IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Classification of Anxiety Disorder and Depression Disorder from EEG using SVM

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Abstract: *Due to constant work pressure, family pressure, current pandemic situation people may suffer from anxiety and depression. It affects their physical and mental health. So, we have developed a system to classify 3 different stages: normal state, anxiety and depression from the EEG signals. Feature extraction technique used are statistical parameters like mean, variance and standard deviation and classifier used is Support Vector Machine (SVM) for detection of anxiety, depression and normal state for an individual.*

Keywords*: DWT, EEG, KNN, SVM*

INTRODUCTION

Nowadays, depression and anxiety are the world's major health concern and economic burden worldwide. In India 43% of people suffer from depression and 38 million from anxiety disorders. It is the main reason of increase in suicide cases. Depression causes deep feelings of sadness, lack of interest, abnormal sleep patterns, feelings of worthlessness and anxiety causes heart disease, diabetes, thyroid, panic attacks which gives a person reason to end their life. Symptoms of mental illnesses are not easy to understand. A lot of people do not know about them, including the people that are suffering. This project can help psychologists to determine the severity of symptoms for patients.

Electroencephalogram remains the primary reorganization test of brain function. EEG is especially valuable in the investigation of patient's electrical activity produced by the cerebral cortex nerve cells and it is extensively used in clinical categorization of brain activities. The scalp may produce various electrical potentials which represent the variation in the brain's activity.

In this project, we have developed a system which can classify whether an individual is suffering from anxiety, depression or is normal using EEG signal datasets by signal processing.

LITERATURE SURVEY

Paper [1], proposes a methodology with an approach to machine learning in order to categorize the subject into 4 levels of depression (normal, mild, moderate and severe) using PHQ-9 and DASS-21 questionnaire and the electric EEG bands Alpha, Beta, Gamma, Delta and Theta.

[2] has recorded EEG signals and extracts features (Alpha, Beta, Gamma, Delta, Theta) from Muse Headband with four sensors (TP9, AF7, AF8, TP10) to categorize three states such as relaxing, neutral and concentrating.

In [3], EEG signals were collected using Pervasive prefrontal-lobe three electrode EEG system at Fp1, Fp2 and Fp3 electrode sites. After preprocessing using FIR filter, DWT, Adaptive predictor filter, linear and non-linear features extracted. Four classification methods (SVM, KNN, CT and ANN) distinguished the depressed participants from normal controls.[4] proposes an ensemble Logistic regression Model for detecting Depression (ELRDD) in Speech. This ensemble model extracts many speech features from different aspects and ensured diversity of the base classifier (logistic regression). ELRDD provide better classification results.

In [5], classification results obtained by using various linear (relative band powers, APV, SASI) and non-linear (HFD, LZC, DFA) features and describe feature selection and classifier configuration to improve classification accuracy.

[6] gives a system for pattern classification and analysis of memory processing based on EEG signal using bandpass filter as pre-processing technique. Feature extracted are statistical features, time-frequency, signal power, Hjorth parameters, Hurst exponent, band power asymmetry and spectral edge frequency and SVM as classifier.

METHODOLOGY

The implementation of the system is done in four steps:

1. EEG signal collection
2. Preprocessing
3. Feature Extraction
4. Classification

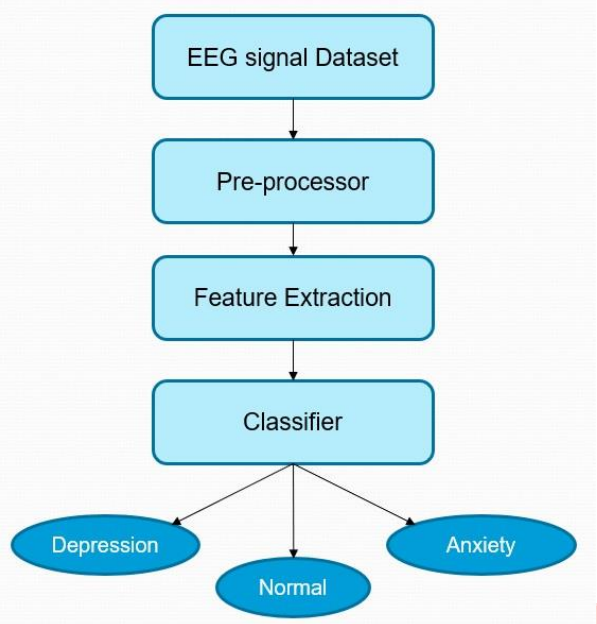


Figure 1: Block Diagram

EEG Signal:

EEG signals give information about brain signals. It records the electrical activity of brain using the electrodes placed on scalp. EEG can detect many problems such as epilepsy, headaches, brain tumors, depression, anxiety, brain deaths. The range of EEG signals is from 0.1 Hz to more than 100 Hz. We read this EEG Dataset in csv file which consists around 20000 number of samples. This dataset is used as testing dataset.

Preprocessing:

Preprocessing is used to remove noise or unwanted frequencies from given input. This can be done by DWT in which any general function can be expressed as an infinite series of wavelets. The main idea is to express a signal as a linear combination of a particular set of functions by shifting and expanding the original wavelets. Discrete wavelet transform has two parameters Low Pass Filter 'g' and a High Pass Filter 'h'. Wavelet φ function i, l(k) and Scale function are defined as:

$\varphi i,\ l(k) = 2i/2\ gi(k2il)$ (1)

$\psi i,l(k) = 2i/2\ hi(k-2il)$ (2)

where the factor 2i/2 is an inner product normalization, 'i' is the scale parameter and 'l' is the translation parameter.

The DWT decomposition can be described as:

$a(i)(l) = x(\varphi i,l(k))$ (3)

Feature Extraction:

From the given EEG data, we extracted statistical features like mean, variance, standard deviation etc. and labelled that data as anxiety, normal and depression. We created csv file which consists this feature extracted data and used this as training dataset. Using frequency samples we calculate the mean, variance, standard deviation and label it to create training dataset.

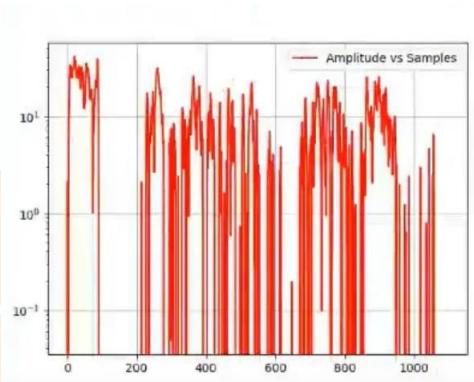
Classifier:

The training dataset is then applied to SVM Classifier to classify the testing data into three classes.

SVM: Commonly also called supper vector machines they are supervised learning models with associated learning algorithm. The SVM is a high efficiency classifier model and is used for comparison purposes. SVM helps in reducing the overall complexity of the model. The linear SVM method is used to classify.
The accuracy calculated as:
[(Total data – failed data)/total data] x 100

