



Simultaneous Control of Multiple Degrees of Freedom in Upper-Limb Prosthesis

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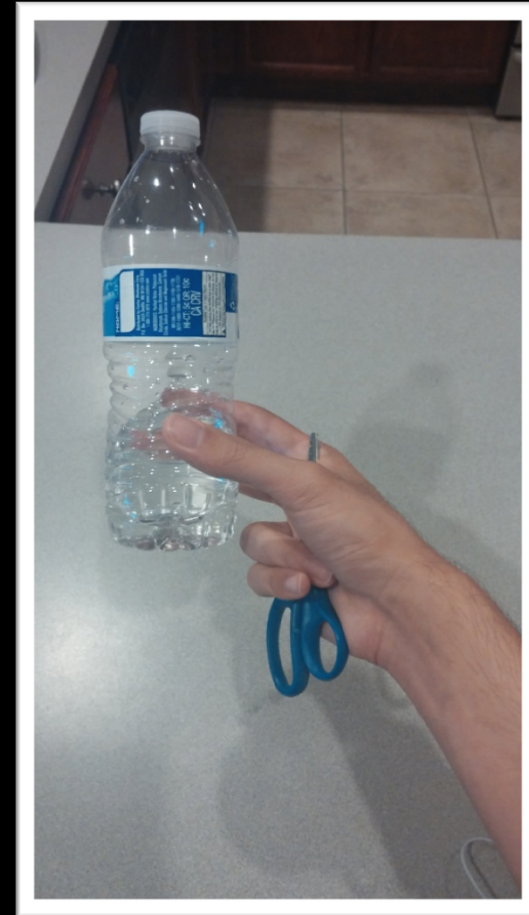
Current Prosthesis

- Expensive
- Not intuitive



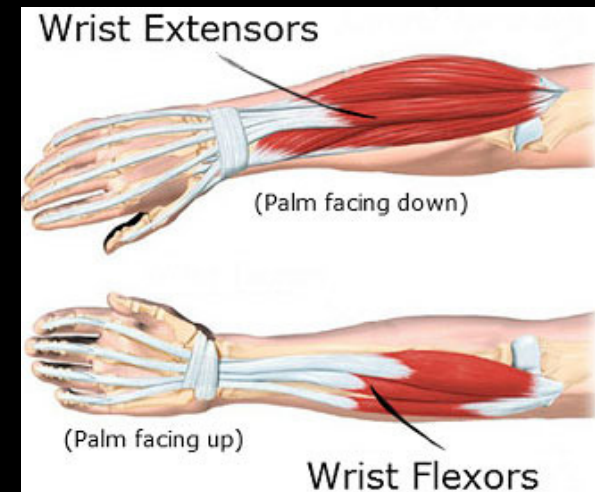
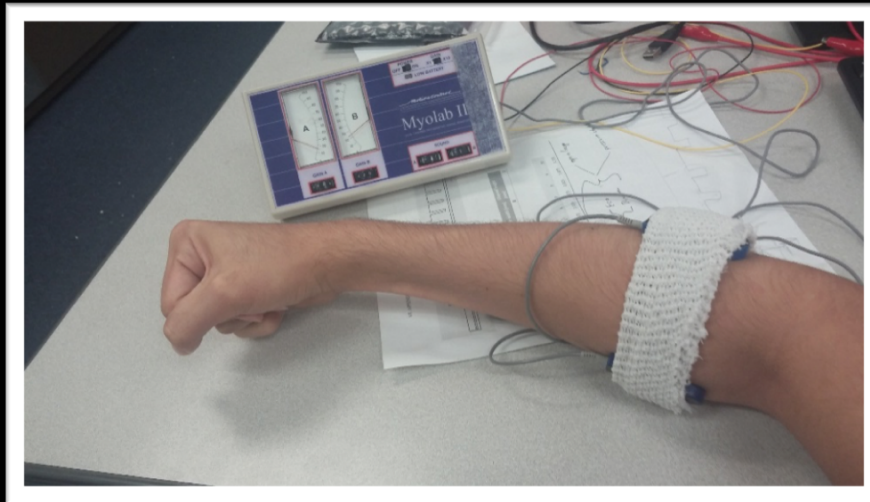
Multitasking

- Current prosthesis can only control a single degree of freedom at a time.



