Integrating Mobile and Cloud Computing for Electromyography (EMG)-based Gesture Recognition

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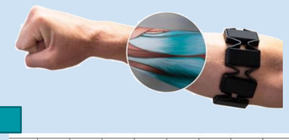
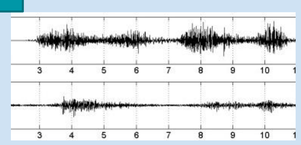
ICE Lab

Background

- Electromyographic (EMG) signals are effective neural signals for expressing movement intent.
- EMG-based pattern recognition (PR) has great potential to provide natural human-machine interaction in many applications such as neural-controlled prostheses, assistive robots, and virtual input devices.
- To apply EMG PR-controlled systems in practice, these systems must be portable, real-time, and robust, which is challenging.

EMG PR Control Interface





Objectives

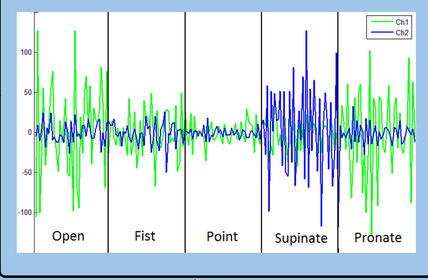
- Develop a low-cost, portable, and flexible research platform for EMG PR-based real-time systems.
- Develop a mobile Android application and cloud computing framework for real-time gesture recognition using EMG data collected from Myo armband.
- Utilize Amazon Web Services to offload local computations and obtain real-time processing speed and sufficient storage capacity for computationally complex EMG PR algorithms.

Methodology

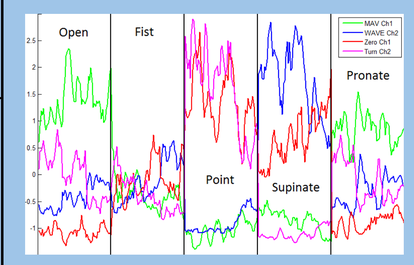
Myo Armband

- 8 EMG sensors, 200 Hz
- 9-Axis IMU sensors, 50 Hz
- Haptic Feedback
- Bluetooth Low Energy

Data Collection

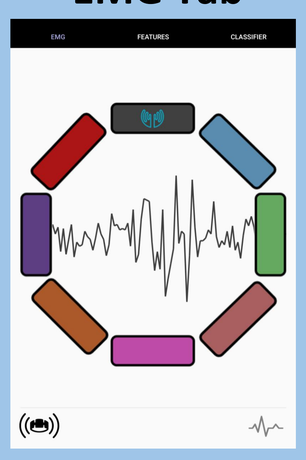


Feature Extraction

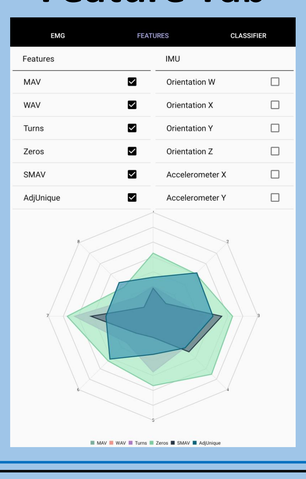


Graphic User Interface (GUI)

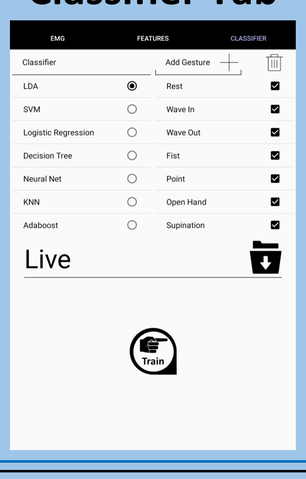
EMG Tab



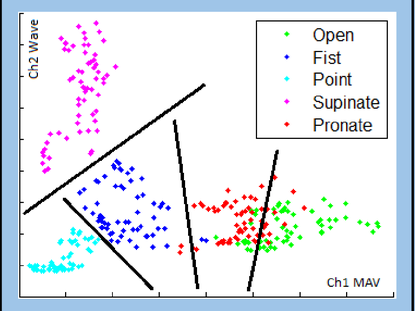
Feature Tab



Classifier Tab



Machine Learning



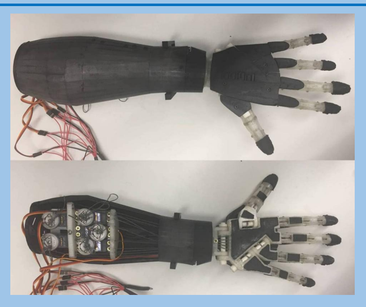
Gesture Recognition

Cloud Computing & Storage

Amazon Web Services

- **Simple Storage Service** (S3) stores training data
- **Elastic Compute Cloud** (EC2) cloud server runs cross accuracy analysis on data or optional alternative to android processor