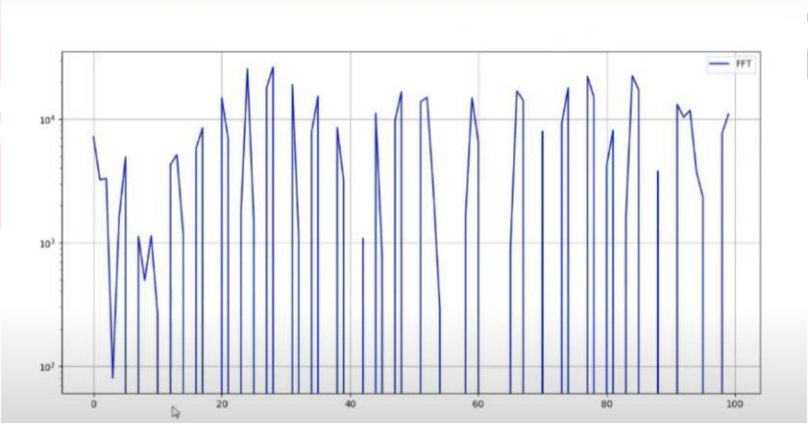
RESULT

1. **Amplitude Vs Samples:**



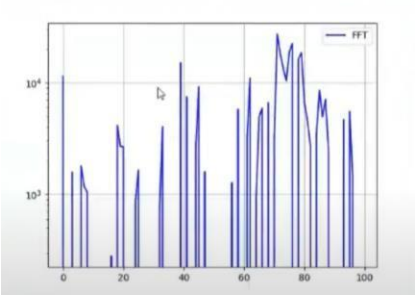
This graph shows the amplitude of each sample

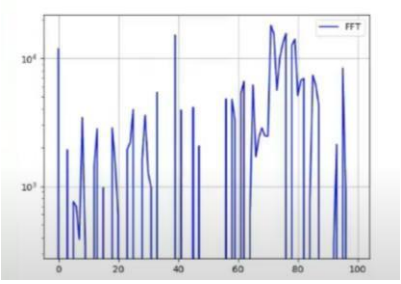
2. **Anxiety:**



This is a frequency response graph of EEG signal with anxiety.

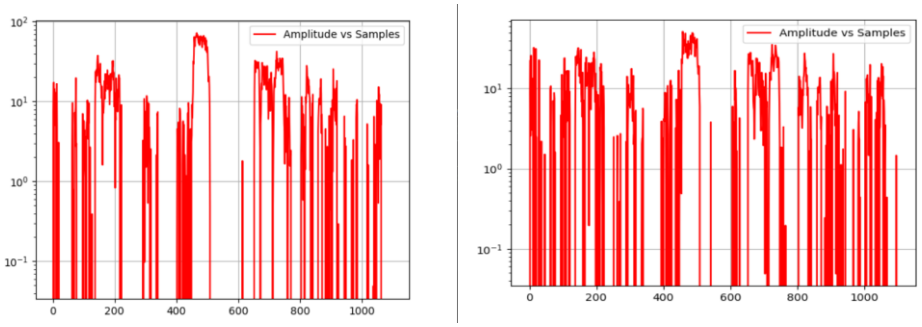
3. **Normal:**





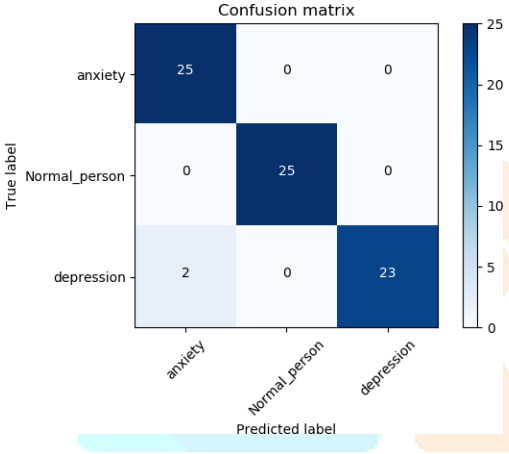
These are the frequency responses of normal people. In this graph, spikes are not spread.

4. Depression:



This is a frequency response graph of EEG signal with depression.

5. Confusion Matrix:



The confusion matrix shows the result we got for this system. This matrix shows the prediction based on the given training data(labelled data). Out of 75 people it shows correct result for the 73 people. From this we can calculate the accuracy for this system.

CONCLUSION

A system to detect normal, anxiety and depressed state of mind from EEG is developed using DWT as feature extraction technique and SVM as classifier. Mean, Variance and standard deviation are the features extracted after applying DWT to the EEG signal. It was found that the accuracy with SVM classifier is 97.33%. SVM classifier was chosen as it is sensitive to over fitting problem and due to its ability for high generalization and accuracy with smaller training dataset samples.

Acknowledgments

We would like to express our sincere gratitude to our internal guide Dr. Bageshree Pathak for her constant encouragement, valuable guidance and her precious time. We take this opportunity to express our sincere thanks to all faculty members of ENTC Department for their constant help whenever required.

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