

MYO-OCULO BASED COMMUNICATING DEVICE FOR PARALYTIC PATIENT

Submitted in partial fulfillment of the requirements for the award of a
Bachelor of Technology degree in Biomedical Engineering.

By,

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**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

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APRIL - 2023





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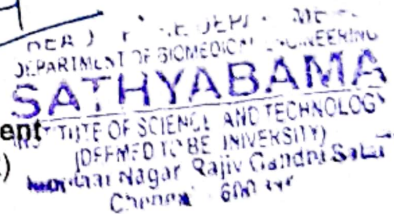
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of Atchaya E (39240009), Sabitha S (39240034) who have done the project work as a team who carried out the project entitled "Myo-oculo based communicating Device for paralytic patient" under our supervision from October 2022 to April 2023.

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Submitted for Viva-voce Examination held on 18/04/2023

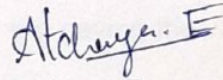
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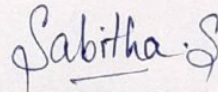
We, **Atchaya E (39240009)** and **Sabitha S (39240034)** hereby declare that the Project Report entitled "**Myo-oculo based communicating Device for a paralytic patient**" done by us under the guidance of **Dr. S. Krishnakumar**, Department of Biomedical Engineering at Sathyabama Institute of Science and Technology is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Biomedical Engineering.

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ACKNOWLEDGEMENT

We are pleased to acknowledge our sincere thanks to the **Board of Management of SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our thanks to **Dr. T. Sudhakar M.Sc., Ph.D., Heads of the Department, Dept. of Biomedical Engineering** for providing us with necessary support and details at the right time during the progressive reviews.

We would like to express our sincere and deep sense of gratitude to our Project Guide **Dr. S. Krishnakumar, M.Sc., Ph.D., Department of Biomedical Engineering** for his valuable guidance, suggestions, and constant encouragement paving the way for the successful completion of our project work.

We wish to express our thanks to all **Teaching and Non-teaching staff members of the Department of Biomedical Engineering** who were helpful in many ways for the completion of the Project.

ABSTRACT

Being able to communicate is crucial in daily life unless a stroke, ALS, or other neurological disorders that can paralyze a person by harming the neural pathways connecting their brain to the rest of their body frequently limit their ability to communicate. For physically disabled people, assistive technologies, such as an alternative form of text entry, can be of tremendous benefit. Biosignal interfaces are utilized in the medical industry for patient health status monitoring, rehabilitation services, or medical automation because they provide crucial data that shows the physical situation of the user. Coming to the medical side, an Individual who is paralyzed is a condition where the patient is unable to move a limb or part of the body due to the inactivity of the muscles in that area. These people find it extremely challenging to communicate with others and express their feelings and desires. Most people with paraplegia or quadriplegia, which severely restricts peripheral mobility, can still coordinate their eye movements. Assistive technologies can be incredibly helpful for people with such physical disabilities. If a device is directed at a paralyzed person's eyes or another facial feature, they may be able to speak. Medical professionals use biosignal that interfaces to monitor patients' health status, and their feeling and provide rehabilitative services. An image-based virtual keyboard has been designed for disabled people where they can operate and express their feeling through words by clicking images that are precoded according to their representation with the help of their EOG and EMG signal.

KEYWORDS: Disabled people; Biosignal; Tilt mechanism; Communication aid, EMG

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CHAPTER – 1

INTRODUCTION

1.1 BASIC INTRODUCTION

Muscles, one of the most vital structures in the human body, are impacted by illnesses of the muscular system. We can move and function in the world because of the force that is produced by our muscles. The muscles in our bodies carry out a variety of tasks, including maintaining posture by constant contraction, moving the skeleton, and producing heat through cell metabolism. Without it, we would spend the rest of our lives confined to one location. Painful muscles, weakened muscles, and paralysis are all symptoms of muscular system disease. It may be brought on by several circumstances, including hormone imbalances, auto-immune issues, genetics, infections, malignancy, or misuse of the muscle.

Most frequently, damage to the neurological system, particularly the spinal cord, results in paralysis (Diptee Gaikar et. al., 2021). Many people in the actual world are paralyzed and find it difficult to communicate. Words and sentences can be conveyed to the audience through motions. New human-computer interfaces have been designed to offer multiform interactions as the demand for computing environments changes (Vidya Sarode et. al., 2021).

The introduction of wearable biological-signal devices has made use in conventional medical systems accessible to the public. Interfaces with biosignals are utilized in fitness, sports, and rehabilitative training, such as when learning how to manage respiration or balance one's body. As the usage of the internet and portable electronic gadgets have grown more commonplace, the use of biosignal systems has moved on the far side of healthcare services to several fields like human-computer interface, information security, and education (Nam et. al., 2018).

The communication ability is often limited due to clinical conditions such as stroke, neurologic disorders, or other nerve injuries that lead to paralysis. Paralysis can damage the neural pathways and connect the brain and the rest of the body (Statland, 2018). Perhaps the greatest scientifically verified way to recuperate

mobility after stroke paralysis is to do regular exercises. The mental involves visualizing themselves and performing a movement that they want to perform. The regular practice is all in their head and requires actual movement. Under such conditions, they can communicate with other people through the oculo-based communication system (Hemanth, 2021).

1.2 PARALYSIS

A temporary or permanent lack of voluntary muscular action is referred to as Paralysis. It happens when your muscles are unable to move on their own. Your body's mechanism for controlling and communicating is called the Nervous System. The brain instructs your body on what to perform by sending messages throughout it. Any part of the body can be rendered immobile. Total paralysis implies you have no control over any forces, while partial paralysis means you can control some muscles but not all. Paralysis can also be categorized as flaccid or spastic depending on where in the nervous system the damage occurred.

Stroke, brain damage, spinal cord injury, broken necks, and multiple sclerosis are among the most common causes of paralysis (Pandarinath et. al., 2017). Additional causes of paralysis include Bell's palsy, which affects the facial muscles, Guillian-Barre syndrome, the polio virus, and other nerve diseases. The various forms of paralysis and their associated symptoms are illustrated in the table 1.1.

Table 1.1 Categories of paralysis

TYPES	SYMPTOMS
Hemiparesis or hemiplegia	Weakness on one side of the body, particularly in the face, arm, or leg.
Paraplegia	Weakness below the waist may include loss of bowel and bladder control.
Quadriplegia	All four limbs are weak
Monoplegia	Weakness in one or more limbs
Gastroparesis	Slowed digestion can result in vomiting or constipation.
Bell's palsy	Kind of facial paralysis that typically affects one side of the face

1.3 ETIOLOGY

A stroke which is a blockage in a brain artery can damage regions of the brain that regulate motor action. Cardiovascular disease risk factors include uncontrolled diabetes, excessive blood sugar, high blood pressure, and high cholesterol. Due to demyelination (damage to the protective coating of nerve fibers) in the brain and spinal cord, multiple sclerosis is an inflammatory disease that frequently results in periods of weakness, abnormalities in coordination, and other symptoms. The rare condition known as amyotrophic lateral sclerosis (ALS) results in the deterioration of a particular area of the spine. It typically affects those over 50 and progresses over a short period. Guillain-Barre syndrome: Usually beginning in the legs and progressing up the body, this condition weakens a person owing to inflammatory demyelination of the peripheral motor neurons. A herniated spinal disc is when a disc of cartilage in the spinal column bulges out of its normal position, typically because of degenerative illness or trauma (Heidi Moawad and Oluseun Olufade, 2022).

1.4 SYMPTOMS

Tingling or discomfort in the afflicted muscles, Muscle tremors, Confusion, Stiffness, Unwilled twitches or spasms, Muscle pain, the loss of muscle in plain sight (muscle atrophy), talking or comprehending problems, Walking problems, dizziness, loss of coordination and balance, severe headache (Bikash Debsingha et. al., 2021).

BIOSIGNAL - BASED COMMUNICATION DEVICES

1.5 ELECTROMYOGRAPHY

The EMG signal is used to capture a muscle's electrical activity. When a muscle fiber is stimulated, the central nervous system produces little electrical currents in the form of ion fluxes. Tremors since body tissue acts as a resistance to electrical current, an electrical field is produced. The ensuing potential differences between certain areas of the body's surface can be monitored. When a muscle is instructed to contract by the brain, signals are sent to motor neurons, which control many fibers. As the membrane fiber depolarizes, an electrical potential with a duration of around 8 ms is created close to the muscle fibers. A motor unit's motor unit action potential (MUAP) is produced by adding the action potentials that are propagating through its fibers. The MUAPs are fired regularly at frequencies between 7 and 20 Hz to maintain the muscle's force. The electrical fields produced by each motor unit in the range are recorded by an electrode that records the activity of the muscle. Surface and intramuscular electrodes are the two types of electrodes used for EMG signal collection. The EMG signal is made up of this group of MUAPs (Tambakhe et. al., 2022).

The signal, which is captured from the surface of the skin, can have peak-to-peak amplitude values of 20–2000 V. It is possible to reliably gather data from motor units or fibers. The mechanical activity of the muscle, on the other hand, could lead to sores and infections. Since communication aid devices would likely be utilized for several hours per day, the decision to employ surface electrodes is ideal for such

procedures. Numerous neuromuscular and neurological problems have been frequently diagnosed using this diagnostic technique. EMG is an intrusive method that calls for training. Because of this, it has only seen limited application in the diagnosis and treatment of voice disorders, particularly in young children (Amrutha and Arul, 2017).

1.5.1 APPLICATION

Switch-based mouse - The human face provides the EMG signal that the EMG human-computer interface uses to direct the computer cursor. The impaired subject can use the facial EMG cursor to interact with the software by tensing their facial muscles. Utilizing Labview, a graphical development environment, the full signal processing method is created. Ultimately, the pattern-recognition system launches the appropriate computer mouse function by the pattern of muscle action.

A human can engage in sensory and cognitive activity in a digitally produced artificial world called virtual reality. This world can be fictitious, symbolic, or a mimic of some features of the authentic world. When the user presses buttons scanned using Arduino (with the right hand, left hand, or both at once) or while the person contemplates pressing the buttons, they can view the genuine outcomes of their interaction with the world in a virtual world (Unity3D or NeoAxis) (Rouillard et. al., 2015).

Patients who can still move their heads or have some use of their limbs may use a pressure device. A similar idea can be used in substituting the action of pressure in EMG signals with the contraction of a muscle. Electromyogram has been utilized before to evaluate patients with consciousness issues, demonstrating their potential as a communication tool. Binary signals can be produced using computational solutions, with '1' denoting muscle activation and '0' otherwise.

Depending on the length of the contraction, the user shifts their chin to convert the Masseter muscle signal into "dot" or "dashes". Characters from the sequence are decoded and sent into a voice synthesizer. This work addresses a critical issue with using EMG— failure to adapt to exhaustion. The main qualification was that, despite

figures not being provided, the information transfer rate was low since people cannot chew and pause quickly.

