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Wheel Chair Control Using EEG Signal Processing with Health Care Monitoring

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Abstract: This project discusses about a brain-controlled wheel chair based on Brain–computer interfaces (BCI). BCI's are systems that can bypass conventional channels of communication (i.e., muscles and thoughts) to provide direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time. The intention of the project work is to develop a robot that can assist the disabled people in their daily life to do some work independent of others. Here, we analyze the brain wave signals. Human brain consists of millions of interconnected neurons, the pattern of interaction between these neurons are represented as thoughts and emotional states. According to the human thoughts, this pattern will be changing which in turn produce different electrical waves. A muscle contraction will also be generate a unique electrical signal. All this electrical waves will be sensed by the brain wave sensor and the different pattern is used for controlling a wheel chair.

I. INTRODUCTION

Data is sensed and used to improve people's lives through the design of smart environments, which is an ongoing study topic. The human brain is one source of data, and information is obtained via a Brain Computer Interface (BCI) to aid in operating equipment in a smart and novel method. Jacques Vidal presented the notion of exploiting EEG waves for human-computer interfaces in 1973.

Electroencephalographic (EEG), Magneto encephalography (MEG), Position Emission Tomography (PET), and functional Magnetic Resonance Imaging are some of the technologies used to record brain activity (FMRI). EEG is a non-invasive method of measuring electrical activity from the scalp that is measured in microvolts over time. The EEG signal is produced by neurons firing, and it varies according to brain activity, ranging from 0 to 100 V.

The inability to move a portion of the body, whether temporarily or permanently, is known as paralysis. Paralysis is nearly always caused by nerve damage rather than an injury to the afflicted location. Even if the physical components of the spinal cord are healthy, an injury in the middle or lower sections is likely to affect function below the damage, such as the ability to move the feet or experience sensations. As a result, at least one of the following symptoms appears in patients. Due to brain damage, the brain is unable to convey a signal to a part of the body. The Brain-Computer Interface (BCI), also known as the "direct neural interface," allows the user's brain and computer to communicate and interact directly. BCI has aided in the direction of assisting, augmenting, or even repairing human cognitive or sensory-motor functions. It has also aided in the development of an interactive system that can translate human Channels based on brain waves and muscles, allowing users to communicate with the outside world without moving. A BCI system simply converts EEG signals from a reflection of brain activity into user action via the hardware and software of the device.

Robots are becoming increasingly important in both industrial and human life. These robots can assist disabled persons in their daily activities. One of the first stages toward maximising the use of robots in human life is the development of a brain-controlled wheelchair. With the aid of a joystick, keyboard, and other devices, a healthy person can control a wheelchair. A person who lacks muscular control, on the other hand, is unable to employ them. As a result, unique techniques such as eye tracking and others have been presented. It does, however, have certain restrictions. To address these issues, the Brain Computer Interface (BCI) technology was created, which bypasses all traditional communication protocols and directly connects the human brain to communication equipment. The suggested method sends commands to physical things directly from the brain.

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The non-invasive technique of electroencephalography (EEG) is one example of detecting brain activity. EEG is a method of measuring electrical activity produced by the firing of neurons in the brain along the scalp. EEG stands for electroencephalography, which is the recording of the brain's spontaneous electrical activity over a brief period of time using several electrodes on the scalp. Neurons cause EEG to be generated. Neurotransmitters are formed when the potential created by neurons travels down the nerve fibres. This neurotransmitter activates dendritic receptors. An electric signal is generated by combining receptors and neurotransmitters, which may be measured on the scalp. This voltage varies from 1 to 100 microvolts. The EEG signal is the name for the producing voltage. This may change depending on a person's brain activity.

The frequency range of the EEG signals that are generated is used to classify them into distinct categories. EEG waves are classified as Delta, Theta, Alpha, Mu, and Beta. The occurrence of these waves is dependent on the brain's many functions. Mu rhythm is used in this suggested system. Mu waves are found in the frontal lobe of the brain.

II. Literature survey

In recent years, various extensively created paradigms have been used to evaluate up-and-coming practical uses of EEG-based BCI. Exogenous (or evoked) EEG-based BCI paradigms employ external triggers (flickering LEDs or auditory beeps) to generate discriminative brain patterns, whereas endogenous (or spontaneous) EEG-based BCI paradigms use self-regulation of brainwaves without external inputs. Gao, D. Xu, M. Cheng and S. Gao et.al, are proposed “the development of brain computer interface (BCI) technology”.

