sets A–D and E.

An onset detection method that works on the basis of dynamic cascade feedforward neural networks (DCFNNs)was proposed by Saadat and Hossein (2011). First of all, spatial and spectral features of nonseizure and L-second seizure activity were extracted and then DCFNN algorithm was applied.This method resulted into smaller latency value of 55% with advanced improvement in sensitivity with practical value of 98%.

PSO and Support vector machine (SVM) evaluated by Harikumar et al. (2016) for robust classification of Epilepsy disease. first sampled the input EEG signals and then removed their artifacts to deal with the problem of higher dimensionality, the PSD procedures were applied.

Wavelet-based neural network classifier used by Akshata et al. (2016) to recognize the EEG signal disturbances. The basic technique involved parting of recorded EEG signal into different frequencies in terms of α, β, γ, δ, and θ .

A model for analyzing seizure and non-seizure EEG signals proposed by Shail and Rao (2014). The method used for extraction of IMFs is empirical mode decomposition and based on the mean weighted

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frequency various features are extracted; finally, the extracted features are classified using neural network[8]

III-METHODOLOGY

The proposed algorithm is shown in figure 2. For epileptic seizures detection by using machine learning algorithms. following steps are

Proposed method Database: Children's Hospital Boston (CHB) and the Massachusetts Institute of Technology (MIT):(https://physionet.org)[11]

Pre-processing –In this processing various artifact removal techniques. Both internal as well as external artifacts are in consideration. Different Feature Extraction methods that efficiently extract the spectral frequency bands and derives the feature based on power spectral density in each of these bands. The property of scalp and intracranial EEG that most complicates the seizure detection task is its variability across individuals with epilepsy, both in the seizure and non-seizure states. Typically, following the onset of a seizure, a set of EEG channels develops rhythmic activity that reflects underlying neuronal hyper synchrony [16 and 17]

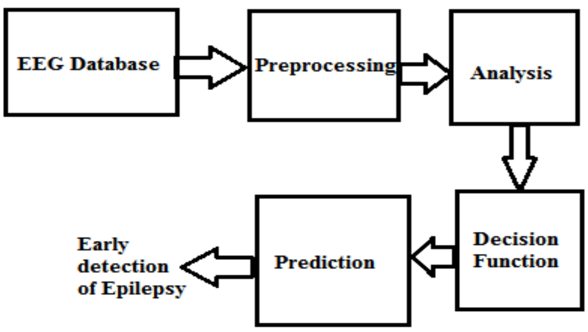

Fig.2:Proposed Algorithm for Epileptic Seizure Detection.

Analysis: The detection of time slots for some patients who have epilepsy and also study on the occurrence of epilepsy seizures [14 and 15].

Decision: To find out the interval between two seizures. Some energy is compared with certain thresholds for decision-making and to apply some threshold for the system. For this feature extraction precision, recall, f1-score and support parameters consider. SVM chooses the extreme points/vectors that help in creating the hyperplane. These extreme cases are called as support vectors, and hence algorithm is termed as Support Vector Machine. Consider the below figure 3there are two different categories that are classified using a decision boundary or hyperplane:

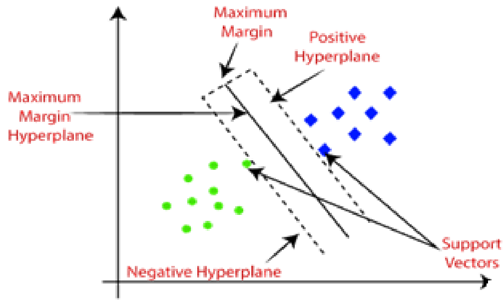

Fig 3.SVM Decision boundary for hyperplane

Figure 4 shows there are two categories, i.e., Category A and Category B, and we have a new data point x1, so this data point will lie in which of these categories. The KNN can easily identify the category or class of a particular dataset. To solve this type of problem.

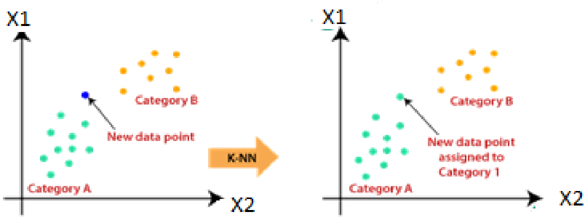

Fig 4.KNNDecision boundary for Category

Prediction: The prediction time of Seizures is to be calculated using the proposed algorithm. For thisprediction value 1 and 0 is consider if 1 shows then epilepsy is present so keep our patient in safe side.If 0 shows then our patient is in no epilepsy (Normal) condition.

IV- DESIGN

Design steps for machine learning algorithms; KNN SVM and RNN

Step 1. Covert Datasset from Multi label to binary label conversion

Step 2. Splitting Data (Train-Test)

Step 3. Build LSTM Model

a. Set Model Sequential

b. Add input_shape with relu activation

c. Add LSTM Layer with Activation function sigmoid

d. Add Dense Layer with Activation function softmax

e. Compile model with loss categorical_crossentropy, optimizer = adam

f. Model metrics set for accuracy

Step4. Train Model for 10 epochs

Step5. Evaluate Model for accuracy

Step6. Model interpretation using LIME Library

V. RESULT & DISCUSSION

The KNN and SVM provides the better results.SVM is a supervised learning algorithm This algorithm is used for classification or regression challenges [13]. Their fundamental issue the fact that they cannot offer the necessary reasons for the patterns in addition logic rules that are contained throughout the modeling techniques. They are not advised towards excellent knowledge discovery methods.So RNN model also provides better results as compared to both KNN and SVM.Along with that the output values of RNN such as Recall, f1-score and support for no epilepsy and epilepsy seizure are better as compared to other models used in present research work.

VI - CONCLUSION

From this study it is observed that one of the important tools for the diagnosis of epilepsy is EEG. The inspection of this complex waveform is highly accomplished interpreter for disease or epilepsy detection. Hence, an early and automatic detectionapproach is desired. The proposed algorithmparameters and features of EEG signals are extracted to get higher accuracy, then it can be helpful in the diagnosis process and patients can be saved from severe injury caused by sudden epilepsy stroke attacks. In this paper, the detailed literature survey was provided discussing popular techniques SVM, KNN and RNN for early detection of epilepsy seizures.

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