Another objective was to create a pointing device that could be operated by facial muscles. Each muscle's level of activation was assessed using a continuous Wavelet transform, which produces displacements in four directions linked to both sides of the mentalis, masseter, and orbicular muscles. The simultaneous execution of the opposite directions for left and right click operations was designated as Up Down for the right click and Left Right for the left click. The wavelet mother and MUAPs' comparable shapes are justified using the wavelet transform. However, as the system's performance was not measured against conventional signal characteristics, this tactic raises some doubts (e.g., the RMS value).

Additionally, compared to a traditional mouse, directing a cursor using face muscles feels odd. When employing EMG signals as the source of control, for instance, diagonal movements typically involve horizontal and vertical movements on the other hand, the movement of the head is comparable to using a joystick.

EMG data from the Sternocleidomastoid muscle were interpolated linearly, and the head's angle was determined. The EMG signal is insufficient to yield any good data for small angle rotations, thus a photo camera was used instead, and the determination of the angle was done by the pupil's location about one another. The camera-based option, which only requires a standard webcam and software that is already accessible for download, looks more acceptable if the person has adequate control of their neck and head.

Since the lips and mouth shapes were fixed, only vowels were employed. Since the Masseter, Mentalis, and Depressor anguli oris muscles are the ones that are most engaged when pronouncing vowels, three channels were employed to record data. The EMG signal's RMS was connected to the vowels using a back-propagation algorithm-based artificial neural network (ANN). Single-word recognition and a speech impediment are covered in other studies. Electrodes were inserted into a pilot's oxygen mask to identify pilot speech that could be mistaken for directives.

While performing the task the error rate for identifying the speech of the numerals "zero" to "nine" was comparatively low, varying from 0% to 10.4%.

1.6 ELECTROOCULOGRAPHY

EOG signal which is produced by the potential difference between the retina and the cornea. It varies between 2 and 20 Mv. However, data recording often falls between 15-20 mV. This possibility arises from the retina's higher concentration of active nerves than the front of the eye. Compared to other methods of measuring eye movement, the EOG has an advantage because head and torso motions do not interfere with recording. The EOG is frequently used to quantify blinking, nystagmus, smooth pursuit eye movements, and saccadic eye movements. With an average accuracy of 1.5 to 2.0, the EOG can capture eye movements up to $\pm 70^\circ$. To capture, 5 Ag/AgCl self-adhesive electrodes are typically positioned for EOG recordings: (i) one pair - above and below the eye to capture vertical movements; (ii) one pair - close to the lateral canthus to capture horizontal movements; and (iii) one in a neutral site to serve as a reference. A constant electrical dipole with a negative pole at the fundus (retina) and a positive pole at the cornea can be used to describe this potential (Shivaprasad and Vishwanath Muddi, 2019). As a result, it is possible to assume that the retina is negative and the corneal center is positive in a human eyeball. It is conceivable to think of the battery in this way—as being lodged in the socket of an eye and rotating near to the torus of the eye through the conductive tissue surrounding the orbit, microcurrents flow radially from the battery's positive to the negative poles. Thus, standing potentials around the eye are produced by these currents and that is estimated with the help of electrodes placed.

1.6.1 APPLICATION

A couple of EOG channels and an EMG channel make up the virtual keyboard writer system was proposed. The angular displacement of the gaze in the vertical and horizontal directions was linked to the cursor movement, and the letter was chosen using an "EMG click" recorded from the brow. The authors cited the system's simplicity and reduced cost as advantages over more advanced techniques like videooculography (VOG) and infraredoculography for detecting eye movements (IROG) (Muhammad Ilhamdi Rusydi et. al., 2019).

Considering the eyelid movements of the patient as a source of signal, our technology uses Morsecode to translate the eye blink's duration and pattern into the standard English alphabet. Blinking takes the human eye around a third of a second on average. During a blink, more light is reflected for a duration and the sensor gives an exceptional output than for an open eye. A microcontroller called an Arduino Uno receives readings at a rate of 10 per second continually. Here, to identify whether the eye was open or closed, they are contrasted with a previously fixed value. The patient can then communicate and form complete words and sentences in this way (Mukherjee et. al., 2015).

In comparison to the EEG, EOG signals exhibit the following qualities: a relatively high amplitude, a linear correlation between the signal and movement of an eye, and a waveform that is simple to identify. Given that EOG is simpler than EMG, it is also simpler to categorize. These factors have made EOG-based HCI systems a particularly intriguing area of study in recent years. In addition, most patients with significant motor impairments can nevertheless control their eye movements. Recent research has demonstrated the feasibility of the application of EOG in assistive communication systems in this way.

1.7 EXISTING SYSTEM

Navigate to the desired letter using an eye-gaze direction and select the navigated letter using an eye blink in a QWERTY keyboard. But blinking is a natural protection system that defends the eye from environmental exposure. This system can be used by those persons only who can control their eye blinks and at the same time can make blinks voluntarily.

EOG-based system for computer control known as Telepathix or ternary keyboard. The system was created to allow users to interact with a computer only by moving their eyes. With each successive eye movement command (Left, Center, or Right) the keyboard iteratively splits into thirds until a letter is chosen. The letter selection process ends when the user initiates the stop sequence by “typing” two blank spaces.

Disadvantages in the existing system:

- Undesired blinks may cause a false selection of the letters.
- Causing eye fatigue by searching up the letters while navigating among the keyboard.

1.8 PROPOSED SYSTEM

In the proposed system, Biosignals such as EOG & EMG is used in communicating device for paralytic people. Signals are used in such a manner where an oculogram is to determine the direction (angle) of the eye movement while a myogram is to record the activity of the brow muscles [eye-gaze-controlled navigation among the images and EMG-based click entry].

It's a virtual keyboard with some predefined images where patients can operate this keyboard with the help of their eye and muscle signals. Each predefined image will are coded according to its representation. For example, if an image is of a glass of water and the patients click that image then it will indicate as the patient needs water.

With eyebrow movement, they click the image according to their need, and images coded with words will be displayed on the screen and that will also be heard as audio.

Here Arduino and keyboard will interfaced where the signals will be processed. and as an output, the text is finally transformed into audio.

Advantages of the proposed system:

- Reduce eye fatigue
- Easy to convey the needs by looking at the images
- Easy to design with low cost

CHAPTER – 2

LITERATURE REVIEW

2.1 INTRODUCTION

The following shows the survey done for Myo oculo-based communicating device for paralytic patient. The most popular of the existing research has been discussed as follows.

2.2 LITERATURE SURVEY

Cobos et. al., (2021) in his paper presentation said that Unwanted signals called artifacts can disrupt neurological events, alter their features, or even be incorrectly employed as the source of control in BCI systems. It is vital to create automatic ways to handle artifacts or to build BCI systems whose performance is resilient to the presence of artifacts since failure to deal with artifacts may cause a specific BCI system's performance to degrade during practical applications. Electrical brain impulses may be captured using relatively low-cost technologies, especially when scalp electrodes are used. Brain signals frequently respond quickly and change with cognition. Modifications in the brain's Mu, Beta, and Gamma rhythms are connected to movement processes.

Monica Jordan, (2020) mentioned that one in every 200 people worldwide cannot express themselves orally because of cognitive, motor, neurological, or emotional problems. This paper presents a Hidden Markov Model-based word prediction method that allows keyboard emulation software to predict words so that children with disabilities can type texts more quickly. The proposed system involved the development of a keyboard emulator, the construction and processing of a corpus, as well as a word prediction algorithm. Children with different cognitive profiles had to produce a text and type it twice: first with free typing, and second, using the virtual keyboard's word prediction. Results indicated the word prediction of the keyboard emulator software reduced typing efforts. However, the software initially increased

the typing time when the corpus was not well adapted to users. The total amount of clicks with word prediction decreased by around 26.2%. Regarding execution time using prediction, 61% typed the text in less time. The tests performed with literate volunteers indicated a reduction in the number of clicks by up to 51.3%. This result surpasses the 15% achieved in the previous study by Free Virtual Keyboard with word prediction based on pure statistics.

Vidya Sarode et. al., (2021) noble aim behind this project is to design a healthcare system that will be helpful for paralyzed and mute people. Dumb individual all through the world uses gesture-based communication for correspondence. The progression in the implanted framework can give a space to plan and build up an interpreter framework to change over communication via gestures into discourse. As sign language is primarily used by deaf but also used by people who can hear having problems speaking so the approach used in this analysis is vision based. The gloves used are fitted with a flex sensors of three dimensions to collect the data from every position of the figure and hand motion to differentiate and distinguish each and every word from a particular sign. Heart attack is the major reason for death among both genders men and women. However, its occurrence cannot be always predictable. A most common device used to detect heart-related problems is an EKG machine which is reliable to normal user, but is not mobile enough to be used as a monitoring device for a heart patient continuously. This project is to develop an algorithm for detecting a heart attack and if so, to alert doctors, family members, and emergency services. Hence here we introduce a smart health care system which will take care of the problems and needs of paralyzed and mute people and will also help in detection of heart attack.

Shivaprasad et. al., (2019) in his paper described that rehabilitation Devices [HMI] have been investigated to regulate electromechanical rehabilitation devices utilizing biosignals, improving the quality of life for persons with varying abilities. The capacity to coordinate eye movement is present in paraplegic or quadriplegic individuals. It concentrates on the wheelchair's prototype motor, which is driven by

EOG data and processed to provide control signals based on the signal's amplitude and duration. The prototype motorized wheelchair's movement was controlled by these user training for the algorithm was far less than. It is highly helpful for implementing rehabilitation aids and other classification methods. EOG signals were seen in both the vertical and horizontal. Signal amplitudes were contrasted with the appropriate threshold values as they were processed concurrently after it.

Partha Chakraborty (2019) in his paper mentioned that human-Computer Interaction is an emerging technology that uses many algorithms and techniques to enhance the interaction process. Eye gaze technology is one of the most significant techniques of modern science and can be used in many areas like security, typing, information tracking, etc. This paper represents the development of a virtual keyboard which works by detecting eye gaze and eye blinking. It involves building a system that captures video directly from PC camera and detects human face, eyes. To detect face accurately, the eyes and lips are always in the sample place as image, which will make the eye detection process much easier. The goal of this system is to type without using finger or hands.

Muhammad Ilhamdi Rusydi et. al., (2019) presented the design and development of gaze-motion controlled adaptive virtual keyboard. The keyboard has the ability to arrange character layout based on specified frequency of a character. The designed virtual keyboard has 45 keys that comprising 26 letters, 10 numerals, 4 symbols, a space, a delete, an enter, a return and a central point key. The keyboard layout has six zones. Characters in the same zone have equal distance to the central point. The distance is the least gazing that possible to move from the central point to the character. The most frequently used character will shift to the shortest distance position. Seven paragraphs were typed using this virtual keyboard. The keywords of each paragraph are 'bukittinggi', 'zimbawe', 'andalas', 'sukarno', 'randang', 'kapal' and 'dokter'. The performance of the adaptive virtual keyboard was evaluated using these seven keywords. Results shows that the number of gaze motion required to type the keyword after the re-arrangement of layout decreased about 27%. This

adaptive ability can reduce the number of gazing to prevent eye fatigue.

