Senior Design Project Description

Group: Andrés (ME), Mete (CE), and Gabriela (BE)

Project Description

The proposed project involves designing and developing a non-invasive brain-computer interface (BCI) that enables control of a robotic toy or system using Electroencephalography (EEG) signals. The solution should be interdisciplinary, integrating machine learning, electrical engineering, and mechanical design to create a seamless interface that interprets brainwave patterns and translates them into real-time commands for a robotic device.

The core objective is to enable users to direct the movements of the robotic toy with brain patterns picked up by an EEG cap. The project will encompass the full range of activities from the mechanical and electronic design of the toy to the development of sophisticated software algorithms capable of extracting relevant features from EEG data, classifying neural patterns, and enabling real-time communication between the user's brain signals and the toy. The deliverables will include a fully functional toy that responds to the user's brain commands, a user-friendly software interface, and a real-time feedback mechanism to enhance user engagement and learning.

Interdisciplinary Approach

This project requires a multidisciplinary team with expertise across several domains, including machine learning, electrical engineering, data science, mechanical design, and human-computer interaction. The integration of these fields is critical to developing a robust and responsive system capable of interpreting brain signals in real-time and controlling a robotic toy effectively. The team will collaborate to ensure seamless integration of the software and hardware components, from the circuitry and motorized structure to the mechanical control systems and CAD design for 3D printing parts.

Technical Skills Required

- Neuroscience: Understanding the principles of brain activity, specifically the behavior and interpretation of EEG signals, including signal acquisition, processing, and transmission.
- Machine Learning: Developing algorithms capable of using EEG data, extracting relevant features, and classifying neural patterns for real-time motor control of external device.
- Electrical Engineering: Designing and implementing the electronic components, including the EEG device, circuitry, and communication systems, to ensure accurate signal capture and transmission.
- Mechanical Design: Creating and prototyping the robotic toy, including CAD design, motorized structures, and the integration of control systems.

- Software Development: Developing the user interface and real-time communication protocols between the EEG device and the robotic toy, ensuring responsiveness and user engagement.
- Human-Computer Interaction (HCI): Designing the system to be user-friendly, considering the ease of use, feedback mechanisms, and overall user experience.

Deliverables

- A robotic toy and software system capable of being controlled through EEG signals.
- Hardware capable of executing a series of predefined movements or actions based on brainwave commands.
- Software that allows the user to direct the toy's movements by focusing on specific thoughts or neural patterns.
- A real-time feedback system that enhances the user experience by providing immediate response to brainwave commands.

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Items Needed

- EEG cap and related hardware for signal acquisition.
- Tools and materials required for the construction of the toy.

Intellectual Property

All intellectual property developed during this project, including software code, mechanical designs, and any associated documentation, will remain the property of the development team