Design and Development of Electroencephalography Based Cost Effective Prosthetic Arm Controlled by Brain Waves

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Abstract - There are inexact 6 million crippled individuals. These handicapped individuals are influenced with Different neuro issue. To convey what needs be, one must furnish them with Artificial and Augmented correspondence. For this, Brain-PC interface framework Based on Electroencephalography has been created to address this Requirement. Correspondence Has Occurred Between the Brain Thoughts and External Devices. Cerebrum Computer Interface Are the framework That can has customary channel Of Communication (for Example Muscles and Thoughts) That Provide the Direct Communication and control the human mind and a physical hand that interpret the distinctive example of mind activities. It is an amazing specialized apparatus among clients and frameworks. It doesn't require any outer gadgets or muscle mediation to issue directions and complete the association. The principal supposition of task reports the plan, development and a testing copy of the human Hand which tries to be dynamic just as kinematic exact. The conveyed hardware attempts to look like the development of organic human Arm by perusing the signs produced by Mind waves. The Mind Brain waves are detected by sensors in the TGAM and produce Theta, alpha, Delta, beta and gamma signals. At that point this flag is prepared by the Arduino-microcontroller and the development is then created to the prosthetic hand by means of servo Mechanism.

Key Words: Prosthetic arm, brain waves, TGAM, Bluetooth module, Arduino, servo motors, electroencephalography, mind waves, robotic arm,

1. INTRODUCTION

In World, there are huge amounts of million incapacitated people in development of arm. In This Research We Tried the Concept of Electroencephalography to Overcome the Problem By Acquiring Different Brain Signals That Are Alpha, Beta, Gamma, Delta, Theta.

Presently a Days with Increasing, the new innovation enhancements in device is achieved a fine height. Every innovation is going for less human interfere, And Further mechanization

Mind Computer Interface innovation speaks to a very developing field of research with application framework. Its Contribution in medicinal field go from avoidance to neuronal recovery for genuine wounds, Mind Reading And remote correspondence has their special unique finger impression in various fields, for example, instructive, self-guideline, generation, promoting, security just as recreations and Entertainment. It makes a common comprehension among clients and the encompassing frameworks

Mind signals mirror the took care of exercises and controlling conduct of the cerebrum or the impact of the got data from other body parts either detecting or inside organs. brain Computer Interfacing gives a diverting office among mind and outer hardware. use of Electroencephalography are, for example, restorative, hierarchical, transportation, amusements and stimulation, and security and validation fields. It likewise exhibits the different gadgets utilized for catching mind signals.

These account gadgets are partitioned into two fundamental classifications: invasive and non-invasive. Invasive class, which requires embedding medical procedure, is normally required for basic deadened circumstances as a result of their higher exactness rates accomplished either spatially or transiently. Then again, the non-invasive class, has been generally spread in other application fields because of its favorable circumstances over the obtrusive one. Different difficulties and issues acted like a consequence of using mind wave signals have likewise been talked about alongside a few arrangements offered by various calculations

The point of this work is to fabricate a model of a Prosthetic arm, and useful. This model is utilized to test and fix the components for driving and controlling. Amid the advancement procedure, a few tests and studies were performed, for example, quality reenactments, dimensional impacts, modification of control parameters to improve the precision, testing of conduct of transmissions, and so forth.

There are Different classes into that the mind wave signals are ordered. This characterization is finished supporting the shifts frequencies they have. These wheat wave signals are alpha, beta, and gamma, theta beams. Bolstered these frequencies the signs might be particular to totally extraordinary classes. Mind signals, alternatives removed through it, directions distributed to relate yield gadget, and furthermore the acknowledgment of style.

Inside the accompanying part, we tend intending to think about Prosthetic Arm and changing Brain Signals into the development of the Prosthetic arm.

