



The Virtual Keyboard Is Accessible Using Wireless EEG Device for Patient's with Paralysis

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Abstract. Most people nowadays are suffering from paralytic disorders, which cause an ample of problems including the inability to talk, the inability to engage in physical activity, and the difficulty in expressing basic needs, while they may still use their eyes and frequently move their heads. A person with certain conditions, such as they are unable to move many voluntary muscles in the body aside from their eyes and blinking. The virtual keyboard offers these victims a way to connect with others and gain access to their vital passwords. The Brain Computer Interface (BCI) theory is applied in this paper. By utilizing the virtual console, which was made utilizing Matlab programming, the casualties can type the letters that will be shown on the screen. The fundamental idea behind brain-computer interfaces is to convert the user's brain activity patterns into the relevant commands. BCI is made up of signal processing and signal acquisition.

Keywords: EEG · Sensor · BCI

1 Introduction

An individual who has motor neuron problems like Amyotrophic Lateral Sclerosis (ALS) can't move their legs and hands. These diseases make the muscles become more fragile and affect the nerve cells that direct willful solid muscular developments. The individual can never again control their own willful movement. In the proposed methodology, the wearable EEG gadget, Mindlink, is employed in place of the cumbersome EEG equipment. Electrooculography (EOG) artefacts cannot be removed by traditional BCI devices because they use linear filtering techniques, which leads to inappropriate signal processing. In order to prevent this, digital IIR filter techniques are employed. These procedures effectively dispose Extra-Physiological and Physiological Artifacts from the recuperated EEG wave, and at the end, signal grouping is done using order methods. The command signal from the Mindlink gadget is transferred to the PC/Laptop using Bluetooth 3.0, allowing users to access the virtual keyboard by blinking their eyes.

BCI is a machine control interface which is used to acquire and analyze the brain signals and then convert them into commands to an output device to perform certain

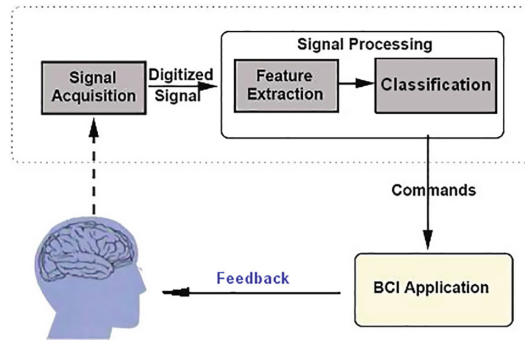


Fig. 1: Steps involved in BCI

tasks. The main steps involved in it are Signal Acquisition, Feature Extraction, and the Classification as shown below in Fig. 1.

Based on the placement of the electrodes on the human head it can be mainly classified into three types: Non-invasive, Invasive, Semi-Invasive BCI. A Non-invasive brain computer interaction is a device which allows the users to send commands to the devices through non-invasive or direct measures of brain activity. In order to detect the magnetic field or the electrical potentials produced by the brain (EEG), sensors are positioned on the scalp (MEG). The scalp, which is the area closest to the outside, is where electrodes are placed to collect the EEG data. Semi-invasive is also known as partially invasive BCI devices. The exposed surface of the brain is where the electrodes are put (ECoG). Electrodes positioned in the dura or arachnoid are used to collect the ECoG signal. While inside the skull, these implants are placed outside the brain. To measure a neuron's activity, tiny electrodes are inserted right into the cortex. These devices are implanted into the grey matter of the brain during neurosurgery.

The term “electroencephalogram” refers to the study of brain waves (EEG). The EEG exam analyses electrical activity in the brain. Berger externally mounted many electrodes on the human skull in 1929 to record the EEG. The human mind starts to work neurally between the 17th and the 23rd week of foetal turn of events. Electrical impulses produced by the brain are thought to indicate both brain function and the overall health of the body from this early period and throughout life. This presumption serves as the driving force for the application of signal processing techniques to EEG signals obtained from the brain. The way that brain cells communicate with one another is through electrical impulses. Any potential issues that could arise from this activity can be found with an EEG. An EEG is a tool used to track and document brain wave patterns. Brain waves are patterns made up of the billions of tiny electrical signals that are produced by the brain's nerve cells. During an EEG, wires and tiny electrodes are placed to your head. Your cerebrum waves are gotten by the terminals, intensified by the EEG machine, and afterward recorded as a wave design on graph paper or a PC screen. Different EEG waveforms are shown in Fig. 2.