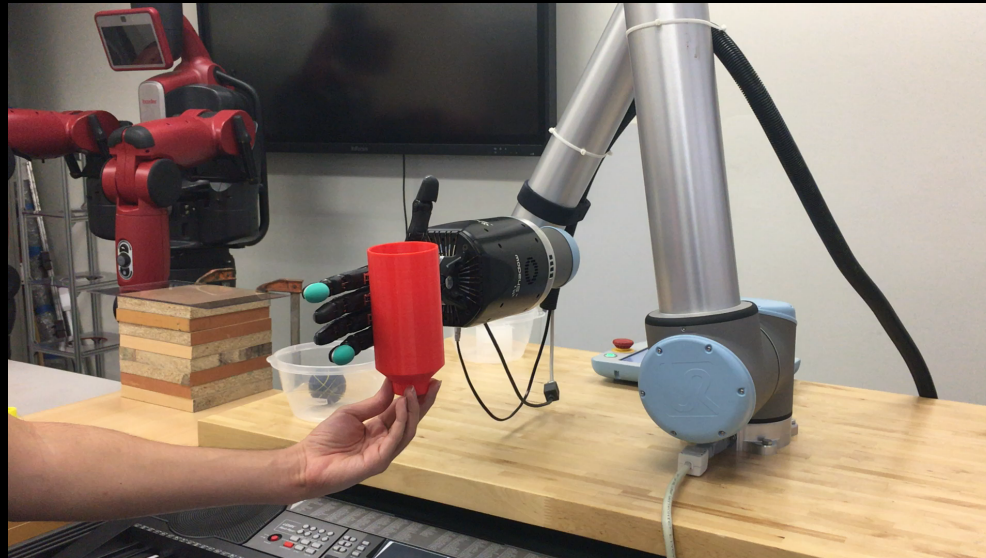
Electromyogram (EMG)

- Detects and quantifies muscle activation
- Most dual-site EMG use two preamplifier



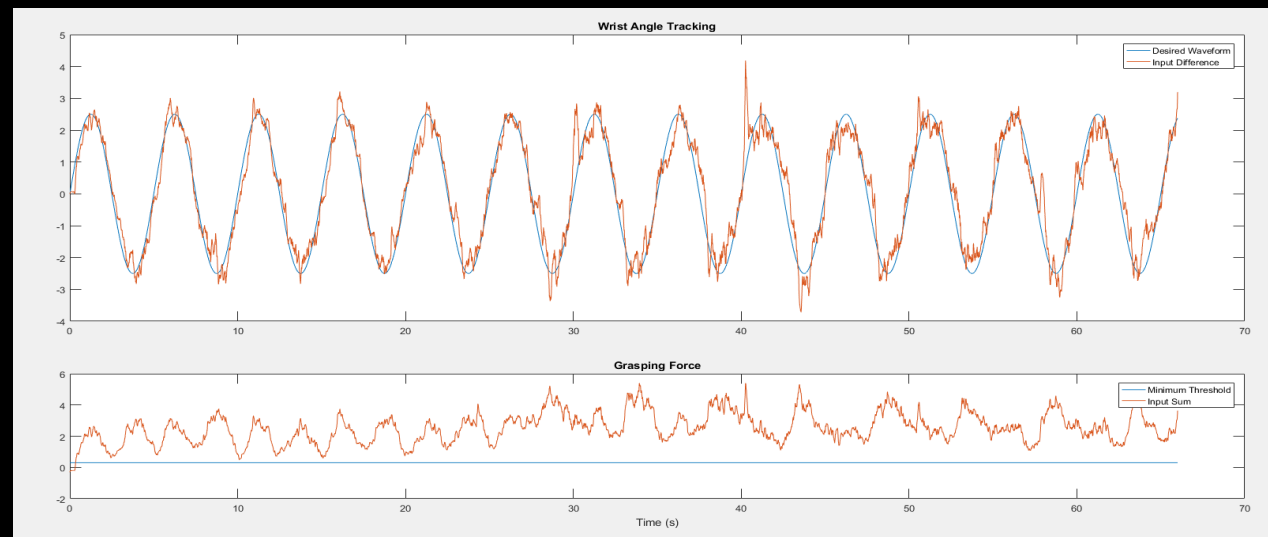
Simultaneous Wrist Angle-Grasp Synergy (SWAGS) Controller

- Uses the sum and difference of the two electrodes
- Wider range of inputs
- Direct control- two analog inputs from 0 to +
- SWAGS- one analog input from - to + and one analog input from 0 to +