2. METHODOLOGY

2.1 System Overview

EEG-based brainwave the prosthetic arm could be a cerebrum the executives interface framework that controls the activity of the mechanical arm utilizing brainwaves for the piece of ordering signal. While, these region unit helpful as same in light of the fact that the normal human hand. Figure one demonstrates the major outline of the brainwave controlled a mechanical arm. This may offer the illuminating of all components that might be utilized in interfacing a mechanical arm

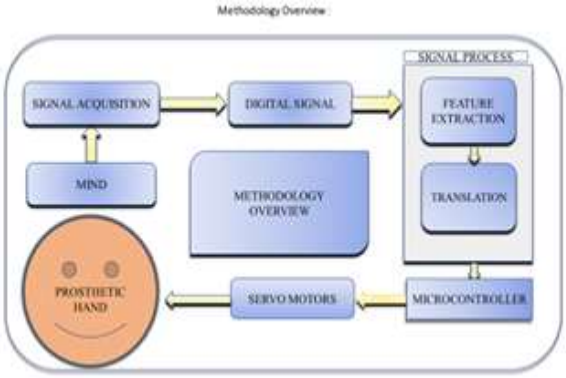

Fig -1: system Overview

2.2 Methodology

Following Is the Overview of methodology That We Have followed During the Experiment

It Start with The Problem Definition As The Prosthetic Arms Are High Costly and Designs Are Complex. Afterwards Objective Need To Be Find Which Is To Design And Develop An Affordable Cost Effective System That Enables Handicap People Having No Upper arm, Though It Can Function As Almost Similar To normal Humans Arm

Subsequently Followed by Literature Survey Data Acquisition Component Selection Servomotor Angle Rotation Test Followed By Mind Signal Testing Modeling of Hand and Result and Conclusion

Fig 2 Shows the Methodology Overview

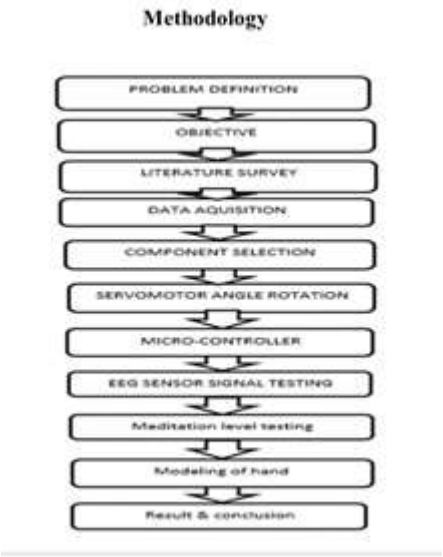

Fig-2 Methodology

2.3 flow chart of the system

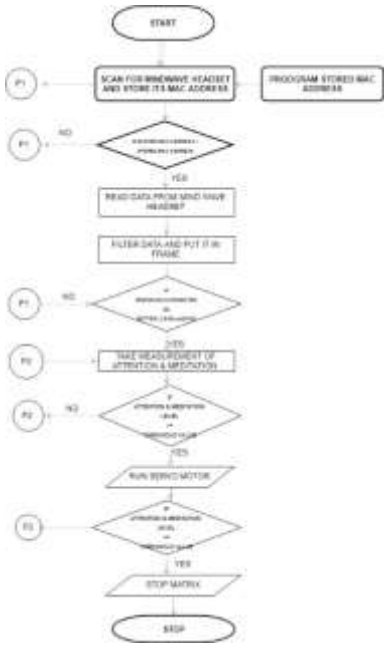

Fig-3 flow-chart

3. EEG Lead Systems

The EEG lead framework characterizes the anode arrangement guidelines to be actualized for EEG Signal obtaining. The International 10 20 cathode situation framework is a universally perceived strategy to portray and apply the area of scalp anodes with regards to EEG flag obtaining. The 10 20 frameworks was formulated to guarantee institutionalized reproducibility which empowers consistent investigations regarding the matter after some time and even correlation between various

