Analysis of Brain Wave Data Using Neurosky Mindwave Mobile II

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ABSTRACT

Human Brain, a very complex part of the human body which generates various types of signals of different frequency in wakefulness or sleeping period. By using these dissimilar types of frequencies brain waves can be distinguished from each other. And these electric signals can be measured by an EEG (electroencephalograph) headset. In the past, the EEG headset was not cheap at all and only used in medicine. But in the last few years, there are many cheap EEG devices available in the market. So, the research in BCI (Brain-Computer Interface) sector has been extended. Neurosky Mindwave mobile II is a cheap and user-friendly EEG device available in the market which we use here for our research. In this paper, Neurosky Mindwave mobile II used to find out our work and also determine the usability of it. This BCI device was used to do brain wave analysis. The main purpose of this paper is to describe the accuracy of detecting brain wave signals by the latest version of this device (Neurosky Mindwave mobile II).

CCS CONCEPTS

• **Human-centered computing**; • **Human computer interaction (HCI)**; • **Interaction devices**;

KEYWORDS

BCI (Brain Computer Interface), EEG, Brain wave, usability

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1 INTRODUCTION

Brain has the power to create electricity. Cerebral cortex could generate electrical simulation which is cleared by Fritsch and Hitzig (1870) and later Ferrier (1875). The signal which we get by a EEG device is very complex, multi-element can be represented by curve using the frequencies. The amplitudes between 8-12 Hz signals are called Alpha wave. And there are five types of waves which can be distinguished by those amplitude and frequencies. These wave also have its own characteristics.

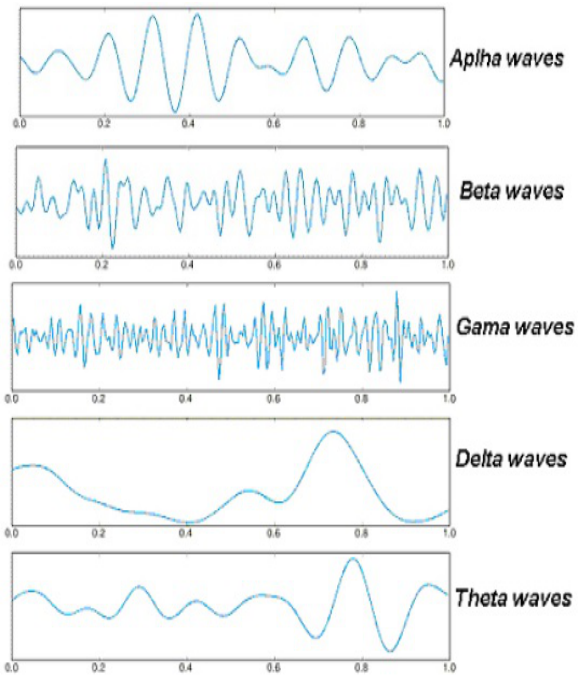

Figure 1: Example of Brain wave [3]

HCI (Human computer interaction) related devices are allowed researchers to interface it with a computer for data collection, model design, data analyze, design user friendly interfaces. In 1929, EEG devices were only used for finding neurological and mental disorders. But in recent times EEG research has got a different sector of investigation such as drowsiness [1], correlation with cognitive stress [7], automated wheelchair [9] using BCI devices and so on.

1.1 EEG Headsets

The detection of brainwaves signal can be performed by EEG devices. EEG devise has some electrode to detect the signals and then transmitting the signals through wireless connection like Bluetooth. In the past, to detect the signals EEG device used analog signal converter to convert the signals into digital signals. For further processing of the signals it uses signal processor and also use a communication unit to send the data into communication channel.

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1.2 Consumer Grade EEG Headset

In the past EEG devices were used in only medicine [11] and those were not budget friendly. But now there are many consumer grade EEG devices available in the market. Among them we chose Neurosky Mindwave Mobile II. The Neurosky Mindwave Mobile II is a lightweight and low-cost EEG device. It is mainly intended for education and research work.

2 LITERATURE REVIEW

2.1 Neurosky Mindwave Mobile II

Neurosky Mindwave Mobile II is a low cost user friendly wireless EEG device which is available to the general people such as students, teachers and researchers. There is also a previous version of neurosky mindwave which was namely Neurosky Mindflex. But in this research we are working with their latest release product. It has a dry active sensor which does not need any kind of gel during the experiment time. However, it is a single channel BCI headset and this gives a super mobility during the usage time.

