BRAIN COMPUTER INTERFACE FOR THE MOVEMENT OF ROBOT

Obaid Ur Rahman[1], Adnan Abbas[2], Md Numan Uddin Fahad[3], Ahraar Shareef Muqsit[4]

[1]Dept. Of Electronics and Instrumentation, Muffakham Jah College of Engineering and Technology,

[2] Dept. Of Electronics and Instrumentation, Muffakham Jah College of Engineering and Technology,

[3] Dept. Of Electronics and Communication, Deccan College of Engineering and Technology,

[4] Dept. Of Electrical and Electronics, Muffakham Jah College of Engineering and Technology,

Abstract— This project discusses a brain-controlled mechanism supported Brain-computer interfaces (BCI). Brain-computer interfaces square measure systems which will bypass typical channels of communication (i.e., muscles and thoughts)to give direct communication and management between the human brain and physical devices by translating utterly totally different patterns of brain activity into commands in real time. With these commands, a mobile automaton will be controlled. The intention of the project work is to develop a mechanism which will assist the disabled folks in their existence to try to some work freelance on others. Here, we tend to square measure analysing the brain wave signals. The human brain consists of legion interconnected neurons. The patterns of interaction between these neurons square measure described as thoughts and emotional states. In step with human thoughts, this pattern is dynamic that successively manufacture totally different electrical waves. A muscular contraction will generate a novel electrical signal of these electrical waves are detected by the brain wave detector and it'll convert the info into packets and transmit through the Bluetooth medium. Level instrument unit (LAU) can receive the brainwave data and it'll extract and method the signal victimization the MatLab platform. Then the management commands are transmitted to the robotic module to the method. With this whole system, we are able to move a mechanism in step with the human thoughts and it may be turned by blink muscular contraction.

Keywords—Brain Computer Interface (BCI); Electroencephalography (EEG); Neurosky Head Gear; Mobile Automaton; Eye Contraction

I. INTRODUCTION

An unfit person cannot do day to day work like feeding themselves, moving from one place to a different therefore our project brain-computer interface for the movement of the automaton is principally meant to style a automaton which may be controlled by our brain signals which may be significantly stress-free for incapacitated and unfit persons. This technique has AN electroencephalogram sensing element and a automaton interface to the sensing element. The sensing element detects the eye level of the person that monitors the automaton to makeover during a specific direction.

Previous analysis work shows the robots area unit helpful for disabled folks in terms of hand controlled movement, head controlled movement, voice-controlled movement etc. this analysis work is to check, perceive and upgrade the brain management led automaton system and to get wireless system between receiver and transmitter module so the topic will even invite the robot through control of the transmitter module at the gap once there's no attendant gift close to the topic.

The project titled 'Brain-Computer Interface for the movement of Robot' is processed and designed beneath software's like MATLAB or Visual Studio. Core programming languages that may be used area unit Python and C++. The project aims to subsume making AN interface between human brain and a pc mistreatment Electroencephalography (EEG) technique, a way to browse brain waves mistreatment sensors that browse delta, alpha, beta, waves from the brain, amplifies it and provides the output in variety of numerical values to the machine. The users simply have to be compelled to management the eye level so as to drive the system. Many brain scanning techniques like MRI, PET, or electroencephalogram area unit capable to research what you're thinking, dreaming, or seeing.

EEG device that's accustomed browse the brain waves is NeuroSky Mindwave telephone receiver (MW001). It contains of a Wi-Fi electronic device and 2 lobes, lobe for forehead and another lobe that connects to the left ear. In all, the device will discover and provides 3 values which may be accustomed develop mind-controlled applications

> Attention Values
> Meditation Value
> Eye Blink Strength

A Brain-Computer Interface (BCI) typically referred to as a Mind-Machine Interface (MMI) or typically referred to as a right away Neural Interface (DNI), artificial thought transference Interface (ATI) or a Brain Machine Interface (BMI) could be a direct communication pathway between the brain associated an external device. BCIs area unit typically directed at helping, augmenting or repairing human psychological feature or sensory-motor functions. [1]

Humans' brain is crammed with neurons; individual nerve cells connected to 1 another by dendrites and axons, each action like assume, move, feel or bear in mind one thing create neurons area unit at work that employment is distributed by tiny electrical signals that nada from vegetative cell to vegetative cell as quick as 250 mph. The signals area unit generated supported the variations in potential carried by ions on the membrane of every vegetative cell. Therefore, BCI could be a system that has a right away interface between the human brain and also the pc. so as to develop the BCI system, the possible technique ought to be studied. BCI systems area unit broadly speaking classified into invasive and non-invasive techniques. [8]

II. LITERATURE SURVEY

Research work on Brain-Computer Interface (BCI) began early within the year 1970 itself. This analysis work was started at the University of California (UCLA) beneath the permission from the National Science Foundation when a contract from federal agency.

