Title of the Project /Problem

Emotion-Aware Brain-Computer Interface to Control Music and Smart Devices

1. Introduction & Motivation

Brain-Computer Interface (BCI) technology is transforming the way humans interact with machines by directly interpreting neural signals. In today's world, emotion-aware systems have gained importance due to their potential to improve user experience, mental health monitoring, and personalized environments. This project aims to bridge human emotions with smart systems such as music players and lighting systems using BCI, offering intuitive control based on real-time brainwave analysis. Such systems are highly relevant in assistive technology, healthcare, and smart home applications.

2. Problem Statement

Current smart control systems require manual or voice-based inputs, which may not be feasible for individuals with disabilities or in emotionally sensitive contexts. There is a need for a non-invasive, real-time system that detects human emotions via brain signals and uses them to control smart environments like music systems or lighting. This project aims to address this by developing an affordable and accessible EEG-based system for emotion-aware control..

3. Objectives

- To collect and process EEG signals for emotion recognition.
- To classify emotions based on brainwave patterns using machine learning.
- To design a system that maps classified emotions to control music and lighting systems.
- To develop a prototype that can be expanded for prosthetic control in the future.
- To evaluate the system's accuracy, responsiveness, and user satisfaction.

4. Literature Review

- **Emotiv Insight** and **OpenBCI** have been widely used in BCI research for signal acquisition.
- Studies like [Koelstra et al., 2012] have proposed the **DEAP dataset** for emotion classification.
- Machine learning algorithms like SVM, CNN, and LSTM have been applied to emotion classification from EEG.
- Existing systems mostly focus on emotion detection without real-time environmental control. There is a gap in systems that integrate emotion recognition with multi-device control.

5. Methodology

Tools & Technologies: Python, OpenBCI/Emotiv device, DEAP Dataset, Scikit-learn, TensorFlow/Keras, Raspberry Pi/Arduino.

Steps:

1. EEG data collection using hardware (OpenBCI/Emotiv or DEAP dataset for training).
2. Preprocessing (filtering, noise removal).
3. Feature extraction (e.g., Alpha, Beta wave power, frequency bands).
4. Emotion classification using ML models (e.g., SVM, CNN).
5. Integration with smart devices (music and lighting) using microcontrollers or APIs.

6. Expected Outcomes

- A functioning prototype that detects emotions from EEG signals and controls music and lighting accordingly.
- Emotion classification accuracy of 75–85% on test data.
- Real-time responsiveness (within 1–2 seconds latency).
- A scalable system that could be extended to prosthetic or gesture-based control.

7.Timeline

Phase	Duration	Milestone
Literature Review & Planning	4 weeks	Completed literature survey and finalized methodology
Data Collection & Preprocessing	5 weeks	EEG data collected (or dataset sourced) and preprocessed
Model Development & Training	6 weeks	Emotion recognition model developed and tested
Hardware Integration	4 weeks	Integration with music and lighting systems completed
Testing & Evaluation	4 weeks	Prototype tested, accuracy and latency evaluated
Optimization & Improvements	3 weeks	Model fine-tuned and system performance optimized
Final Report & Presentation	2 weeks	Complete documentation and prepare final presentation

8. References

- Koelstra, S., Muhl, C., Soleymani, M., et al. (2012). *DEAP: A Database for Emotion Analysis using Physiological Signals*. IEEE Transactions on Affective Computing.
- Al-Nafjan, A., Hosny, M., Al-Ohali, Y., & Al-Wabil, A. (2017). *Review of Brain-Computer Interface Systems*. International Journal of Advanced Computer Science and Applications.
- Bashivan, P., Rish, I., Yeasin, M., & Codella, N. (2015). *Learning Representations from EEG with Deep Recurrent-Convolutional Neural Networks*. ICLR.
- M. Zhang, Y. Xu, & J. Zhao. (2020). *Emotion recognition from multi-channel EEG through parallel convolutional recurrent neural network*. Sensors

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