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To cite this article: R. Velnath *et al* 2021 *IOP Conf. Ser.: Mater. Sci. Eng.* **1084** 012003

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Analysis of EEG Signal for the Estimation of Concentration Level of Humans

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Abstract

Especially when studying or thinking, focus is an important part of our lives. To understand humans' concentration mechanism, the brain activity is monitored using EEG signals. Electroencephalogram (EEG) is test used to track and record the brain wave patterns based on the electrical activity of the brain. It is a very versatile tool for the detection of brain activity. Based on concentration and thinking the brain waves will get change due to their change in brain activity. The variations in brain waves are analysed and the features are extracted using various methods. EEG data are collected for different persons under two different age groups of 20 to 23 age and 29 to 31 aged people because the concentration varies with respect to age. The characteristics are extracted from the collected EEG signal using FFT, Mean, Standard Deviation (SD), Median and Mean Root Square. The concentration level is determined by comparing the extracted features for different aged individuals.
Keywords: Electroencephalogram (EEG) signal, concentration, FFT, LabVIEW

1. INTRODUCTION

The brain is composed of different lobes, while the prefrontal lobes are the brain's cortex region is responsible for attention and concentration, reflection. The EEG results for different individuals with different tasks are analysed and extracted from the EEG signal to determine their concentration. It is possible to implement it in Gaming sector to monitor the gamer's thought. Participation attention and in the game for improvisation and modern games creativity.

1.1 Brain

It consists of three major sections, such as the cerebrum, The brainstem and the cerebellum. The brain is subdivided into four parts: Frontal lobe, Temporal lobe, Parietal lobe and Occipital lobe. Each lobe is accountable for many operations. The frontal lobe is responsible for the resolution of issues, Concentration, judgment and the work of the motor. The lobe of the parietal Sensation, handwriting, and body posture are handled. The in memory and hearing function, the temporal lobe is involved. The occipital lobe comprises the sensory processing system of the brain. In concentration, the prefrontal cortex area is mainly involved.

1.2 EEG Signal

An indicator of brain waves is the electroencephalogram (EEG). It records and monitors the patterns of brain waves. Those brainwaves adjust according to the emotions of the individuals and their motions. If slower brainwaves are dominant, it indicates that the It makes people feel sleepy, lazy, sluggish, or dreamy, while dominant are the higher frequencies, Indicating that people are wired, or hyper-alert. In Hertz (cycles per second), brainwave velocity is measured and they are broken down into bands. EEG Signals. A indicator of brain waves is the electroencephalogram (EEG). It tracks and records the patterns of brain waves. Depending on the emotions of people and their movements, the brainwaves shift. It shows that when slower brainwaves are dominant, individuals feel sleepy, slow, sluggish, or dreamy. It shows that individuals feel wired, or hyper-alert, when the higher frequencies are dominant. In Hertz (cycles per second), brainwave intensity is determined and they are split into bands.Based on their frequency spectrum, EEG signals are as alpha, beta, theta, delta, and gamma waves in Table 1.

Table 1. EEG waves

WAVE	FREQUENCY	STATE
Delta	Below 4 Hz	Dreamless sleep, lack of physical activity Consciousness
Theta	4-8 Hz	Reduced consciousness, deep consciousness, deep perception Light sleep, meditation
Alpha	9-13 Hz	Relaxed physically and emotionally, Sleepy, awake but drowsy
Beta	14-30 Hz	Awakening, alertness and perception
Gamma	Above 30 Hz	Elevated vision

2. RELATED WORK

Certain literature surveys are focused on the study of the EEG signal and its extraction and functionality classification. De Xiao Di Xiao. By agreeing on the emphasis meaning R [9], humans suggested the measurement of the degree of concentration level. NagpalChetna uses the distribution of frequencies, standard deviation, and variance for Extraction of features and fuzzy logic for classification of Measured EEG signals from rats [8] .Tae Jin Choi presents a system for concentration state estimation Using several channels of EEG. It uses eight channels for the Measurement during times of resting and focusing. Kalaivani suggested diagnosing the defects that are present in a brain that uses signals from EEG. Pre-processing, attribute extraction, choice of characteristics and classification are needed.

The discrete wavelet transformation is used for the decomposition of the EEG. Applying average, regular variance, maximum and minimum, the signal and the features are extracted. Signals are graded as regular or abnormal by means of the k means classifier [12].