A stimulator, a digital signal processor, and a trainable infrared remote-controller make up the system. Non-invasive signal recording, minimal training requirements, and a fast information transfer rate are some of the system's appealing advantages. Our tests revealed that this system can recognise at least 48 targets and send data at a rate of up to 68 bits per minute. The system has been used to control a piece of electrical equipment. "Design and implementation of a brain-computer interface with high transmission rates," a brain-computer interface (BCI) that can assist users in entering phone numbers, is proposed by M. Cheng, S. Gao, and D. Xu et al. The visual evoked potential system is based on steady-state visual evoked potentials (SSVEP). The system's appealing qualities include non-invasive signal capture, little user training, and a fast information transfer rate.

"An adaptable P300-based online brain-computer interface," suggested A. Lenhardt, M. Kaper, and H.J Ritter. The P300 component of an event related potential is commonly utilised in combination with brain-computer interfaces (BCIs) to translate the subject's intent into instructions to operate artificial equipment using just thoughts. Spelling words is a well-known application, with letter selection done out by focusing attention on the desired letter. The most precise data, with an accuracy of 87.5 percent, revealed a transfer rate of 29.35 bits/min. "Asynchronous P300-based brain computer interfaces: A computational method with statistical models," offered H. Zhang, C. Guan, and C. Wang et al. Asynchronous control is a critical challenge for real-world brain computer interfaces (BCIs), which must discern not only the intended command but also when the user wishes to enter it using brain signals. We provide a unique computational technique for resilient asynchronous control in this work. electroencephalogram (EEG) and a P300-based oddball paradigm. The results suggest that the BCI can convey information at a rate of around 20 bits per minute on average, with a low false positive rate (one event per minute).

The utility metric: A unique way to measure the overall performance of discrete brain-computer interfaces is proposed by B. D. Seno, M. Matteucci, and L. T. Mainardi et al. The capacity to effectively turn user intentions into accurate actions, as well as how to appropriately quantify this efficiency, is an important challenge in a brain-computer interface (BCI). The most common method for evaluating a BCI system is to quantify the performance of the classifier, which is frequently done using the information transmission rate (ITR). Jzau-Sheng Lin, Kuo-Chi Chen and Win-Ching Yang developed wheelchair using Mr. Ahmed's Methods were fairly similar in terms of EEG waves and eye blinking pattern, with the exception of the gear utilised for EEG acquisition and the control signals.

III. Problem statement

Physically impaired persons, particularly those with paralysis below the neck, are unable to move around on their own and must rely on human caregivers to push them around. This renders disabled individuals reliant on caregivers for the rest of their lives. Because paralysis might occur as a result of a stroke or an accident, they must be watched for vital health indicators like as heartbeat, spo2, and body temperature. There is currently no automated system that can directly operate the wheel chair based on the patient's motivation while also monitoring health data.

This suggested system employs BCI, a communication technique that enables a machine to respond to human brain ideas. BCI is employed in a variety of sectors, including medicine, where it is used to operate an electronic wheelchair or orthotic equipment. In addition, you may use it to manage household items like the TV, lights, and doors. Furthermore, operating virtual reality features such as virtual games and composing a message on an LCD panel. BCI has aided in the direction of assisting, augmenting, or even repairing human cognitive or sensory-motor functions. It has also aided in the development of an interactive system that can translate human Channels based on brain waves and muscles, allowing users to communicate with the outside world without moving.

A BCI system simply converts EEG signals from a reflection of brain activity into user action using the hardware and software of the device.

IV. Objectives

Human beings require independent movement in order to function in their daily lives. Physically challenged people have limited mobility. The Brain Computer Interface (BCI) is a promising option for these folks. The project's key design goals are listed below.

- To lessen the amount of effort required by the user to control the wheelchair
- To guarantee that the movement is safe.
- A smart wheelchair built using open-source software and low-cost hardware.
- To use sensors to track a person's activity in real time.

The user should be able to transport the proposed system.

V. Methodology

The Arduino microcontroller is the system's brain. The technology uses an EEG sensor to control the movement of a wheel chair. The electrical signal sent by the brain to govern muscle action is intercepted and measured by an EEG sensor. When a person tries to move their eyes, the signal is received by electrodes from EEG sensors connected near the forehead. The system is programmed to distinguish distinct patterns of eye movement, such as blinking, blinking quickly, and blinking hard, and to utilize these patterns to regulate the wheel chair's orientation.

Various other sensors are used to monitor the health of the patient.

