EEG-BASED ASSISTIVE COMMUNICATION SYSTEM FOR APHASIC PATIENTS

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College : St Joseph Engineering College, Mangaluru
Branch : Department of Electronics and Communication Engineering
Guide : Dr. Shama B N
Student(s) : Mr. Abel Babu
Mr. Anush
Mr. Channaveergouda H
Mr. Christopher

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Introduction:

1. Aphasia is a neurological disorder that affects a person's ability to communicate, making it difficult to speak, write, or express thoughts despite having normal cognitive abilities. This creates a major dependency on caregivers for basic communication. Existing assistive systems are often expensive, complex, and require significant physical interaction.
2. To address this issue, the proposed project develops a low-cost EEG-based assistive communication system that uses voluntary eye blinks as an input method. The system captures EEG/EOG signals using electrodes, processes them using signal conditioning circuits, and detects blink patterns such as single, double, and triple blinks. These patterns are mapped to communication commands, allowing users to express their needs effectively.

Objectives:

1. To design a low-cost EEG signal acquisition system using dry electrodes.
2. To develop signal conditioning circuits for accurate blink detection.
3. To implement real-time blink pattern recognition using ESP32.
4. To create a user interface for communication using blink-based commands.

Methodology:

1. The system uses dry electrodes placed on the forehead to capture EEG/EOG signals generated by eye blinks. These weak signals are amplified using an instrumentation amplifier (INA333) and stabilized using an operational amplifier (MCP6002). The processed signal is then fed into an ESP32 microcontroller, where it is digitized and analyzed in real-time.
2. A threshold-based algorithm detects blink patterns by analyzing signal peaks and timing intervals. The detected patterns (single, double, triple blinks) are transmitted via Bluetooth to a Python-based application. The application converts these inputs

into predefined messages and generates speech output, enabling communication for aphasic patients.

Result and Conclusion:

In conclusion, the system successfully detects eye blink patterns in real time and converts them into meaningful communication outputs. It demonstrates reliable performance with good accuracy and minimal delay. The developed prototype is cost-effective, portable, and easy to use, making it suitable for real-world assistive applications. This solution significantly improves communication ability and independence for aphasic patients.

References:

- Kay Robbins, Tim Mullen, “What Large Scale Analysis Tells Us About EEG Pre-Processing,” 2021.
- Michael Nolan, “DIY Neurotech: Making BCI Accessible,” 2023.
- Ravi Teja, Arun Kumar, “Portable BCI for Communication Using ESP32 and Dry Electrodes,” 2023.
- Lina Al-Saadi et al., “EEG Feature Extraction Using Wavelet Families,” 2021.

Future Scope:

The future scope of this project includes:

1. Integration with mobile applications for portability
2. Addition of multilingual speech output
3. Use of machine learning for improved accuracy
4. Integration with smart home systems for device control