Visual examination of EEG data can be used to diagnose a variety of brain illnesses. The classification of brain waves in the EEG signals is well-known to clinical experts in the field. The amplitudes and frequency of these signals vary in healthy adults depending

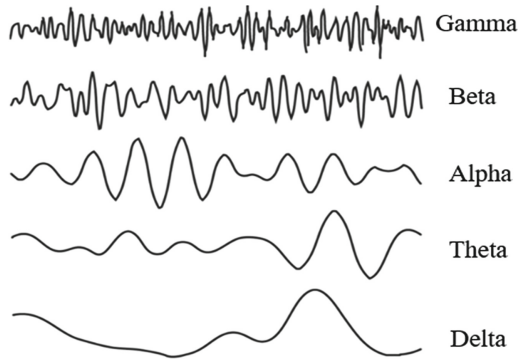


Fig. 2: Different EEG waves

on the human's state, such as awake or sleep. With age, the waves' features also alter. There are five main brain waves, which can be identified by their various frequency bands. The various frequency bands are referred to as alpha, theta, beta, delta, and gamma. Types of brain waves are shown in Table 1.

Nerve cells and glia cells, which are tracked in the middle between neurons, make up most of the CNS. Axons, dendrites, and cell bodies are the primary parts of each nerve cell. Significant distance data transmission and reaction to boosts are elements of nerve cells. Most of a nerve cell's digestion, especially which related with protein combination, is found in the body of the nerve cell, which has a solitary core. Different areas of the neuron get the proteins delivered in the cell body. In vertebrates, an axon is a long barrel shaped structure that conveys electrical motivations and can arrive at lengths of a few meters. The length in people can go from a negligible part of a millimeter to in excess of a meter. Proteins can be shipped along axons through an axonal vehicle system, which utilizes sub-atomic engines' that movement along tubulin rails. Dendrites interface with the axons or dendrites of different cells to either get motivations from different nerves or move the signs to different nerves. Around 10,000 extra nerves are connected with each nerve in the human mind, for the most part through dendritic associations. The flows that stream when a few pyramidal neurons' dendrites in the cerebral cortex are synaptically enacted are estimated by an EEG signal. As synapses are invigorated, synaptic flows are created inside their dendrites. The attractive field that this flow creates can be estimated

Table 1: Types of brain waves

Frequency Band	Frequency	Brain State
Delta (δ)	0.5–4 Hz	Sleep, Dreaming
Theta (θ)	4–8 Hz	Drowsiness
Alpha (α)	8–12 Hz	Restful
Beta (β)	12–35 Hz	Active mind, Busy
Gamma (γ)	>35 Hz	Concentration, Problem solving

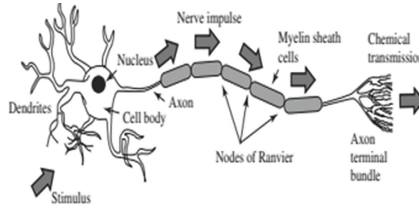


Fig. 3: Structure of Neuron

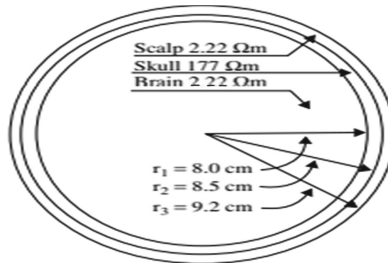


Fig. 4: Three main layers of the brain

utilizing electromyogram (EMG) gear, and the auxiliary electrical field that this flow produces over the skull can be estimated utilizing EEG gadgets. Postsynaptic evaluated possibilities from pyramidal cells, which make electrical dipoles between the soma (Fig. 3).

