Master Thesis
Machine Learning For EMG Data

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1 Introduction

2 State of the art

2.1 EMG

- What is an EMG signal
- EMG and EEG
- EMG and ENG
  https://pubmed.ncbi.nlm.nih.gov/33091891/
  https://pubmed.ncbi.nlm.nih.gov/29498358/
- sEMG and iEMG sensor
- high density EMG
  https://www.sciencedirect.com/science/article/abs/pii/S1746809419302186
  https://pubmed.ncbi.nlm.nih.gov/22180516/

2.2 Myoelectric hand prosthesis

- Purpose
- Existing brands
  https://ieeexplore.ieee.org/document/8733629
  https://app.dimensions.ai/details/publication/pub.1112252996?and_facet_journal=jour.1041772
- Difficulties
  - limitation of non-invasive sensor
  - Lack of EMG data for amputees
  - Mirrored billateral training
    https://pubmed.ncbi.nlm.nih.gov/22180516/
    https://pubmed.ncbi.nlm.nih.gov/22006428/

2.3 Hand gesture prediction

- Applications (prosthetic, VR)
- Classification and regression

2.3.1 Gesture classification

- Classification techniques
  https://journals.physiology.org/doi/pdf/10.1152/jn.00555.2014
  https://www.nature.com/articles/s41551-016-0025
- Limitations

2.3.2 Movement regression (joint angle classification)

- Needed for a more natural feeling
- 27 degrees of freedom of the hand
- Regression techniques
  https://jneuroengrehab.biomedcentral.com/articles/10.1186/1743-0003-11-122
  https://www.hindawi.com/journals/isrn/2012/604314/
  https://pubmed.ncbi.nlm.nih.gov/22180516/

2.4 Existing data set of synchronized EMG and hand gesture data

- Which ones exist
  https://www.nature.com/articles/s41597-019-0285-1
  https://www.nature.com/articles/sdata201453
  https://jneuroengrehab.biomedcentral.com/articles/10.1186/1743-0003-11-122
- Data collection
  - Experimental setup
    - EMG sensor
    - Hand pose Estimation
  - Electrodes placement
    - Palpation
      https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0186132
      https://www.hindawi.com/journals/isrn/2012/604314/
    - Identified zones of activity
      https://jneuroengrehab.biomedcentral.com/articles/10.1186/s12984-018-0437-0
    - Arm band
      "CAMERA - GUIDED INTERPRETATION OF (56) NEUROMUSCULAR SIGNALS"
      from Facebook
      https://www.mdpi.com/2079-9292/9/12/2143/pdf
      https://www.mdpi.com/1424-8220/19/14/3170/pdf-vor
  - Gesture performed
    - Single finger motions
      https://www.researchgate.net/publication/341629918_Simultaneous_Hand_Gesture_Classification_and_Finger_
      Output_Deep_Learning_Model
    - Activities of daily living (ADL)
      https://www.tandfonline.com/doi/abs/10.3109/02844319509034334
    - Sign language
      https://www.mdpi.com/1424-8220/19/14/3170/pdf-vor
      https://www.mdpi.com/1424-8220/20/10/2972
      https://www.researchgate.net/publication/243769865_A_Sign_Language_Recognition_System_Using_Hidden_M
    - Irregular moves

    * Maximum voluntary contraction (MVC)
      https://pubmed.ncbi.nlm.nih.gov/29355119/

- Hand position data representation
  https://www.sciencedirect.com/science/article/abs/pii/S002192900400301X?via%3Dihub
- Synchronization
  https://www.researchgate.net/post/How_can_I_synchronize_EMG_and_acceleration_data

3 Realisation: Creation of a data set

3.1 Hand tracking using Oculus Quest

How Oculus uses AI for hand tracking : https://augmentedstartups.medium.com/how-oculus-uses-ai-for-hand-tracking-8d9eb8046029
Using deep neural networks for accurate hand-tracking on Oculus Quest : https://ai.facebook.com/blog/hand-tracking-deep-neural-networks
DeepHandsVR: Hand Interface Using Deep Learning in Immersive Virtual Reality: https://www.mdpi.com/2079-9292/9/11/1863
Handcrated and Deep Trackers: Recent Visual Object Tracking Approaches and Trends: https://arxiv.org/pdf/1812.07368.pd
Hand pose estimation : https://www.tensorflow.org/lite/models/pose_estimation/overview How Accurate is Oculus Quest 2 Hand-tracking Feature?: https://www.youtube.com/watch?v=g8fGShHy3MAab_channel=SpookyFairy
Hand Physics Lab: Hand Tracking Demos in Oculus Quest!: https://www.youtube.com/watch?v=J0KhC1GpLSQab_channel=
Hand physic lab: https://sidequestvr.com/app/750/hand-physics-lab

- Unity
- The OVR library
  https://developer.oculus.com/documentation/unity/unity-utilities-overview/
- Data collection
- Interface

3.2 Synchronization of EMG signals

- remote control
  - UTC
  - Trigger signal
- Experimental setup

3.3 Data collection protocol

https://github.com/MColot/MA-Thesis-Martin-Colot—Machine-learning-for-EMG-data/blob/master/notes/dataAcquisitio

- Chosen electrodes locations
- Chosen Gestures