Hosni et. al., (2018) Used a gadget based on electromyography (EMG) to identify five eye motions and categorize them in order to interact with various apps without using your hands. Long blinks, rapid blinks, winks to the right and left, and lastly squints or frowns are among the suggested eye motions in this work. The instrument utilized is the MUSE headband, which was initially a Brain-Computer Interface (BCI) that monitors the Electro Encephalo Graphy (EEG) signals. According to the Wadsworth Center first conceived the use of BCIs as a different means of providing muscle-free communication for severely paralyzed patients. This involved recording the EMG signals from behind the earlobes using two Smart rubber sensors and at the forehead using two additional electrodes.

Yi Liu et. al., (2016) described that for a subset of physically challenged people, assistive technologies, such as the alternative form of text entry, can be of tremendous benefit. Eye gaze technologies have the potential for text entry but still tend to be relatively slow. Dwell-free eye- typing systems have been proposed, but can be vulnerable to common text entry problems, such as the selection of the wrong letters. A recognition approach for inferring the words which the user intends to type is proposed. The method is robust to missing letters and even when a neighboring letter on the keyboard is incorrectly selected. Simulation and experiment results suggest that our proposed approach has better accuracy and more resilience to common text entry errors.

Matthew Mifsud et. al., (2022) in his work presents the development of an asynchronous dwell-free virtual keyboard application which can be operated using electrooculographic (EOG) data. Unlike other EOG based eye typing applications, the developed system avoids the use of dwell-times and relieves the user from the need to perform repetitive and unnatural eye movements to move a cursor towards the desired letter or the need to perform voluntary blinks to interact with the application. Instead, the proposed application requires the user to simply glance

through the vicinity of the desired letters, as one would swipe through letters when typing on a touchscreen device, after which a set of word predictions are displayed for the user to select. The proposed application obtained a top five rate of $76.00 \pm 12.61\%$ using EOG data which is comparable to the top five rate of $79.00 \pm 13.37\%$ obtained when operating the application using a vision-based eye gaze tracker.

Tanja Schultz, (2017) demonstrated that the speech is a complex process involving a wide range of biosignals, including but not limited to acoustics. These biosignals-stemming from the articulators, the articulator muscle activities, the neural pathways, and the brain itself-can be used to circumvent limitations of conventional speech processing in particular, and to gain insights into the process of speech production in general. Research on biosignal-based speech processing is a wide and very active field at the intersection of various disciplines, ranging from engineering, computer science, electronics and machine learning to medicine, neuroscience, physiology, and psychology. Consequently, a variety of methods and approaches have been used to investigate the common goal of creating biosignal-based speech processing devices for communication applications in everyday situations and for speech rehabilitation, as well as gaining a deeper understanding of spoken communication. This paper gives an overview of the various modalities, research approaches, and objectives for biosignal-based spoken communication.

Carlos Pinheiro et. al., (2020) collected sufficient evidence that using electrical biosignals in the field of Alternative and Augmented Communication is feasible. Additionally, they are particularly suitable in the case of people with severe motor impairment, e.g. people with high-level spinal cord injury or with locked-up syndrome. Developing solutions for them implies that we find ways to use sensors that fit the user's needs and limitations, which in turn impacts the specifications of the system translating the user's intentions into commands. After devising solutions for a given user or profile, the system should be evaluated with an appropriate method, allowing a comparison with other solutions. This paper submits a review of the way three

bioelectrical signals - electromyographic, electrooculographic and electroencephalographic - have been utilised in alternative communication with patients suffering severe motor restrictions. It also offers a comparative study of the various methods applied to measure the performance of AAC systems.

CHAPTER – 3

AIM AND SCOPE

3.1 AIM

The main idea of this research paper is to provide an efficient communication device for disabled people.

In this project, we proposed a communicating virtual keyboard that produces an immediate response and prevents fatigue.

It can be used by those who are affected by paralysis where they could not afford to move as their muscles are damaged, patients with any muscular disorder, and even children.

3.2 SCOPE

People may now do tasks over large distances and in a short amount of time because of advancements in telecommunications technology. People always utilize technology to finish tasks or assist careers, particularly in hospitals. This is also true for family members who assist paralyzed patients at home or in other specific locations.

Several systems have been created to take eye-gaze and muscle signals to satisfy the demand for communication. By employing this technology, eye tiredness can be reduced, Looking at the visuals makes it simple to communicate the needs, Simple and inexpensive to create. More parameters can be sensed and monitored in accordance with sensor availability or biomedical trend development, greatly enhancing the effectiveness of wireless monitoring systems in the biomedical area. This technology allows the paralyzed patient to communicate with others, which reduces stress by allowing them to express their thoughts, and it also helps them stay as motivated as they can.