Some literature surveys have concentrated on the study of the EEG signal and its extraction and classification of features. By evaluating the focus value R, Di Xiao suggested calculating the degree of concentration level of humans [9]. ChetnaNagpal uses frequency distribution, standard deviation, variance for feature extraction and fuzzy logic[8] for the classification of EEG signals measured by rats. Tae Jin Choi uses several EEG channels to introduce a framework for estimating the concentration state.For the measurement during resting and concentrating cycles, eight channels are used. Kalaivani suggested using EEG signals to diagnose disorders present in the brain. It needs pre-processing, feature extraction, feature selection and classification. In order to decompose the EEG signal, the discrete wavelet transform is used and uses mean, standard deviation, maximum and minimum to extract the features. By means of the k means classifier[12], signals are classified as regular or abnormal.

3.ANALYSIS OF HUMAN BRAINWAVES

The primary objective of the work proposed is to evaluate the Centered on their brain function, concentration level of humans. The source of emotions, feelings and actions are the Inside the brain, contact takes place between neurons. Synchronized electric pulses produce brainwaves from masses of neurons that communicate with each other. In order to measure the electrical activity of the collective Cortex of the cerebrum, electroencephalography uses electrical leads that are located all over the scalp. This spontaneous behavior is categorized based on the classification of on the frequency created as alpha at the time of operation, Beta, alpha, delta, gamma and theta.

The EEG 10-20 amplification method is used to evaluate the brain for measurement purposes. It consists of silver cup electrodes that are placed over the scalp. This device has three leads, with the active and reference electrodes being one lead, the soil and the other two lead. These three electrodes are used for EEG signal control. In different citizens during various events. Electrodes of the test person and their forehead are placed over the measuring person's forehead. By using DSO, brain activity is tracked.

To suppress the noise present in the raw EEG signal [3], it uses a notch filter. The notch is a very selective filter with a filter selected only for a limited frequency band across the city with a very high rejection frequency. The production is fed after the elimination of the noise. Through the DSO. The suggested scheme consists of separate phases. For the study of human brain waves as a set of data, Feature extraction and selection of functions.

3.1 Data Collection

The involvement of individuals, paying on the basis of age, changes in focus, concentration and reflection. The data were obtained in two separate timings for groups of people under different age categories. Persons under 20 to 23 years of age Class 1 and individuals under the age of 29 to 31 are Group 2, 15 participants, with different tasks, are evaluated. For, Each person is given certain tasks, such as reading books, Puzzle solving, listening to music and counting numbers in reverse manner for the duration of 10 minutes.

The EEG waveforms are tracked and recorded as shown, in Fig. 1 for each assignment within the first two minutes and the last one Two minutes of an assignment. Based on the behavior of the person, the Neurons are stimulated in the cortical area [13]. For example, if the sound waves entering the ear drums are transmitted to the brain stem, the signal is passed to the cortex region of the brain and the EEG 10-20 amplification device controls the stimulation of the brain.

Figure 1 Measurement of EEG Signal

3.2 Feature Extraction

The features are derived from the EEG signal in order to reduce the loss of valuable signal-embedded information. Different techniques have been used extensively to extract the EEG Signals Features. The most widely used are FFT and average, standard deviation and determination of variance [14].

3.2.1 FFT Transformation

The raw EEG signal is transformed into a frequency domain signal. Use FFT to assess the spectrum of measured frequencies signaling signal. The signal, based on the resulting frequency, is classified as alpha among the five brain waves, as alpha, beta, gamma, theta and delta waves.
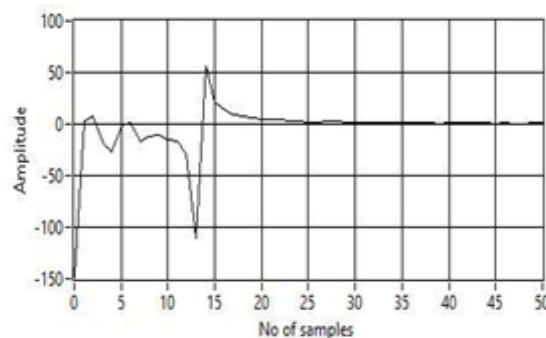
Figure 2 FFT of Puzzle Solving (first 2 min)

For one person, after FFT transformation the EEG signal of puzzle solving for first two minutes is shown in the Fig. 2. The frequency lies in the signal is 14 Hz so the type of brain wave generated at first two minutes is beta wave. It will be produced during alert and conscious condition. It is evident that the person is concentrating on solving the puzzles for the first two minutes.

