BRAIN WAVE CONTROLLED MINIATURE WHEEL CHAIR USING BCI TECHNOLOGY

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Keywords

Brain-Computer Interface (BCI), EEG, Bio-medicine, Health challenges, prevent impairments, Electroencephalographs, Mind wave Headset, Eye blink strength.

INTRODUCTION

The integration of Brain-Computer Interface (BCI) technology with assistive devices has emerged as a transformative frontier in enhancing the autonomy and quality of life for individuals with severe mobility impairments. Among these innovations stands the brainwave-controlled miniature wheelchair, a revolutionary advancement that promises to redefine the landscape of mobility assistance. By leveraging neural signals captured through electroencephalography (EEG), this wheelchair enables users to navigate and control their movement solely through their brain activity, circumventing the limitations imposed by traditional input methods such as joysticks or switches. In this introduction, we explore the significance of this breakthrough technology, its potential impact on users' lives, and the broader implications for the field of assistive technology.

References from the work done earlier:

1. **“Sensitive BCI to help manoeuvre a miniature wheelchair using Electroencephalography”**

Author: Prashanth Kumar Tiwari, Abhishek Choudary, Saurabh Gupta, IEEE, February 2020.

Description: The project demonstrates the feasibility of using EEG signals to control a miniature wheelchair, opening doors for potential applications in assistive technology for individuals with motor impairments.

Ideas obtained: Attention Level.

2. **"Research and Development of a Brain-Controlled Wheelchair for Paralyzed Patients"**

Author: Mohammad Monirujjaman Khan, Mehedi Masud, Shamsun Nahar Safa, Minhazul Hoque Ashik, 13 April 2021.

Description: We have worked by decoding brain activity like imagining movement and turning it into commands for the wheelchair to navigate. It offers for increased mobility, independence, and a better quality of life. The viability of using Brain-Computer Interfaces to control wheelchairs for paralyzed individuals.

Ideas Obtained: Brain-Computer Interfaces.

Objectives

By considering the necessities of the different efficient techniques in BCI technology, few objectives are proposed in the present work.

The main research objectives are listed below:

- To develop a brainwave-controlled wheelchair for people who have met with an accident-causing severe injury leading to disability or paralysis.
- Design an intuitive and user-friendly interface for users to interact with the BCI system and control the wheelchair.
- Achieve a high degree of accuracy in interpreting brainwave patterns associated with desired movements (e.g., forward, backward, right and left).
- Implement adaptive navigation algorithms to enable the wheelchair to navigate various environments and obstacles with precision and efficiency.

Methodology

This project aims to develop a miniature wheelchair controlled by the user's brainwaves through a Brain-Computer Interface (BCI)

1. System Design

- Define the functionalities of the miniature wheelchair. How many directions (forward, backward, turn left, turn right, stop) will it support?
- Choose a suitable BCI technology.
- Electroencephalogram (EEG) is a common non-invasive approach for capturing brainwaves.
- Select appropriate hardware components:
    - EEG headset to capture brain signals. Consider factors like cost, number of electrodes, and ease of use.
    - Microcontroller board (e.g., Arduino) to process signals and control the wheelchair.
    - Motors and motor drivers for movement.
    - Battery for power supply.

2. EEG Signal Acquisition and Processing

- Design the BCI system to identify specific brain patterns associated with desired movements (e.g., motor imagery for forward movement).
- Develop a program to capture and pre-process EEG signals from the headset in real-time. This may involve filtering noise and extracting relevant features.
- Implement signal classification algorithms to translate brain patterns into control commands for the wheelchair. Popular methods include Common Spatial Patterns (CSP) or machine learning algorithms.

3. Control System and Wheelchair Movement

- Design the control system that translates the classified brain commands into motor control signals.

- Program the microcontroller to receive commands and control the wheelchair motors accordingly. This may involve speed control and safety features.

4. Training and Calibration

- Develop a training protocol for the user to learn how to control the wheelchair with their brainwaves. This may involve practicing specific mental tasks to generate recognizable brain patterns.
- Implement a calibration routine to personalize the BCI system to the user's specific brainwave patterns for optimal performance.

5. Testing and Evaluation

- Conduct rigorous testing of the brain-controlled wheelchair in a controlled environment. Evaluate factors like accuracy, speed, and user comfort.
- Refine the system based on testing results.

RESULTS AND CONCLUSIONS

RESULTS:

Figure 1 and Figure 2 represents the normal mode and sleep mode operation of our project.

The process starts. The system checks for obstacles. If obstacles are detected, the process likely jumps to a stop command to halt the wheelchair for safety reasons. If there are no obstacles, the process proceeds to acquire an EEG signal using a brainwave sensor. Based on the processed EEG signal, the microcontroller extracts a control signal corresponding to the user's intended movement (e.g., forward, backward, left, right). The microcontroller sends the control signal to the motors, activating them according to the desired movement. At the end of the current cycle, and the process repeats from first step to continuously monitor for obstacles, acquire brainwave signals, translate them into control signals, and drive the wheelchair motors.

