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Research Article

Movement Of Wheelchair Using EEG Signal

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ABSTRACT
One of the primary roles of the responsible members of society is to ensure that the elderly and disabled receive the proper care at the appropriate time and that their quality of life is improved. The elderly and disabled frequently use wheelchairs as a form of transportation, albeit they can be challenging to use. It is essential to design wheelchairs that are easy to use and innovative. In this line, a thought-controlled wheelchair has been proposed, which analyzes collected signals from the eyes and brain to control the wheelchair. Using an electrode cap applied to the user's scalp, the Electroencephalography (EEG) signals acquisition is performed using E-motive device and the signal are processed and given to wheelchair for movement. These EEG signals are then converted into movement orders by an Arduino microcontroller, which moves the wheelchair. For the aged and disabled this wheelchair offers excellent support.

Key words: Electroencephalography, wheelchair, Brain-computer interface, EMOTIVE Device

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1 INTRODUCTION:

Wheelchair users are the most visible members of the disabled population; they have high jobs, low jobs, and less jobs. The elderly are the group that uses books and power chairs the most. Wheelchair users report difficulty with activities of daily living and visual impairment [1]. Using the electric chair is not easy for disabled and elderly people. Many technologies have emerged in recent years to assist people with disabilities. These checks are specifically designed to assist people with physical disabilities. This competitive process replaces the self-service process.

These machines can help people with limited mobility. People with more severe paralysis can also use these machines because they need precise control. In order to help improve the lifestyle of disabled people, this project aims to create a wheelchair that moves according to signals received from neurons in the brain through the ear. Because the brain consists of many neurons that process information, this project aims to explore the signals collected by electroencephalograms to help with wheelchair replacement. Brain-computer interface (BCI) is a technology that provides a direct connection between the human brain and a computer [2]. BCI techniques are broadly divided into invasive and non-invasive techniques. Non-invasive techniques are becoming popular and more research is being done on the subject. There are many non-invasive brain-computer interface technologies, such as electroencephalography (EEG) and electrooculography. EEG technology connects different scalp potentials through various movements using an electrode head placed on the user's scalp to receive EEG signals [3]. It has advantages over traditional BMI due to its non-invasive nature and does not harm health. As technology has improved, EEG recorders have become compact, convenient and wireless. Using the above technology, this article introduces a simple thought-controlled wheelchair[4]. The study and creation of brain-controlled rehabilitative technologies has seen a significant upsurge in interest lately. Some attempts have been made to create a brain-actuated wheelchair after the 2004 demonstration of brain-actuated robot control [5]. Certain devices employ one of the typical event-related potentials (evoked potentials in the human brain associated with external stimuli [6] to synchronize the EEG signals with external cues in accordance with the therapeutic protocol. For instance, the wheelchair created in Bremen [7] and Singapore [8] both use P300 potentials and steady-state potentials, respectively, to choose high-level primitives (such going to the kitchen) in a menu-driven system. To operate the power wheelchair as though it were controlled by a joystick, the user's motion commands are transmitted from the head controller to the adapting unit, which then generates motion commands in the x or y direction. The wheelchair will then travel in the chosen direction, and by holding down the switch for the appropriate amount of time, you can change its pace [9]. The brain-computer interface has an accuracy rate of over 94%, and the sensor-based motion system's adaptability enables navigation in populated and unprepared environments.

2. METHODOLOGY:

The primary goals of this work are to facilitate attention and meditation by using the information gathered by the headset to move the wheelchair in the desired directions. The suggested methodology involves using EEG signals for moving the wheelchair [10-12].

In this project, the non-invasive method uses the scalp's electrophysiological signals to measure various physiological parameters. The EEG is the most widely used medium because it is user-friendly and straightforward, and it satisfies BCI system requirements. Figure 2.1 shows the signal acquisition using E-motive device and the signal are processed and given to wheelchair for movement.