subjects. This framework depends on the connection between the area of a terminal and the fundamental zone of cerebral cortex. The "10" and "20" allude to the way that the genuine separations between adjoining anodes are either 10 % or 20 % of the absolute front-back or right-left separation of the skull. Every anode arrangement area is related to a blend of a letter which indicates the flap and a number to distinguish the side of the equator area. The letters relating to different projections, for example, frontal, worldly, focal, parietal, and occipital are F, T, C, P and O, individually. Naturally, the focal projection does not exist and the "C" letter is utilized just for distinguishing proof purposes as it were. A cathode set on the midline of the human mind is meant by a letter 'z'. Indeed, even numbers (2,4,6,8) are devoted to anode arrangements on the correct side of the equator and odd numbers (1,3,5,7) are committed to the terminal situations on the left half of the globe. Likewise, A, Pg and Fp distinguish the ear cartilage, nasopharyngeal and frontal polar locales individually. Two anatomical tourist spots go about as the reference to the entire terminal situation framework. The nasion is the point simply over the extension of the nose and inion, which is the absolute bottom of the skull from the back of the head. The 10 20 terminal situation framework is spoken to in Fig

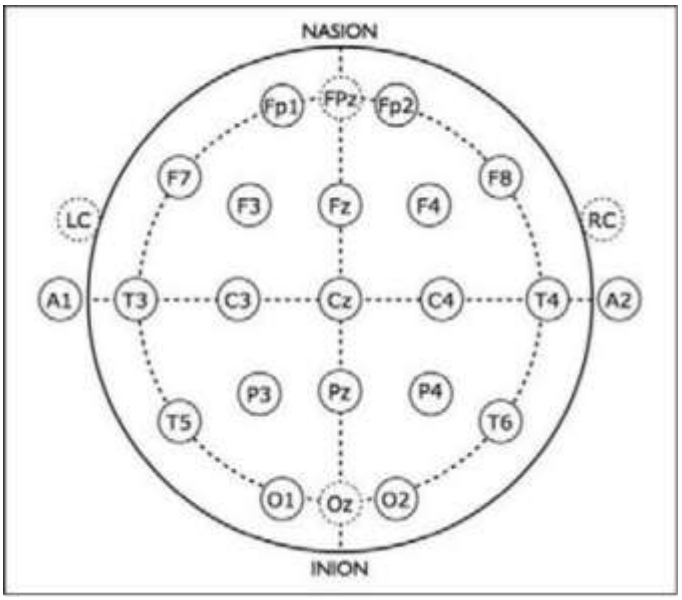

Fig-4 10-20 international system

4. Brain wave frameworks

as quickly grouped into following four phases. Figure 2 demonstrates the order of the accompanying four phases. These are Signal identification, Signal procurement, Signal transmission, and Mapping sign to the arm.

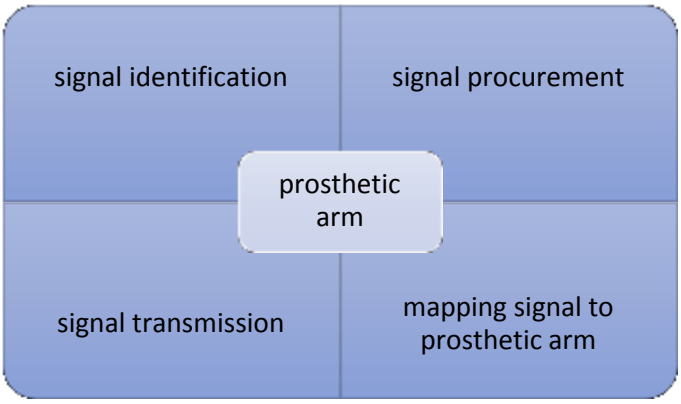

Fig -5: Four stages of prosthetic arm

4.1.1 Signal Identification

This stage firstly targets at the careful detection of the EEG signal from the human brain. The human brain consists of million number of neurons. Each nerve cells are connected to one another by dendrites and axon. Each and every time we think, move, and feel, sense our neurons are at work. These signals are generated by an electric potential, these are carried out by ions on a membrane of individual neurons. To detect various signals, these can help for interpreting what they mean and use them to control a device of some kind. EEG measures voltage fluctuations emerging from ionic current within the neurons of the brain. In the brain, there are millions of neurons, each of which creates small electric voltage fields. EEG is a superposition of many elementary signals. The basic of an EEG signal in normal adult basically ranges from about 1 μV to 100 μV. These signals are generally described in frequency ranges.

