Study of EEG Signals for Different Mental States and Car Movements Direction using Brainwave Senor

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Abstract - *Brain– computer interface (BCI) is used in Brain controlled robotic car. BCIs are computer-based system that bypass channels for communication to provide direct communication and control with human brain and devices that acquires brain signals and translates them into commands in real time. The brain waves formed by interaction between the neurons are seen as thoughts and emotions. The pattern for each human thoughts vary which produce different electrical waves. The intention of this work is study on different brains states.*

Key Words: **Brain Signal, EEG Headset Module, Brain computer interface (BCI), HC-05**

1. INTRODUCTION

Human brain composed of millions of neurons. These neurons are considered as most important cells in the human brain and also can send signals over long distances. The brain waves formed by interaction between the neurons are seen as thoughts and emotional states. The pattern for each human thoughts vary which produce different electrical waves.

Electroencephalography (EEG) is a test used to measure the electrical activity in the brain[2]. The brain wave sensors are used in BCI. BCIs are computer based system that has direct communication pathway between the brain and external device by translating different patterns of brain activity into commands in real time.

Head surface is being attached with metal electrodes, as well as conductive media, being a measurement of electrical activity is defined as the EEG. Brain wave patterns are unique to individuals. Brain wave sensor will send analog electrical signals and convert signals in digital amplified form. Brain sensing module decode the brain signals and also connect with computer to observe the brain activities.

2. METHODOLOGY

The EEG is a record of the oscillations of brain. The recorded brain waveforms reflect the cortical electrical activity. EEG activity has small signal intensity, measured in microvolts (μV). And signal frequency of human EEG waves are Alpha, Beta, Delta and Theta.

EEG signals are captured by using Brain sensor interface. The human brain consist of neurons which interacts to create a minuscule electricals discharge. However, the hundreds of thousands of discharges created by each activity forms into waves which can be measured.

Different brain states are the result of different patterns of neural interaction. These patterns lead to waves characterized by different amplitude and frequencies.

- Alpha waves (8-13 Hz): Relaxation, non-arousal, meditation, relaxed awareness without any concentration. Alpha Waves can be induced by closing the eyes and relaxing, and abolished by opening the eyes or engaging the brain in activities such as thinking or calculating[1].
- Beta Waves (13-30 Hz): Focus, active attention, thinking, problem-solving. Beta Waves dominate when the brain is aroused and mentally engaged in activities.
- Delta Waves (0.5-4 Hz): Deep sleep, unconsciousness.
- Theta Waves (4-8 Hz): Drowsiness, deep Relaxation, daydreaming.

3. DESIGN AND IMPLEMENTATION

Brain waves changes according to the individual thinking and not require any physical movement. Brain wave sensor consist of Neurosky sensor and mind sensor.

Neurosky sensor comprises of dry cathode situated in the forehead. Dry terminal peruses the changes from neurons present at the human brow. These changes are separated from noise to enhance the signal quality. This is done by using Thinkgear and eSense meter[1].

A mind sensor comprises of dry anode, power supply, Bluetooth module and think gear module. The attention and meditation level of the mind is recognized by eSense meter and exchange to the control framework module.

Fig-1: Brainwave sensing module.

3.1. EEG Signals

EEG signals can be collected in many ways. EEG data is read by using Neurosky sensor[1]. The brain waves are collected by using electrodes placed in a band like structure. This is effective with lower complexity and very simple.

3.2. NeuroSky Technology

1. Brainwaves
    Human brain consist of large number of neurons[1]. This neurons emits energy during communication of information throughout the body results in some signals. These signals are detected by using electrode present in Neurosky sensor.

2. ThinkGear
    Thinkgear is the technology used in Neurosky that enhance the reading of brainwaves [1]. It consist of sensor that indicates contact and reference points located in the ear clip and sensor seen in forehead and on- board chip that processes all data named as TGAM. The raw brainwaves and eSense meters are computed on the Think gear chip.