Jens Naumann, a person with non inheritable visual disorder, being interviewed regarding his vision BCI on CBS's the first Show. In vision science, direct brain implants are accustomed treat non-congenital (acquired) visual disorder one in all the primary scientists to come back up with an operating brain interface to revive sight was non-public investigator William Dobelle.

Dobelle's initial paradigm was constituted into "Jerry," a person unsighted in adulthood, in 1978. A single-array BCI containing sixty eight electrodes was constituted onto Jerry's cortical region and succeeded in manufacturing phosphates, the feeling of seeing lightweight. The system enclosed cameras mounted on glasses to send signals to the implant. Initially, the implant allowed Kraut to visualize reminder gray during a restricted field of vision at a coffee frame-rate. This conjointly needed him to be connected to a two-ton mainframe, however shrinking physics and quicker computers created his artificial eye additional moveable and currently alter him to perform easy tasks unassisted.

In 2002, Jens Naumann, conjointly unsighted in adulthood, became the primary during a series of sixteen paying patients to receive Dobelle's second generation implant, marking one in all the earliest business uses of BCIs. The second generation device used a additional refined implant sanctioning higher mapping of phosphenes into a coherent vision. Phosphenes area unit detached across the sight view in what researcher's decision the starry-night impact. In real time when his implant, Jens was ready to use his amiss fixed up vision to drive slowly round the park of the analysis institute.

BCIs specializing in motor neuroprosthetics aim to either restore movement in paralytic people or give devices to help them, like interfaces with computers or mechanism arms.

Researchers at Emory University in Atlanta junction rectifier by Philip Kennedy and Roy Bakay were initial to put in a brain implant during a human that made signals of high enough quality to simulate movement. Their patient, Johnny Ray, suffered from 'locked-in syndrome' when suffering a brain-stem stroke. Ray's implant was put in 1998 and he lived long enough to begin operating with the implant, eventually learning to manage a pc pointer.

Tetraplegic Matt Nagle became the primary person to manage a man-made hand employing a BCI in 2005 as a part of the primary nine-month human trial of Cyber kinetics Neurotechnology's Brain Gate chip-implant constituted in Nagle's right central gyrus (area of the cortical area for arm movement), the 96-electrode Brain Gate implant allowed Nagle to manage a robotic arm by puzzling over moving his hand further as a pc pointer, lights, and TV.

As well as invasive experiments, there have conjointly been experiments in humans exploitation non-invasive neuroimaging technologies as interfaces. Signals recorded during this manner are accustomed power muscle implants Associate in Nursingd restore partial movement in an experimental volunteer. though they're simple to wear, non-invasive implants manufacture poor signal resolution as a result of the os dampens signals, dispersing and blurring the magnetic force waves created by the neurons. though the waves will still be detected it's harder to see the realm of the brain that created them or the actions of individual neurons.

Several laboratories have managed to record signals from monkey and rat cerebral cortexes so as to work BCIs to hold out movement. Monkeys have navigated pc cursors on screen and commanded robotic arms to perform easy tasks just by puzzling over the task and with none motor output. alternative analysis on cats has decoded visual signals.

In the Eighties, Apostolos Georgopoulos at Johns Hopkins University found a mathematical relationship between the electrical responses of single motor-cortex neurons in macaque catarrhine monkeys and also the direction that

monkeys affected their arms (based on a cos function). He conjointly found that spread teams of neurons in several spaces of the brain put together controlled motor commands however was solely ready to record the firings of neurons in one area at a time owing to technical limitations obligatory by his instrumentation.

There has been speedy development in BCIs since the mid-1990s. many teams are ready to capture advanced brain motor center signals exploitation recordings from neural ensembles (groups of neurons) and use these to manage external devices, together with analysis teams junction rectifier by Richard Andersen, John Donohue, Phillip Kennedy, Miguel Nicolelis, and Andrew Schwartz.

In 1999, researchers diode by rule Dan at the University of Golden State, Berkeley decoded neuronic firings to breed pictures seen by cats. The team used Associate in Nursing array of electrodes embedded within the neural structure (which integrates all of the brain's sensory input) of sharp-eyed cats. Researchers targeted 177 brain cells within the neural structure lateral crooked nucleus space, that decodes signals from the membrane. The cats were shown 8eight short movies, and their vegetative cell firings were recorded. exploitation mathematical filters, the researchers decoded the signals to get movies of what the cats saw and were ready to reconstruct recognizable scenes and moving objects. Similar leads to humans are since then achieved by researchers in Japan.

