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Sleep Disorders Classification Using Discrete wavelet Transform Technique

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Abstract **- Electroencephalogram (EEG) is a non-invasive test which is used to measure electrical activity in the brain. EEG is mostly found in cognitive science, neuroscience and physiological research. Numerous research and techniques were developed for analyzing the neural dynamics of EEG signal. This proposed paper discusses various techniques for understanding Neurophysiology in the brain during sleep. To classify the different sleep disorders with respect to neuro-electric data, the Psychological and clinical effects of sleep are concise, incorporated, and discussed. The author proposes an Innovative method in order to calculate and visualize the time-frequency representations for the EEG data being collected during sleep. In this paper we concentrated on classification of sleep disorders like insomnia, bruxism, narcolepsy and nocturnal frontal lobe epilepsy and estimation of the parameter like Power, RMS, Standard deviation, Variance, MSE of Sleep disorder.**

Keywords- **Electroencephalogram, Insomnia, Bruxism, Narcolepsy, Nocturnal frontal lobe epilepsy.**

I. INTRODUCTION

Electro encephalo graphy (EEG) is an electrophysiological checking technique to record the electrical movement of the cerebrum. It is ordinarily non-intrusive, with the cathodes set along the scalp, albeit obtrusive anodes are at times utilized in explicit applications. EEG estimates voltage variances coming about because of ionic current inside the neurons of the cerebrum. Basically EEG is a low amplitude signal which lies in the range of two micro to several hundred micro volts and its frequency range varies from 2 to 60 Hertz. EEG signals are random in nature which contains the useful information of the brain state. But in time domain it is very difficult to extract all the predominant features directly by signal observation.

It is a non-stationary and non-liner signal. A sleep disorder, or somnipathy, is a medical disorder of the sleep patterns of a person or animal. Some sleep disorders are serious enough to interfere with normal physical, mental, social and emotional functioning. Polysomno graphy and autography are tests commonly ordered for some sleep disorders. Disruptions in sleep can be caused by a variety of issues, including teeth grinding (bruxism) and night terrors. When a person suffers from difficulty falling asleep and/or staying asleep with no obvious cause, it is referred to as insomnia.[1]. Sleep disorders are broadly classified into dyssomnias, parasomnias, circadian rhythm sleep disorders involving the timing of sleep, and other disorders including ones caused by medical or psychological conditions and sleeping sickness.

The most common sleep disorder is sleep apnea (stops in breathing during sleep). Others are narcolepsy and hypersomnia (excessive sleepiness at inappropriate times), cataplexy (sudden and transient loss of muscle tone while awake), sleeping sickness (disruption of sleep cycle due to infection), sleepwalking, night terrors and bed wetting. Management of sleep disturbances that are secondary to mental, medical, or substance abuse disorders should focus on the underlying conditions.

II. LITERATURE SURVEY

As with other neurological disorders, an accurate medical history is an essential part of diagnosing a sleep disorder. People with sleep disorders should keep a daily diary of activities and sleep—both when they try to go to sleep and when they actually do fall sleep. The raw EEG signals are processed by the removal of artifacts that are present in signals. By using the wavelet decomposition we extract desired features ignoring the noise present in it. In the literature, numerous examples on how the EEG signal variation takes place for the sleep disorder subjects are discussed. Also the various techniques used to extract the features.

Ebrahimi, F et al, examined the biomedical signals, such as EEG, EMG, ECG and EOG are used in sleep labs

among others for diagnosis and treatment of sleep related disorders. The usual method for sleep stage classification is visual inspection by a sleep specialist. Therefore, in this work an attempt was made to classify four sleep stages consisting of Awake, Stage1 + REM, Stage 2 and Slow Wave Stage based on the EEG signal alone. Wavelet packet coefficients and artificial neural networks were deployed for this purpose. Seven all night recordings from Physio net database were used in the study. The results demonstrated that these four sleep stages could be automatically discriminated from each other with a specificity of 94.4 ± 4.5%, of sensitivity 84.2+3.9% and an accuracy of 93.0 ± 4.0% [5]. Chouvarda,

I and et al, aims to investigate new markers for the quantitative characterization of insomnia, in the context of sleep microstructure, as expressed by cyclic alternating pattern (CAP) sleep. The increase in CAP rate, main findings regarding the microstructure difference in insomnia include: 1) as regards the deep sleep building phases, more irregular activation-deactivation patterns, with bigger deactivation time, i.e., distance between consecutive activation events, and appearing with higher EEG complexity in deactivation, and 2) a bigger duration of de-synchronization phases, with increased EEG complexity and more irregular patterns. This opens new perspectives for the understanding of the role of CAP in the quantitative characterization of sleep and its disorders.[6]