EMG Training

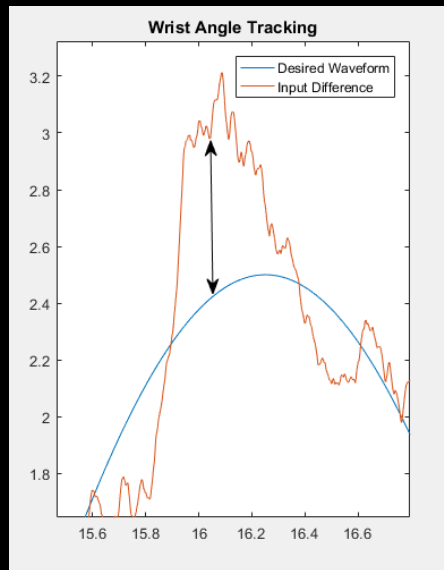
- New to EMG → Poor performance
- Difficult to assess SWAGS if user has no prior EMG experience
- Short training set of eight, 66 second trials to familiarize users



Error Metrics

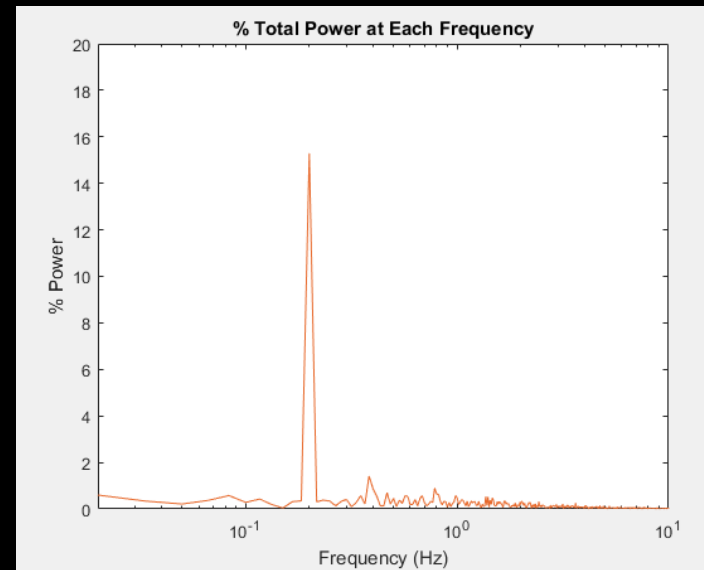
- How I define how well an individual performs

Mean absolute error



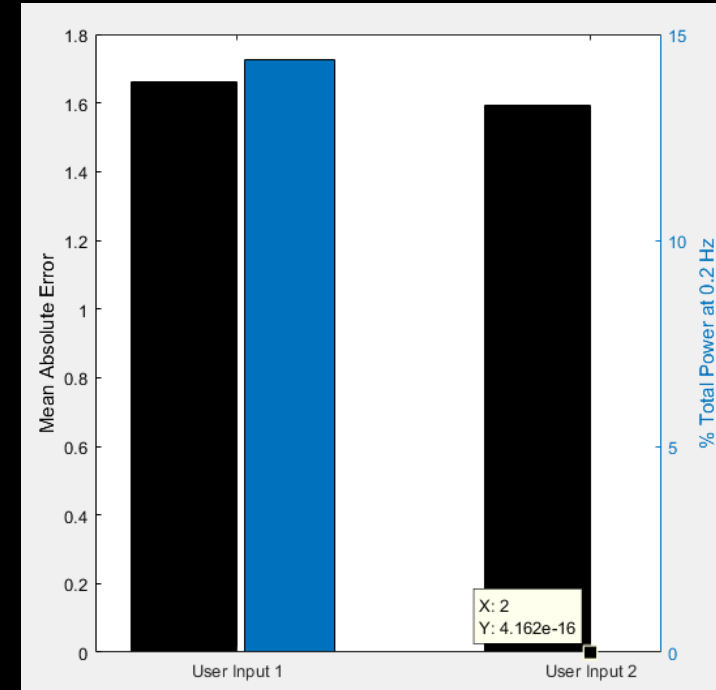
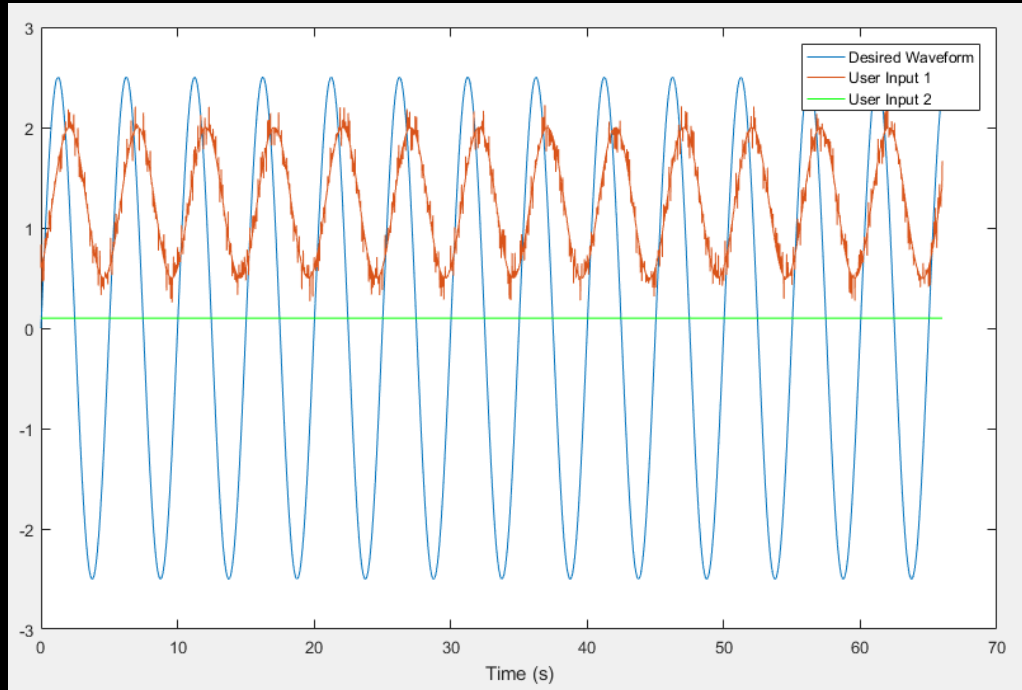
(smaller is better)