CHAPTER – 4

MATERIALS AND METHODS

4.1 BLOCK DIAGRAM OF THE PROPOSED SYSTEM

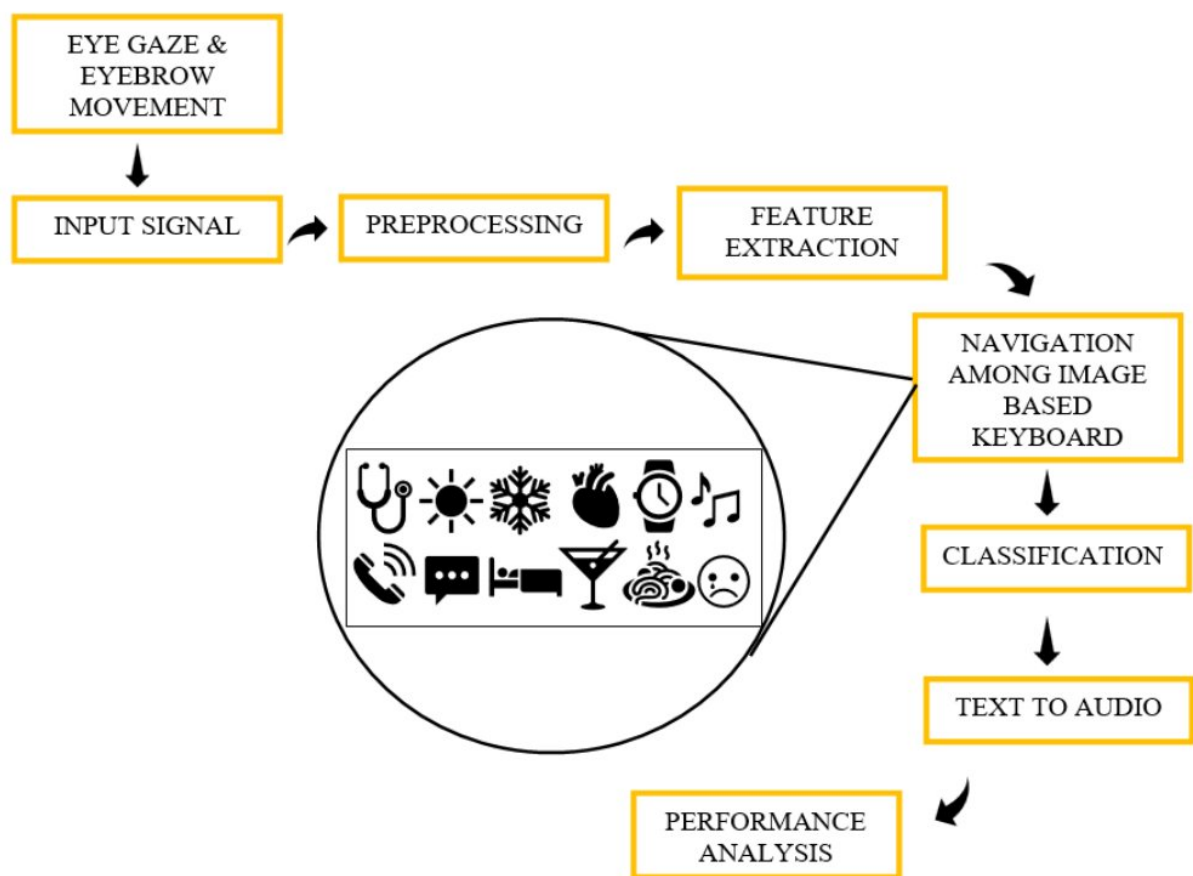


Fig. 4.1 Block Diagram of Biosignal-based communication system

4.2 WORKING

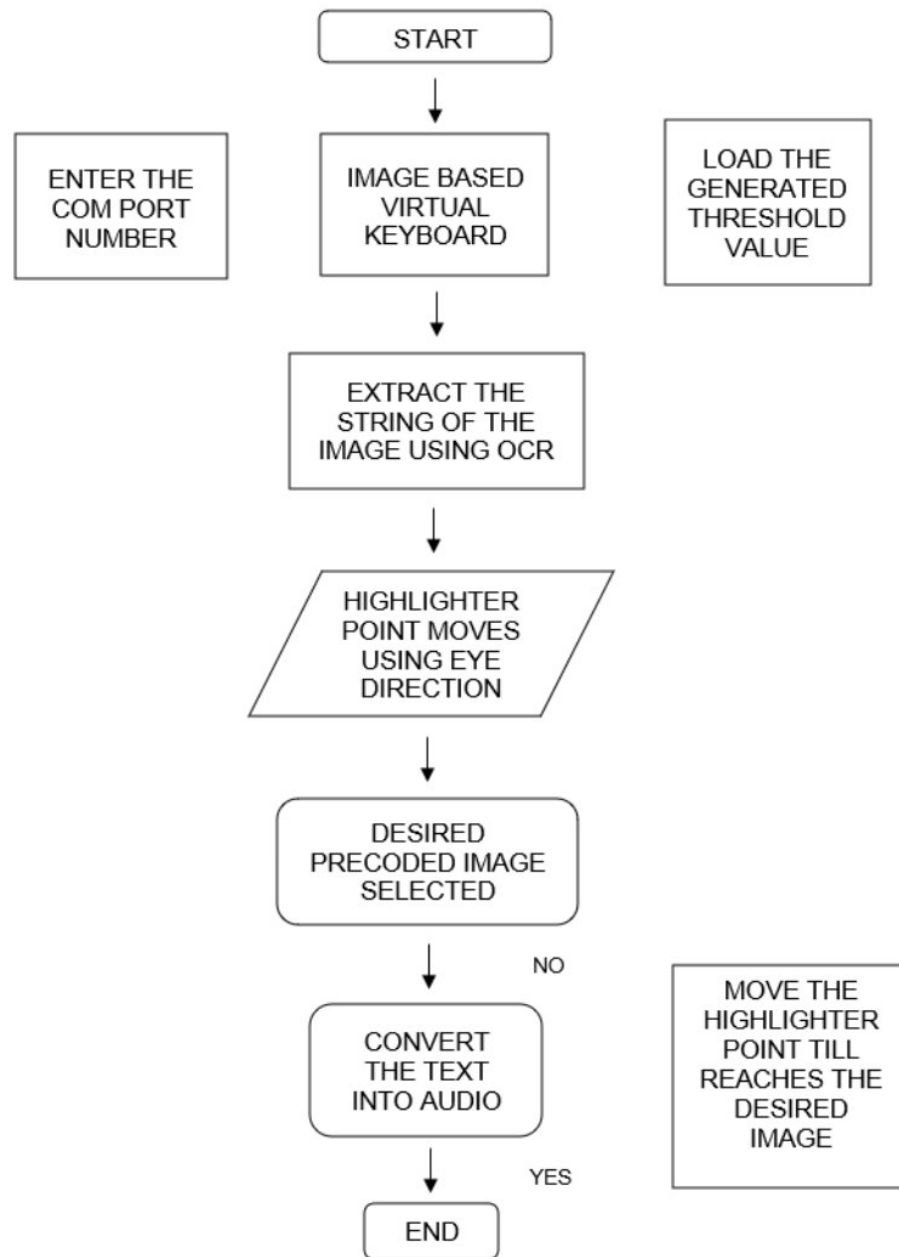


Fig. 4.2 Workflow of the virtual keyboard communication device

4.3 EMBEDDED SYSTEM

An embedded computer system that is primarily designed to perform a large number of tasks, which includes accessing, to till data controlling in different electronic systems. Hardware and software are both components of embedded systems, software—called firmware—which is integrated directly with the hardware. The system's most crucial feature is that it provides the opportunity within the allotted time. Embedded systems help to increase the efficiency and precision of the work. Both simple and multiplex devices are used in this system The primary real-world uses for embedded systems are in a variety of appliances, including TV remote controls, microwaves, home security systems, calculators control systems of local traffic, etc.

Since most of these embedded systems are real-time systems, real characteristics like reaction time, worst-case executing time, etc., are crucial elements in consideration. The systems typically have to adhere to strict requirements for reliability, availability, safety, and other dependability-related qualities. These systems have a limited amount of hardware capability and a tiny amount of resource usage because of their compact size, mobility requirements, and extremely low production costs. Embedded real-time systems are becoming more complex, which raises the need for effective life-cycle management properties like portability, maintainability, and adaptability. These demands include requiring engineering, design at a high level, error detection, productivity, verification, integration, and maintenance.

4.4 WIRELESS COMMUNICATION

The medium used for communication can be guided or unguided, and communication systems can be wired or wireless. In wired communication, a physical channel, such as coaxial cables, twisted pair cables, optical fibre links, and so on, serves as the medium and directs the signal as it travels from one point to another. A guided medium is one such form of medium. Wireless communications or data transmissions take place over long distances without the use of wires, cables, or any other type of electrical conductor. One of the key means of transmitting data or information to other devices is wireless communication. Without the need for cables, communication is established and the data is sent in the air using electromagnetic waves such as radio frequency,

infrared, satellites, etc in a wireless technology network.

4.5 ARDUINO MICROCONTROLLER

The Arduino (Fig. 4.3) is so accessible and affordable across the globe because all of the Arduino hardware is open-source. Being open-source has a plethora of advantages- anyone can access the design and build of the device and make improvements; anyone can use the same hardware design to create their product lineup. Since Arduino is open-source, it has its own devoted community that strives to help the core company develop and improve its hardware products. Another significant advantage of being open-source, especially in the case of hardware, is that local companies can create replicas of the products, making it more accessible and affordable to local consumers as it avoids hefty customs and shipping charges. All of these advantages contribute to Arduino being so widespread, affordable, and ever-improving. It is necessary to know that Arduino doesn't necessarily offer just one piece of hardware, it provides a range of boards, each of which caters to a different level of expertise and has different use-use cases together. Arduino Uno is one of the most basic and popular boards that Arduino offers. This is because it features an ATmega328 microcontroller that is both cheap and powerful enough for most basic beginner-level projects. Once you're familiar with Arduino IDE, you can move up to boards with more powerful and sophisticated chipsets like the MKR range which is concerned with IoT applications and inter compatibility, or the Nano range which as the name suggests is designed to keep the form factor as small as possible while packing most of the features and power of the full-sized boards.

1. USB: can used for both power and communication with the IDE
2. Barrel Jack: used for power supply
3. Voltage Regulator: regulates and stabilizes the input and output voltages
4. Crystal Oscillator: keeps track of time and regulates processor frequency
5. Reset Pin: can used to reset the Arduino Uno
6. 3.3V pin: can used as a 3.3V output
7. 5V pin: can used as a 5V output

- 8. GND pin: can used to ground the circuit
- 9. Vin pin: can used to supply power to the board
- 10. Analog pins(A0-A5): can used to read analog signals to the board

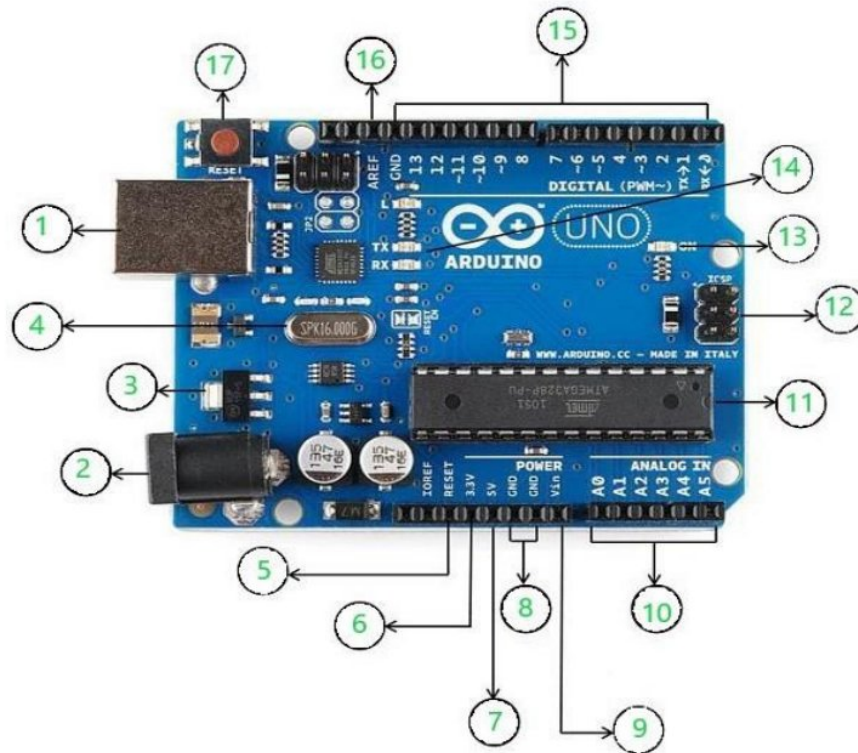


Fig. 4.3 Arduino Microcontroller

- 11. Microcontroller (ATMega328): the processing and logical unit of the board
- 12. ICSP pin: a programming header on the board also called SPI
- 13. Power indicator LED: indicates the power status of the board
- 14. RX and TX LEDs: receive (RX) and transmit (TX) LEDs, blink when sending or receiving serial data respectively
- 15. Digital I/O pins: 14 pins capable of reading and outputting digital signals; 6 of these pins are also capable of PWM
- 16. AREF pins: can used to set an external reference voltage as the upper limit for the analog pins
- 17. Reset button: can used to reset the board

4.6 VOLTAGE REGULATOR

A voltage regulator (Fig. 4.4) is a system designed to automatically maintain a constant voltage. A voltage regulator may use a simple feed-forward design or may include negative feedback. It may use an electromechanical mechanism or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages. A voltage regulator circuit is used to make as well as maintain a permanent output voltage even when the input voltage otherwise load conditions are changed. The voltage regulator gets the voltage from a power supply and it can be maintained in a range that is well-suited with the remaining electrical components. Most commonly these regulators are used for converting DC/DC power, AC/AC otherwise AC/DC.

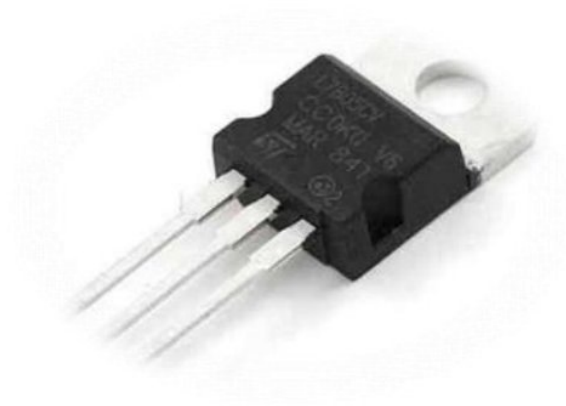


Fig. 4.4 Voltage Regulator

4.7 HYLAM SHEET

Bakelite (Hylam sheets) (Fig. 4.5) are used where mechanical strength, wear resistance and resilience are more important than electrical insulation. Phenolic Resin Bonded Cotton Fabric Laminates (SRBP) (or) cotton fabric reinforced phenolic is Natural (light tan to brown) in colour and is composed of a continuous cotton woven cloth impregnated with a phenolic resin binder. Typical applications of fabric laminates are gears, textile shuttles, bearings, pickers, bushes and marine application. Different grades are offered to suit specific applications. The working temperature of Hylam sheet material: Hylam. Density: 1.9 g/cm³. Temperature: 100 to 1800 C.



Fig. 4.5 Hylam sheet

4.8 BRIDGE RECTIFIER

A Bridge rectifier (Fig. 4.6) is an AC-to-DC converter that rectifies mains AC input to DC output. Bridge Rectifiers are widely used in power supplies that provide the necessary DC voltage the electronic components or devices. They can be constructed with four or more diodes or any other controlled solid-state switches. Depending on the load current requirements, a proper bridge rectifier is selected. Components' ratings and specifications, breakdown voltage, temperature ranges, transient current rating, forward current rating, mounting requirements, and other considerations are taken

into account while selecting a rectifier power supply for an appropriate electronic circuit's application. The main benefit of this design is the lack of an exclusive center-tapped transformer. So, the size, as well as the cost, will be reduced. Once the input signal is applied across the two terminals like A & B then the o/p DC signal can be attained across the RL. Here load resistor is connected between two terminals like C & D. The arrangement of two diodes can be made in such a way that the electricity will be conducted by two diodes throughout every half cycle. The pairs of diodes like D1 & D3 will conduct electric current throughout the positive half cycle. Similarly, D2 & D4 diodes will conduct electric current throughout a negative half cycle.

Characteristics – Ripple Factor, Peak Inverse Voltage (PIV), Efficiency



Fig. 4.6 Bridge rectifier

4.9 JUMPER WIRE

A jump wire (Fig. 4.7) (also known as jumper, jumper wire, DuPont wire) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.