Output Control Interface



Prosthetics

- Recognition of use intent
- Intuitive control

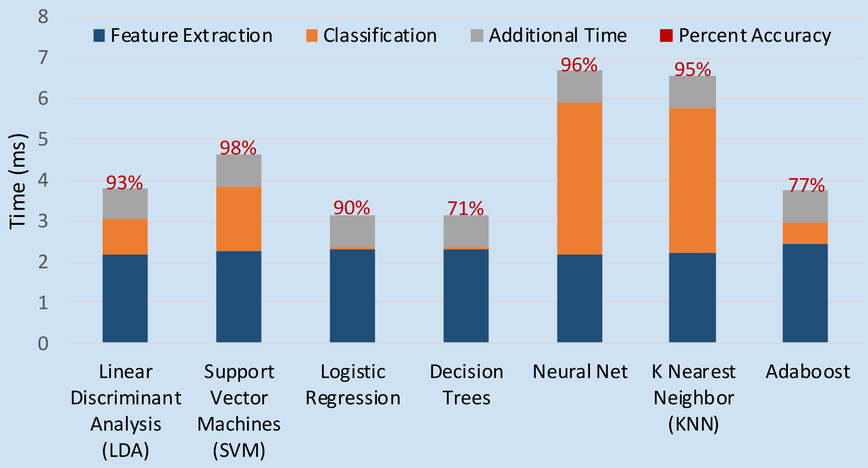
Virtual Reality Applications

- Practicing use of prosthetics
- Entertainment-based video games
- Rehabilitaton-based video games
- Task-based assesment of physical ability

Experimental Results

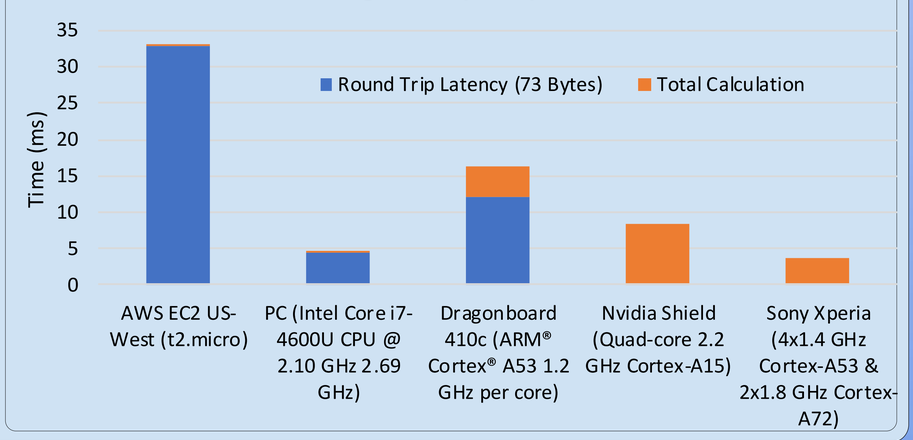
- 10 test subjects perform 3 trials of 8 gestures
- Post-training testing phase records data for all gestures to be stored in S3, EC2 server performs cross accuracy tests

Classification Algorithm Performance: Sony Xperia (4x1.4 GHz Cortex-A53 & 2x1.8 GHz Cortex-A72)



- Comparison of calculation time for various computation platforms (AWS EC2 Server, Local PC, IOT Gateway, Android Devices) for LDA algorithm
- Calculations outside of Android devices send data via TCP/IP - Latency must be accounted for

Total Processing Time (LDA): Server vs. Local



Conclusions

- Our platform can predict gestures with high accuracy (95%) in under 10 milliseconds.
- Users reported the developed app responsive, aesthetic, and easy to use.
- Ongoing work includes integrating fog computing technology and developing gesture-controlled VR applications for stroke rehabilitation.

Acknowledgement

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