TEAM 102

EEG-Controlled Prosthetic Arm to Enable Natural Interaction for Individuals with Upper Limb Loss

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ICS ISE 4 ME COE

Introduction/Background

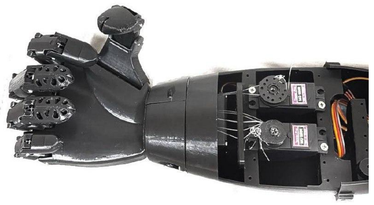
Introduction
Many amputees can't use current prosthetics due to limited muscle function. This project offers an alternative and could benefit healthcare and biomedical fields

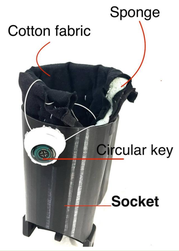
Problem Statement
Controlling bionic limbs is challenging due to the need for precise, real-time movement with minimal latency to ensure a seamless and natural user experience.

Specifications

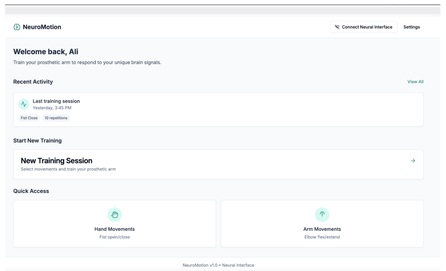
- Lightweight Structure (<=3kg)
- AI must interpret EEG signals and classify in real time (<=100ms)
- Continuous use without discomfort ≥ 6 hours.
- High Durability(can hold >=1kg)
- Attachment time ≤ 120 seconds
- Extended Battery Life(>=6 hours)
- Actions are classified with accuracy (>=90%)
- Quick Execution – Responds in ≤150 ms
- **Ensure accurate and instant movement response (<=250ms)**
- **Power Efficiency – Battery lasts 6+ hours**
- **Ensures comfort while maintaining functionality**

Prototype Design

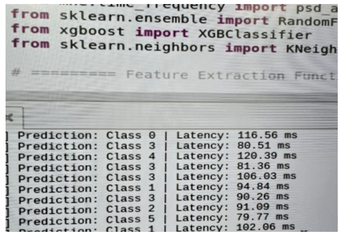


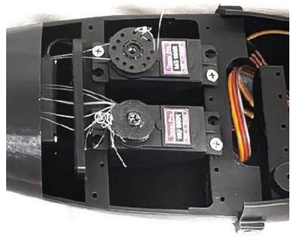


Testing / Validation



AI Training Website	Latency for classifying signals from epochs to one of the six classes
The arm weighs less than 1.5 kg.	Cost less than 10,000 SR
Enhancing air circulation for better comfort	Motors operate within the required range.
Attachment time is under 120 seconds.	Human-like design (75%)





Constraints

- Non-invasive design(100%)
- Must adapt 16-32 channels datasets to 6 channels
- motors could limit the turning degree of the elbow and wrist (90 -180 degree)
- Limited FPGA memory size (1GB)
- Fixed internal components size inside the arm
- Cost Effective <= 10,000 SR
- Human-like design (75%)
- Operates reliably in 5°C - 55°C and 20% - 80% humidity.

Conclusion

This project introduces a comfortable, non-invasive prosthetic arm controlled by EEG signals. A Raspberry Pi processes brain signals, while an ESP32 drives four motor functions. The lightweight PLA+ design ensures both durability and user comfort.