Table -1: Brain activities generated in frequency

Brainwave type -Frequency Range			
Delta	1-3Hz	L-Beta	13-17Hz
Theta	4-7Hz	H-Beta	18-30Hz
L-Alpha	8-9Hz	L-Gamma	31-40Hz
H-Alpha	10-12Hz	H-Gamma	41-50Hz

Brainwave speed is measured in Hertz (cycles per second) and they are divided into bands delineating slow, moderate, and fast waves.

A. Delta Waves

Delta brainwaves are slow, loud brainwaves (low frequency and deeply penetrating, sort of a drum beat). They're generated in deepest meditation moreover as untroubled sleep. Delta waves suspend external awareness. Also, they're the supply of sympathy. Healing and regeneration are excited during this state. That's why deep

restorative sleep is thus essential to the healing method.

B. Theta Waves

Theta brainwaves occur most frequently in sleep however also are dominant in deep meditation. It acts as our entrance to learning. In theta, our senses are withdrawn from the external world additionally as targeted on signals originating from at intervals. It's that twilight state that we tend to unremarkably only expertise the amount as we tend to wake or doze off to sleep. In theta, we tend to are in a dream; vivid representational process, intuition and knowledge on the far side our traditional aware awareness. It's wherever we tend to hold our 'stuff', our fears, troubled history, and nightmares.

C. Alpha Waves

Alpha brainwaves are dominant throughout quietly flowing thoughts and in some thoughtful states. Alpha is that the power of being here, within the present. It's the resting state for the brain. Alpha waves aid overall mental coordination, calmness, alertness, mind/body integration and learning.

D. Beta Waves

Beta brainwaves dominate our normal waking state of consciousness. It's a 'fast' activity. It present once we are alert, attentive, engaged in problem-solving, judgment, decision making, and engaged within the focused mental activity.

Beta brainwaves are any divided into 3 bands; Lo-Beta may be thought of as a 'fast idle, or musing. Beta is that the high engagement or actively computation one thing out. Hi-Beta is highly advanced thought, group action new experiences, high anxiety, or excitement. Continual high-frequency process isn't associate economical way to run the brain, because it takes an amazing quantity of energy.

E. Gamma Waves

Gamma brain waves are the fastest of brain waves. This is relate to simultaneous processing of information from different brain areas. It passes information rapidly. In gamma waves the most subtle of the brainwave frequencies is the mind has to be quiet to access it. Gamma is also above the frequency of neuronal firing, so how it is generated remains a mystery. Gamma rhythms modulate perception and consciousness. The greater presence of Gamma relates to expanded consciousness and spiritual emergence.

F. Think Gear

The think Gear connector runs as a background method on your laptop. This is often accountable for directional telephone receiver information from the serial port to an open network socket. It's available on each Windows and OS X. Any language contains a socket library ought to be ready to communicate with it.

4.1.2 Signal Acquisition

Signal acquisition is the method of sampling signals that measure universe conditions. This converts the resulting samples into digital numeric values which might be manipulated by a computer.

The signals scan by Think Gear Asic Module is distributed to Bluetooth module. The headset only detects, processes, and converts the signals into digital type.

4.1.3 Signal Transmission

Bluetooth Module

Signal transmission is completed between the Bluetooth HC-05 and microcontroller. Bluetooth could be a wireless communication protocol. It's utilized in 2 devices for sending as well as receiving the data. It's free to use within the wireless communication protocol whereas the range of the Bluetooth is a smaller amount than different wireless communication protocols like Wi-Fi and Zigbee. It operates at the frequency of the 2.41 GHz.