Fig. 4.7 Jumper wire

4.10 POWER CORD

A power cord (Fig. 4.8), line cord, or mains cable is an electrical cable that temporarily connects an appliance to the mains electricity supply via a wall socket or extension cord. The terms are generally used for cables using a power plug to connect to a single-phase alternating current power source at the local line voltage (generally 100 to 240 volts, depending on the location). A cord set includes connectors molded to the cord at each end (see Appliance coupler). Cord sets are detachable from both the power supply and the electrical equipment, and consist of a flexible cord with electrical connectors at either end, one male, and one female. One end of the cord set is attached to a molded electrical plug; the other is typically a molded electrical receptacle to prevent the possibility of having an exposed live prong or pin which would cause electric shock. The female connector attaches to the piece of equipment or appliance while the male plug connects to the electrical receptacle or outlet. Unwary substitution of a standard mains-voltage connector for the power supply would result in the application of full line voltage to the connected device, resulting in its destruction and possible fire or personal injury.



Fig. 4.8 Power cord

4.11 BIO AMP EXG SENSOR

BioAmp EXG Pill (Fig. 4.9) is a small, powerful analog-front-end (AFE) biopotential signal-acquisition board that can be paired with any microcontroller unit (MCU) or single-board computer (SBC) with an analog-to-digital converter (ADC) such as Arduino UNO & Nano, Espressif ESP32, Adafruit QtPy, STM32 Blue Pill, BeagleBone Black, and Raspberry Pi Pico, to name just a few. It also works with any dedicated ADC, like the Texas Instruments ADS1115 and ADS131M0x, among others. BioAmp EXG Pill is capable of recording publication-quality biopotential signals like ECG, EMG, EOG, and EEG, without the inclusion of any dedicated hardware or software filters. Its small size allows easy integration into mobile and space-constrained projects, and its powerful noise rejection makes it usable even when the device is close to the AC mains supply. Any 1.5 mm diameter wire can be used as a strain-relieving electrode cable, making it very cost-effective in comparison to the other available.

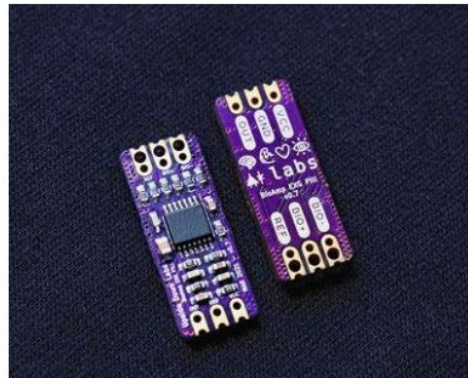


Fig. 4.9 Bio amp EXG pill sensor

4.12 ELECTRODES

Surface electrodes (Fig. 4.10) are types of electrodes applied to the skin of the subject. Major applications include electrocardiography (ECG), electrooculography (EOG), electromyography (EMG), or electroencephalography (EEG), which are techniques for recording and evaluating the electrical activities of the heart, eye, skeletal muscles and neurons of the brain, respectively, from the surface of the skin. Other types of electrodes are used to measure the conductance of body parts. Examples are measurements of skin conductance or transthoracic impedance. In some cases, electrodes are simple metal plates connected with a lead wire. Electrode may be made in the form of a suction cup attached with a bulb, facilitating easy attachment and relocation.



Fig. 4.10 Electrodes

4.13 ELECTRODE PLACEMENT AND SIGNAL

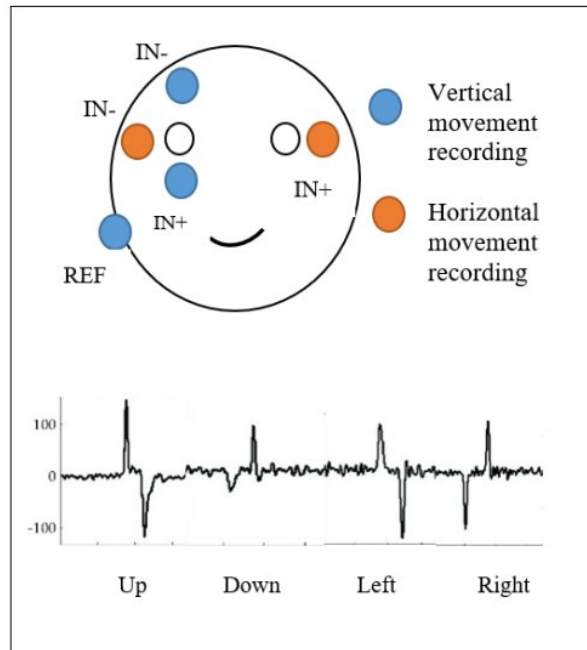


Fig. 4.11 EOG electrode placement and its wave

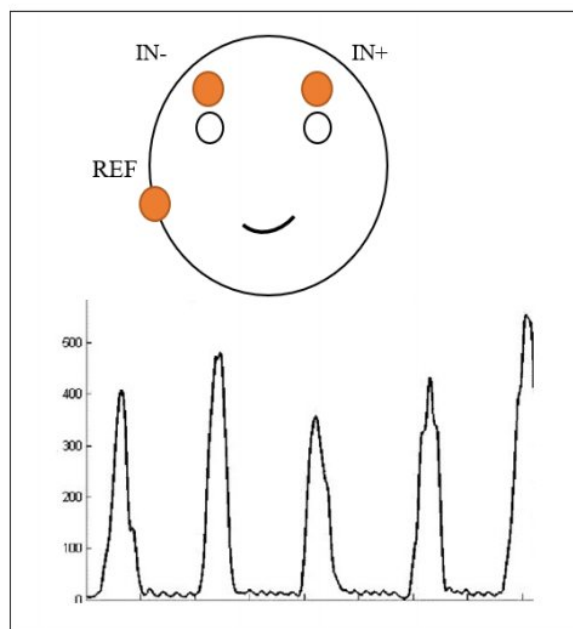


Fig. 4.12 EMG electrode placement and its wave

CHAPTER – 5

RESULTS AND DISCUSSION

5.1 RESULTS

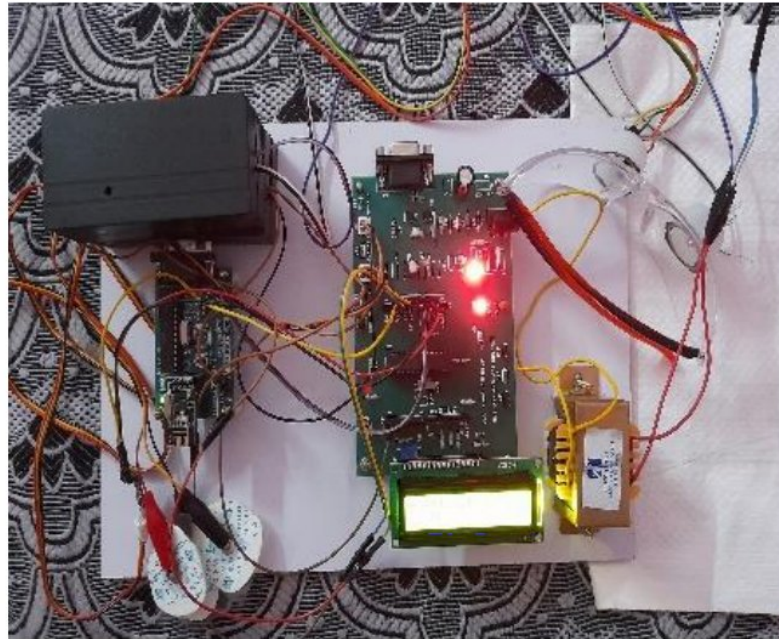


Fig. 5.1 Hardware Implementation of the system for picking and processing of the biosignal

The project's laudable goal is to create a virtual image-based keyboard that will be useful for the deaf and the paralysed. A dumb person uses gesture-based communication for correspondence everywhere in the world. The development of the implanted framework can provide room for the planning and construction of an interpretation framework to convert gesture-based communication into discourse. In terms of simplicity and the employed sensors, the proposed equipment is also more affordable than the other existing systems. The project's goal was to build a system with an ARDUINO as its primary controller. This idea was developed in accordance with current technology to guarantee the paralysed patient receives the greatest care while in the hospital without family members there.

Fig. 5.1 depicts the hardware implementation of the system for picking and processing of the Biosignal (EOG and EMG) from the human body. The developed kit has an Arduino as the primary microcontroller and a spectacle attached with a sensor on both sides to pick the EOG signal from the eye movement. Then a reference electrode and a pair of electrodes are to be placed on either side of the upper portion of the eyebrow to pick the EMG signal. Both signals are processed and used to validate the created image-based virtual keyboard.

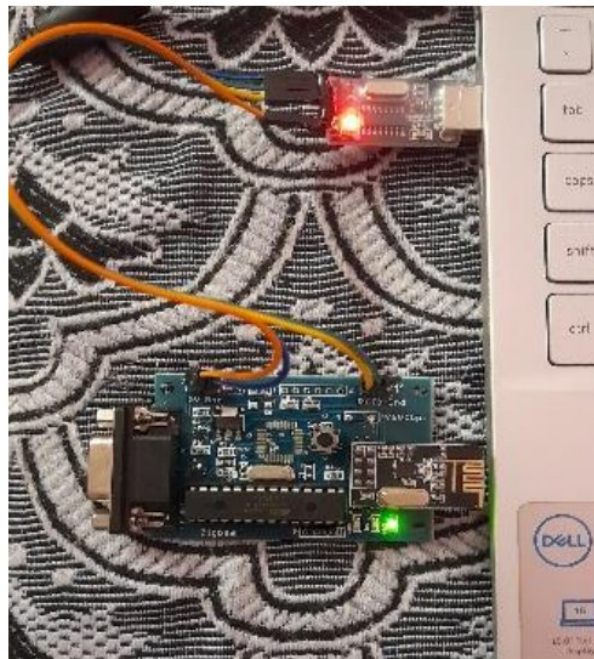


Fig. 5.2 Hardware Implementation for the wireless communication between the PC and the kit

Hardware kit for wireless communication (Fig. 5.2) of the processed signal in the form of raw data transferring into the PC as 0's and 1's. 0's indicates no movement and 1's indicates a movement. It takes place over free space through RF (radio frequency), one device, a Transmitter, sends a signal to another device, a Receiver. Two devices (transmitter and receiver) are able to communicate with each other.

5.2 IMAGE-BASED VIRTUAL KEYBOARD

The image-based virtual keyboard (Fig.5.3) had designed using Visual Studio with HTML. It had created with 22 self-explanatory image-based keys where each image

was precoded according to its representation and 1 space key, unlike an ordinary QWERTY keyboard. This type of keyboard pays the way for ease of access, so the patients can operate with the help of images so that the word is displayed in a text area. For instance, if a patient clicks on an image of a glass of water, it will signal that the patient needs water. They move their eyebrows to select the image that best suits their needs, and word-coded visuals will then be displayed on the screen together with audio. their eye and muscle signals. Eye signals (right and left movement) are used to move the highlighter among the images. Muscle signals (eyebrow movement) are used to click the image so that it can appear in the text area.