When a person is in sleep mind state, due to variations in brainwaves the wheelchair may move. To avoid this, we have designed sleep and standby mode operation block. To achieve this, we make use of IR sensor and Ultrasonic sensor. Based on angle variation in ultrasonic sensor, wheelchair movability is stopped. We make use of relay module in order to reset the microcontroller boards as it may make use of previously stored data values and make wheelchair move.

Figure 3 represents hardware setup of our project. Team members' expertise and dedication, alongside the guide's support, have been crucial in achieving project objectives. Their collective efforts have overcome challenges and reached milestones, illustrating their integral role in project success.

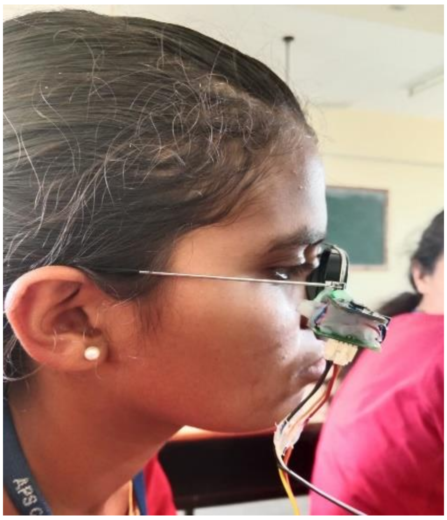

Figure 1: Normal mode

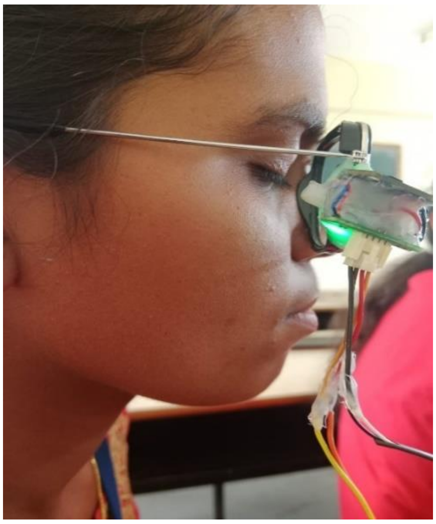

Figure 2: Sleep mode

Figure 3: Hardware setup

Conclusion:

The main objective of our project is to bring mobility back to people who are facing physical disorders and for the paralysed patients who can't move on their own without someone's assistance. The ongoing research and development works in the field of brain controlled robots have received a great attention all over the globe because they can help physically disabled people to move independently. Use of BCI (Brain Computer Interface) technology in human life ensures a comfort zone to a physically challenged people and our project is one among them. We have used Brain sense EEG sensor which is used to capture the EEG signal from the brain. Arduino Uno board is used to control the movement of the wheelchair. Headband used to read and analyse the brain wave data and to generate and send the command to the Arduino board for movement of the wheel chair & ultrasonic sensor is used for obstacle avoidance thereby ensuring the safety of user. Brain-controlled miniature wheelchairs offer promising advancements in mobility and independence for individuals with limited physical control. This technology represents a breakthrough in assistive technology, paving the way for more personalized control interfaces for wheelchairs and other medical devices while acknowledging the exciting possibilities, it's essential to address ethical concerns regarding user privacy, safety protocols, and accessibility of this technology.

INNOVATION IN THE PROJECT

- **Improved Signal Processing Algorithms**

One area of innovation lies in developing more advanced signal processing algorithms to accurately interpret brainwave signals.

- **Enhanced Electrode Technology**

Innovations in electrode technology are crucial for improving the quality and reliability of brainwave signals. Advancements such as dry electrodes, flexible electrode arrays, or even implantable electrodes could lead to more comfortable and long-term use of BCI devices.

- **Miniaturization and Wearability**

Making the wheelchair miniature requires not only shrinking the size of the wheelchair itself but also miniaturizing the BCI hardware.

- **Adaptive Control Systems**

Implementing adaptive control systems that can learn and adapt to users' brainwave patterns over time can enhance the wheelchair's responsiveness and user experience.

- **Integration with Smart Assistive Technologies**

Integrating the brainwave-controlled wheelchair with smart assistive technologies opens up new possibilities for enhancing user autonomy and safety.

Scope For Future Work

The future of brainwave-controlled miniature wheelchairs is brimming with possibilities. This technology has the potential to revolutionize the lives of individuals with limited mobility, while also pushing the boundaries of human-machine interaction and redefining our relationship with technology. As research and development continue, it's exciting to imagine the transformative impact this technology could have on our world. These or more can be proposed in the future scope of the wheel chair. It can be implemented is vehicles which would help a lot in advancing of technology for physically disabled.

- **Transform into reclining position**: Allow users to relax by converting the chair into a semi-sleeper position.
- **Advanced Maneuvers**: Integrate existing technology for climbing stairs and other complex movements.
- **Vehicle Integration**: Explore incorporating brain control into vehicles for increased mobility.
- **Adaptive Shared Control**: Develop systems that adjust assistance based on user needs (fatigue, frustration) and environment.
- **Long-Term Use**: Focus on shared control that adapts to user needs over time, enabling extended daily use.