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Estimation of Meditation Effect on Attention Level Using EEG

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Abstract - *During the learning process, whether students remain attentive throughout the learning generally influences their learning efficiency. Attention concentration is the indispensable basis for learning. Traditional teaching methods generally require that teachers observe students expressions to determine whether they are attentively learning. However, this method is often inaccurate and increases the burden on teachers. The similar cases of attention decreasing can be found not only within students but also in adults. Attention Deficit Hyperactivity Disorder is define as the lack of attention and focus and it is one of the most spread cognitive disorders. Hence, the concentration and stress management is essential for the student. The meditation is considered as a promising technique for body and mind regulation. The meditation plays an important role at physical, mental, and spiritual levels. With the development of electroencephalography (EEG) detection tools, detection of attention have become affordable technique. EEG measures the brain activity useful to recognize the attention states. In this paper, the effect of meditation on attention level using EEG data analysis is investigated. Random forest method is used for classification and it gives correct classification rate with 90 % accuracy.*

Key Words: **ADHD, EEG, CFS, KNN, RFC, SD**

1. INTRODUCTION

Our brain is constantly processing information and it is paying attention and also it reacted accordingly, to all sensory inputs i.e. audial or visual, etc. During the learning process, whether students remain attentive throughout instruction generally influences their learning efficiency. In traditional face-to-face instruction, teachers generally observe student's expressions to determine whether they are sufficiently attentive. However, this method is excessively subjective and consumes a significant amount of the teacher's energy. Furthermore, besides Face-to-face instruction, students may engage in distance learning over the Internet, which further increases the difficulty of determining whether students are attentive.

So there is the need to accurately measure a person's level of attention to monitor their performance, and also ADHD in children, etc. Meditation has been used as self-mastery and self-help technique. Meditation helps us to control our own mind and consequently our own life**.** Daily Meditation helps to reduce stress and improve concentration. An EEG is a recording of brains spontaneous electrical activity. This is controlled by billions of neurons. These neurons continually send messages to each other which can be picked up as electrical impulses from the scalp. The process of picking up and recording the impulses is known as EEG. An EEG can be divided into following basic frequency bands.

Table -1: Brain waves classification

Sr. no.	Type of waves	Frequency range	Human mental stages
1.	Alpha waves	8-13 Hz	Relaxed
2.	Beta waves	13-30Hz	Thinking , aware of self and surrounding , alertness
3.	Delta waves	0.5- 4Hz	Deep, dreamless sleep
4	Theta waves	4-8Hz	Fantasy, dreaming

2. LITERATURE SURVEY

Various work has been done of EEG data analysis on various platform and with various assumption. Some related proposed work has been discuss below.

Bin Hu, Xiaowei Li, Shuting Sun, Martyn Ratcliffe [1] presented work on the processing of EEG data to identify attention during the learning process. The authors propose a classification procedure that combines correlation-based feature selection (CFS) and a k-nearest-neighbour (KNN) data mining algorithm. It was found that CFS+KNN gives correct classification rate (CCR) of 80.84+3.0%.

Laxmi Shaw, Aurobinda Routray [2] presented technique which was undertaken to study the specific statistical

features of EEG data collected during meditation and normal conditions. The statistical features are calculated from different wavelet coefficients to categorize two diverse groups i.e. Meditators and Non-Meditators.

Brahim Hamadicharef, Haihong Zhang, Cuntai Guan et.al. [3] Proposed new approach in which spectral-spatial features from multichannel EEG are extracted by a two filtering stages: a filter-bank (FB) and common spatial patterns (CSP) filters. The most important features are selected by a Mutual Information (MI) based feature selection procedure and then classified using Fisher linear discriminant (FLD). The outcome is a measure of the attention level.

Esmeralda C. Djamal, Dewi P Pangestu, Dea A. Dewi [4] proposed a technique for recognition of attention state using wavelet filter and support vector machine. Evaluation of students learning process divided by two states, that attention and inattention. EEG was extracted using wavelet that filterd in the frequency range of 5-30 Hz.

Narendra Jadhav, Ramchandra Manthalkar, Yashwant Joshi [5] proposed a system in which the effect of meditation on emotional response using EEG is investigated. The asymmetry of band power (theta, alpha and beta band) and Hjorth features are used as emotion-specific EEG features. The average effect of these features is more on frontal asymmetry. The results revealed that more coherence in the post-meditation is found for all emotions. The K-Nearest Neighbours (K-NN) classifier is used and emotion classification accuracy after 8 weeks of meditation is decreased.