The Bluetooth module is that the most popular module within the Indian market. It's largely utilized in the embedded projects. It's simple to use and straightforward, its worth is low. These modules are designed for the clear wireless association setup. It is extremely simple to use within the Bluetooth interface protocol.

4.1.4 Mapping signal to Prosthetic Arm

The signal received from Bluetooth HC-05 module transceiver has to be mapped to the Robotic/Prosthetic arm in the microcontroller (i.e. Arduino Uno). The received signal will act as a command signal to control the arm.

(A) Arduino Uno

Arduino board design use a variety of microprocessors & microcontrollers. The boards are equipped with sets of digital and analog input and output pins that may be interfaced to various expansion boards and other circuits. The microcontrollers are typically programmed using features from the programming languages C and C++.

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input and output pins, 6 as analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or battery. This microcontroller-based Arduino is easy to use for beginners

and can run on Mac, Windows, and Linux. This also supports environment.

(B) Prosthetic Arm

An artificial arm is a man-made device that is integrated into a human to replace a natural organ, for the purpose of duplicating a specific function so that the patient may return to normal life as soon as possible. New plastics and other materials, such as carbon fiber have allowed artificial arm to become stronger and lighter, limiting the amount of extra energy necessary to operate the arm. This technology has been used in both animals and humans. This artificial arm having servo motors each individually connected to the five finger. These servo motors will help in controlling function such as extension and flexion. These movements will be controlled by the command signal generated from Arduino Uno according to the brainwaves value received. Hence, the arm is controlled by using the command signal on a real time basis.

5. EXPERIMENTAL STUDY

This artificial arm uses Arduino Uno platform continuously for analyzing the incoming EEG signals and map them to appropriate actions. This system consists of two important sections. The first one is brainwave headset provided by Think Gear Asic Module and the other one is Bluetooth module which is used for reception of the signal. Signal acquisition is done by Bluetooth module HC-05. The other section is Arduino which process incoming data and map into the robotic arm. Think Gear Asic Module and Arduino will be interlinked with the help of Bluetooth wireless communication and on the other hand, the robotic arm or artificial arm is connected to the Arduino.

The attention and meditation level is the parameter to control the three action of the artificial arm. These values can be classified into two different ranges. For this two ranges, a specific action is set. These actions will be performed by the Arduino according to the incoming raw EEG signals. The table below will help to understand the classified ranges.

Table -2: Commands for the control of the Artificial Arm

Actions	Range Assigned
Flexion (Closing Fingers)	25 above
Extension(Opening Fingers)	25 below

6. RESULT

The research and development of this robotic arm have achieved great attention because they enhanced disable people for their quality of life.

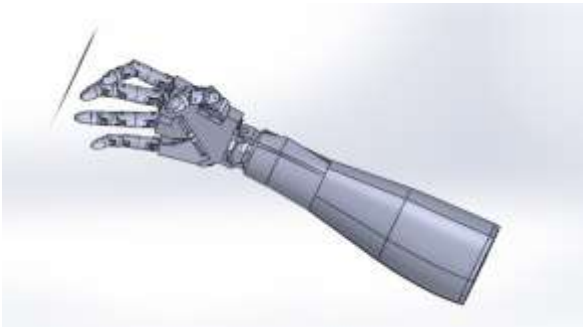

Fig -6: Design of Robotic Arm

In this paper, we had discussed complete review and design of the system and evaluate complication of brainwave artificial hand. For this research, the attention value has been classified in two sets, of which these movements control the main action of hands. While the first movement gives flexion i.e. closing all fingers then the attention range is 69 above whereas, when the second movement gives extension i.e. opening of all fingers, then the attention range is 70 below. At meditation level, the attention range will be at 50 above and elbow will start to move.