Miguel Nicolelis has been a distinguished human of exploitation multiple electrodes touch a bigger space of the brain to get neuronic signals to drive a BCI. Such neural ensembles area unit aforesaid to scale back the variability in output made by single electrodes, that may build it troublesome to control a BCI.

After conducting initial studies in rats throughout the Nineteen Nineties, Nicolelis and his colleagues developed BCIs that decoded brain activity in bird of Minerva monkeys and used the devices to breed monkey movements in robotic arms. Monkeys have advanced reaching and grasping skills and sensible hand manipulation skills, creating them ideal check subjects for this type of labour. [6]

III.   MAIN CONTRIBUTION OF THE PROJECT

The major contribution that this project has given is minimizing the usage of the foremost elements of the form and makes use of the brain signals which can provide several edges for the unfit folks. The patient could realize it easier and a lot of responsive once it involves giving the commands to the automaton simply by dominant the eye level.

Another contribution this project provides is by mistreatment AN RF (Radio Frequency) module which is RF transmitter and a receiver. This interaction of the transmitter section with the receiver section is another contribution that created his a lot of a couple of wireless management of a automaton, which can facilitate the patient generally to ask his automaton at a distance simply by dominant the eye level and also the automaton accelerates towards the patient because the receiver module is connected to the automaton and also the interaction between the tow is wireless. [2]

IV.   METHODOLOGY AND DISCUSSION

A.   *Electroencephalography (EEG)*

EEG is that the 1st non-invasive vegetative cell imaging technique discovered that is employed for activity the electrical activity of the brain. graph signals area unit detected from the scalp and contain noise as a results of electrical interference and movement of electrodes. Applying an oversized range of graph channels might embody hissing and redundant signals that degrade the BCI performance and conjointly involve a protracted preparation time that directly impacts the convenience within the use of the BCI. Therefore, choosing the smallest amount range of channels that yield the most effective or needed accuracy will balance each desires for performance and convenience, because of its easy use, value and high temporal resolution this technique is that the most generally used one in BCIs these days.

The benefits of exploitation graph technique area unit

> ➢ Hardware prices area unit considerably under those of most alternative techniques.
> ➢ EEG sensors are often utilized in a lot of places than magnetic resonance imaging, SPECT, PET, MRS, or MEG, as these techniques need large and immobile instrumentality. for instance, 1000000 needs instrumentality consisting of liquid helium-cooled detectors which will be used solely in magnetically secure rooms, altogether costing upwards of many million greenbacks and magnetic resonance imaging needs the employment of a 1-ton magnet in, again, a secure space.
> ➢ EEG contains a terribly high temporal resolution, on the order of milliseconds instead of seconds. graph is often recorded at sampling rates between 250 and 2000 cycles/second in clinical and analysis settings, however trendy graph information assortment systems area unit capable of recording at sampling rates higher than twenty,000 cycles/second if desired.
> ➢ EEG is silent, that permits for the higher study of the responses to sense modality stimuli.

➢ EEG doesn't worsen simple phobia, not like magnetic resonance imaging, PET, MRS, SPECT, and generally 1000000.

The characteristics of graph that compare favourably with activity testing:

➢ EEG will discover covert process (i.e., process that doesn't need a response)

➢ EEG are often utilized in subjects World Health Organization area unit incapable of creating a motor response.

➢ EEG may be a powerful tool for trailing brain changes throughout totally different phases of life. graph sleep analysis will indicate vital aspects of the temporal arrangement of brain development, together with evaluating adolescent brain maturation.

➢ In graph there's a far better understanding of what signal is measured as compared to alternative analysis techniques, i.e. the daring response in MRI. [5]

B.   *EEG conductor Brain Channel*

Typically, in BCI study, conductor locations area unit designated indiscriminately from scalp space like the motor cortical area to record the electrical activity of the brain. it's documented that the variation of the surface potential distribution on the scalp reflects practical activities rising from the underlying brain [12]. This surface potential variation which will be a record and also the voltage of electrodes are often measured, that is then filtered, amplify, and record.

Electrodes conduct voltage potentials as potential unit level signals and carry them into amplifiers that enlarge the signals around 10 thousand-fold. the employment of this technology depends powerfully on the electrodes positioning and also the electrodes contact. For this reason, electrodes area unit sometimes made from semiconducting materials, like gold or chloride together with a semiconducting gel that may apply between conductor and scalp to take care of an appropriate signal to noise quantitative relation. The gel primarily based conductor system, however, have difficulties with the requirement of long icon time and also the got to wash the user's hair once the recording. Therefore, the dry conductor system are wont to cut back the electrode-skin electric resistance.

