
BMES Technical Projects Symposium

Wednesday, June 5th, 2024
BMES @ UCLA

Brain-Controlled Prosthetic Hand

Design Team

Project Manager: Evan Bird

Hardware: Madeleine Doi, Aaron Li, Joseph Moon, Helen Ran

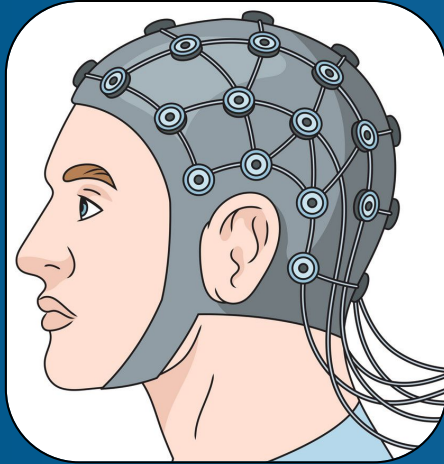
Software: Martin Bourdev, Ganesh Koka, Aryan Singh, Anthony Wu

Overview

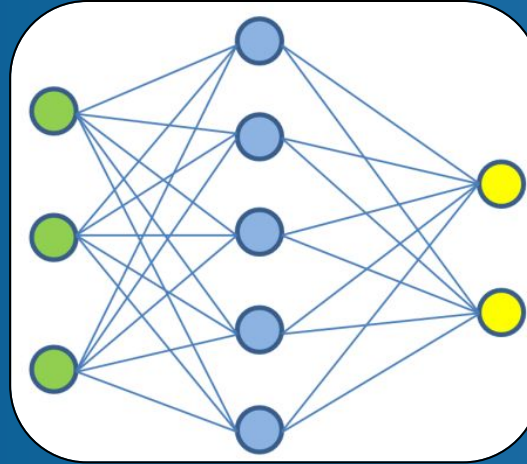
- **Background:** Paralysis and loss of mobility are devastating conditions that severely impact an individual's quality of life. Past research has shown that electroencephalograms (EEGs) can detect signals from actions such as clenching one's jaw.
- **Objective:** Translate brain signals into mechanical motion for the purpose of reintroducing mobility into individuals suffering from paralysis
- **Device:** Utilize an EEG and various machine learning tools to detect brain signals; translate these signals into movement of a prosthetic arm



Proposed Device Structure



Electrodes on head
channeled to EEG
board



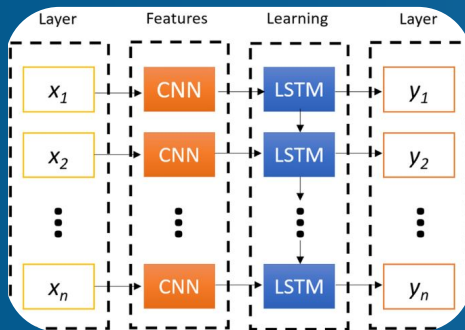
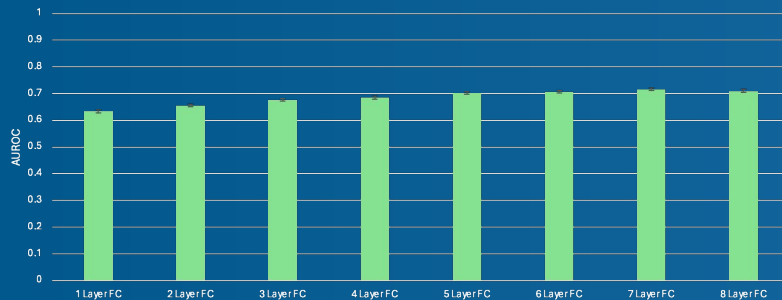
Machine Learning Model
for signal detection