% Power at desired frequency



(larger at 0.2 Hz is better)

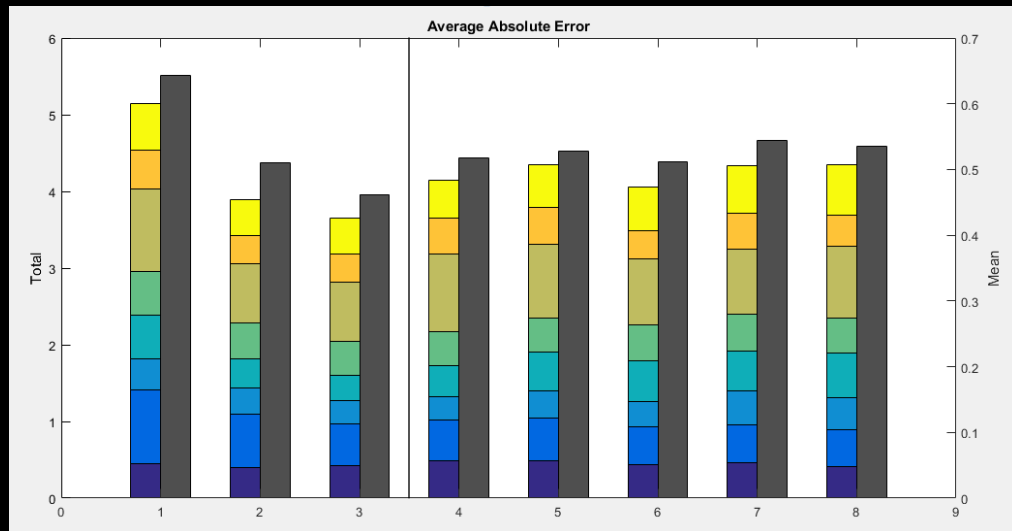
Frequency Spectrum Importance



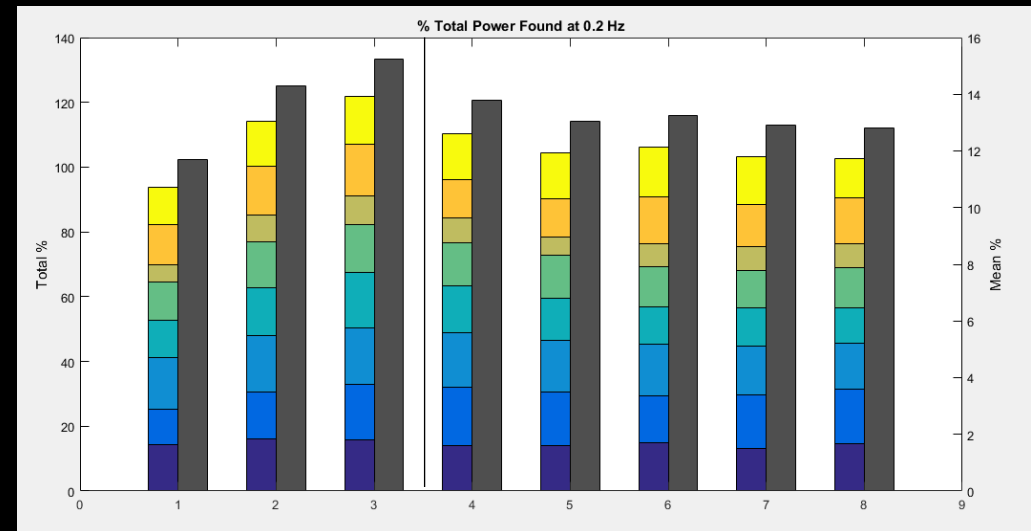
- The 2nd input has less mean absolute error than the 1st input, but is unusable as a control signal.

