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Review on Brain-Controlled Device Using EEG Signals

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***Abstract:** Brain–Computer Interface (BCI) technology enables direct communication between the human brain and external devices without muscular involvement. This paper presents the design and implementation of a brain-controlled device using Electroencephalogram (EEG) signals. Brain signals are acquired through an EEG sensor and processed using signal filtering and feature extraction techniques*
***Keywords:** Brain–Computer Interface, EEG, Brain Control Device, Assistive Technology, Signal Processing, Human–Machine Interaction.*

I. INTRODUCTION

A Brain–Computer Interface (BCI) is a communication system that allows users to interact with external devices using brain signals alone. EEG-based BCIs have gained significant attention due to their non-invasive nature, portability, and relatively low cost. Brain-controlled devices are especially beneficial for individuals suffering from motor disabilities, enabling them to control wheelchairs, robotic arms, or home appliances using their thoughts. This paper focuses on the design and implementation of an EEG-based brain-controlled device that translates brain signals into actionable control commands.

II. LITERATURE REVIEW

Several studies have explored EEG-based BCI systems for device control. Earlier systems focused on simple signal acquisition and threshold-based decision making. Recent advancements incorporate machine learning algorithms to improve classification accuracy. However, many existing systems are expensive, complex, or require extensive user training. This research aims to develop a simplified and cost-effective BCI system while maintaining reliable performance.

III. SYSTEM ARCHITECTURE

The proposed system consists of the following components:
EEG Sensor for brain signal acquisition

- Signal Processing Unit
- Microcontroller Unit
- Controlled Device (robot or assistive device)

EEG signals are captured from the user's scalp and transmitted to a processing unit. The processed signals are converted into control commands and sent to the microcontroller, which drives the external device.

IV. METHODOLOGY

1) Signal Acquisition: EEG signals are acquired using a non-invasive EEG headset. The sensor captures electrical activity generated by brain neurons.
2) Signal Processing: Raw EEG signals contain noise and artifacts. Band-pass filtering is applied to remove unwanted noise and improve signal quality.
3) Feature Extraction: Relevant features such as frequency bands (alpha, beta) are extracted from the filtered signals.
4) Classification : Extracted features are classified using threshold-based or machine earning algorithms to identify user intent

V. IMPLEMENTATION

The system is implemented using an EEG sensor interfaced with a processing unit running MATLAB or Python for signal analysis. An Arduino microcontroller receives control commands and activates motors or relays to control the external device. A flowchart illustrates the complete operational process from signal acquisition to device actuation.

VI. FUTURE SCOPE

The proposed brain-controlled device using EEG signals demonstrates promising results; however, there are several directions in which the system can be further enhanced. Advanced machine learning and deep learning algorithms such as Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks can be employed to improve classification accuracy and reduce resp.

VII. RESULTS AND DISCUSSION

different brain pattern implemented system successfully interprets EEG signals and controls the device with acceptable accuracy. The response time is suitable for assistive applications. Performance analysis shows that accuracy improves with user training and optimized signal processing techniques.

VIII. APPLICATIONS

1) Wheelchair control for disabled individuals
2) Robotic arm control
3) Gaming and virtual reality

IX. ADVANTAGES

1) Increased independence
2) Reduced dependency on caregivers
3) Better mental well-being and confidence

X. LIMITATIONS

1) EEG signals are highly sensitive to noise and artifacts, affecting accuracy.
2) Requires user training to achieved reliable control performance.
3) Limited number of control commands due to overlapping brain signal patterns.
4) Accuracy may vary between users because of individual brain signal differences.
5) System performance depends on signal processing and classification techniques used.

XI. CONCLUSION

This paper presents a functional EEG-based brain-controlled device that demonstrates the potential of BCI technology in assistive applications.

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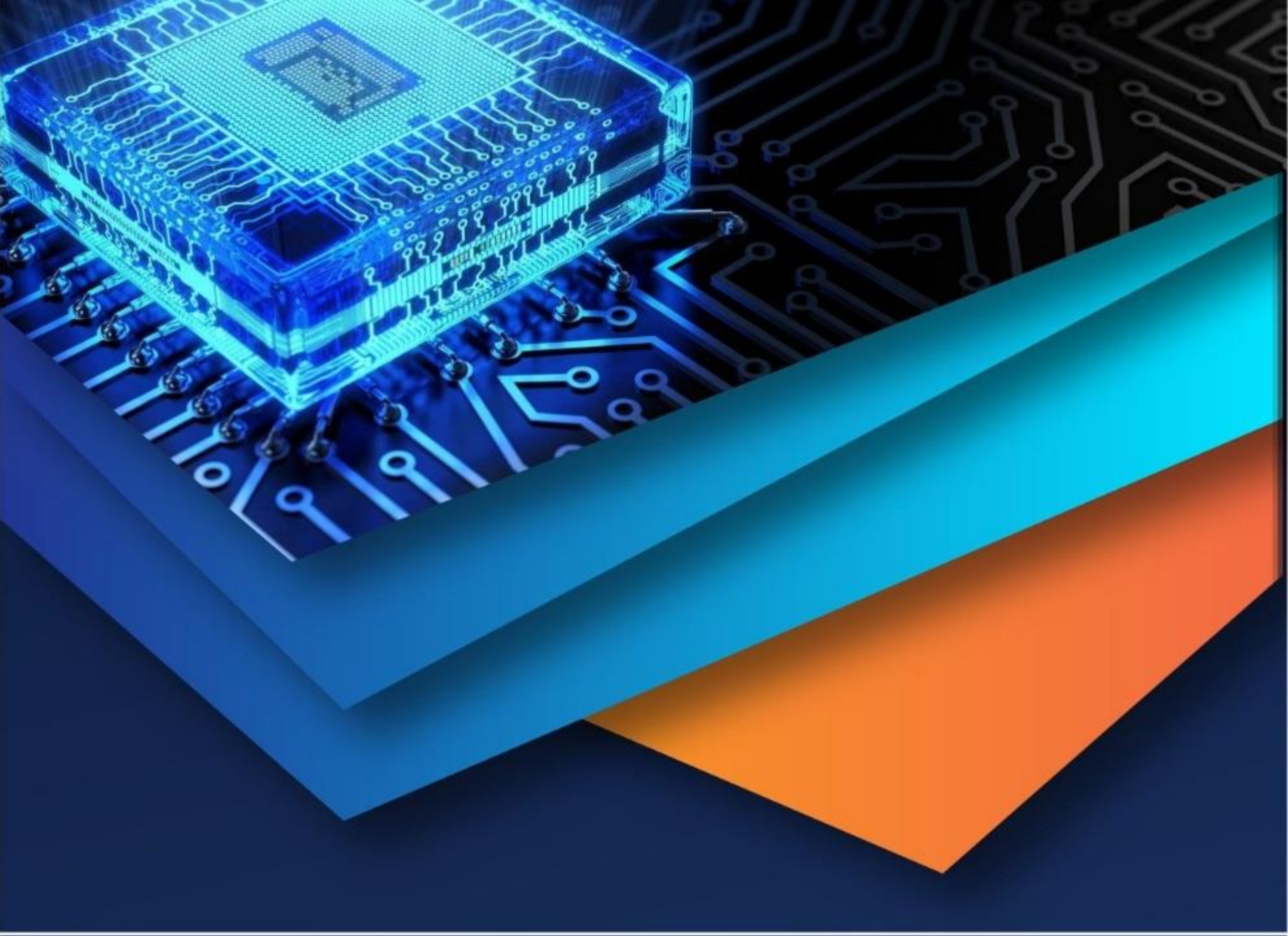

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