The scalp, skull, cerebrum, and numerous other dainty layers are among the few layers that make up the human head, as portrayed in Fig. 4. Signals are lessened by the skull multiple times more than by delicate tissue. Then again, the cerebrum or the scalp are where the vast majority of the clamor is created.

2 Literature Survey

The prototype has a matrix that has all the letters of the alphabet as well as special characters like spaces and erased letters depending on the language being used, in this instance Spanish. Each letter has a light indicator that will be used to pick a character by scanning rows and columns. Electromyography signals from the eyelid, which is the only muscle controlled by a person with quadriplegia, are used to make the decision [1]. A virtual console and a mouse recreation that looks for each letter with a brief time span are shown on the graphical UI. The patient with amyotrophic horizontal sclerosis (ALS) will actually want to choose and compose by moving the eyelid assuming the mouse cursor is in the ideal letter [2]. The article explores preprocessing, feature extraction. Post processing methods for processing both traditional and modern EEG signals [3]. The purpose of [4] is to provide an overview of the various EEG brain signal recording artefacts that might occur during BCI, as well as the approaches for removing them from the data. The performance of denoising and computational complexity of the suggested systems are compared to those of the traditional FIR-based DWT systems. In [5], engineered

commotion is acquainted with crude ECG information from the MIT-BIH arrhythmia data set, and the clamor is then eliminated utilizing the previously mentioned channel banks. The qualities and particulars of EEG-based human PC interfaces for ongoing applications are introduced in this study [6]. The improvement of a BCI framework, a Virtual Console, utilizing the LabVIEW stage is the primary focal point of this review. Blinking the eyes serves as a control signal for choosing a block on the virtual keyboard [7]. The development of a programme is done in C#. While the students are learning, the built programme captures raw EEG data, average attentiveness, and meditation. The pupils learn the course material because their levels of concentration and meditation are high. The designed programme does not let moving on to another subject if specified meditation and concentration levels are not recognised. The motivation behind this study is to assess the single-channel dry cathode convenient Neurosky Mindwave EEG framework's helpfulness in distinguishing the thoughtful state. This goal is achieved by gathering information from 20 subjects during reflection utilizing both a solitary channel EEG gadget and a typical 19-channel EEG recording framework [8, 9]. In [10], individuals utilise the Attimo keyboard in this study to communicate with others by providing input in the form of eye movements and blinking [11], recommends and contrasts a few applications that can be downloaded for free from the Google Play store for Android devices and that reflect the user's level of concentration, their level of meditation, or both. This study describes an eye blinking-based on-screen typing technique that makes use of a virtual keyboard. Image processing to identify the eyes and eye-blinking are the two primary components. The computer's camera first takes a picture of your face, which is then used to calculate the size and placement of your eyes. Based on the well-known "68 points" of the face detection method, this is done. In [12], a character is entered by blinking the eye, much like pressing the "Enter" key on a keyboard. In [13], an attempt was made to develop a related method using feature extraction from EEG data collected from several patients in order to create a straightforward virtual keyboard control, which is one application for BCI. In [14], a voltage threshold algorithm to create a new electrooculography-based system for virtual keyboard word input. Different eye movements in both the horizontal and vertical directions are observed in the EOG signal. Six electrodes are used on two channels to measure the EOG signal.

3 Methodology

This methodology employs a non-intrusive technique. The Mind Link device uses bluetooth to transmit the unprocessed EEG data to the computer or laptop.

The Mind Link device, depicted in Fig. 5, is the hardware component employed in this process. The Mind Link device has RAW e-sense data, a Think Gear ASIC Module (TGAM) CPU, and Bluetooth 3.0. The EEG electrode, the ground electrode, and the reference electrode are the three electrodes that make up this device. A lithium 3.7V 180mAH battery powers it. EEG data from the brain is collected by the first electrode, unwanted noise is removed by the second electrode, and the ground electrode is made by the third electrode. The 16-bit RAW wave obtained from the Mind Link device has a range of -4000 to 2024 and works at a baud rate of 57,600. Additionally, a fixed point format is used.



Fig. 5: Mind Link device

Figure 6 depicts the unfiltered output of one eye blink measured in the Matlab platform at various time intervals (Fig. 7).