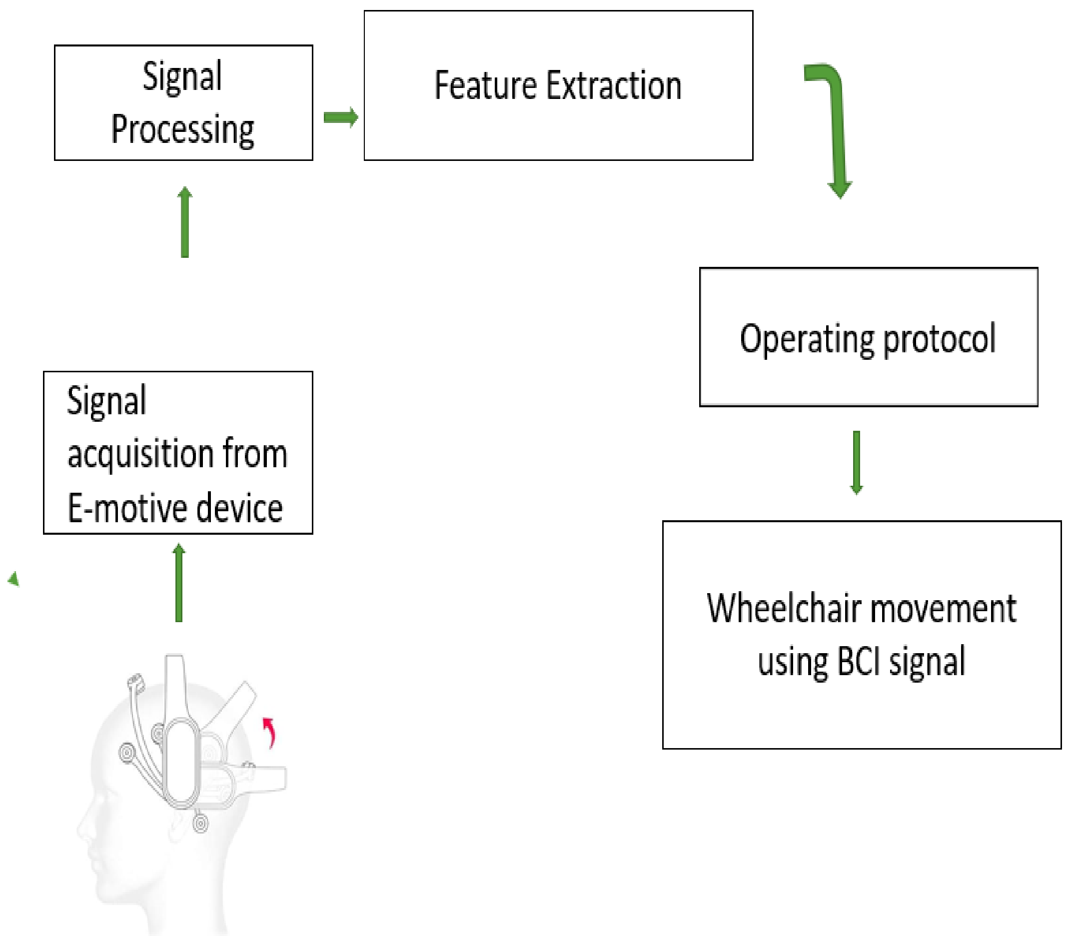


Figure 2.1 Proposed wheelchair movement using EMOTIVE Device

A wearable EEG headset that can wirelessly transmit brainwave data to a smartphone or computer. Figure 2.2 and Figure 2.3 shows 14 EEG electrodes and 2 reference electrodes. The Insight 2.0 has 20 hours of battery life and Bluetooth 5.0 connectivity. A near headset with 16 electrodes that was originally designed to work as a BCI input device.