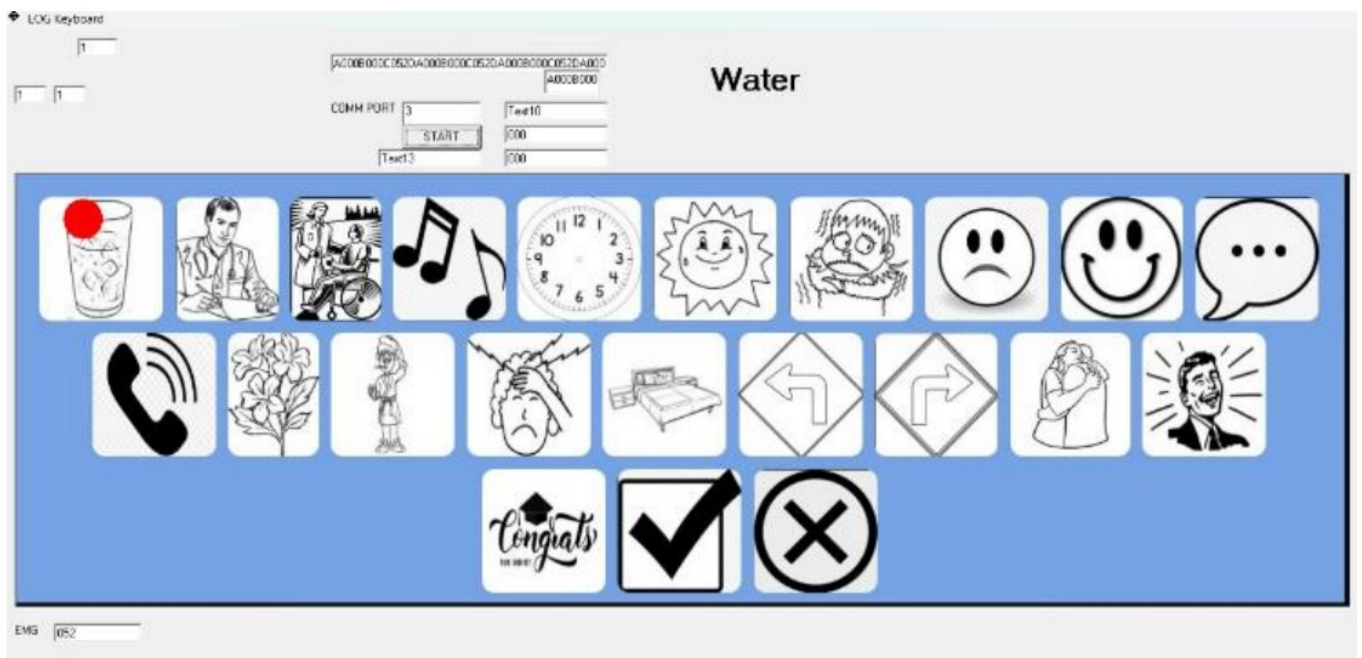


Fig. 5.3 Image-based virtual keyboard

5.2 DISCUSSION

Our goal is to create a computer-to-human communication tool that is user-friendly unlike similar state-of-the-art systems, and allows users to reach any icon from any location directly and asynchronously. This study describes a virtual keyboard based on

EOG and EMG signals. Eye motions are recognized and eye-gaze angles are computed using electrooculography (EOG). It costs a lot since a video camera is needed to record eye movements in real-time. It detects eye movements from graphic representations of the eyeball. Because the eyes often get dry and tired after prolonged use, eye movement detection using IROG is challenging (Kenji Yamagishi et. al., 2006). Because the EOG method offers good face access, good accuracy and resolution, a wide range of displacements, operates in real-time, and is affordable, we chose to utilize it to measure eye movements.

The above experiment was conducted for a few volunteer subjects who are affected with various forms of paralytic condition which is mentioned in Table 1.1. The experiment is done in a calm environment to hear the words so as to determine the system's stability. The electrode placement to take the signal and the amplitude of normal EOG signal and EMG signal with eye movement direction and eyebrow raise obtained from the subjects is shown in Fig. 4.12 and Fig. 4.13. Image-based virtual keyboard as in Fig. 4.11 helps the patient to select the words and convey their feeling with ease without much trouble. The proposed system is much better than the existing system as the oldest type has a QWERTY-based keyboard (Muhammad Ilhamdi Rusydi et. al., 2019) where the patient has to search the letter to form a word to convey which eventually consumes time and causes eye fatigue. The proposed system doesn't consume time and works effectively.

The average writing speed across subjects in the QWERTY layout keyboard is 11.9 ± 4.4 and 9.9 ± 3.6 characters per minute were obtained using the conventional EOG setup, which has been shown to improve substantially with user experience with the system (Nathaniel Barbara et.al., 2018) but in image-based virtual keyboard the user and select the image and obtain the result within the second. In other literature reports (Yi Liu et. al., 2016) and (Jordan et. al., 2020) the obtained results were encouraging about 1.5 – 1.8 WPM with an error rate equals to 5 – 5.25%. But in our report there is no need to select the particular letter to form a word as it's image based virtual keyboard and can obtain the results within a few second.

CHAPTER – 6

SUMMARY AND CONCLUSION

6.1 SUMMARY

Paralysis may alter a person's whole existence. Disabilities can range from slight, sporadic weakness to chronic muscular loss, inability to do routine occupations, and the usage of a motorized chair, with most people performing reasonably well owing to medicine and lifestyle. Currently, in addition to the identification of medications that aid in the restoration of paralyzed nerves, several alternative therapies with the same purpose are being investigated. The lack of basic methods has hindered experiment testing and assessment, contributing to the sluggish pace of advancement in this field of study. Paralysis is a life-altering illness. Even brief paralysis might impair your ability to perform the activities you like. When paralysis strikes unexpectedly, adjusting to big changes in your lifestyle can be difficult. Many persons with paralysis lead busy lives thanks to mobility aids and the support of loved ones. Emotional and social support can also be beneficial in a person's therapy. Because of this, it is crucial to provide these individuals with various forms of support, and it is our responsibility as aspiring engineers to create new technology to assist those who are paralyzed. They can communicate when they need assistance using our image-based virtual keyboard, and they can use this movement detection to live normally in this world.

6.2 CONCLUSION

We are all aware that paralysis results in a loss of muscular function throughout the body. It can happen to any region of your body at any time, and you might not even notice any pain in the place that is being affected. Innovations in technology and medicine exist to enhance the quality of life. Our objective is to create a communicator-type gadget that is both inexpensive and simple to use. We are aware that these persons are unable to communicate their wants or messages. To solve this problem, we developed a technology that enables these patients to show messages by extremely basic motion.

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APPENDIX

1) CREATION OF VIRTUAL KEYBOARD USING HTML

```
<!DOCTYPE html>
<html lang="en" dir="ltr">
  <head>
    <meta charset="utf-8">
    <title>Custom Keyboard Design | Myooculo</title>
    <link rel="stylesheet" href="style.css">
  </head>
  <body>
    <div class="container">
      <form class="wrapper" name="form">
        <div class="display">
          <textarea name="textarea" cols="30"
rows="10"></textarea>
        </div>
        <div class="keys">
          
          
          
          
          
          
          
        
        
        
</div>

<div class="keys">
    
    
    
    
    
    
    
    
    
</div>
<div class="keys">
    
    

```

```

        
    </div>
    <div class="keys">
        <input type="button" id="Space" value="Space">
    </div>
</form>
</div>
<script>
    const spaceBtn = document. querySelector("#space");
    const display = document. querySelector(".display");
    function disp(result){
        form.textarea.value = form.textarea.value + result;
        spaceBtn.onclick = (()=>{
            form.textarea.value += " ";
        });
        Display.onbldclick = (()=>{
            form.textarea.value = " ";
        });
    }
</script>
</body>
</html>

```

2) STYLING OF VIRTUAL KEYBOARD

```

@import url('https://fonts.googleapis.com/css2?family=Mukta&display=swap');
*{
margin: 0;
padding: 0;

```

```

    box-sizing: border-box;
    font-family: 'Mukta', sans-serif;
}
body{
    display: flex;
    align-items: center;
    justify-content: center;
    min-height: 100vh;
    flex-direction: column;
    background: #b6b4b9;

}
.container{
    width: 60%;
}
.container .wrapper{
    min-width: 1100px;
    max-width: 1000px;
    border-radius: 10px;
    padding: 25px;
    border-radius: 10px;
    padding: 25px;
    background: #a776e65e;
    box-shadow: -3px -3px 7px #ffffff73,
                2px 2px 5px rgba(18, 87, 206, 0.298);
}
.wrapper .keys{
    display: flex;
    justify-content: center;

}

```

```

img{
  max-width: 100px;
  height: 100px;
  margin:5px;
  border-radius: 10px;
  border-radius: 10px;
  background: #76a3e6;
}
.wrapper .keys input{
  height: 50px;
  min-height: 50px;
  padding: 10px;
  outline: none;
  border: none;
  margin: 10px;
  border-radius: 5px;
  font-size: 20px;
  color: grey;
  text-transform: uppercase;
  background: #020812;
  box-shadow: -3px -3px 7px #ffffff73,
              2px 2px 5px rgba(94,104,121,0.288);
}
.wrapper .keys input:active{
  color: #3498db;
  font-size: 19px;
  box-shadow: inset -3px -3px 7px #78525273,
              inset 2px 2px 5px rgba(94,104,121,0.288);
}
.wrapper .keys input[value="space"]{
  width: 60%;

```

```

}
.wrapper .display{
    width: 100%;
    height: 150px;
    margin-bottom: 20px;
    user-select: none;
}
.wrapper .display textarea{
    height: 100%;
    width: 100%;
    border: none;
    outline: none;
    resize: none;
    color: #3498db;
    font-size: 20px;
    padding: 10px 15px;
    border-radius: 10px;
    background: #dde1e7;
    pointer-events: none;
    box-shadow: inset -3px -3px 7px #ffffff73,
                inset 2px 2px 5px rgba(94,104,121,0.288);
}

```

3) CODE TO RUN A HARDWARE SETUP

```

#include <string.h>
#include <ctype.h>
#include <LiquidCrystal.h>
LiquidCrystal lcd(13, 12, 11, 10, 9, 8);

```

```

// twelve servo objects can be created on most boards
int pos = 0; // variable to store the servo position
char fy=0;

// constants won't change. They're used here to
// set pin numbers:
const int buttonPin = 7; // the number of the pushbutton pin
int buttonState1 = 0; // variable for reading the pushbutton status
int buttonState2 = 0; // variable for reading the pushbutton status
int buttonState3 = 0; // variable for reading the pushbutton status

int ledPin = 8; // LED test pin
int rxPin = 0; // RX PIN
int txPin = 1; // TX TX
int byteGPS=-1;
char comandoGPR[7] = "$GPRMC";
int cont=0;
int bien=0;
int conta=0;
int indices[13];
int sensorValue1 = 0; // variable to store the value coming from the sensor
int sensorValue2 = 0; // variable to store the value coming from the sensor
int sensorValue = 0; // variable to store the value coming from the sensor
int sensorValue4 = 0; // variable to store the value coming from the sensor
int sensorValue5 = 0; // variable to store the value coming from the sensor
int sensorValue3 = 0; // variable to store the value coming from the sensor
int sensorValue7 = 0; // variable to store the value coming from the sensor
int sensorValue6 = 0; // variable to store the value coming from the sensor
int sensorValue8 = 0; // variable to store the value coming from the sensor
int sensorValue9 = 0; // variable to store the value coming from the sensor