(a)   Delta

Delta waves lie among the vary of zero.5 to 4 Hz, with variable amplitudes. It tends to be the very best in amplitude and also the slowest waves. Delta waves area unit typically related to slow wave sleep (during stages three and four of the stage of sleep). These brainwaves area unit primarily related to deep sleep, and within the waking state, were thought to15 indicate physical defects within the brain. The brain wave Pattern is shown in Figure 1.1.
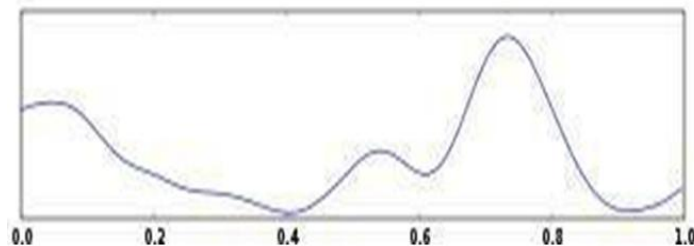

Figure 1.1: Brain wave Pattern

It is typically the foremost outstanding frontally in adults (e.g. FIRDA - Frontal Intermittent cadenced Delta) and posterior in kids (e.g. OIRDA - os Intermittent cadenced Delta).

(b)   Theta

Theta waves lie among the vary of four to eight cps, with associate amplitude typically bigger than 20µV. alphabetic character arises from emotional stress, particularly frustration or disappointment. alphabetic character has been additionally related to access to unconscious material, inventive inspiration, and deep meditation. the big dominant peak of the alphabetic character waves is around seven cps. The theta rhythm Pattern is shown in Figure 1.2.
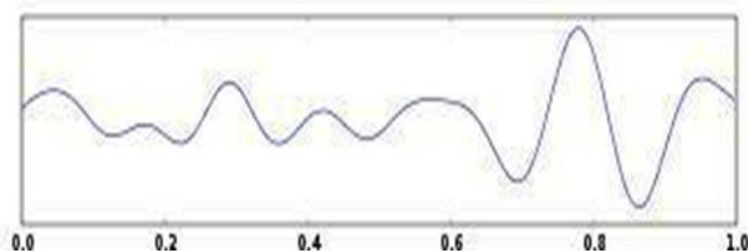

Figure 1.2: theta rhythm Pattern

(c)   Alpha

The rate of modification lies between eight and thirteen cps, with 30-50μV amplitude. Alpha waves are thought to point each a relaxed awareness and additionally basic cognitive process. Alpha alone appears to point associate empty mind instead of a relaxed one, a mindless state instead of a passive one and may be reduced or eliminated by gap the eyes, by hearing unknown sounds, or by anxiety or mental concentration. they're strongest over the os (back of the head) cortex and additionally over frontal area. Alpha is that the most outstanding wave within the whole realm of brain activity and probably covers a bigger vary than has been antecedently thought of. it's frequent to examine a peak within the beta vary as high as twenty cps, that has the characteristics of associate alpha state instead of a beta, {and the|and therefore the|and additionally the} setting during which such a response seems also results in identical conclusion. The cortical potential Pattern is shown in Figure 1.3.
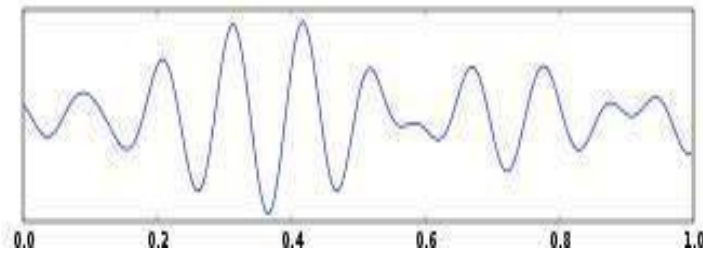