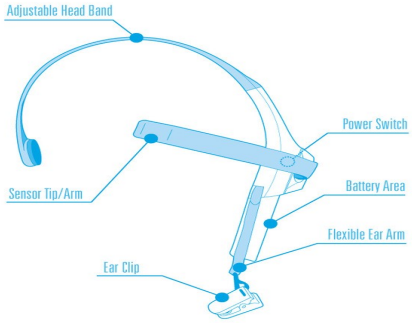

Figure 2: Neurosky Mindwave Mobile II Components

Neurosky Mindwave mobile II use a chipset acknowledged as ThinkGear which gives it the ability to interact with certain interfaces to visualize brainwaves and examine them [10]. We can get various data such as raw EEG data, frequency band magnitude Alpha, Beta, Delta, Gamma. Moreover, this device also gives Attention, Meditation and Eye Blinking data statistics also. Neurosky Mind wave mobile II diminishes possible implementation error by doing prepossessing in the device.

2.2 EEG Frequency Bands

EEG data info is usually calculated by frequency bands. And this date varies in amplitude and frequency that signifies a number of brain statuses [6]. This situation is also depending on a person's internal and external mental circumstances [2].

The Neurosky Mindwave Mobile II device gives the scopes to represent the data in graphical illustrations of brainwave activity. And the mathematical evaluation of brainwave data could be easily done by digital signal processor. The frequencies and significance of different brainwaves are given below in table 1 [4].

Table 1 illustrates the brainwaves frequency ranges as well as the mental states and conditions. Using this frequencies, it also can be possible to find the level [5] of attention, meditation or any kind of mental disorders [3].

Brainwave Type	Frequency range	Mental states and conditions
Delta	0.1Hz to 3Hz	Deep, dreamless sleep, non-REM sleep, unconscious
Theta	4Hz to 7Hz	Intuitive, creative, recall, fantasy, imaginary, dream
Alpha	8Hz to 12Hz	Relaxed, but not drowsy, tranquil, conscious
Low Beta	12Hz to 15Hz	Formerly SMR, relaxed yet focused, integrated
Midrange Beta	16Hz to 20Hz	Thinking, aware of self & surroundings
High Beta	21Hz to 30Hz	Alertness, agitation
Gamma	30Hz to 100Hz	Motor Functions, higher mental activity

Table 1: Frequencies and Significance of Brainwaves

3 METHODOLOGY

3.1 Hardware And Software

For hardware part neurosky headset is used in this procedures. Moreover, in this research we use Neuroexperimenter software by Fred Mellender. This software is using Thinkgear library to connect with the interface and then collect all the data. But at first neurosky should be connected to this software interface to collect data.

3.2 Data Gathering and Manipulation

In this research, data were collected in some states of our brain as well as the samples were categorized on the basis of age and gender. Data were collected by Age category of 10-29 and above 29. Then collected data are saved in a csv file for further evaluation.

For connection of this device with computer at first we need to turn on Bluetooth on both device and then pair them. After pairing them Neurosky headset should be wear properly in head. It's one probe must be on hairy scalp. and another is in the earlobe. Then software interface should be opened and press the connect button to generate data.

The testing took place in a calm and quiet place approximately 4-6 minutes for per participants. This procedure involved each of the participants to do 3 tasks. Those are given below-

- Analytical reasoning- Participants were asked to do a couple of mathematical problems based on the age and education level wearing the headset. To verify the task, they were asked to solve equation, calculus and matrix problems.
- Attention focusing- Participants were told to concentrate on a certain activity. As our test was a simple control task, we have asked to look at a picture. This involves in sitting in a calm and quiet place, closing their eyes to get relaxed.
- Blinking rate- Participants were instructed to blink their eyes randomly throughout the full session. By asking each participant to blink for approximately 150 times (blink continuously for three minutes)

There were 40 participant varies from ages from which data were collected. Three sets of data were collected from a participant with a little break of time so that all data were generalized. Three data sets collected from three sessions obviously as well as the variability of different task.