```

```

int count=0,fl;
unsigned long time1=0; // store the initial time
unsigned long time2; // store the current time
int count1;

int cnt = 0,i; // variable to store the value coming from the sensor
long duration, inches, cm,distance;

int hb,hbt,hbtt,boc,finc,ioc,hf;
char kval;
int bhb,bhbt,bhbtt;

void txs(unsigned char val)
{
int i;
Serial.write(val);
for(i=0;i<1200;i++);
}

char f1,f2,f3,oc,oc1,oc2,oc3,hc,oc4,oc5,oc6;

void setup() {

Serial.begin(9600);
// Print a message to the LCD.

pinMode(7, OUTPUT);

```

```

pinMode(6, OUTPUT);
pinMode(5, OUTPUT);
pinMode(4, OUTPUT);

pinMode(2, OUTPUT);
lcd.begin(16, 2);
lcd.print("EOG   ");
delay(2000);
lcd.clear();

pinMode(A2, INPUT_PULLUP);

}

long ll;
int distance1,duration1;

void loop()
{
  sensorValue1=analogRead(A0)/2;
  sensorValue2=analogRead(A1)/2;
  sensorValue3=analogRead(A2)/2;

  lcd.setCursor(0, 0);
  lcd.print('L');
  lcd.print('=');
  lcd.write((sensorValue1/100)+0x30);
  lcd.write(((sensorValue1%100)/10)+0x30);
  lcd.write((sensorValue1%10)+0x30);

  lcd.setCursor(8, 0);
  lcd.print('R');

```

```

lcd.print('=');
lcd.write((sensorValue2/100)+0x30);
lcd.write(((sensorValue2%100)/10)+0x30);
lcd.write((sensorValue2%10)+0x30);

lcd.setCursor(0, 1);
lcd.print('E');
lcd.print('=');
lcd.write((sensorValue3/100)+0x30);
lcd.write(((sensorValue3%100)/10)+0x30);
lcd.write((sensorValue3%10)+0x30);

Serial.print('A');
Serial.write((sensorValue1/100)+0x30);
Serial.write(((sensorValue1%100)/10)+0x30);
Serial.write((sensorValue1%10)+0x30);

Serial.print('B');
Serial.write((sensorValue2/100)+0x30);
Serial.write(((sensorValue2%100)/10)+0x30);
Serial.write((sensorValue2%10)+0x30);

Serial.print('C');
Serial.write((sensorValue3/100)+0x30);
Serial.write(((sensorValue3%100)/10)+0x30);
Serial.write((sensorValue3%10)+0x30);

Serial.print('D');
delay(200);

}

```



A REVIEW OF COMMUNICATING DEVICES FOR PARALYTIC PATIENTS

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Abstract: For physically disabled people, assistive technologies, such as an alternative form of text entry, can be of tremendous benefit. Biosignal interfaces are utilized in the medical industry for patient health status monitoring, rehabilitation services, or medical automation because they provide crucial data that shows the physical situation of the user. Biosignals are vital for extracting user emotions or measuring user experience and can be combined with virtual reality to create fresh content. Coming to the medical side, an Individual who is paralyzed, is a condition where the patient is unable to move a limb or part of the body due to the inactivity of the muscles in that area. These people find it extremely challenging to communicate with others and express their feelings and desires. To address this need various systems have been developed to accept eye-gaze, muscle signal, brain signal, tilt mechanism of accelerometer, and so on as input and convey the patient need to the caretaker. The review paper's purpose is to describe the cause of paralysis and progress from the treatment and end with various communication aids.

Index Terms - Disabled people, Biosignal, Tilt mechanism, Communication aid, ECG

I. INTRODUCTION

Muscles, one of the human body's most important features, are impacted by illnesses of the muscular system. We can move and function in the world because of the force that is produced by our muscles. The muscles in our bodies carry out a variety of tasks, including maintaining posture by constant contraction, moving the skeleton, and producing heat through cell metabolism. Without it, we would spend the rest of our lives confined to one location. Painful muscles, weakened muscles, and paralysis are all symptoms of muscular system disease. It may be brought on by several circumstances, including hormone imbalances, autoimmune issues, genetics, infections, malignancy, or misuse of the muscle [1].

Most frequently, damage to the neurological system, particularly the spinal cord, results in paralysis [2]. Many people in the actual world are paralyzed and find it difficult to communicate. Words and sentences can be conveyed to the audience through motions. New human-computer interfaces have been designed to offer multiform interactions as the demand for computing environments changes [3]. The introduction of wearable biological-signal devices has made use in conventional medical systems accessible to the public. Interfaces with biosignals are utilized in fitness, sports, and rehabilitative training, such as when learning how to manage respiration or balance one's body. As the usage of the internet and portable electronic gadgets have grown more commonplace, the use of biosignal systems has moved on the far side of healthcare services to several fields like human-computer interface, information security, and education. [4]

II. MATERIALS AND METHODS

The databases of PubMed, Academia, Scopus, ResearchGate, Springer Nature, Google Scholar, and Web of Science were systematically searched for a recent systematic review with randomized methods that evaluated the treatment for paralysis, its types, and communication aids, published to the present. A larger collection of articles were found after the search was conducted using the phrases "paralysis" along with "communication devices for severe motor impaired" or "biosignal-based communication devices." The etiology, therapy, and procedure descriptions from experimental research papers, reviews, and abstracts were merged. These publications are evaluated critically, and the superiority is debated using the data found.

III. PARALYSIS

A temporary or permanent lack of voluntary muscular action is referred to as Paralysis. It happens when your muscles are unable to move on their own. Your body's mechanism for controlling and communicating is called the Nervous System. The brain instructs your body on what to perform by sending messages throughout it. Any part of the body can be rendered immobile. Total paralysis implies you



have no control over any forces, while partial paralysis means you can control some muscles but not all. Paralysis can also be categorized as flaccid or spastic depending on where in the nervous system the damage occurred. Stroke, brain damage, spinal cord injury, broken necks, and multiple sclerosis are among the most common causes of paralysis [5,6]. Additional causes of paralysis include Bell's palsy, which affects the facial muscles, Guillain-Barre syndrome, the polio virus, and other nerve diseases [7]. The various forms of paralysis and their associated symptoms are illustrated in the table below.

Table 1 Categories of paralysis

Types	Symptoms
Hemiparesis or hemiplegia	Weakness on one side of the body, particularly in the face, arm, or leg.
Paraplegia	Weakness below the waist may include loss of bowel and bladder control.
Quadriplegia	All four limbs are weak.
Monoplegia	Weakness in one or more limbs.
Gastroparesis	Slowed digestion can result in vomiting or constipation.
Bell's palsy	Kind of facial paralysis that typically affects one side of the face.

IV. ETIOLOGY

A stroke which is a blockage in a brain artery can damage regions of the brain that regulate motor action [8]. Cardiovascular disease risk factors include uncontrolled diabetes, excessive blood sugar, high blood pressure, and high cholesterol. Due to demyelination (damage to the protective coating of nerve fibers) in the brain and spinal cord, multiple sclerosis is an inflammatory disease that frequently results in periods of weakness, abnormalities in coordination, and other symptoms. The rare condition known as ALS (amyotrophic lateral sclerosis) results in the deterioration on a particular area of the spine. It typically affects those over 50 and progresses over a short period. Guillain-Barre syndrome: Usually beginning in the legs and progressing up the body, this condition weakens a person owing to inflammatory demyelination of the peripheral motor neurons. A herniated spinal disc is when a disc of cartilage in the spinal column bulges out of its normal position, typically because of degenerative illness or trauma [9].

V. SYMPTOMS

Tingling or discomfort in the afflicted muscles, Muscle tremor, Confusion, Stiffness, Unwilled twitches or spasms, Muscle pain, the loss of muscle in plain sight (muscle atrophy), talking or comprehending problems, Walking problems, dizziness, loss of coordination and balance, severe headache [10].

VI. BIOSIGNAL – BASED COMMUNICATION DEVICES

6.1 ELECTROMYOGRAPHY

The EMG signal is used to capture a muscle's electrical activity. When a muscle fiber is stimulated, the central nervous system produces little electrical currents in the form of ion fluxes. Since body tissue acts as a resistance to electrical current, an electrical field is produced. The ensuing potential differences between certain areas of the body's surface can be monitored [11]. When a muscle is instructed to contract by the brain, motor neurons receive the signal, which controls many fibers. As the fiber membrane depolarizes, an electrical potential with a duration of around 8 ms is created close to the muscle fibers. A motor unit's motor unit action potential (MUAP) is produced by adding the action potentials that are propagating through its fibers. The MUAPs are fired regularly at frequencies between 7 and 20 Hz to maintain the muscle's force [12]. The electrical field is produced by each motor units are recorded by an electrode that records the activity of the muscle. Muscle signal collection is done by the usage of two different surface and intramuscular types of electrodes. The EMG signal is made up of this group of MUAPs. The signal, which is captured from the surface of the skin, can have peak-to-peak amplitude values of 20–2000 V [13]. It is possible to reliably gather data from motor units or fibers. The mechanical activity of the muscle, on the other hand, could lead to sores and infections. Since communication aid devices would likely be utilized for several hours per day, the decision to employ surface electrodes is ideal for such procedures [14]. Numerous neuromuscular and neurological problems have been frequently diagnosed using this diagnostic technique. EMG is an intrusive method that calls for training. Because of this, it has only seen limited application in the detection and treatment of voice disorders, particularly in young children [15].

6.1.1 APPLICATION

Switch-based mouse - The human face provides the EMG signal that the EMG human-computer interface uses to direct the computer cursor. The impaired subject can use the facial EMG cursor to interact with the software by tensing their facial muscles. Utilizing Labview, a graphical development environment, the full signal processing method is created. Ultimately, the recognition of the pattern system introduces the appropriate computer mouse function by the pattern of muscle action [16]. A human can engage in sensory and cognitive activity in a digitally produced artificial world called virtual reality. This world can be fictitious, symbolic, or a mimic of some features of the authentic world. When the user presses buttons scanned using Arduino (with the right hand, left hand, or both at once) or while the person contemplates pressing the buttons, they can view the genuine outcomes of their interaction with the world in a virtual world (Unity3D or NeoAxis) [17].

