Diagnosing Epilepsy using EEG signals and classification of EEG signals using SVM

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Abstract - *This thesis mainly aims to analyzes the EEG signal for epilepsy detection in time and frequency domain and classify the EEG signal as epileptic or non-epileptic by using and automated algorithm using Support Vector Machine (SVM). SVM is supervised learning models that is used to analyzed data for classification. SVM classify the EEG signal into various frequency bands by using wavelet transform. And a performance evaluation parameter is also calculated as Total classification Accuracy.*

(*Keywords- Epilepsy, EEG, Seizure Detection, Feature Extraction, Mixed Wavelet Transform, Time and Frequency Analysis, Support vector machine.*)

1. INTRODUCTION

Epilepsy is a neurological condition expressed with the occurrence of chronic seizures that can change the normal electrical activity of brain's neurons for some time. Approximately 1% of the total population is suffering from epilepsy. It can be happen at any age and any time. The causes of epilepsy are still unknown. Electroencephalogram (EEG) signals are mostly used in diagnosing epilepsy. EEG signals are non-linear and non-stationary time sequences which can be detected by placing the electrodes on the scalp of the patient and monitor the change in brain electrical activity electronically and record it on a strip of paper. Then these EEG signals are used for further processing and detecting epilepsy.

1.1 Literature Review

Epilepsy is a neurological disease which can be detected with the help of EEG signals. Two types of states are very common in epilepsy. Ictal and Interictal. Ictal (state during epileptic seizure) EEG recordings are more reliable in diagnosing epilepsy than interictal(state between two seizures) recordings.

1.2 Diagnosis of Epilepsy

Epilepsy can be diagnosed by following steps.
i) Extract raw EEG signals.
ii) EEG signal analysis.
iii) Feature extraction and dimension reduction.
iv)Classification of EEG signals using Support vector machine.
v) Performance evaluation.

1.3 Data set used- An EEG data set from the epilepsy centre of Bonn University hospital of Freiburg is used. The data set contains five subsets A, B, C, D and E. Each subset containing 100 single channel EEG files and each file containing 4096 EEG sample values. Each signal has 23.6s of time duration.

2. Methodology

i) EEG signal analysis- The EEG signals can be analyzed using three types –Time domain analysis, Frequency domain analysis, and time-frequency domain analysis. In this thesis we analyze the EEG signals and extract the features using time-frequency domain analysis.

ii) Feature extraction and dimension reduction- Feature extraction is the most important part of the pattern recognition because the classification performance will be degraded if the features are not chosen well. The feature from the EEG signals are extracted using STFT (short term Fourier transform) and DWT (Discrete wavelet transform). Two statistical features are extracted in this thesis. Mean and Variance. Down sampling is used to reduce the dimensions of the feature by 25% of the original signal maintaining the original quality of the signal.

iii) Classification of EEG signals using SVM-The feature extraction process is followed by classification procedure of EEG signals by SVM. SVM is one of the best states of art machine learning algorithm and it has been broadly used in many fields. SVM is able to distinguish input variables by mapping the inputs to a high dimensional field in which feature can be differentiated by linear function.

SVM is supervised model of signal classification.

In it all the sets are divided into two even parts: Training and Testing data set. In other words 50% features vectors are randomly selected as training data set and the remainder becomes the testing data set.

Steps for SVM-

1. First we train the SVM machine and tell the input and output outcomes.

2. Give the unknown input data to machine for testing purpose.

3. At last apply the formulae for calculating accuracy.

iv) Performance Evaluation-To evaluate the performance of feature extractor the performance parameter Total Classification Accuracy is defined.

Acc-No. of correctly classified patterns/Total no. of patterns.

v) Software overview- All the software implementation has been done in MATLAB R2013a. Steps performed in software implementation are-

1. Read the clinical EEG signals for analysis.

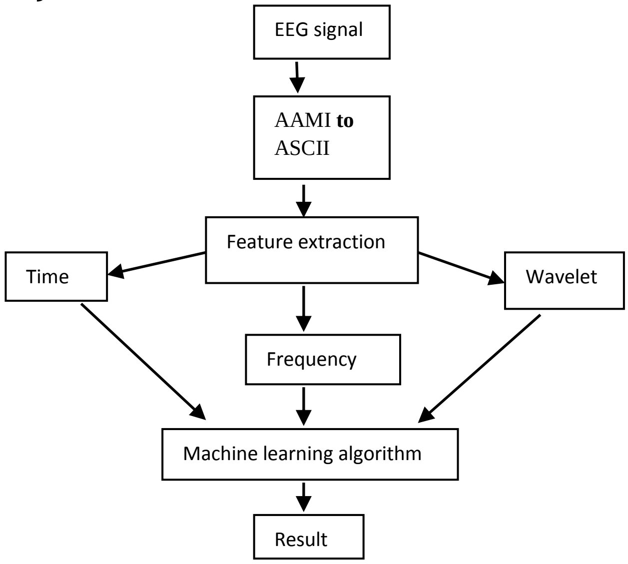
2. Down sampling the original signal using wavelet transform.

3. Reduce the feature set and arrange it in single matrix form.

4. Calculate the statistical features.

5. Train the SVM for testing and classification.

Vi) Flow Chart-



Flow chart for Diagnosing epilepsy and classification of EEG signals

3. Result- This data is analyzed by a machine learning algorithm called Support vector machine. In this research work a single data length is 100*4096 samples. All these samples are analyzed and feature are extracted followed by feature reduction and classification of data using SVM.

The accuracy has been calculated by training some of the data set using support vector machine and applied rest of the data set for testing.

The table shows the accuracy achieved by the support vector machine-

Training samples	Testing samples	Accuracy
1:270	271:500	96.52%
1:300	301:500	98.50%
1:330	331:500	99.41%

The accuracy achieved in this thesis is very high as compare to the other thesis work. So it can be definitely said that the SVM can be clinically and industrially used for classification of EEG signals as epileptic or non-epileptic.

4. CONCLUSIONS

Complete analysis of data has been done in time and frequency domain and features are extracted using wavelet transform. For individual signal two time domain feature are calculated then by passing through all the features by feature reduction process at last classification of the signal has been done by. a machine learning algorithm as Support vector machine

This thesis contributes the classification of EEG signals for epilepsy by an automated machine learning algorithm as the provided signals are epileptic or non-epileptic. As many commercial software packages are available for the classification purpose but the support vector machine classifies the data as epileptic or non-epileptic on the basis of currently available data. There are many advantages of using SVM classifier.

- The runtime for training the classifier very faster than machine learning algorithms.
- The testing time observed was also very less.

So this allows for the classifier for the classification purpose of real time data during EEG data acquisition. So this machine learning algorithm can be finely used for signal analysis and data classification.

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