Figure 1.3: cortical potential Pattern

(d)   Beta

The rate of modification lies between thirteen and thirty cps and frequently incorporates a low voltage between 5-30μV. Beta activity is closely connected to motor behavior and is mostly attenuated throughout active movements like active thinking, active attention, and specialize in the skin world or determination concrete issues. It will reach frequencies close to fifty cps throughout intense mental activity. cadenced beta with a dominant set of frequencies is related to numerous pathologies and drug effects, particularly benzodiazepines. it should be absent or reduced in areas of plant tissue injury. it's the dominant rhythm in patients UN agency area unit alert or anxious or UN agency have their eyes open. The brain wave Pattern is shown in Figure 1.4.
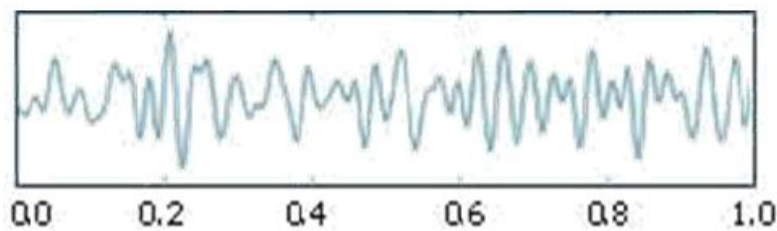

Figure 1.4: Brain wave Pattern

V.   EXPERIMENTAL SETUP

A.   *Brain Wave sensing element*

A variety of sensors for observance brain activity exists and might give the idea for a BCI. These embody electroencephalography (EEG) and a lot of invasive electrophysiological strategies like electrocorticography (ECoG) and recordings from individual neurons at intervals the brain, magnetoencephalography (MEG) etc.

There square measure several business choices for encephalogram headsets and head-caps. Single conductor headsets, like the Neurosky Mind wave square measure cheap and straightforward. Most devices had associate degree accessible package Development Kit (SDK) therefore development would be comparatively easy. For multichannel montages, a conductor caps square measure most popular, with a variety of electrodes put in on this surface. usually used scalp electrodes incorporates Ag-AgCl discs, one to three millimeter in diameter, with long versatile leads that be blocked into associate degree amplifier. AgCl electrodes will accurately record conjointly terribly slow changes in potential. In 1958, International Federation of Electroencephalography and Clinical neuroscience adopted standardization for conductor placement referred to as 10-20 conductor placement system that is mentioned on top of within the section. [3]

27

B.   *Electrodes*

Electrodes scan signal from the top surface. The encephalogram electrodes and they're correct to operate square measure vital for effort befittingly high-quality information for interpretation. many sorts of electrodes exist, usually with totally different characteristics. Basically, their square measure following forms of electrodes:

➢   Disposable (gel-less and pre-gelled types)
➢   Reusable disc electrodes (gold, silver, stainless steel or tin)
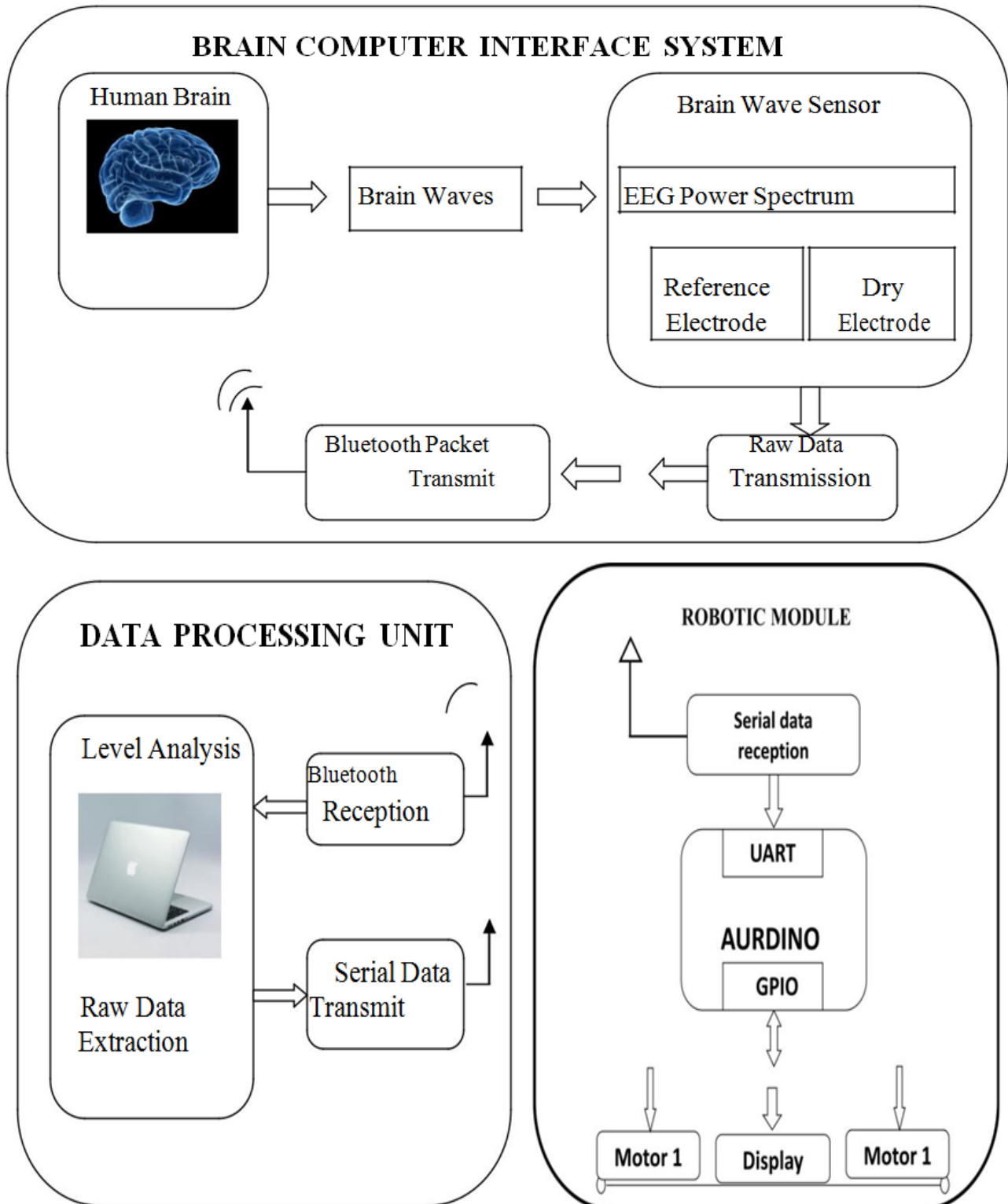➢   Headbands and conductor caps
➢   Needle electrodes