Prosthetic hand
control

Software: Unique Challenges

Model Performance of Fully Connected Neural Networks

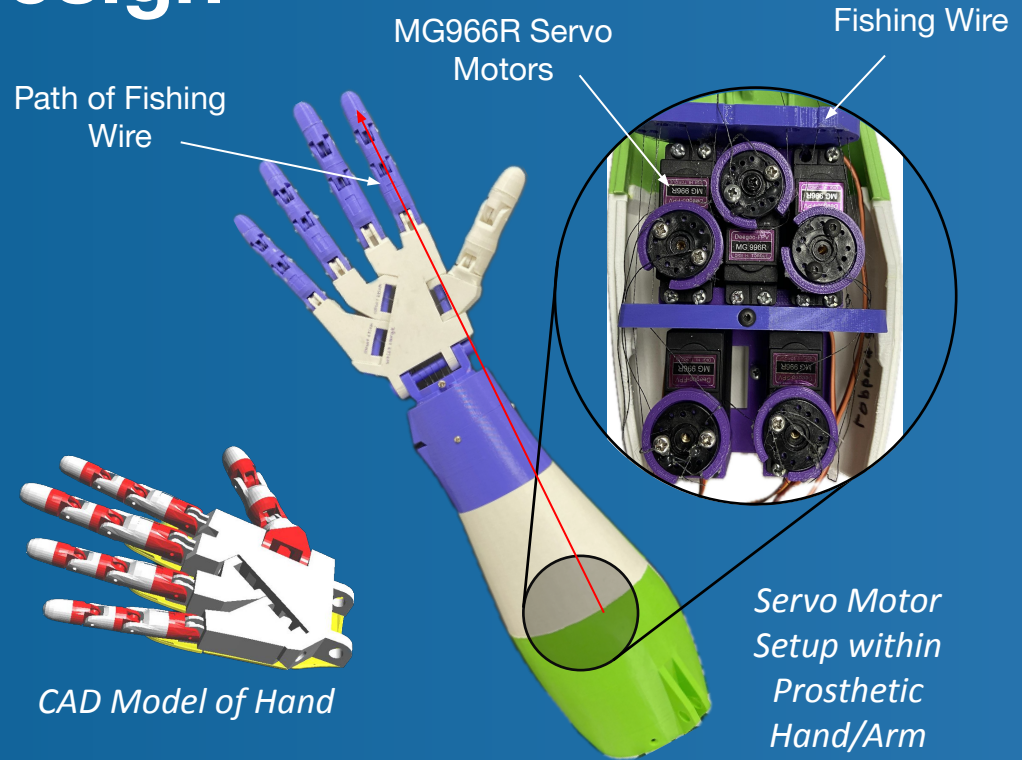


Combining Convolutions with LSTM

- Unlimited data and maximum model complexity performs best, but real-time inference poses challenges in latency.
- Transfer learning: lots of EEG datasets but few collected for our task.
- Applying our understanding to other waveform domains, such as ECG, to gain more understanding about our models.

Prosthetic Hand Design

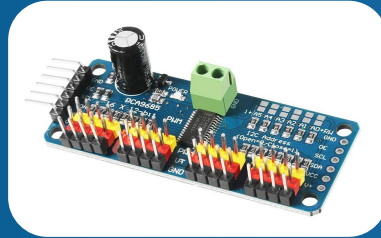
- Modeled off of InMoov and adjusted according to our project
- Parts were 3D printed with Prusa printers and assembled using super glue, screws, and fishing wire
- Synchronous contraction and extension through pulley mechanism



