Surface Electromyography Processing System

Classifying Two Degrees-of-Freedom Wrist Motion

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Team

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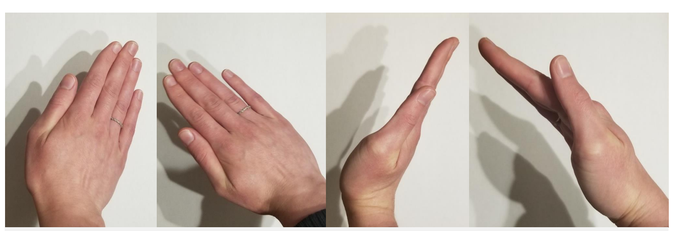
Problem

Functional, user-friendly and affordable prosthetics are a necessity. A functional prosthetic would closely emulate the missing extremity. This includes performing multiple motions simultaneously, such as twisting the wrist and flexing the hand. Unfortunately, according to prosthetist Andrew Curran, there are only a few upper-body prosthetics on the market that can recognize more than one degree of motion at the time.

Solution

Develop a surface Electromyography (sEMG) signal processing pipeline to recognize two degrees of freedom of wrist motions. These are a combination of ulnar/radial deviation and flexion/extension. This system is not a prosthetic, but a device that could with some modification be integrated into one.

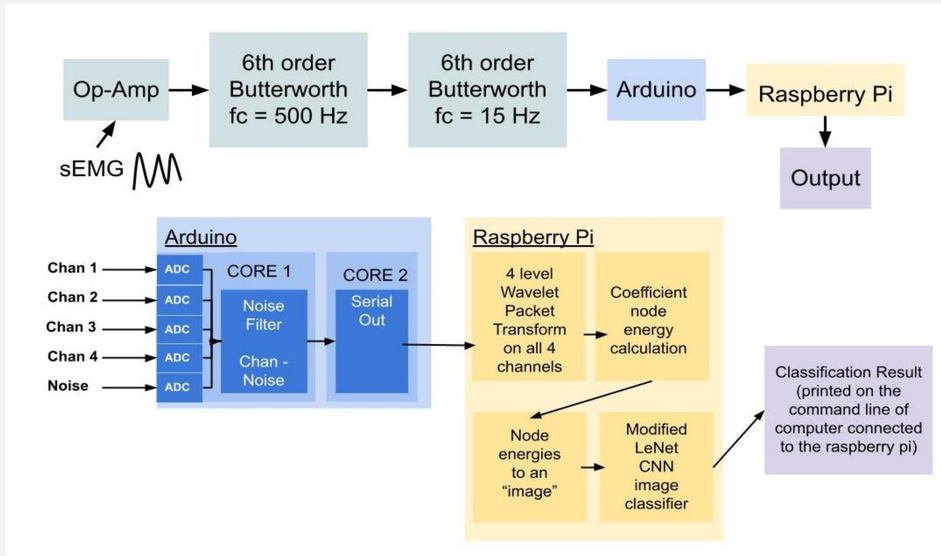


(From left to right) Ulnar Deviation, Radial Deviation, Flexion, Extension

System

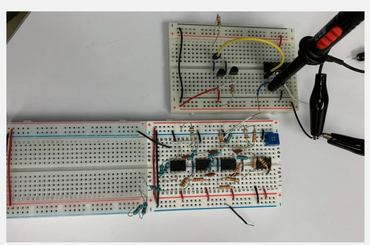
Requirements

1. Classification accuracy ≥ 90%
2. To acquire and process the signal takes at most 300 ms.



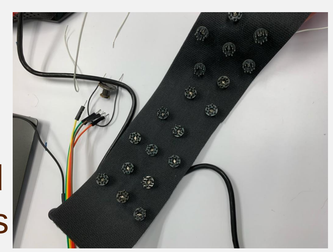
Results

- Created a separate software and hardware system
- Model accuracy = 70% Model trained to classify 4 motions with an online database that used 2 instead of 4 sEMG channels
- Inference with just a Raspberry PI 0 takes approximately 230 ms



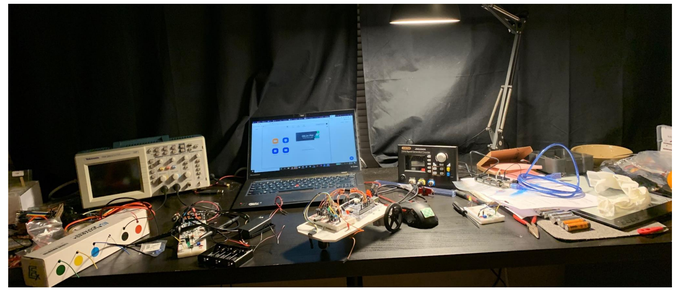
Filter Circuit

User armband with electrodes



Project Challenges

1. Lack of sEMG documentation and resources caused a delay in system implementation
2. Limited work-space and limited access to proper tools due to Covid
3. Difficulties integrating system components due to team members living in different locations
4. Remote environment hindered team communication and task completion



Path Forward

1. Integrate the software and hardware system to gather representative user data and retrain the LeNet model
2. Optimize the system to run in less then 300 ms
3. Improve the signal acquisition interface and classification result visualization
4. Improve the CNN model / develop a new model to classify more then 9 wrist motions