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EEG-BASED BRAIN-COMPUTER-INTERFACING WITH HAPTIC FEEDBACK

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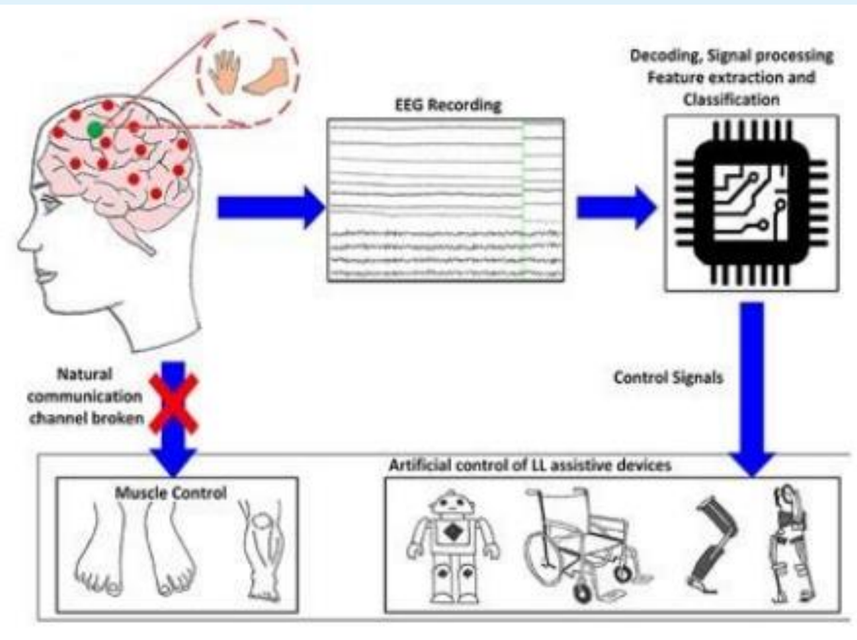
Abstract- This research focuses on an EEG-based Brain-Computer Interface (BCI) that employs a pattern recognition neural network (PRNN) to classify EEG signals into various control commands. The proposed system achieved high accuracy in classifying visual imagery tasks, demonstrating its potential as a reliable and efficient BCI for controlling a robot arm. The results also suggest that the PRNN can enhance the accuracy and speed of the BCI system, making it a promising technology for future developments.

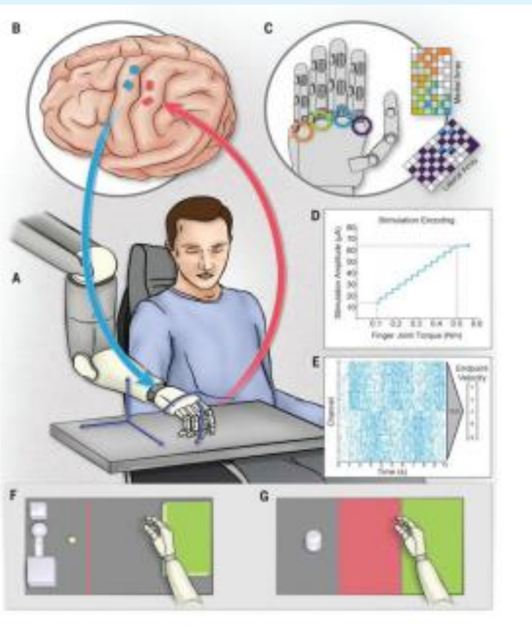
INTRODUCTION

"EEG-based BCI and a Haptic Feedback system" is a technology that enables direct communication between the human brain and external devices through electroencephalography (EEG) and haptic feedback. By using brain signals to control devices, this technology has the potential to revolutionize human-computer interaction, particularly for individuals with disabilities. Integrating haptic feedback provides a sensory response that enhances the user's experience and helps improve the system's accuracy.