3. PROPOSED WORK

It has been study that EEG signals contain considerable information for attention recognition, and give effective and objective solutions to detect attention in learning process. Based on these results, objectives of this work are defined as focusing on the processing of EEG data to identify effect of meditation on attention level.

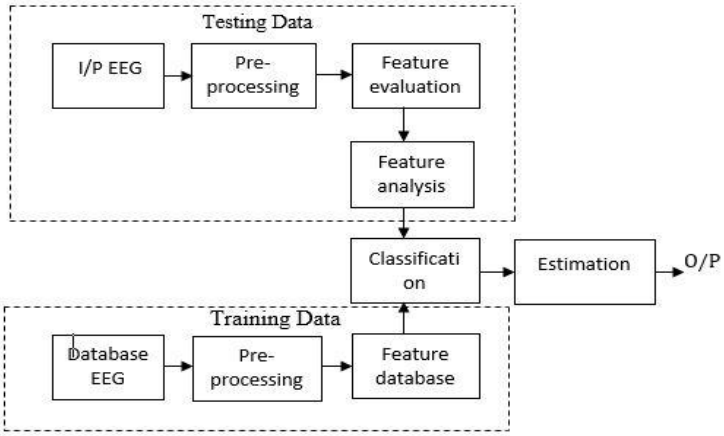

Fig -1: Proposed block diagram

3.1 Data Acquisition

The EEG signal acquisition is very important in biomedical field because it detect problems in the electrical activity of the brain for signal analysis. In this paper we will take the data by using the 10-20 system. The data acquisition is done using NEUROCOMPACT 2400 EEG Device. The 10-20 system the placement of the electrodes is based on the relationship between area of cerebral cortex (the 10 and 20 refers to the 10% and 20% inter-electrode distance) and location of electrode. It is the standard system for placement of the electrodes on the human scalp.
F: frontal lobe, C: central lobe, T: temporal lobe, P: parietal lobe, O: Occipital lobe.

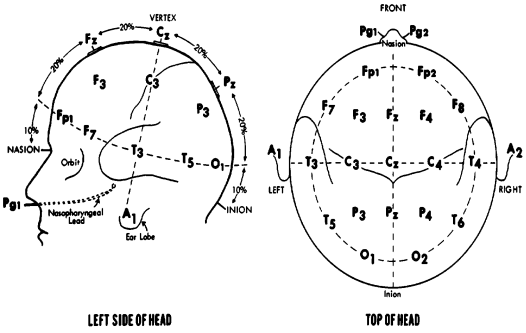

Fig -2: 10-20 system for electrode placement

3.2 Pre-Processing

EEG signal contains the low range of the frequency components and amplitude. The critical problem in analyzing the EEG signal is because of detection of the different types of noise signal mixed with the EEG signal during the recording process. These Sources of noise in EEG may be due to static electricity and EMF produced by

surrounding devices. With these external noises, the EEG signal influenced by artifacts that originate from our body movement or eye blinks during recording process. To remove these noises from signal we have used NEUROCOMPACT 2400 EEG Device

Data segmentation is the process of taking the data i.e., EEG signal and segmenting it so that it can be easy to analyze the brain activities. As mentioned earlier that, EEG signals of meditating and non-meditating person are collected for analysis. The data is acquired on 24 channels. The electrode positions were selected manually based on the interest of our study. The electrode positions which are selected based on our requirement are FP1, FP2, F7, F3, Fz, F4, and F8.

3.3 Feature Evaluation

Statistical parameters calculation:
Statistical parameter is an important component of any statistical analysis. In simple words, a parameter is any numerical quantity that characterizes a given set of data or some aspect of it. This means the parameter tells us something about the whole data. The different types of parameters that we have calculated are Standard deviation, Relative power, Avg. Power Spectral density, entropy, HFD, Mean, Variance.

3.4 Classification Method

Classification algorithms help to predict the qualitative features of a subject's mental state by extracting useful information from the EEG data. Here we will consider Random forest method for classification.
Random Forest classifiers (RFC) are the ensemble classifier introduced by Leo Breiman and Adele Cutler. Random Forest is a combination of many Decision Tree classifiers. Random Forest generates n number of random trees, with the help of bootstrap of training dataset and generating trees. It has an effective method for predicting missing data and also maintains accuracy when the proportion of missing data is more.

4. RESULT AND DISCUSSION:

EEG signals are recorded using NEUROCOMPACT 2400 EEG device. The electrodes are placed using International standard 10-20 lead configuration. The data is recorded from 10 subjects out of which 4 subjects as training data and 6 subjects as testing data. All subjects are normal, free from any medication and without any disorder. Here we used common protocol of rest position and then motor activity.