Each session was a duration of 6 minutes for collecting one set of data. In this session participants were asked to remain relaxed and calm so that collected data were generalized. And after that they are

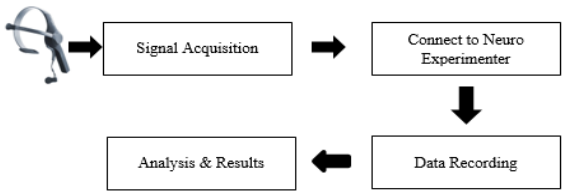

Figure 3: Experimental Framework

asked to perform those experimental task described above. From EEG we get Alpha, Beta, Gamma etc. values. Moreover, Attention, meditation and Eye blink data were also gathered from the session. In this particular part, participant needed to be very comfortable, relaxed and quiet.

3.3 Data Analysis

Collected data were divided into two groups according to the age of 10-29 and above 29 over men and women.

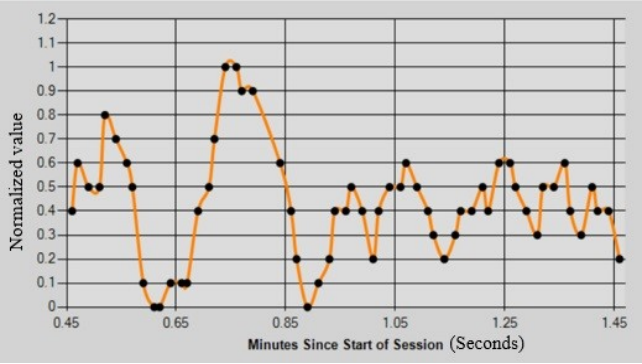

Figure 4: Sample graph representation (Attention)

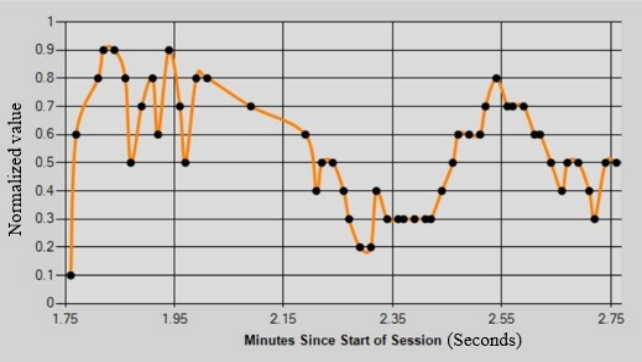

Figure 5: Sample graph representation (Meditation)

X- axis of this graph shows the last 'n' seconds (60 seconds in the sample above) of the selected waveforms. Here, in X- axis 1 small unit = 12 seconds. All of the waveforms are normalized to be between 0 and 1. The unit of measure on the Y-axis is the normalized

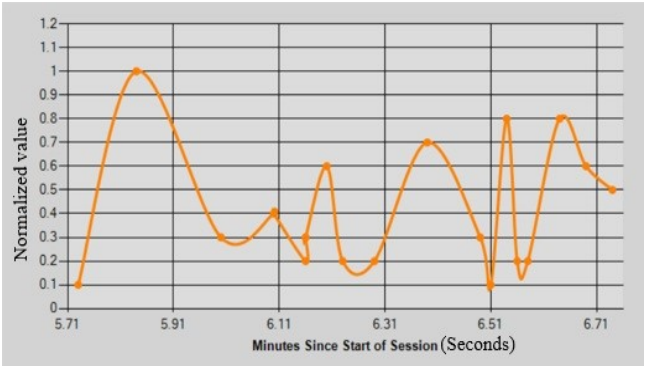

Figure 6: Sample graph representation (Eye Blink)

value. The Attention and Meditation data are simply divided by 100 since these values are already scaled to be between 0 and 100 by the headset. These data are (approximately) normally distributed. Blink Strength is divided by 255. All data from the headset are plotted as they are received.

We got six types of data (Alpha, Beta, Gamma, Attention, Meditation, Eye blink) from Neurosky mindwave mobile II. But not all of them are used in this experiment. Only Attention, Meditation and Eye Blink values are used here. We only took these three data because of having a research work relating to this. So that we can compare our principles with same appropriate principles by the researcher which we will discuss in result section. In future work, we will use the other data for our further work. Some differences were seen from them. In this paper, we considered only mean threshold value of those brainwaves. The mean threshold values of Attention, Meditation and Eye blink are described in below in figure 7, figure 8 and figure 9. These threshold values will be compared with another consumer headset (Emotive) which was done by another researcher Maskeliunas et al. so that we can compare between them to find the usability of Neurosky mindwave mobile II.