Meissner, D and et al, explained that during an ordinary night, the human body goes through various sleep stages, most commonly classified as REM and non-REM sleep cycles. Abnormalities in the electrical expression of such slows waves could be an indicator of long term deficiencies in these functional process as a consequence of some neurological disorders like epilepsy. In this work, we have studied different characteristics measured from the electrical expression of slow waves between normal and epileptic subjects. These parameters allowed us to determine significant differences in the preferential depolarization and hyperpolarization times, suggesting a possible alterations in the underlying neuronal processes. [7]

Yashima Ahuja & Sumit Kumar Yadav have studied the concept and need of Multiclass classification in scientific research. Various classification approaches are discussed in brief. Support Vector Machines (SVM) has well known record in Binary Classification.Thier major emphasis in this paper is to study the fitness of Support Vector Machines in multiclass classification.[8]. Dayanand Vishwanath Dhongade and et al, examined, seven different sleep disorders along with one healthy subject. Large amount of EEG records have been taken from PhysioNet database and analyzed with the help of discrete wavelet transform (DWT). The various statistical measures like maximum value, minimum value, mean value and standard deviation value of DWT sub-bands are used as extracted features for detection of different sleep disorders. The results of these feature reduction techniques are used to classify different sleep disorders using k nearest neighbor (KNN) classifier. The performance of these classification processes is evaluated by using their accuracy to predict the sleep disorders.[9]

III. METHODOLOGY

1. Acquisition and Preprocessing Of Eeg Signal

1.1 EEG signal data acquisition

The EEG signals can be captured with open source hardware such as Open BCI and the signal can be processed by freely available EEG software such as EEGLAB or the Neuro physiological Biomarker Toolbox or we can collect readily available EEG data related to sleep disorder from Psycho net.

1.2 Pre-processing and artefacts removal methods:

The obtained raw EEG signal has to be pre-processed to remove unnecessary artefacts and noise from the signal. The following steps are to be followed:

1. Band pass filtering- The EEG signal samples are to be extracted with a sampling frequency. So the data has to be band pass filtered by a FIR filter.

2. Notch Filtering- Band pass filter includes the power line interference of 50Hz along with EEG frequency. So a notch filter is used, which removes power line interference from the EEG signals.

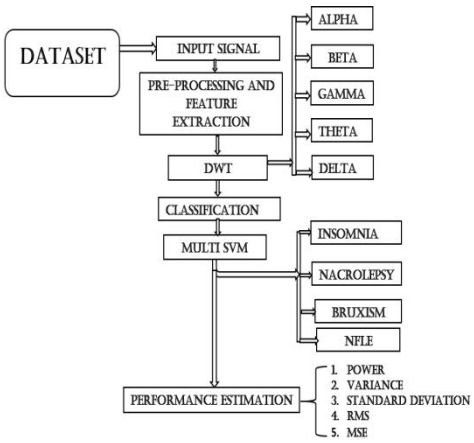

Fig. 1 Sleep disorder identification system.

1.3 Baseline Removal- Here the baseline has to be removed. This can be done by just subtracting the mean from the data.

1.4 Artifact Removal- To avoid interpretations, unwanted artifacts has to be removed. These artifacts are to be removed from different frequency bands.

2. Flow of Multi Svm Technique

In machine learning, support-vector machines (SVMs, also support-vector networks [2]) are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis. Given a set of training examples, each marked as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier (although methods such as Platt scaling exist to use SVM in a probabilistic classification setting). An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall.

In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high-dimensional feature spaces.

Multiclass SVM aims to assign labels to instances by using support-vector machines, where the labels are drawn from a finite set of several elements. The dominant approach for doing so is to reduce the single multiclass problem into multiple binary classification problems. [3] Common methods for such reduction include. [4][3]

There are 2 main phases in classification of sleep disorder using Multi SVM technique. i.e., training phase and testing phase. In training phase we train all sleep disorder signal and estimate their parameters like Power, Variance, Standard deviation, RMS and MSE values and stored with some reference number. While in testing phase by giving different input we test the sleep disorder type with reference to trained signal and sleep disorder type is identified.