Computational Analysis:

The graphical analysis of different statistical features between the non-meditating and meditating subjects are shown below:

1] Standard Deviation:

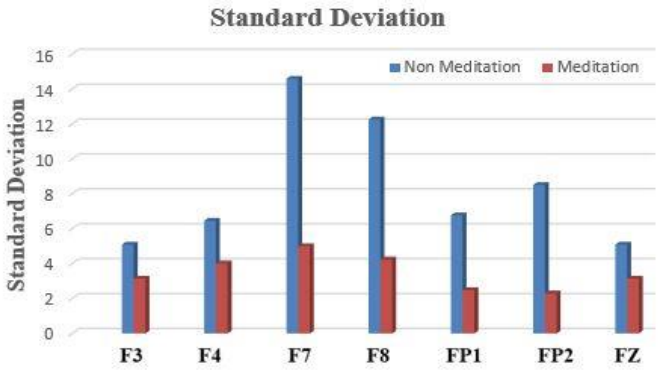

Chart-1: SD variation

2] Relative power:

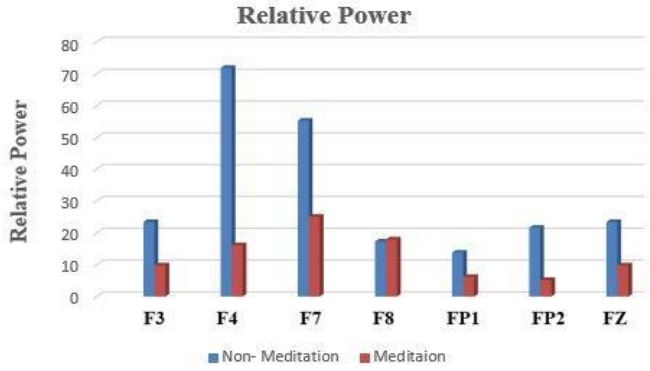

Chart-2: Relative power comparison

3] Avg. power Spectral density:

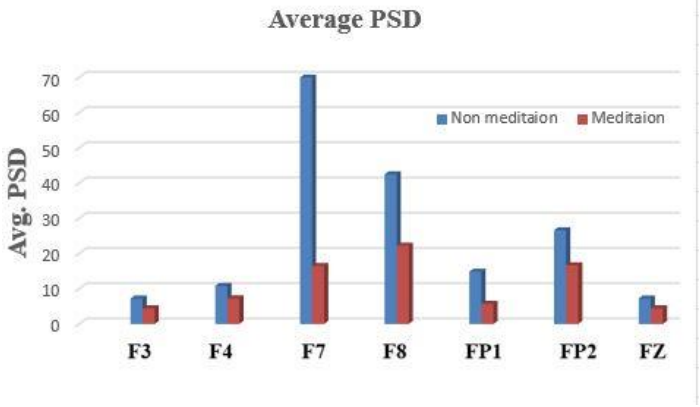

Chart-3: Average power spectral density

4] Entropy

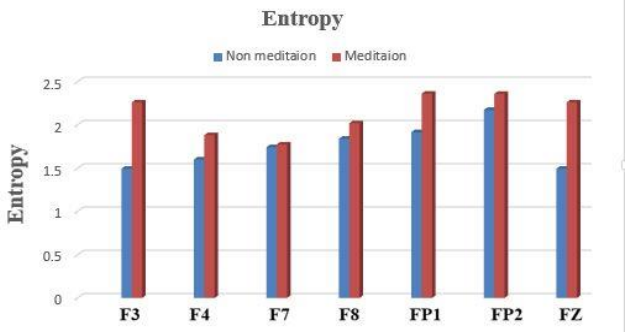

Chart-4: Entropy

5] HFD

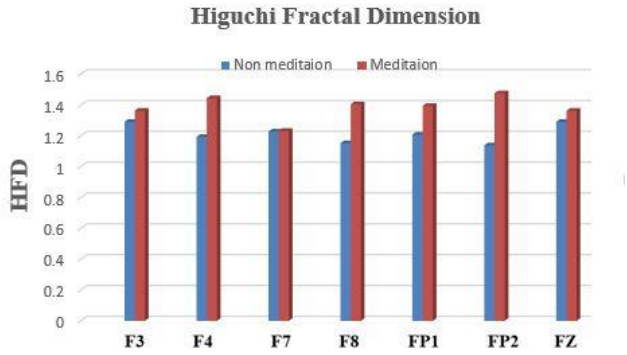

Chart-5: Higuchi fractal dimension

6] Mean

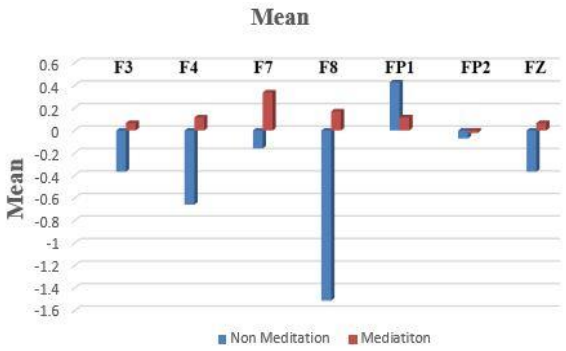

Chart-6: Mean

7] Variance

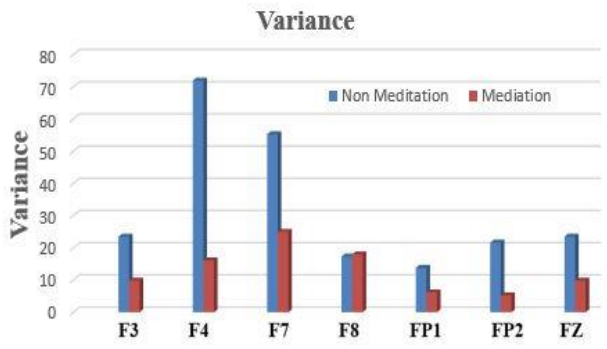

Chart-7: Variance

The above graphs draws the conclusion that several analysis performed on non-meditation subject's show increased neuronal activities during different cognitive task, whereas meditational subjects tend to suppress their neuronal activity. The standard deviation is lower in meditating subjects than in non-meditating subjects.

A confusion matrix contains information about actual and predicted classifications done by a classification system. Performance of such systems is commonly evaluated using the data in the matrix. The following fig. shows the confusion matrix for Random forest classifier.

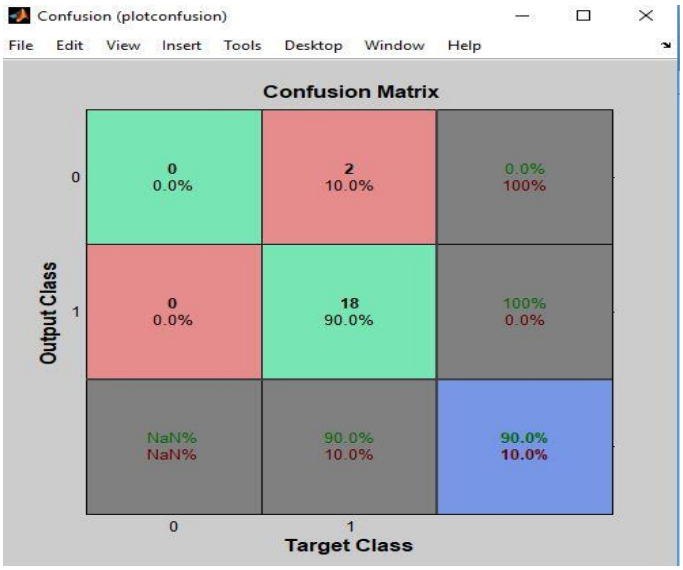

Fig -3: confusion matrix plotting

Comparative Analysis:

Table -2: Accuracy comparison

Feature Classification Method	Accuracy (%)
Naïve Bayes (1)	78.00
SMO (1)	78.04
KNN (1)	80.84
SVM (4)	83.00
Random Forest Method (proposed)	90.00

It was found that Random forest method had much better performance and it gives correct classification rate of 90 % accuracy.

5. CONCLUSIONS

Subjects who are anxious, angry or depressed don't learn and take information efficiently, so there is need to measure the attention level. The meditation plays an important role at physical, mental, and spiritual levels. Daily Meditation helps to reduce stress and improve concentration. So with the help EEG we are measuring the brain activity useful to recognize the attentional states and effect of meditation on attention level. Several analysis performed indicate that, non-meditation subjects show increased neuronal activities in the rest position, whereas meditational subjects tend to suppress their neuronal activity. Extremely high standard deviations are found in the non-mediational subjects in rest position as well as in motor activity, whereas in the normal subjects, all parameters show significantly lower values. This indicates the deviation from the mean value and implies about the hyper-active nature of non-meditational subjects.

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