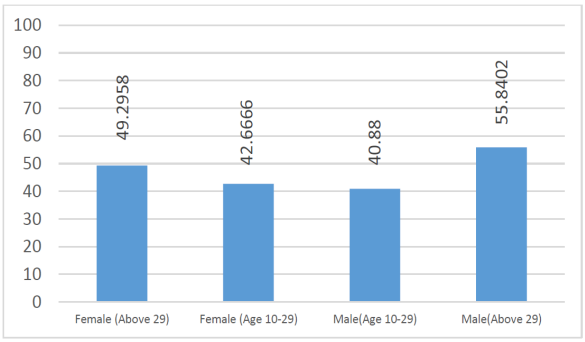

Figure 7: Mean threshold level of Attention

Data were divided into age group so that we can find that how neurosky mindwave mobile II work on particular group of people. Moreover, it also can be found the mental condition of different age of people.

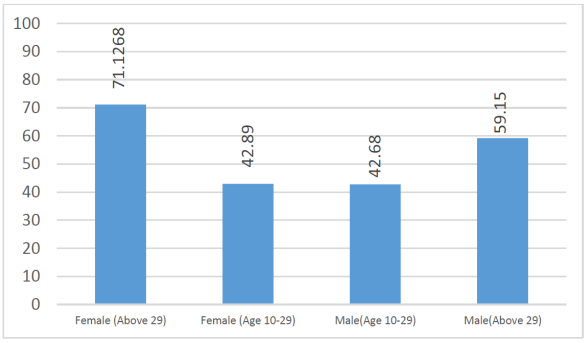

Figure 8: Mean threshold level of Meditation

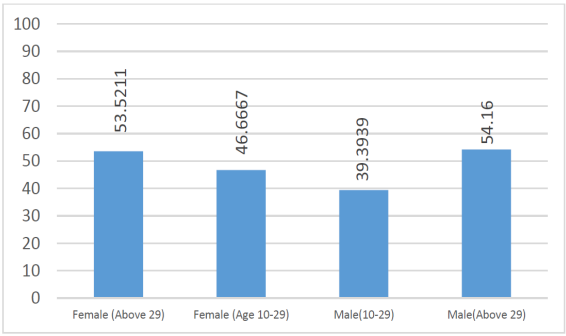

Figure 9: Mean threshold level of Eye blink

4 RESULT AND DISCUSSION

The final recognition accuracy of Attention data for age 10 -29(Female) was nearly 43%, age above 29 (Female) was 50%, age 10-29 (Male) was 41%, age above 29 (male) 56%. If we collaborate these accuracies into one group, then the mean value is 47.5%. The previous generation neurosky mindflex was only 22.2% [8] along with the Emotiv accuracy was 60.5% [8].

Overall recognition accuracy of meditation data for age 10 - 29(Female) was nearly 43%, age above 29 (Female) was 71%, age 10-29 (Male) was 43%, age above 29 (male) 60%. If we collaborate these accuracies into one group, then the mean value is 54.25%. The previous generation neurosky mindflex was same as attention only 22.2% [8] along with the Emotiv accuracy was 60.5% [8].

Recognition accuracy of Eye blink data for age 10 -29(Female) was nearly 45%, age above 29 (Female) was 54%, age 10-29 (Male) was 40%, age above 29 (male) 54%. If we collaborate these accuracies into one group, then the mean value is 48.25%. The previous generation neurosky mindflex was only 49.6% [8] along with the Emotiv accuracy was 75.6% [8].

So, the newer generation of neurosky get a worthy development in attention and meditation detection accuracy. But comparing with Emotiv it recognized the data more precisely. Again, Attention accuracy was same as before on neurosky. But again Emotive headset did a good job here.

5 CONCLUSION

To sum up, it can be said that considering the value for money Neurosky is fair enough for this level of recognition. But more deep work for brain work it will not be a good decision to expense money on this. As a result, one can face many problems because of technical illustration of this product. Moreover, it has lack of feedback from the neurosky development team. As a final point, one thing to say one should be very careful to set up this device and to collect the meditation and attention data the surrounding environment should be very calm and quiet.

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