Figure 8 represents the Filtered output of an eye blink at different time intervals observed in Matlab platform.

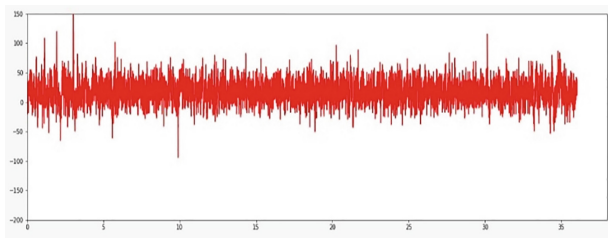


Fig. 6: Non-filtered output of an eye blink

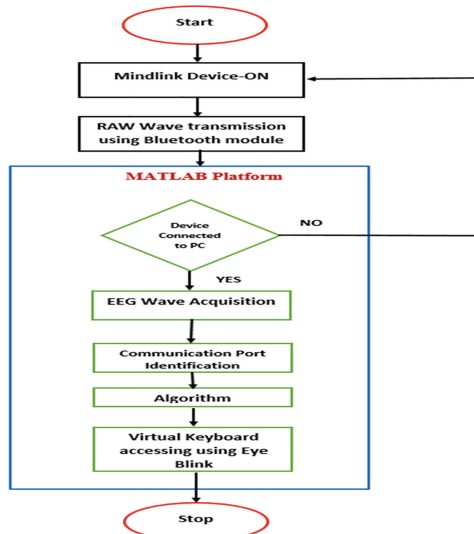


Fig. 7: Flow chart for accessing virtual keyboard

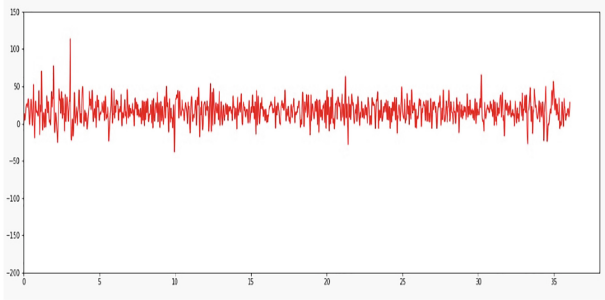


Fig. 8: Filtered output of an eye blink

MATLAB is the programme used in this system. After turning on the Mind Link device, it immediately establishes a Bluetooth connection with the PC/Laptop, as seen in Fig. 6. The device must restart in order to make the connection if it is not currently connected to the PC or laptop. Following identification, the algorithm must update the communication port (COM Port). The algorithm creates a virtual keyboard using the Thinkgear.dll library, and the pointer is moved to each key on the keyboard. Eye blinks can be used as an input command to access certain keys. Subsequent to changing the correspondence port number, the subject's Crude EEG information is remotely Bluetooth-communicated to the PC/PC. Utilizing the Thinkgear.dll library, a virtual console will be gotten to in the Matlab climate.

4 Results

The virtual keyboard will be accessed as shown in Fig. 9.

The virtual keyboard has four rows, 1–4 numbers, the alphabets from A to Z, and three special keys: speak, speak backwards, and delete. The printed word will be read aloud when you press the Speak key. All of the keyboard's keys are continuously under the cursor's pointer. Any of the keys can be selected by blinking, and that particular key will print.

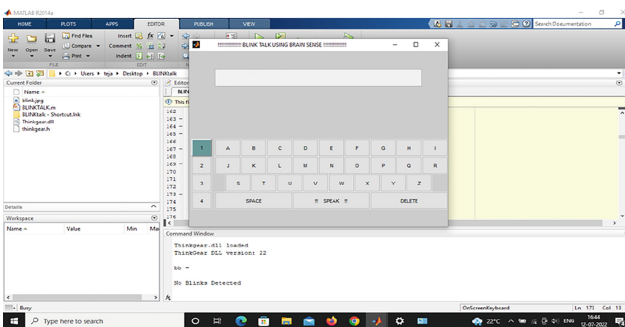


Fig. 9: Virtual Keyboard

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