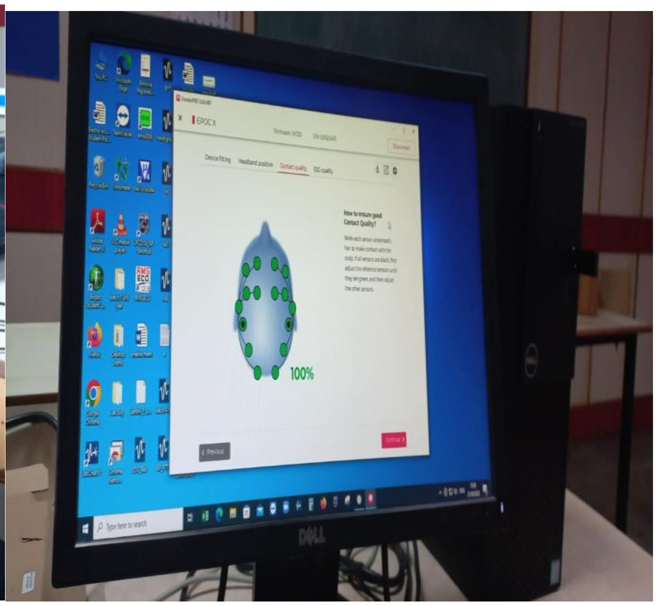
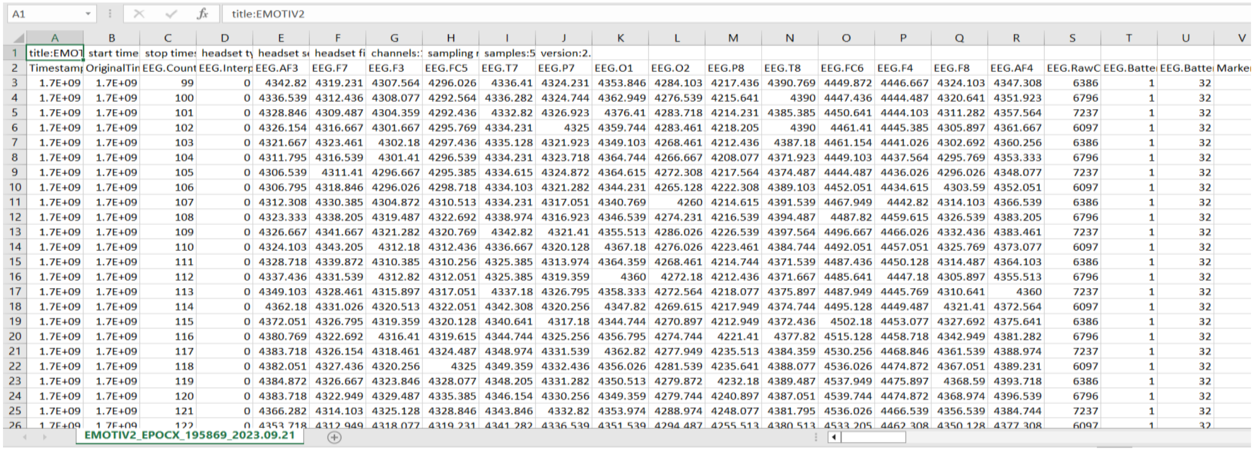


Figure 2.2 Wearable headset **Figure 2.3 Electrode position**

2.1 .SIGNAL PROCESSING:

Signal processing can be used to extract information or data that is only needed. In this method the EEG signal is processed in the form of a csv file. Figure 2.4 shows nearly 5000+ datasets of EEG. From the acquired dataset features are extracted for actuating the wheelchair.