1. **Heart beat sensor:** The heart beat sensor is connected to the microcontroller and detects the patient's heart rate. If the heart rate is too low or too high, the microcontroller emits an alarm sound**.**

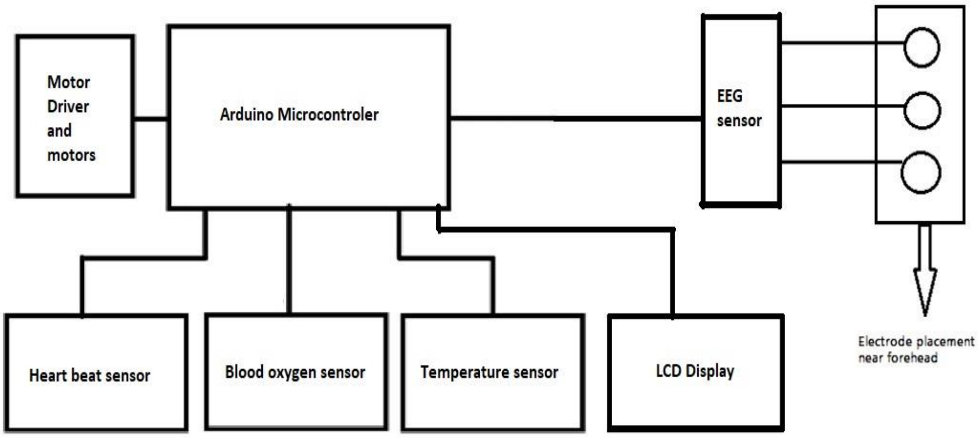

Fig .2.1. Block diagram

2. Blood Oxygen Sensor: This sensor monitors the amount of oxygen in a patient's blood. This is a critical characteristic to examine since paralyzed patients have little control over their lungs, and disorders like asthma can exacerbate the problem. The system will issue an alert if the measured value is less than the threshold value.

3. Temperature sensor: This sensor measures the patient's body temperature and alerts the user if the temperature is abnormal**.**

4. GPS Module: The neo 6m GPS module is utilised to get the user's GPS position in terms of latitude and longitude**.**

5. GSM module: The GSM module is used to transmit SMS messages containing user location information.

Advantages/Disadvantages/Applications

Advantages:

- The wheelchair that does not require the user to turn the wheels is a step forward from electric wheelchairs, and it may be useful for everyone for mobility without the need for physical labour.
- The simultaneous EEG collection can identify any significant improvement in the body's state.
- We can get the wireless location of the wheel chair.

Disadvantages:

- The fixing of the electrodes must be done before any further course.
- The mental state must be stable at all times.
- Some training is must before it is fully efficient and used for practical purposes.

Applications:

- The developments in the field of brain-computer interface are a juvenile step towards the improvements of the wheelchair.
- The wheelchair controls only 2 wheels whereas the same condition may be used to drive a car with 4 wheels.
- The functionality of the brain can be used to trounce many other manual works at industries as well as a house-hold levels.
- The day-to-day gadgets may be evolved to work using mind waves.

VI. Results and Discussion

Non-invasive procedures are used to capture neuronal activity in the brain (Mind wave sensor). Because we're using a single electrode, it'll be simple to utilise. It will provide people more options for interacting with their surroundings in a more effective manner. With the support of their brain impulses, this research will assist the physically handicapped in leading an independent life. The use of EEG signals is an important study topic that can assist physically challenged persons. For physically challenged people, a brain-controlled wheelchair is a slow but dependable solution. The Brain-Computer Interface (BCI) is a communication mechanism based on the brain's voluntary neural activity, which is independent of the brain's regular output channels of peripheral nerves and muscles.

Various sensors like heart rate sensor, blood oxygen sensor, EEG sensor and EMG sensor are connected to the user. based on the users' inputs detected via EEG and EMG wheel chairs direction is changed. Here user has to focus for 2 seconds in order to select the mode. The mode decides in which direction the wheel chair need to move this process is done by microcontroller based on the sensory inputs. Along with the direction control this system also measures heart beat of the user constantly, if the heart beat reduces below the threshold value, then the microcontroller will give an alert signal which can be interpreted using LEDs or buzzers. Apart from this, oxygen content in the blood is also measured. This feature is very important as paralyzed patients don't have control over their lungs and another disease like asthma will worsen the effect which will be very harmful as any attacks which cannot be detected extra venously.