Patients who can still move their heads or have some use of their limbs may use a pressure device. A similar idea can be used in the substitution of the action of pressure in EMG signals with the contraction of a muscle. Electromyogram has been utilized before to evaluate patients with consciousness issues, demonstrating their potential as a communication tool. Binary signals can be produced using computational solutions, with '1' denoting muscle activation and '0' otherwise [18]. Depending on the length of the contraction, the user shifts their chin to convert the Masseter muscle signal into "dot" or "dashes". Characters from the sequence are decoded and sent into a voice synthesizer. This work addresses a critical issue with using EMG—failure to adapt to exhaustion. The main qualification was that, despite figures not being provided, the information transfer rate was low since people cannot chew and pause quickly [19].

Another objective was to create a pointing device that could be operated by facial muscles. Each muscle's level of activation was assessed using a continuous Wavelet transform, which produces displacements in four directions linked to both sides of the mentalis, masseter, and orbicular muscles. The simultaneous execution of the opposite directions for left and right click operations was designated as UpDown for the right click and LeftRight for the left click. The wavelet mother and MUAPs' comparable shapes are justified using the wavelet transform. However, as the system's performance was not measured against conventional signal characteristics, this tactic raises some doubts (e.g., the RMS value) [20]. Additionally, compared to a traditional mouse, directing a cursor using face muscles feels odd. When employing EMG signals as the source of control, for instance, diagonal movements typically involve horizontal and vertical movements [21]. On the other hand, the movement of the head [22] is comparable to using a joystick.

EMG data from the Sternocleidomastoid muscle were interpolated linearly, and the head's angle was determined. The EMG signal is insufficient to yield any good data for small angle rotations, thus a photo camera was used instead, and the determination of the angle was done by the pupil's location about one another. The camera-based option, which only requires a standard webcam and software that is already accessible for download, looks more acceptable if the person has adequate control of their neck and head [23].

Since the lips and mouth shapes were fixed, only vowels were employed [24]. Since the Masseter, Mentalis, and Depressor anguli oris muscles are the ones that are most engaged when pronouncing vowels, three channels were employed to record data. The EMG signal's RMS was connected to the vowels using a back-propagation algorithm-based ANN (artificial neural network). Single-word recognition and a speech impediment are covered in other studies [25–27]. Electrodes were inserted into a pilot's oxygen mask [27] to identify pilot speech that could be mistaken for directives. While performing the task the error rate for identifying the speech of the numerals "zero" to "nine" was comparatively low, varying from 0% to 10.4%.

6.2 ELECTROOCULOGRAPHY

Eye signal is produced by the deviation of potential between the retina and the cornea [28]. It varies between 2 and 20 Mv. However, data recording often falls between 15-20 mV. This possibility arises from the retina's higher concentration of active nerves than the front of the eye [29]. On comparing with other methods of measuring eye movement, the EOG has an advantage because head and torso motions do not interfere with recording. The EOG is frequently used to quantify blinking, nystagmus, smooth pursuit eye movements, and saccadic eye movements [30]. With an average accuracy of 1.5 to 2.0, the EOG can capture eye movements up to $\pm 70^\circ$ [31]. To capture, 5 Ag/AgCl self-adhesive electrodes are typically positioned for EOG recordings: (i) a pair - above and below the eye to capture movements of vertical; (ii) a pair - close to the lateral canthus to capture movements of horizontal; and (iii) one in a neutral site to serve as a reference. A constant electrical dipole with a negative pole at the fundus (retina) and a positive pole at the cornea can be used to describe this potential. As a result, it is possible to assume that the retina is negative and the corneal center is positive in a human eyeball [32]. It is conceivable to think of the battery in this way—as being lodged in the socket of an eye and rotating near to the torus of the eye through the conductive tissue surrounding the orbit, microcurrents flow radially from the battery's positive to the negative poles. Thus, standing potentials around the eye are produced by these currents and that is estimated with the help of electrodes placed [33].

6.2.1 APPLICATION

A couple of EOG channels and an EMG channel make up the virtual keyboard writer system proposed by Dhillon et al. [33]. The angular displacement of the gaze in the vertical and horizontal directions was linked to the cursor movement, and the letter was chosen using an "EMG click" recorded from the brow. The authors cited the system's simplicity and reduced cost as advantages over more advanced techniques like videooculography (VOG) and infraredoculography for detecting eye movements (IROG). Considering the eyelid movements of the patient as a source of signal, our technology uses Morse code to translate the eye blink's duration and pattern into the standard English alphabet. Before, Nicolaou et al. in 2008 [34] and Luna et al. in 2002 [35] employed this code as a communication tool. Blinking takes the human eye around a third of a second on average. During a blink, more light is reflected for a duration and the sensor gives an exceptional output than for an open eye. A microcontroller called an Arduino Uno receives readings at a rate of 10 per second continually. Here, to identify whether the eye was open or closed, they are contrasted with a previously fixed value. The patient can then communicate and form complete words and sentences in this way. [36].

In comparison to the EEG, EOG signals exhibit the following qualities: a relatively high amplitude, a linear correlation between the signal and movement of an eye, and a waveform that is simple to identify [37]. Given that EOG is simpler than EMG, it is also simpler to categorize. These factors have made EOG-based HCI systems a particularly intriguing area of study in recent years. In addition, most patients with significant motor impairments can nevertheless control their eye movements. Recent research has demonstrated the feasibility of the application of EOG in assistive communication systems in this way. Using infrared cameras [38], which make use of the eye structures' reflections and their spatial correlation, is the most common technique for estimating gaze. Since the technical issue faced by the devices based on eye gaze is the loss of reference whenever the patient shifts their head, people with severe motor impairments who are unable to move their head may be the greatest candidates for gaze-based devices. Absolute coordinates (gaze) [38,39] or movement direction [40,41] can both be used to control the cursor.

6.3 ELECTROENCEPHALOGRAPHY

One important component of people is their brain, which has complete control over various body systems. Human behavior is controlled by the brain, which can be seen as a network of interconnected neurons [42]. EEG's nondestructive, painless, adverse-effect-

free, and correct interpretations for several brain disorders including epilepsy, memory loss, autism, and Alzheimer's disease, are important features [43-47]. These signals have certain frequency bands between 0 and 100 Hz assigned to them. Some have frequencies greater than 100 Hz. Medical researchers can better comprehend the functional and behavioral traits of complex brain regions thanks to this signal-based analysis of various states.

A promising possibility for the creation of a BCI (brain-computer interface) is electroencephalography (EEG), a non-invasive technology for assessing brain activity. Muscle control and communication become frequently impossible for those with severe motor disabilities like locked-in syndrome. However, these individuals typically retain their cognitive and sensory abilities. Electroencephalography, which measures cerebral activity, is considered a potential remedy to overcome this disability. Typically referred to as a brain-computer interface, this sort of interface uses cerebral waves [48].

6.3.1 APPLICATION

A computer-based system called a BCI (brain-computer interface) converts brain impulses into instructions that are sent to an external program or device to carry out the user's intention. People can communicate with their surroundings while not using their muscles or peripheral nervous system [49]. For persons with poor speech or movement, the concept of controlling an external gadget with their thoughts is a very intriguing one. Numerous clinical studies in the research field of BCI have demonstrated not only the integration and the potential utilities of these cutting-edge approaches to technology in the lives of humans with disabilities in the motor but also the beneficial effect that takes place by converting knowledge of science and design of experiments into clinical benefits by allowing the person to communicate with the outside world in a revolutionary genuine manner [50].

The thought translation device (TTD)-Users using slow cortical potentials-EEG-based BCI devices must be trained to change the polarity of the SCPs [51]. The subjects had to create either a negative or positive greater than a predetermined amplitude during the response interval. The patients had been trained to generate SCPs that lasted between 2 and 4 seconds willingly. Afterward, a TTD was created. The participants received a training process that taught them how to regulate their SCPs on their own in the "Language Support system," allowing them to converse verbally [52], which is an alphabet split into halves that are successively displayed at the screen's bottom for many secs. By causing an SCP shift, the subject can choose which letter bank is displayed. If the subject chooses that letter bank, it will divide into two additional halves, and so on, until just one letter contains in each of the two letter banks [52]. In general, motor-disabled participants use this strategy to learn how to write using their mental strategies for cursor movement (training in basics). After a practice of six months, the user was able to maintain their SCP on their own by eliciting two distinct responses from the brain. Despite the speller's output of one letter per minute, he managed to reproduce 454 German words (a full written text by the user while maintaining of SCPs on his own is represented in the article which is published). Nonetheless, the participant expressed satisfaction with the system operation [53].

Control of external device - A recent study developed and tested a BCI system on two groups of participants. They discovered [54] differences in amplitudes of P300 between people with and without impairment. Both groups performed a successful examination without any coaching, and no progress was detected after training. Most disabled folks did poorly than others, demonstrating that P300 is compromised when there is a substantial impairment. However, it should be noted that the group of participants wasn't homogeneous, as the authors examined five participants who are paralyzed with varying impairments. This study demonstrates that proper response without coaching is possible using the modulation of P300. A recent study in this area tested a BCI system based on P300 on participants with various cognitive and motor restrictions, to manage eight real domestic devices using 113 control instructions [53]. 10 of the fifteen participants were able to deliver the suggested apparatus with greater than 75% precision.

Speller system - The primary applications of BCI that make use of the modality of P300 are called speller systems [54]. Whether BCI P300 may be employed as a substitutive EEGbased BCI communication modality in the denizen with ALS was the subject of a seminal study. By testing persons with and without ALS and by using four random stimuli (YES, NO, PASS, and END), they were able to assess the BCI system's effectiveness. It was the responsibility of the individual to concentrate on one stimulus while disregarding the alternatives. For a point, a mission involved concentrating on the target impulse (i.e., YES or NO as determined by the instructor at the start of each run), whereas the alternative job involved concentrating on the impulse (YES or NO) that answered the researcher's query correctly. ALS and non-ALS, healthy users can both benefit from BCI based on P300 as a potent and affordable communication method without muscle action. The ITR (bits/selection) ranges 0.43 - 1.80 in this study, which is low in comparison to other alternatives and contemporary BCI based on P300 investigations [52]. Additionally, the conditions of the people with the most severe ALS impairments were worse than those of the other participants, reflecting the P300's inability to serve as an effective communication option for those with more serious impairments.

VII. CONCLUSION

Paralysis may alter a person's whole existence. Disabilities can range from slight, sporadic weakness to chronic muscular loss, inability to do routine occupations, and the usage of a motorized chair, with most people performing reasonably well owing to medicine and lifestyle. Currently, in addition to the identification of medications that aid in the restoration of paralyzed nerves, several alternative therapies with the same purpose are being investigated. The lack of basic methods has hindered experiment testing and assessment, contributing to the sluggish pace of advancement in this field of study. Paralysis is a lifealtering illness. Even brief paralysis might impair your ability to perform the activities you like. When paralysis strikes unexpectedly, adjusting to big changes in your lifestyle can be difficult. Many persons with paralysis lead busy lives thanks to mobility aids and the support of loved ones. Emotional and social support can also be beneficial in a person's therapy.

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