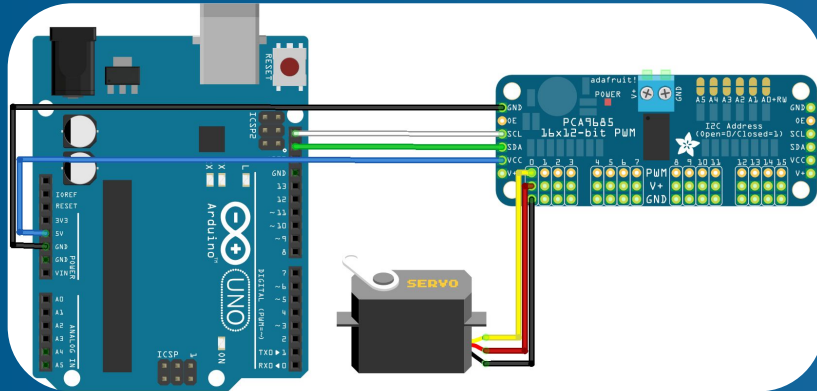
Prosthetic Hand Circuitry



5 MG966R Servo Motors



PCA9685 Servo Driver



Schematic Diagram of Prosthetic Arm Circuit



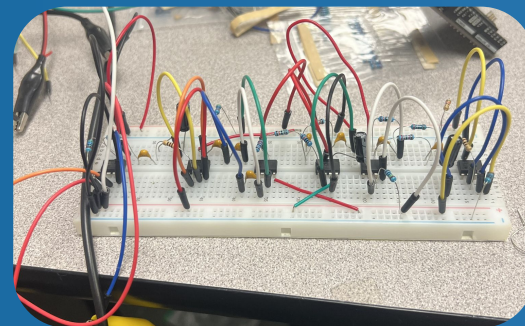
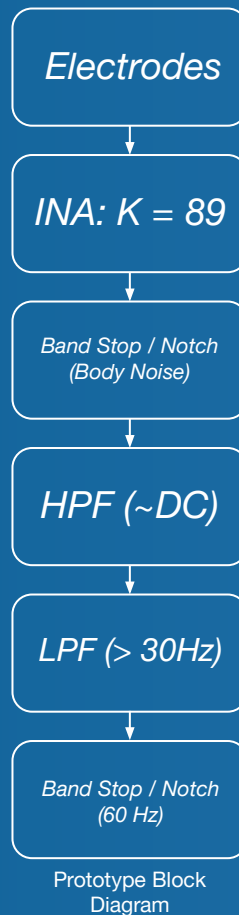
Servo Motor
Control

→
Actuation in
fingers

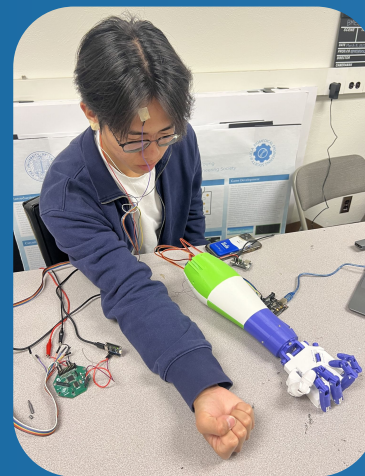


EEG PCB Circuitry

- Our team had prototype EEG circuits, followed by a final PCB modeled after the 8-lead OpenBCI design
- 80+ hand-soldered parts were on the final PCB design
- Attempted to make the PCB wired using an FTDI serial converter chain with a physical isolator, done to increase the bit rate
- Converting the communication protocol used by the firmware was a challenge
- Difficulty maintaining tension in the fingers when the hand is fully contracted, addressed in the code and with a motor driver



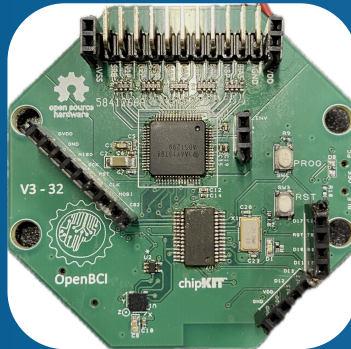
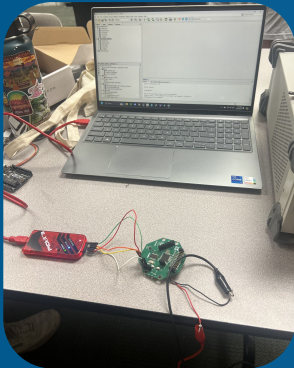
Prototype EEG Circuit



Attempts with final board & hand

Future and Ongoing Considerations

- Future improvements include using springs and stronger wire within the prosthetic hand for cleaner and more robust actuation. The training of our models with actual patients could have also allowed for the actuation of individual fingers to further replicate the functionality of human limbs.
- Another future improvement is getting the finalized PCB to read into a custom Python GUI, as it would be very intuitive for users to read their own data
- Having trouble reading from PCB board and consistency with the prototypes, need to go back and perform more thorough testing on PCB filters & amplifiers (EDA software)



Acknowledgements

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- The UCLA Engineering Alumni Association
- SPARK Campaign Donors
- The Biomedical Engineering Society at UCLA
- UCLA Department of Bioengineering

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