A1 title:EMOTIV2

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	title:EMOT	start time	stop time:	headset ty	headset s	headset fi	channels:	sampling r	samples:5	version:2.												
2	Timestamp	OriginalTin	EEG.Count	EEG.Interp	EEG.AF3	EEG.F7	EEG.F3	EEG.FC5	EEG.T7	EEG.P7	EEG.O1	EEG.O2	EEG.P8	EEG.T8	EEG.FC6	EEG.F4	EEG.F8	EEG.AF4	EEG.RawC	EEG.Batte	EEG.Batte	Marke
3	1.7E+09	1.7E+09	99	0	4342.82	4319.231	4307.564	4296.026	4336.41	4324.231	4353.846	4284.103	4217.436	4390.769	4449.872	4446.667	4324.103	4347.308	6386	1	32	
4	1.7E+09	1.7E+09	100	0	4336.539	4312.436	4308.077	4292.564	4336.282	4324.744	4362.949	4276.539	4215.641	4390	4447.436	4444.487	4320.641	4351.923	6796	1	32	
5	1.7E+09	1.7E+09	101	0	4328.846	4309.487	4304.359	4292.436	4332.82	4326.923	4376.41	4283.718	4214.231	4385.385	4450.641	4444.103	4311.282	4357.564	7237	1	32	
6	1.7E+09	1.7E+09	102	0	4326.154	4316.667	4301.667	4295.769	4334.231	4325	4359.744	4283.461	4218.205	4390	4461.41	4445.385	4305.897	4361.667	6097	1	32	
7	1.7E+09	1.7E+09	103	0	4321.667	4323.461	4302.18	4297.436	4335.128	4321.923	4349.103	4268.461	4212.436	4387.18	4461.154	4441.026	4302.692	4360.256	6386	1	32	
8	1.7E+09	1.7E+09	104	0	4311.795	4316.539	4301.41	4296.539	4334.231	4323.718	4364.744	4266.667	4208.077	4371.923	4449.103	4437.564	4295.769	4353.333	6796	1	32	
9	1.7E+09	1.7E+09	105	0	4306.539	4311.41	4296.667	4295.385	4334.615	4324.872	4364.615	4272.308	4217.564	4374.487	4444.487	4436.026	4296.026	4348.077	7237	1	32	
10	1.7E+09	1.7E+09	106	0	4306.795	4318.846	4296.026	4298.718	4334.103	4321.282	4344.231	4265.128	4222.308	4389.103	4452.051	4434.615	4303.59	4352.051	6097	1	32	
11	1.7E+09	1.7E+09	107	0	4312.308	4330.385	4304.872	4310.513	4334.231	4317.051	4340.769	4260	4214.615	4391.539	4467.949	4442.82	4314.103	4366.539	6386	1	32	
12	1.7E+09	1.7E+09	108	0	4323.333	4338.205	4319.487	4322.692	4338.974	4316.923	4346.539	4274.231	4216.539	4394.487	4487.82	4459.615	4326.539	4383.205	6796	1	32	
13	1.7E+09	1.7E+09	109	0	4326.667	4341.667	4321.282	4320.769	4342.82	4321.41	4355.513	4286.026	4226.539	4397.564	4496.667	4466.026	4332.436	4383.461	7237	1	32	
14	1.7E+09	1.7E+09	110	0	4324.103	4343.205	4312.18	4312.436	4336.667	4320.128	4367.18	4276.026	4223.461	4384.744	4492.051	4457.051	4325.769	4373.077	6097	1	32	
15	1.7E+09	1.7E+09	111	0	4328.718	4339.872	4310.385	4310.256	4325.385	4313.974	4364.359	4268.461	4214.744	4371.539	4487.436	4450.128	4314.487	4364.103	6386	1	32	
16	1.7E+09	1.7E+09	112	0	4337.436	4331.539	4312.82	4312.051	4325.385	4319.359	4360	4272.18	4212.436	4371.667	4485.641	4447.18	4305.897	4355.513	6796	1	32	
17	1.7E+09	1.7E+09	113	0	4349.103	4328.461	4315.897	4317.051	4337.18	4326.795	4358.333	4272.564	4218.077	4375.897	4487.949	4445.769	4310.641	4360	7237	1	32	
18	1.7E+09	1.7E+09	114	0	4362.18	4331.026	4320.513	4322.051	4342.308	4320.256	4347.82	4269.615	4217.949	4374.744	4495.128	4449.487	4321.41	4372.564	6097	1	32	
19	1.7E+09	1.7E+09	115	0	4372.051	4326.795	4319.359	4320.128	4340.641	4317.18	4344.744	4270.897	4212.949	4372.436	4502.18	4453.077	4327.692	4375.641	6386	1	32	
20	1.7E+09	1.7E+09	116	0	4380.769	4322.692	4316.41	4319.615	4344.744	4325.256	4356.795	4274.744	4221.41	4377.82	4515.128	4458.718	4342.949	4381.282	6796	1	32	
21	1.7E+09	1.7E+09	117	0	4383.718	4326.154	4318.461	4324.487	4348.974	4331.539	4362.82	4277.949	4235.513	4384.359	4530.256	4468.846	4361.539	4388.974	7237	1	32	
22	1.7E+09	1.7E+09	118	0	4382.051	4327.436	4320.256	4325	4349.359	4332.436	4356.026	4281.539	4235.641	4388.077	4536.026	4474.872	4367.051	4389.231	6097	1	32	
23	1.7E+09	1.7E+09	119	0	4384.872	4326.667	4323.846	4328.077	4348.205	4331.282	4350.513	4279.872	4232.18	4389.487	4537.949	4475.897	4368.59	4393.718	6386	1	32	
24	1.7E+09	1.7E+09	120	0	4383.718	4322.949	4329.487	4335.385	4346.154	4330.256	4349.359	4279.744	4240.897	4387.051	4539.744	4474.872	4368.974	4396.539	6796	1	32	
25	1.7E+09	1.7E+09	121	0	4366.282	4314.103	4325.128	4328.846	4343.846	4332.82	4353.974	4288.974	4248.077	4381.795	4536.026	4466.539	4356.539	4384.744	7237	1	32	
26	1.7E+09	1.7E+09	122	0	4353.718	4312.949	4318.077	4319.231	4341.282	4336.539	4351.539	4294.487	4255.513	4380.513	4533.205	4462.308	4350.128	4377.308	6097	1	32	