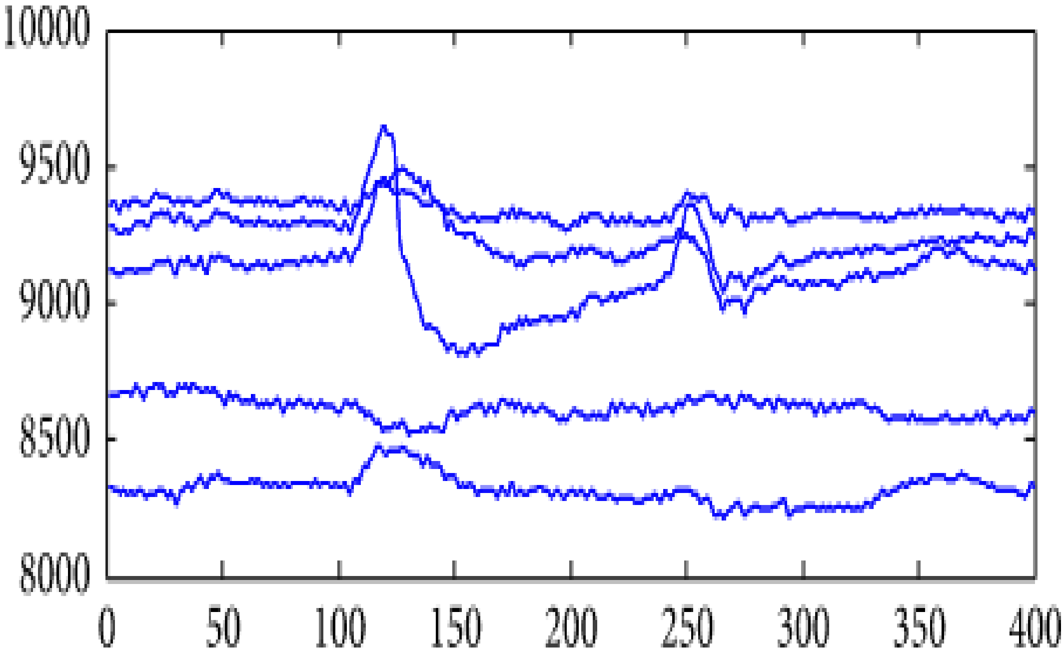

Fig 3.1.2 Neutral pose

This pulse wave depicts a neutral pose, patient relaxing and not doing anything also standby mode.

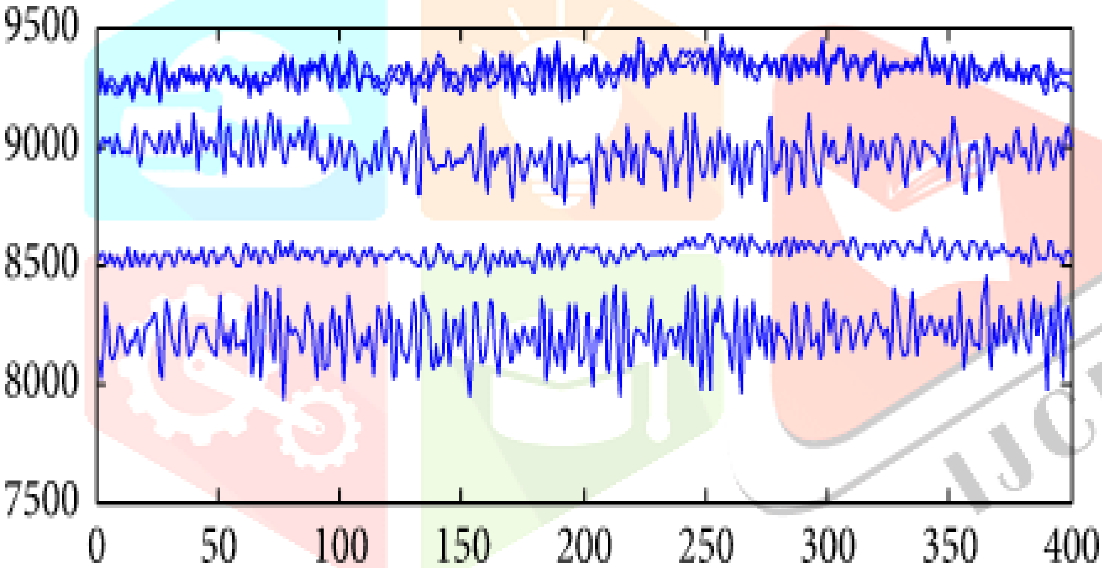

Fig 3.1.3 Positive gesture pose

This pulse wave is not as constant as neutral pose, it is sequentially changing along the direction of the movement.

VII. Conclusion

A review of the literature on various hardware implementation approaches exposes the benefits and drawbacks of previously constructed systems. A portable brain-controlled wheelchair using Arduino and a Mind wave headset is created to achieve the design objectives.

1. The strengths and downsides of previously developed systems are shown through a survey of the literature on various hardware implementation methodologies. To meet the design goals, a portable brain-controlled wheelchair is built utilising Arduino and a Mind wave headset.

2. This project is designed to be user-friendly in order to accomplish real-world target-reaching tasks, such as turning the wheelchair left or right in stages and then moving forward.

3. In a typical environment such as moving ahead and turning left/right, there is a fair probability of testing all possible combinations of instructions, such as non-control and control, move forward and halt, turn and continue forward, much like in actual wheelchair control.

4. A brain-computer interface (BCI) is a type of communication based on the brain's voluntary neutral activity, which is independent of the brain's regular output channels of peripheral nerves and muscles.

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