Figure 1.5: Block Diagram Of Brain Computer Interface

C. *Raw Data*

Raw information is primarily unstructured or unformatted repository data. It will be within the kind of files, visual pictures, information records or the other digital information. data is extracted, analyzed, processed and utilized by humans or purpose-made package applications to draw conclusions, build projections or extract pregnant data. The processed information takes the shape of knowledge.

Business intelligence, methoding and a few AI might process data to supply weighty results. [4]

D. *Signal process victimization suppose Gear*

ThinkGear is that the technology within each NeuroSky product or partner product that empowers a tool to interface with the wearers' brainwaves. each the raw brainwaves and therefore the eSense Meters square measure computed on the ThinkGear chip. to manage the automaton, encephalogram and Eye-Blinking signals square measure required. we've got signals like attention. additionally, we have a tendency to conjointly extract the eye-blinking signals from BCI. Therefore, attention and eye-blinking signals square measure collected because the management signals through a Bluetooth interface and thus the electrically interface within the automaton.

Two sorts of graphical record signal area unit classified, as an example, raw graphical record and long graphical record. The raw graphical record signal is employed to convert the electrical voltage to regulate the automaton. Then we have a tendency to classified 2 forms of digital signal, as an example, Attention and Meditation from long graphical record brainwave.

E. *Level Analysis Platform (MATLAB)*

MATLAB package provides tools to accumulate, analyze, and visualize information, alter to achieve insight into the info during a fraction of the time mistreatment spreadsheets or ancient programming languages. This package can also communicate with instruments like oscilloscopes, perform generators, and signal analyzers.

Furthermore, MATLAB allows to manage, filter and pre-process information. MATLAB provides functions for filtering and smoothing, interpolation, convolution, and quick Fourier transforms (FFTs). It can also perform wildcat information analysis to uncover trends, take a look at assumptions, and build descriptive models like mistreatment Neural Network.

F. *DC Motors*

DC motors are moving the wheels of our automaton. the foremost usual variety of DC has restricted rotation. they're used once you got to flip the motor to a selected angle. In our automaton, we have a tendency to solely got to management speed and direction. And, of course, the motor must be able to flip freely. Continuous rotations DC area unit created for this. virtually any servo may be changed to continuous rotation.