EMOTIV2_EPOCX_195869_2023.09.21

Figure 2.4 EEG Dataset

2.2 ARDUINO:

A microcontroller board based on the ATmega328 is called the Arduino Uno was used. It contains a 16 MHz ceramic resonator, 6 analog inputs, 14 digital input/output pins (six of which can be used as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button. They operate at 5 Volts.

3. RESULTS:

EEG signals are acquired using E-motive device using 16 electrodes. Figure 3.1 shows the graph values of 16 electrodes

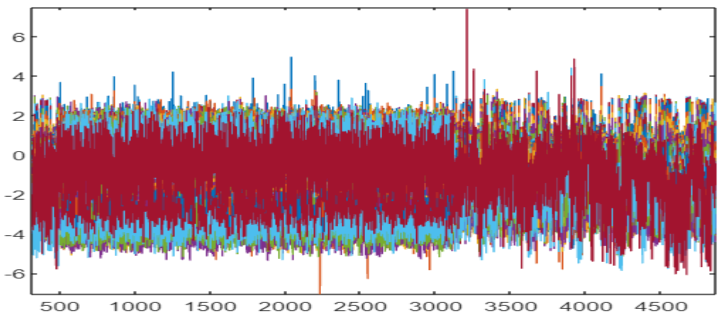


Figure 3.1 Graph values of 16 electrode

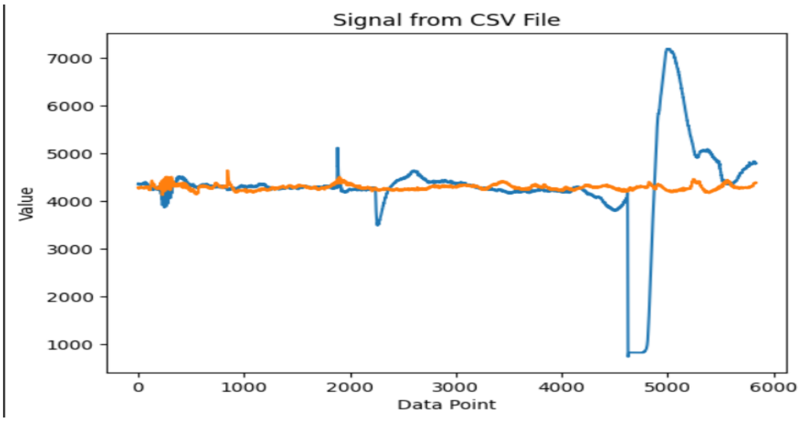


Figure 3.2 Graph for occipital region

Moving to Figure 3.2 after separating the occipital region separately from other electrodes, it has been divided into 2 electrodes. This is done by taking the absolute signal from csv file format.
The occipital region consists of 2 electrodes O1 and O2 from the figure 3.3 and figure 3.4.