Following are the Data Of Mind Waves In The Form Of Chart

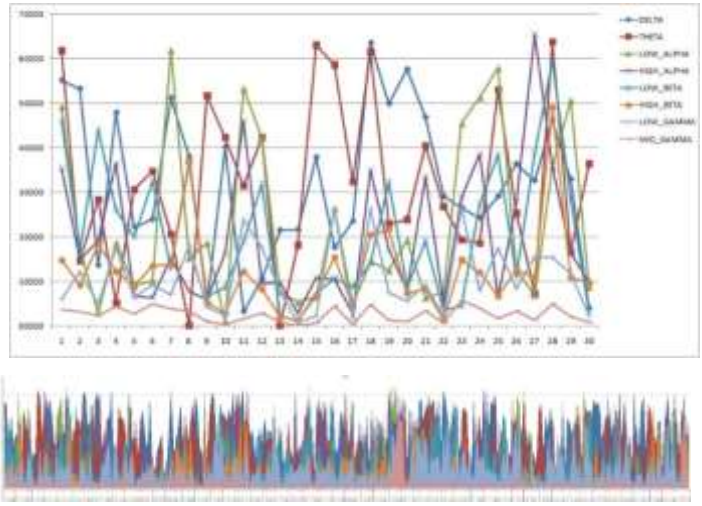

Fig-7: Brain Waves Chart 1

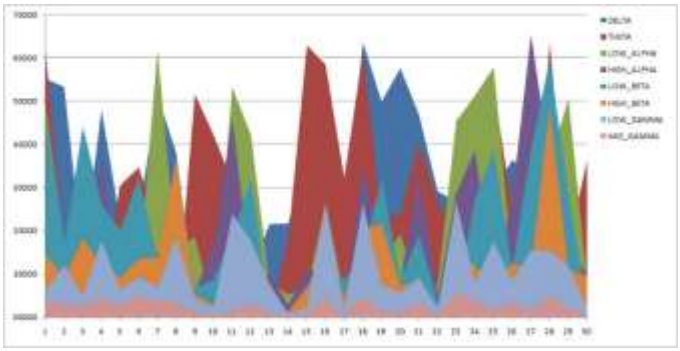

FIG:8 TIME VS BRAIN WAVE SIGNAL

7. STATIC ANALYSYS

I have done a static analysis over designed prosthetic arm and results are safe as per below

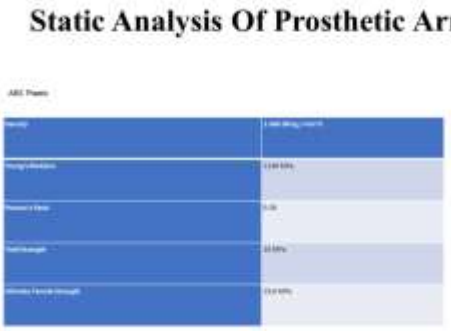

Fig -9: ABS Material Properties

Fig -10 Fixed Constraint

Fig-11: Forced Applied

Fig-12 Result Summery Of Static Force Analysis

8. CONCLUSION

The above-developed system for controlling the prosthetic arm through electroencephalographic data shows promise. We were able to classify user data to 3 outputs given by the Think Gear Asic Moduleheadset system. Unfortunately, we were unable to control the arm with the veracity necessary to complete all the movement task. In order to complete the given task, we will need to either curtail the complexity of the task or revamp the potency of our classified system. Our system could be further revised and improved through collecting more data and using different optimization techniques to upsurge the classification of ranges. An extensive training time would allow the user to readily control the arm more accurately. Also, a number of EEG sensors would boost the accuracy and would help in exploring it into more ranges. If the accuracy could be increased, then we suppose the prosthetic arm could be successfully implemented in real world situation. For future work, we would like to delve into these techniques to increase the accuracy so that we could start running trials on the efficiency of this control system. We could also then check out the use of the system on different people and in diverse experimental environments.

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BIOGRAPHIES

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