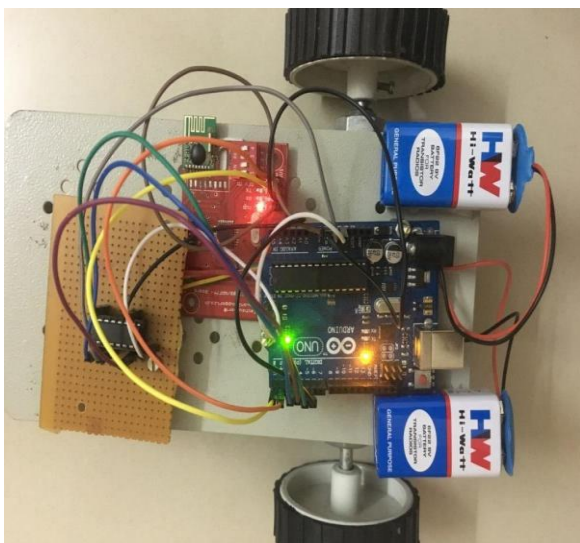G. *Brain Controlled Robot Setup*

Fig 1.5: Robot Setup

Fig 1.6: Neurosky Headgear

VI. RESULTS

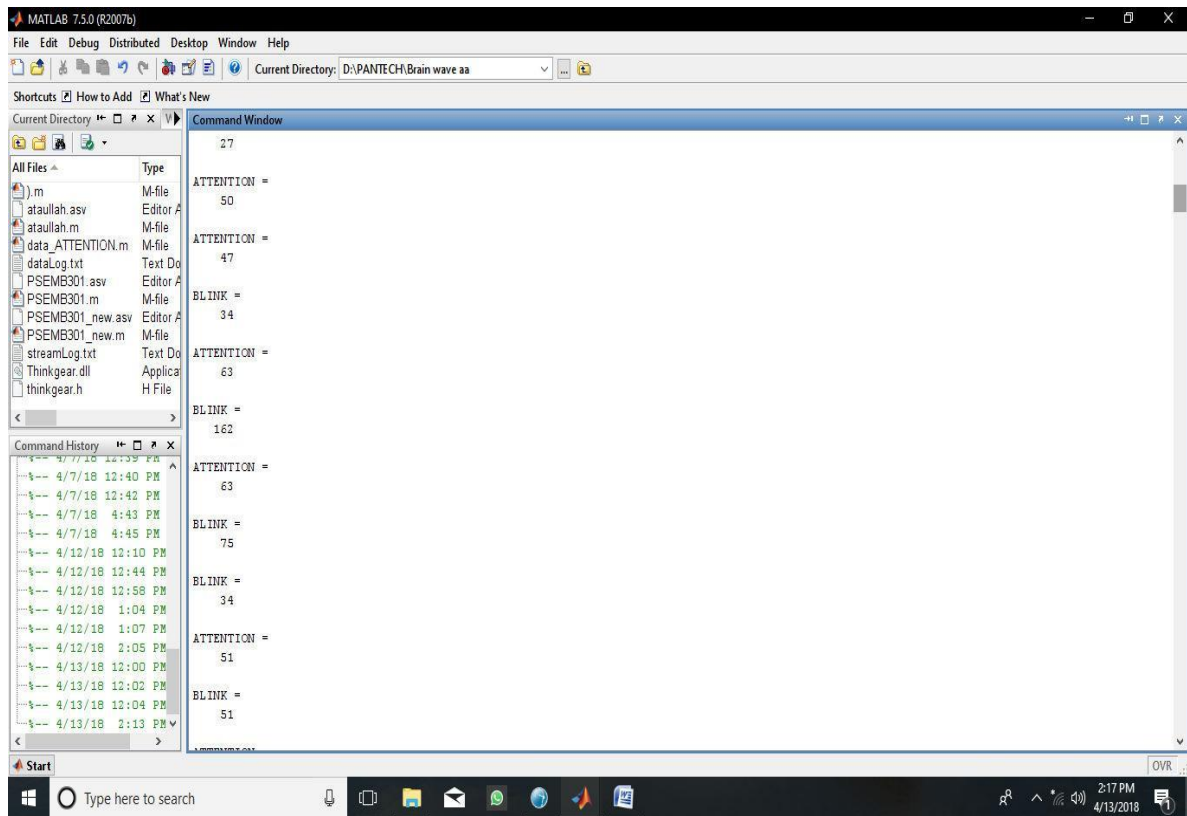A. *The attention and blink values of a person are recorded*