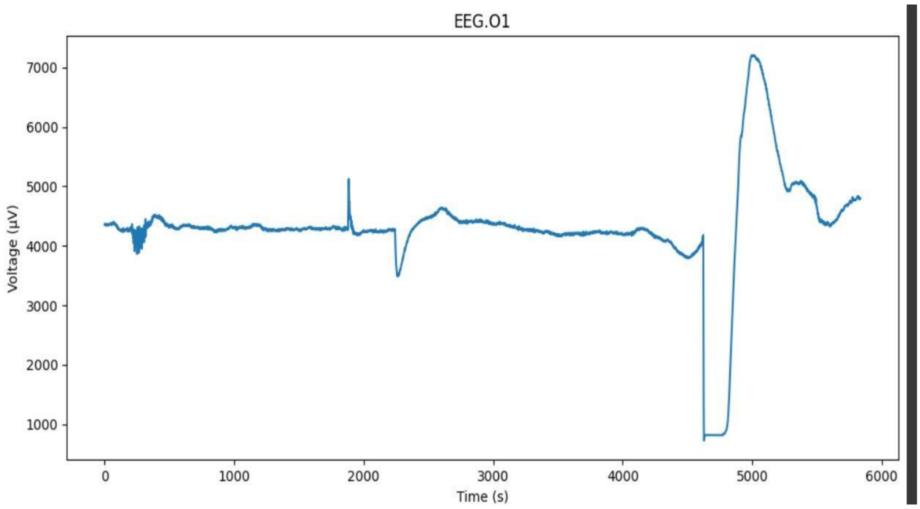


Figure 3.3 Signal acquisition using O1 electrode

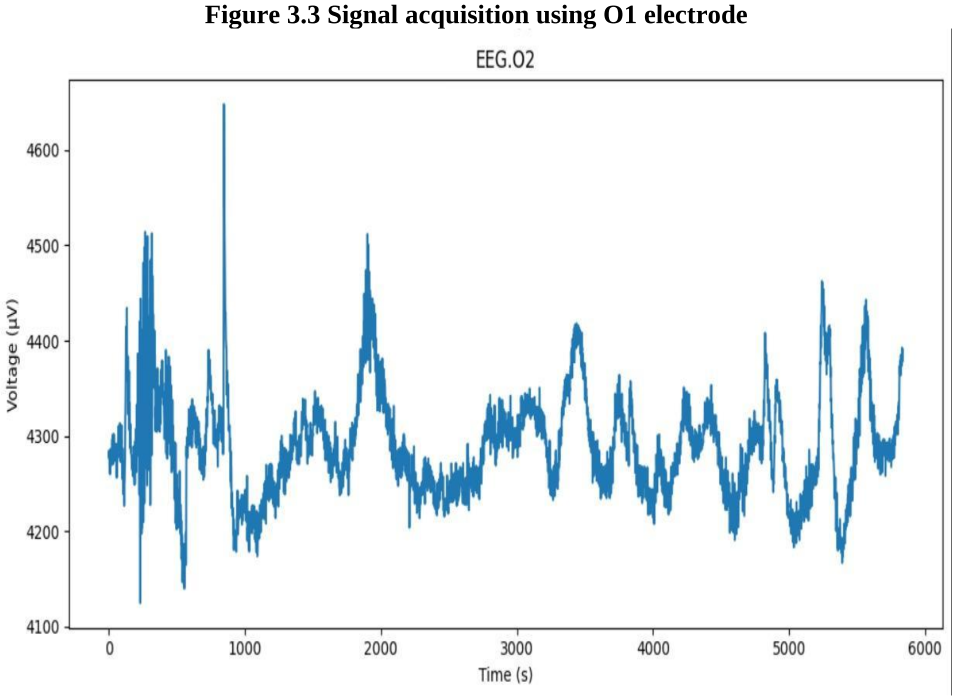


Figure 3.4 Signal acquisition using O2 electrode

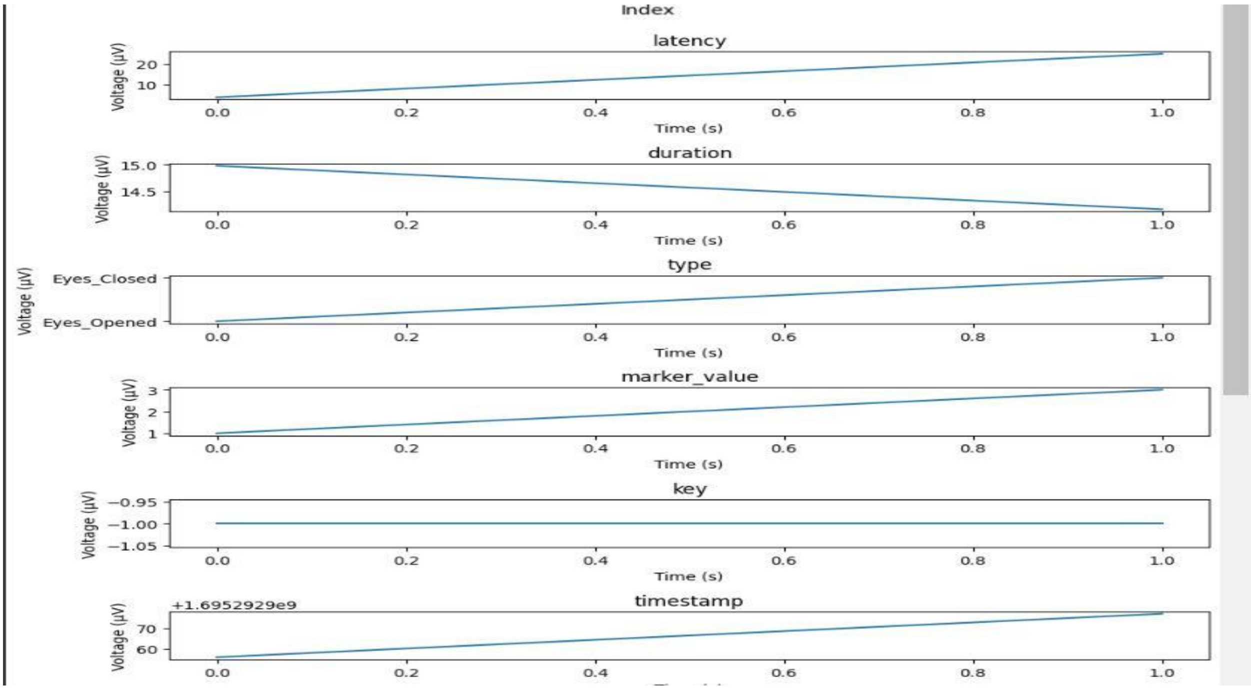


Figure 3.5 Signal during eye open and eye close

Figure 3.5 illustrates latency , duration ,marker value , timestamp of eye open and close in graphical representation form. The eye open determines the motor is on and the eye closes as the motor is off. The value of eye open and closed is given as input to the arduino board which makes the motor on or off , along this value the frequency of occipital region of electrode O1 and O2 is also given as support and to make the decision quick and strong. Thus the wheelchair motor is turned off or on with the help of arduino using the eye open and close data acquired from the E-motive device in the format of csv file. Figure 3.6 and 3.7 shows Power in frequency band for EEG O1 and EEG O2 respectively.