Similarly for the same person, the EEG signal in transformed domain while solving puzzles for the last two minutes is shown in the Fig. 3. It indicates the frequency of about 0.5 Hz, delta waves are generated at last two minutes of the task. It shows the person is not concentrating and in the state of loss of awareness during end of the given task. For all the collected EEG signals of 15 participants for various tasks, the FFT transformation should be made and based on the frequency present in the signal, the type of brain waves present in the obtained signal is measured. The determination of type of brain waves provides better analysis of the person's concentration while doing the task.
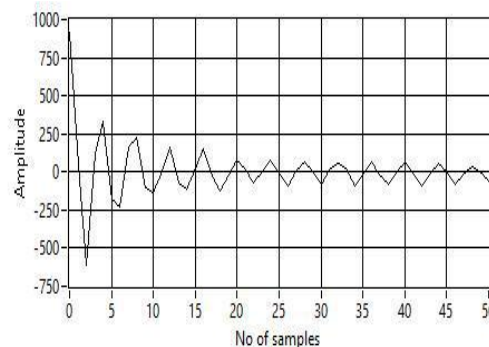
Figure 3 FFT of Puzzle Solving (last 2 min)

3.2.2 Computation of Mean, S.D, RMS and Variance

The another method of feature extraction is evaluating parameters such as mean, standard deviation, root mean square, and variance during their separate activities to determine the concentration of individual individuals.

TABLE II. Parameter estimation for puzzle solving

| PARAMETERS	FIRST 2 MIN	LAST 2 MIN
Mean	0.57536	0.40888
RMS	28.107	24.4458
S.D	28.1096	24.4432
Variance	790.148	597.47

Table II displays the various approximate parameters at two different timings when solving the puzzles. The data represents maximum for the first two minutes of puzzle solving and minimum for the last two minutes [8]. From both the methods of feature extraction, it is evident that the person is concentrating towards the puzzle solving for first two minutes and lags their concentration at the end of the task. Similarly, their attention is analyzed for the entire task of relaxed state, reading books, counting numbers in reverse order, solving puzzles and hearing melody for all the tested participants.

3.2.3 Feature Selection

This is the process of removing the features containing negligible information. Better results and accuracy are provided by the feature with more data. When comparing all feature extraction methods,the FFT transformation method provides high accuracy than parameter estimation method with less time consumption.

4. RESULTS AND DISCUSSION

At the forehead, where the prefrontal cortex region is present, the EEG signal is measured. The function of neurons in the brain varies depending on individual behaviours.
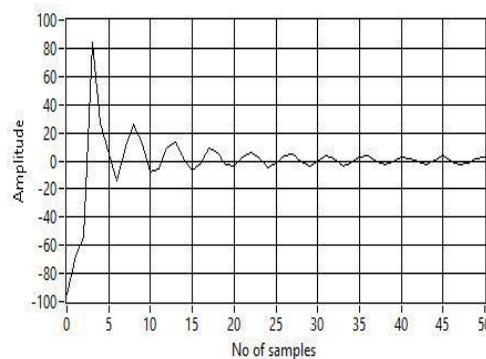
Figure 4 FFT of Person while Sleeping

The Figure 4 shows the transformed EEG signal for a person in sleeping state. It indicates the frequency of 3 Hz where the delta waves are generated it is proven that the person is in dreamless sleep condition.
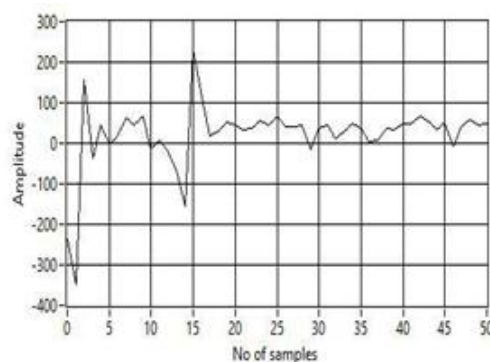
Figure 5 FFT of Person from Sudden Awake

The EEG signal of person when wakes suddenly from sleep is depicted in the Figure 5 with the frequency of 15 Hz. The produced frequency indicates that the generated EEG signal has beta waves. The beta waves are produced during awake and alert condition so it is proven that the person is conscious and alert at the moment of waking from sleep.

The FFT transformation is an effective method of feature extraction from the EEG signals to determine the people's concentration level.

5. CONCLUSION AND FUTURE SCOPE

The level of concentration of different people with distinct activities is controlled. Based on the attention of individuals to the mission, frequency range and type of brainwaves defined It fluctuates. From brain waves collected at the beginning of the Task and task completion, the concentration of individuals is stated. In the future, the level of concentration can be categorized as using fuzzy logic, regular, High and low algorithm concentration.

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