Figure 1.7: Attention and Blink values

Brainwave is connected and blink is detected and after that, it will show the attention values and Blink values of brain wave sensor as shown in Figure 1.7
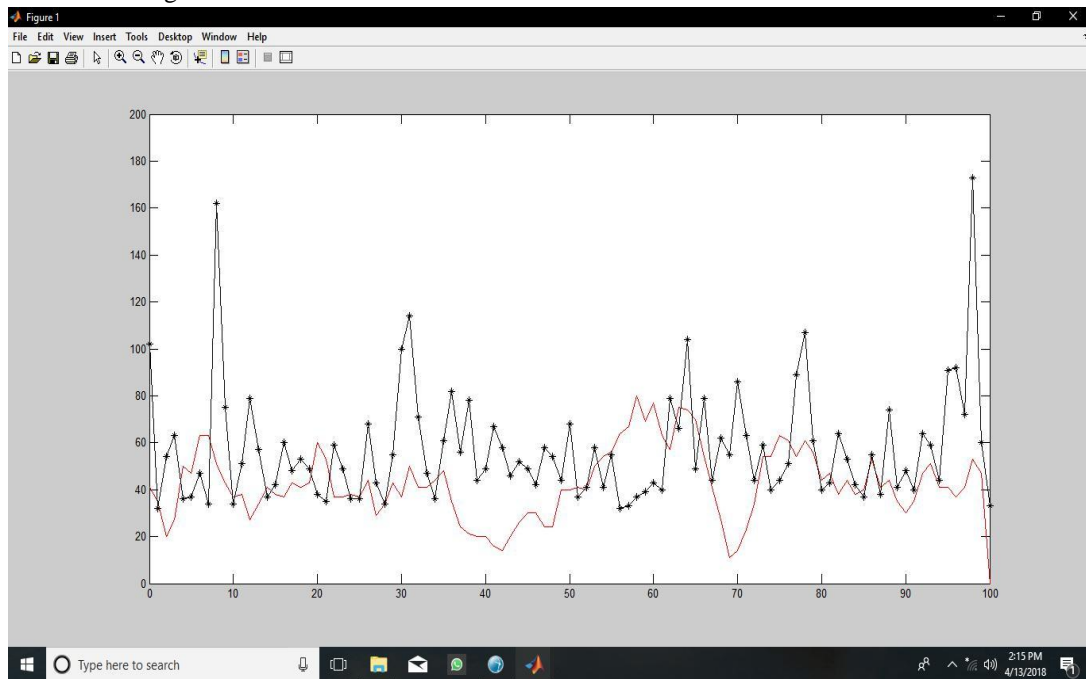

Figure 1.8: Attention and Blink Waveform

Attention and blink values graph will be generated and the graph there will be two signals, the Black Signal is Blinking level and the red signal is Attention signal as shown in Figure 1.8.

VII. CONCLUSIONS

This work implements a brand new methodology for getting and characterizing eye blinks recorded on the scalp through the use of NeuroSky technology (Mindset). The aim of this work is to implement a mechanism module which will assist individuals with disabilities particularly individuals full of neuron unwellness (MND). The result incontestable that mental activities records for the particular users generated by the mental attitude will be wont to act with robots and alternative applications. This could greatly improve the BCI recognition rate and well management the direction of the mechanism module to succeed in the destination supported the user's reflex strength and a spotlight level. The rippling rework is employed to extract options of flicker signals to elevate the accuracy level of blink strength.

VIII. FUTURE SCOPE

As the returning step of technological advancement, several analysis staff and scientists are attempting to bring out a large sort of BCI applications helpful for society. returning years, we will build BCI restore and augment human functions thereby up the standard of living. Some applications like flying associate aeroplane simply by thinking, a blind driving a vehicle etc. are returning to a reality. within the medical sector, analysis staff are attempting to bring out miniaturized instrumentation and therefore the introduction of wireless BCI. It's same that within the returning future, we will replace the robotic devices and directly bypass the signals to the nerves within the broken a part of the brain, thereby permitting the unfit patient to maneuver their body. Last however not least, development in BCI will bring out forceful and engaging changes to the society.

Future applications of BCI:

- ➢ Transfer the hearing impulse to the brain.
- ➢ Robotic help to previous and disabled. [7]
- ➢ Use a tool the same as Google Glass. embody a BCI device among it.
- ➢ Use a BCI Universal Product Code reader in an exceedingly product.
- ➢ When BCI Universal Product Code browseer is read by a Google glass device activate the BCI interface within the device and record and method the signal on a server level.

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AUTHORS

1.   **Mr. Obaid Ur Rahman** completed Bachelor of Engineering degree in Electronics and Instrumentation Engineering from Muffakham Jah college of Engineering and Technology during the academic year 2014-2018.

2.   **Mr.Adnan Abbas** completed Bachelor of Engineering degree in Electronics and Instrumentation Engineering from Muffakham Jah college of Engineering and Technology during the academic year 2014-2018.

3.   **Mr.Md Numan Uddin Fahad** completed Bachelor of Engineering degree in Electronics and Communication Engineering from Deccan college of Engineering and Technology during the academic year 2014-2018.

4.   **Mr.Ahraar Shareef Muqsit** completed Bachelor of Engineering degree in Electrical and Electronics Engineering from Muffakham Jah college of Engineering and Technology during the academic year 2014-2018.