4. ANALYSIS OF DIFFERENT MENTAL STATES USING APPLICATION

Unique rhythms are formed in human brain. The brain is always in active mode, that human mind never switches off. Research says that a fully functioning brain can generate maximum up to 10 watts of electric power [2]. In human brain the brain wave states are alert, stressed, aroused and concentrated. An ideal condition to learn new information, learn languages along with analyzing complex situations and perform more elaborate tasks are done when we lower the brain wave frequency to alpha. In the alpha wave range, the electrical signals of the brain slow down as well as relax, also

the amplitude of brainwaves getting stabilizes during high meditation level.

4.1. Brainwave Visualizer

A colorful interactive application controlled by our brain is Brainwave Visualizer. It shows a graphical representation of brain's activity [2]. The shapes change color depending on the state of mind. The figure shows the application while recording EEG signal.
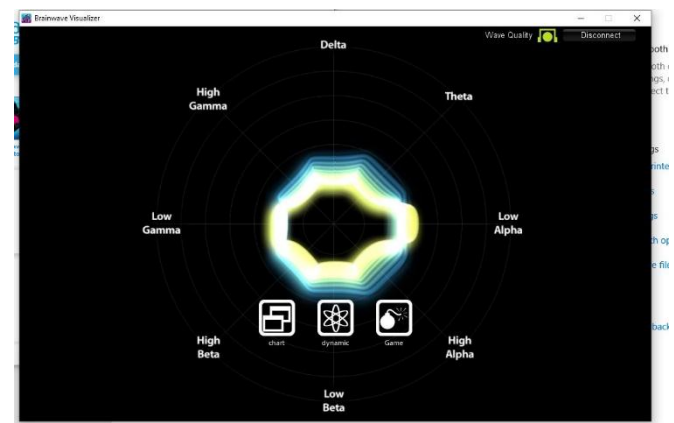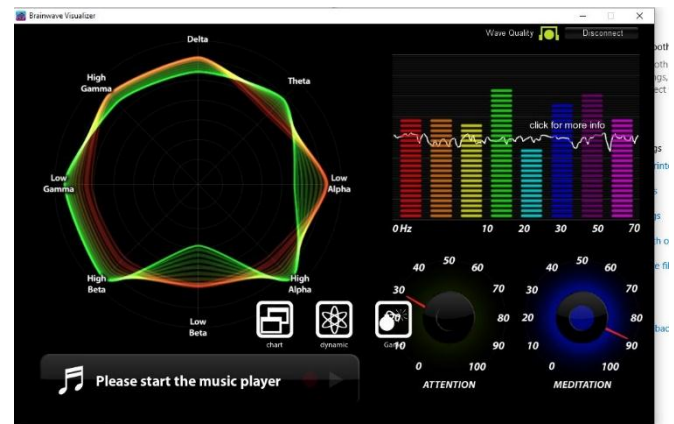

Fig-2: Brainwave visualizer application.

This application requires connectivity with Brain wave sensor headset. By listening to different modes of music, our mind's response will be displayed on screen. We can record our mind's reaction for any specific music tracks [2]. The brain waves vary from person to person and can be analyze different mental states using this Brainwave Visualizer.

5. RECORDING OF EEG DATA

Analytical study of the brain waves are dealing with certain conditions of the mind along with the EEG pattern [2]. The brain waves are faster during relaxation time. The data was extracted for listening music mental states and values where extracted for car movement: forward, backward, left and right direction.

