NeuroControl: EEG-Powered Hands-Free Computer Control System

(Dataset-Driven Simulation)

Abstract / Project Summary

This project aims to create a brain-computer interface (BCI) software platform that enables users to control computer operations using EEG signals—without requiring physical movement or hardware. Using publicly available EEG datasets and simulation, we will build a system that classifies mental commands (like imagining left or right movement) and converts them into real-time cursor or keyboard actions. The project will be implemented in two software-focused phases.

Objectives

- Enable hands-free control of computer operations using brain signals.
- Train machine learning models to interpret EEG patterns.
- Build a simulated real-time control system.
- Expand software functionalities without physical hardware.

Methodology Overview

EEG Data (Dataset) → Preprocessing → Feature Extraction → ML Model Prediction → Action Mapping → Computer Control

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Phase 1 – Core Simulation-Based System

Goal:

Develop a working software prototype that uses motor imagery EEG data to control computer operations in real time via simulation.

Phase 1A: Model Training from Dataset

- Select motor imagery datasets (e.g., PhysioNet EEG)
- Preprocess EEG signals
- Extract features (FFT, PSD, etc.)
- Train an ML model to classify imagined left/right-hand movement

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Phase 1B: Real-Time Action Simulation

- Simulate EEG data stream epoch-by-epoch
- Predict actions using trained model
- Map predictions to:
    - Mouse cursor movement
    - Clicks
    - Typing basic text
- Provide a CLI or basic GUI showing real-time feedback

Phase 2 – Advanced Software Features

Goal:

Make the system more intelligent, versatile, and user-friendly by extending command sets, improving the interface, and supporting additional control modes — all based on simulated EEG data.

Phase 2A: Expand Control Functionality

- Introduce multi-class classification (e.g., left, right, blink, neutral)
- Add actions:
    - Open apps (e.g., Notepad, Chrome)
    - Scroll pages
    - Text typing with virtual keyboard
    - Voice assistant integration

Phase 2B: Interface & Feedback Layer

- Build GUI using Tkinter or PyQt
- Visual logs of commands, EEG waveform visualization
- Real-time prediction display
- Add audio feedback using TTS (e.g., pyttsx3)

Future Enhancements

- Text speller system
- SSVEP control interface (focus-based control)
- Custom user calibration profiles

- Exportable logs and session data
- Gamification (use EEG to play a simple game)

Tools & Technologies

- Python, MNE, scikit-learn, PyAutoGUI
- Dataset: PhysioNet EEG Motor Imagery
- ML Models: SVM, kNN, Random Forest
- GUI: Tkinter or PyQt5
- Audio Feedback: pyttsx3

WorkFlow Diagram