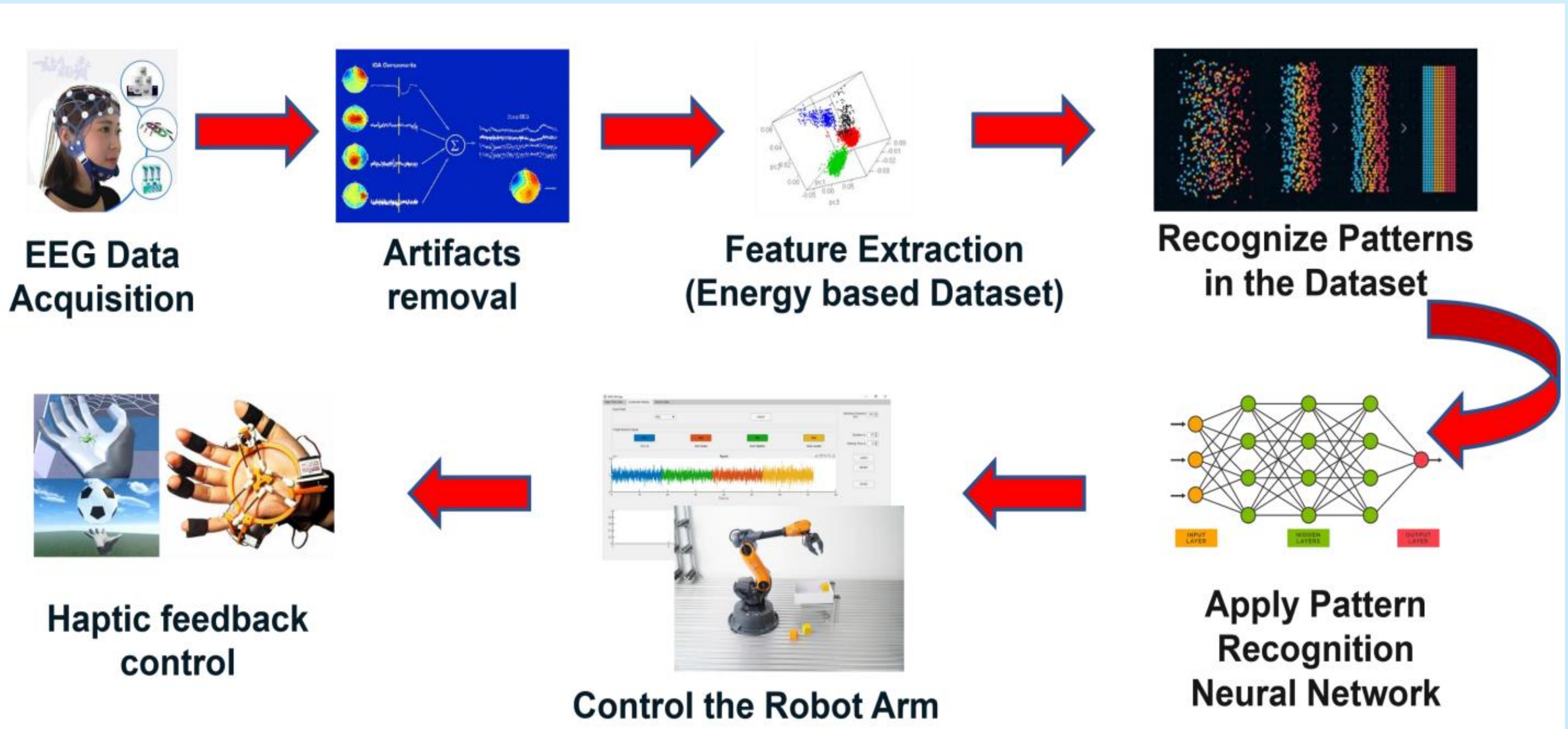
MOTIVATION

Combining an EEG-based BCI and a Haptic Feedback system has immense potential to revolutionize human-computer interaction, enabling people with disabilities to control technology using their thoughts and receive tactile feedback. This innovation could improve the quality of life for millions of people worldwide.





METHODOLOGY



The proposed algorithm for EEG-based BCI demonstrated a noteworthy accuracy improvement compared to existing methods. Moreover, its relatively straightforward implementation may be more feasible and accessible for broader practical use

RESULTS

Algorithm	Accuracy
Canonical Correlation Analysis (CCA)	75% - 90%
Feed-Forward Neural Network (Offline)	**72%**
Pattern recognition Neural Network (Offline)	**95%**
Pattern recognition Neural Network (Real-time)	**91%**

CONCLUSION

The proposed EEG-based BCI system relies on an energy dataset generated by calculating energy in the fundamental frequencies and first harmonics. Using a pattern recognition neural network (PRNN), the system achieves high accuracy rates of 95% in offline mode and 91% in real-time controlling. These results outperform the traditional Canonical Correlation Analysis (CCA) method, which is only 75%-90% accurate.

However, the accuracy is optimized for a limited time window of 6 seconds in the offline dataset and 10 seconds in the real-time operation. Therefore, a tradeoff exists between the BCI algorithm's accuracy and the time window size. Effective artifact removal algorithms can be used to overcome this limitation, and this will produce precise frequency information in the relevant time window that can be increased. By addressing these challenges, the EEG-based BCI system can become an effective solution for controlling robots with haptic feedback.

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