IV EXPERIMENTAL RESULTS

Various parameters can be used to define the performance of this technique. The results of this method can be compared with other methods by few parameters like

- The RMS value is the effective value of a varying voltage or current. It is the equivalent steady DC (constant) value which gives the same effect. For example, a lamp connected to a 6V RMS AC supply will shine with the same brightness when connected to a steady 6V DC supply.
- Electrical power is the rate at which electrical energy is converted to another form, such as motion, heat, or an electromagnetic field.
- Mean Square Error (MSE) – The Mean Squared Error (MSE) is a measure of how close a fitted line is to data points. Small value of the Mean Squared Error, represents closer the fit to the data.
- In probability theory and statistics, variance is the expectation of the squared deviation of a random variable from its mean. Informally, it measures how far a set of (random) numbers are spread out from their average value. Variance is an important tool in the sciences, where statistical analysis of data is common.
- The standard deviation is a statistic that measures the dispersion of a dataset relative to its mean and is calculated as the square root of the variance.

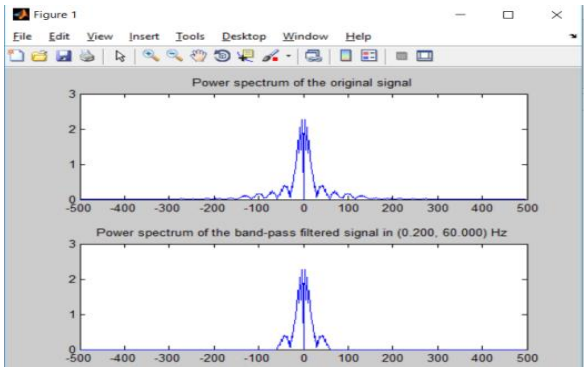

Fig.2 Power spectrum of original and BPF signal.

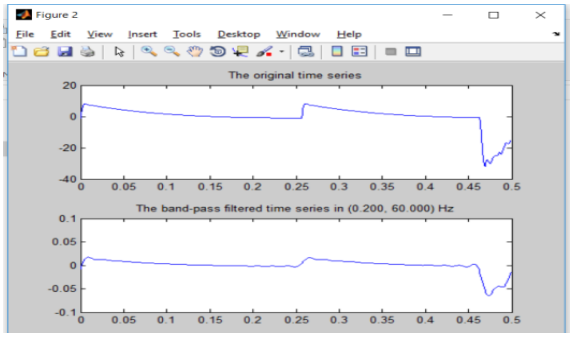

Fig.3 Time series of original and BPF signal.

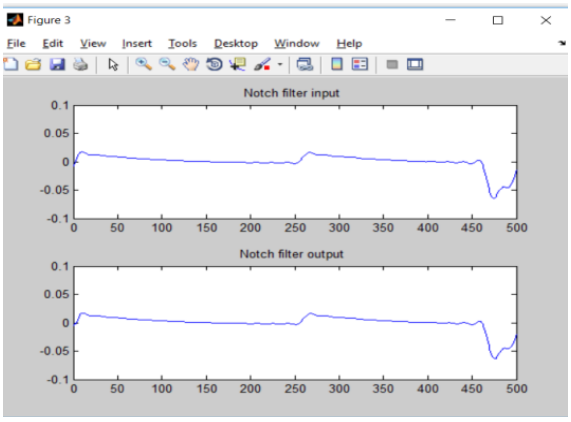

Fig. 4 Notch filter input and output.

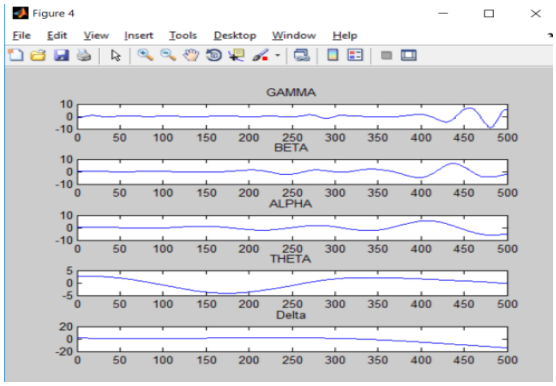

Fig. 5 Parameters of EEG signal.

V. CONCLUSION

The present review has attempted to explore the psycho physiological changes, state and traits summary of how sleep disorders affects the brain. Here from the literature survey the author proposes an innovative technique and algorithmic approach of multi SVM which shows better neural connectivity compared to DTF. The neuro-scientific study of meditation is still in its Infancy, further neuro electric and neuro imaging studies are needed to understand the brain oscillatory activity of sleep disorders at different stages. The estimated parameters will have different value depending upon the sleep disorder. That can be seen by calculating the parameters like Power, Variance, Standard deviation, MSE and RMS value of the sleep disorder signal.

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