Differentiating Pinch and Grasp using Forearm sEMG

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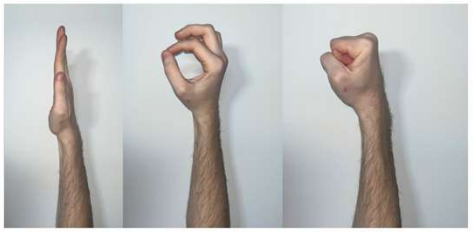
Introduction

SHFT Apparatus

- Dataset of 22 patients hand joint angles and sEMG
- 26 Activities of Daily Living (ADL)
- sEMG data from seven locations
- Hand recorded in 18 Degrees of Freedom (DOF)

CYBERGLOVE I

18 DOF Hand



Abstract

This paper applies sEMG enveloping, median frequency, and coherence to the Sollerman Hand Function Test Dataset recorded by Jarque Bou et al in order to differentiate sEMG activity during pinching and grasping tasks. Pinches and Grasps were found to cause very different activation patterns in sEMG spot 3 relating to flexion of digits I - V. Median frequency was found to be less correlated with differentiation and provided information about the degree of object manipulation performed during each task. Coherence was shown to increase between flexors and extensors with intensity of task, some spectral results correlated between finger flexor and extensor power spectra.

Methods

- MATLAB
- Comparison:
  - Activation
  - Joint Angle Motion
  - Power Spectra
  - Coherence

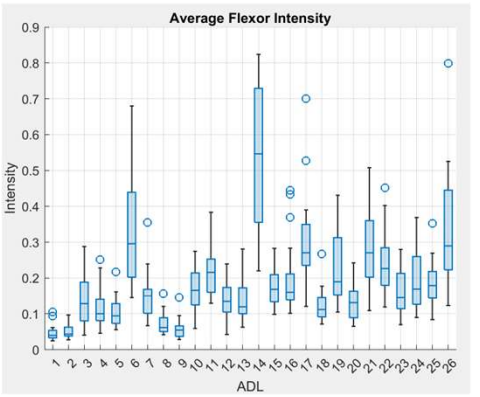
$$P_{tot} = \sum_{f=0}^{f_{max}} X^2(f)$$

$$\sum_{f=0}^{f_M} X^2(f) = \frac{1}{2} P_{tot}$$

$$CS[n,k] = \frac{|\sum_{i=0}^{L-1} X_i[n,k] Y_i^*[n,k]|^2}{\sum_{i=0}^{L-1} |X_i[n,k]|^2 \sum_{i=0}^{L-1} |Y_i[n,k]|^2}$$

$$S[n,k] = \sum_{i=0}^{L-1} |X_i[n,k]|^2$$

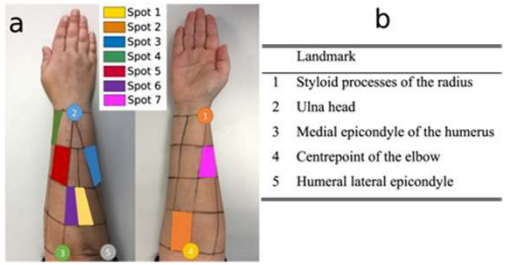
Jarque Bou Dataset



Average Flexor Intensity All ADL

Pinch and Grasp ADL

ADL	Description
1	Picking up and placing coins in a purse
3	Removing coins from the purse
6	Turning a screwdriver 360°
14	Cutting clay with a knife

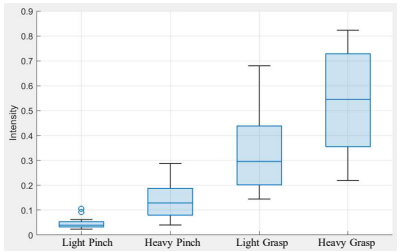


	Landmark
1	Styloid processes of the radius
2	Ulna head
3	Medial epicondyle of the humerus
4	Centrepoint of the elbow
5	Humeral lateral epicondyle

sEMG Sensor Locations

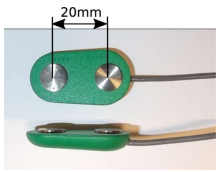
Results

Pinch ➡ Grasp



Task	Attributes
Pinch	Low Intensity Twitches Pinches tetanized when joint angles are held relatively constant
Grasp	High Intensity Tetanus Activation composed of tetanus with spikes in intensity Minima of tetanus was comparable to the maxima of a low intensity pinch

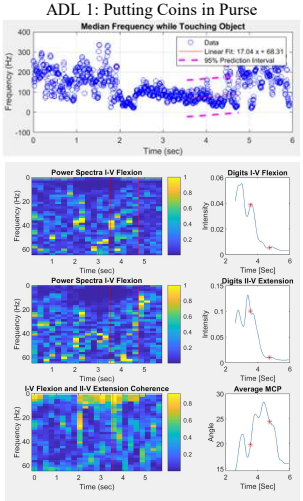
Spot	Action
3	Flexion I-V
4	Extension I
5	Extension II-V



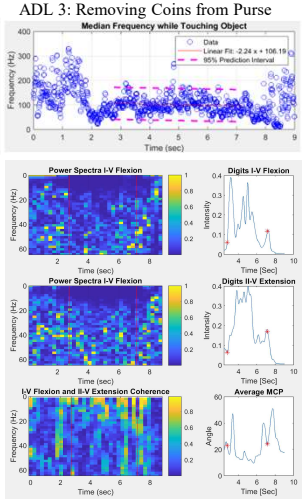
sEMG Sensor
(SX230 Electrode)

- Observe tasks of varying grasp strength
- Muscles correlated from spots to fingertip workspace
- Changes in intensity, power spectra and coherence observed

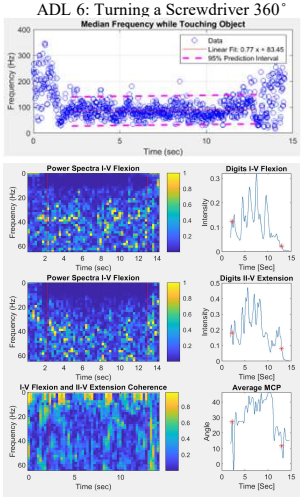
ADL 1: Putting Coins in Purse



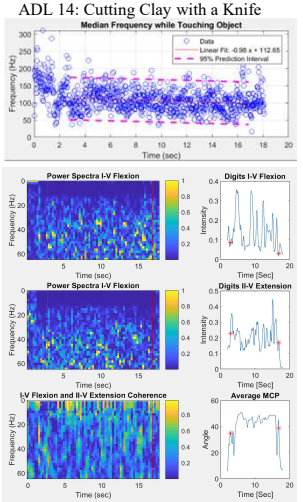
ADL 3: Removing Coins from Purse



ADL 6: Turning a Screwdriver 360°



ADL 14: Cutting Clay with a Knife



Conclusions

- Pinch and Grasp tasks were differentiated using sEMG activation from spot 3
- As forces required to perform tasks increased, intensity of activation increased
- Tasks where a high degree of object manipulation was required had higher median frequencies than those requiring stabilization
- Coherence results were subdivided into three categories
  - Mutual Source Coherence
  - Mutual Innervation
  - Anticipatory Activation

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