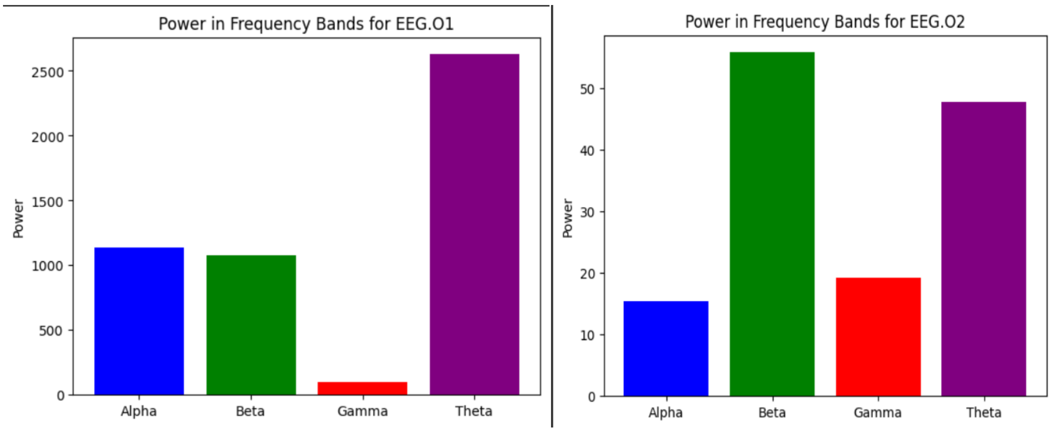


Figure 3.6 Power in frequency band for EEG O1 and EEG O2

SI.NO	ALPHA	BETA	GAMMA	THETA
O1	**1137.319465934372**	**1075.059551319446**	**99.53899042463433**	**2627.808647072417**
O2	**15.477497000239824**	**55.87042883248077**	**19.32326570154969**	**47.84475764538897**

Figure 3.7 Power in frequency band values for EEG O1 and EEG O2

The output of the O1 and O2 dataset of the EEG signal has been extracted and plotted as a graph. The mean and variance of the electrode O1 and O2 is also extracted.

4. DISCUSSION

Even though much progress has been made in the area of intelligent wheelchairs, the design of such devices has received relatively little focus up until this point. Along with this various health measuring parameters, obstacle distance and positioning of the wheelchair will also be designed and proposed for the future. A microprocessor and a Bluetooth connectivity module form the foundation of the system was used in most advanced wheelchair. It is made to be as adaptable as possible with the least amount of resources [13]. The classifier in Hidden Markov models learns each person's chosen class from muscle activation patterns, leading to a natural control actuation. The uninterrupted performance of intricate manipulation sequences involving numerous joints is made possible by the continuous decision stream [14].

Typically, these projects include rigid hardware and software designs that are out of reach for the majority of potential customers. As a result, the research direction should attempt to develop a user-centered smart wheel chair that takes into account several limitations without compromising user comfort. Designing a smart wheelchair will be a productive study field for many years. Finally, in conclusion, this methodology offers a promising approach for real-time consciousness monitoring, demonstrating effectiveness and potential for widespread adoption across diverse domains with opportunities for further validation and refinement.

5. CONCLUSION

The wheelchair based on the E-motive device, is presented in this study. Control purposes involve an evaluation of the user's emotional and musculoskeletal conditions. In order to maneuver turn on or off a wheelchair, the design of a brain-controlled interface (BCI) has been implemented, utilizing eye movements such as opening and closing. With the use of the E-motive device, a mind-controlled wheelchair has been developed and put into use, marking a significant breakthrough in assistive technology and providing new opportunities for people with physical disabilities. Transitioning from conventional wheelchair controls to an autonomous brain-signaling system has enormous potential to improve mobility, self-sufficiency, and general quality of life.

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