Training Results

- 8 IRB reviewed individuals
- Trials 1-3 only involve wrist tracking
- Trials 4-8 involve wrist tracking and grasping force

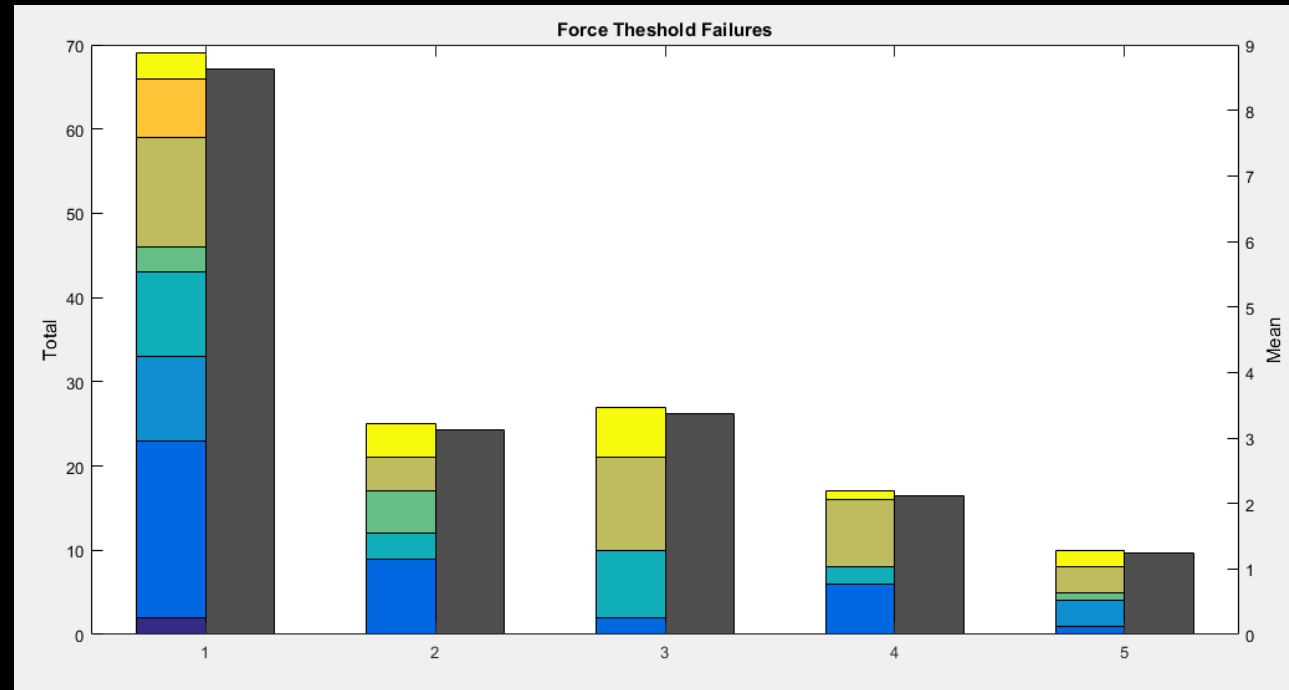


(smaller is better)



(larger is better)

Training Results



Training greatly improves user's ability to hold an object without dropping it.

Post-Training Prosthetic Use



Conclusion

- SWAGS has the potential to be a computationally inexpensive EMG control scheme that allows simultaneous control of 2 degrees of freedom.
- Most people will not be able to use EMG effectively without any prior training.
- A short training regimen greatly improves user ability.

Future Work

- Completion of artificial neural network to determine direction of slip
- Completion of haptic feedback mechanism to alert user of slip