5.1. Listening to music condition
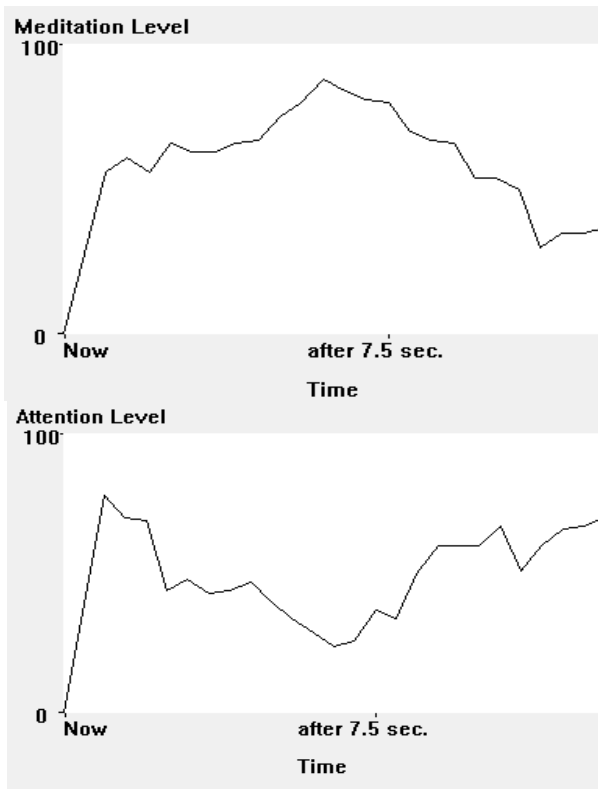
Fig-3: Meditation and attention levels of brain when listening to music.

This condition we are mentally active or resting or asleep, the brain always has some level of electrical activity. During meditation, theta waves were most abundant in the frontal and middle parts of the brain. Alpha waves were more abundant in the posterior parts of the brain during meditation than during simple attention.

5.2. Car movement directions

Table -1: Values extracted for forward direction.

	TIME	ATTENTION	MEDITATION
1	09:58:07	54	80
2	09:58:08	64	54
3	09:58:09	56	63
4	09:58:10	56	51
5	09:58:11	43	51
6	09:58:12	50	60
7	09:58:13	37	38
8	09:58:14	40	38
9	09:58:15	44	47

Table -2: Values extracted for stop direction.

	TIME	ATTENTION	MEDITATION
1	10:14:54	75	57
2	10:14:55	87	54
3	10:14:56	69	54
4	10:14:57	43	67
5	10:14:58	34	78
6	10:14:59	21	93
7	10:14:00	23	100
8	10:14:01	26	81
9	10:14:02	30	64
10	10:14:03	30	61
11	10:14:04	34	47
12	10:14:05	38	57
13	10:14:06	37	64
14	10:14:07	37	61

Table -3: Values extracted for left direction.

	TIME	ATTENTION	MEDITATION
1	10:11:40	54	80
2	10:11:41	38	84
3	10:11:42	29	100
4	10:11:43	4	91
5	10:11:44	1	90
6	10:11:45	7	77
7	10:11:46	7	77
8	10:11:47	20	84
9	10:11:48	20	97
10	10:11:49	11	100
11	10:11:50	13	96
12	10:11:51	3	90
13	10:11:52	1	69
14	10:11:53	24	54

Table -4: Values extracted for right direction.

	TIME	ATTENTION	MEDITATION
1	10:09:00	50	53
2	10:09:01	35	57
3	10:09:02	16	60
4	10:09:03	3	81
5	10:09:04	1	84
6	10:09:05	3	81
7	10:09:06	1	77
8	10:09:07	1	54
9	10:09:08	1	44
10	10:09:09	10	56
11	10:09:10	29	54
12	10:09:11	29	69
13	10:09:12	38	93
14	10:09:13	38	100
15	10:09:14	30	100
16	10:09:15	40	100
17	10:09:16	40	100

The above table shows the values extracted for car direction movements using brainwave sensor. The values may vary for four direction according to mediation and attention. The four direction: right, left, forward and stop direction range of values extracted are conclude in given below table.

Table -5: Attention and Mediation range of values according to each Direction.

DIRECTION	ATTEN-TION	MEDIA-TION
FORWARD	35-75	35-70
STOP	20-50	60-100
LEFT SIDE	1-20	60-100
RIGHT SIDE	1-40	40-80

6. CONCLUSION

Brainwave sensing module gives the measurement of brain activity. The signs gathered by Neurosky have attention and meditation levels. The brain signals will vary according to different car movement directions. This sign are changed over into parcels and sent it to controlling device. In this way by controlling vehicles it can spare numerous mishaps and can spare numerous lives.

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