Natalia Sempere 2025

Week 24

Tongue EMG XR Project

[Digital Future Events](#)
[XR inputs](#)
[CNN](#)
[7-Classes Online Classification](#)
[Next Week](#)

Digital Future Events

- Presented the project overview in the Kick-off Introduction Event.
- Visited Astra Zeneca in Södertäljeon on Friday.

XR inputs

- Researched common uses of EMG in XR and proposed a list of actions/effects. To be further discussed when the online classificator is ready.

CNN

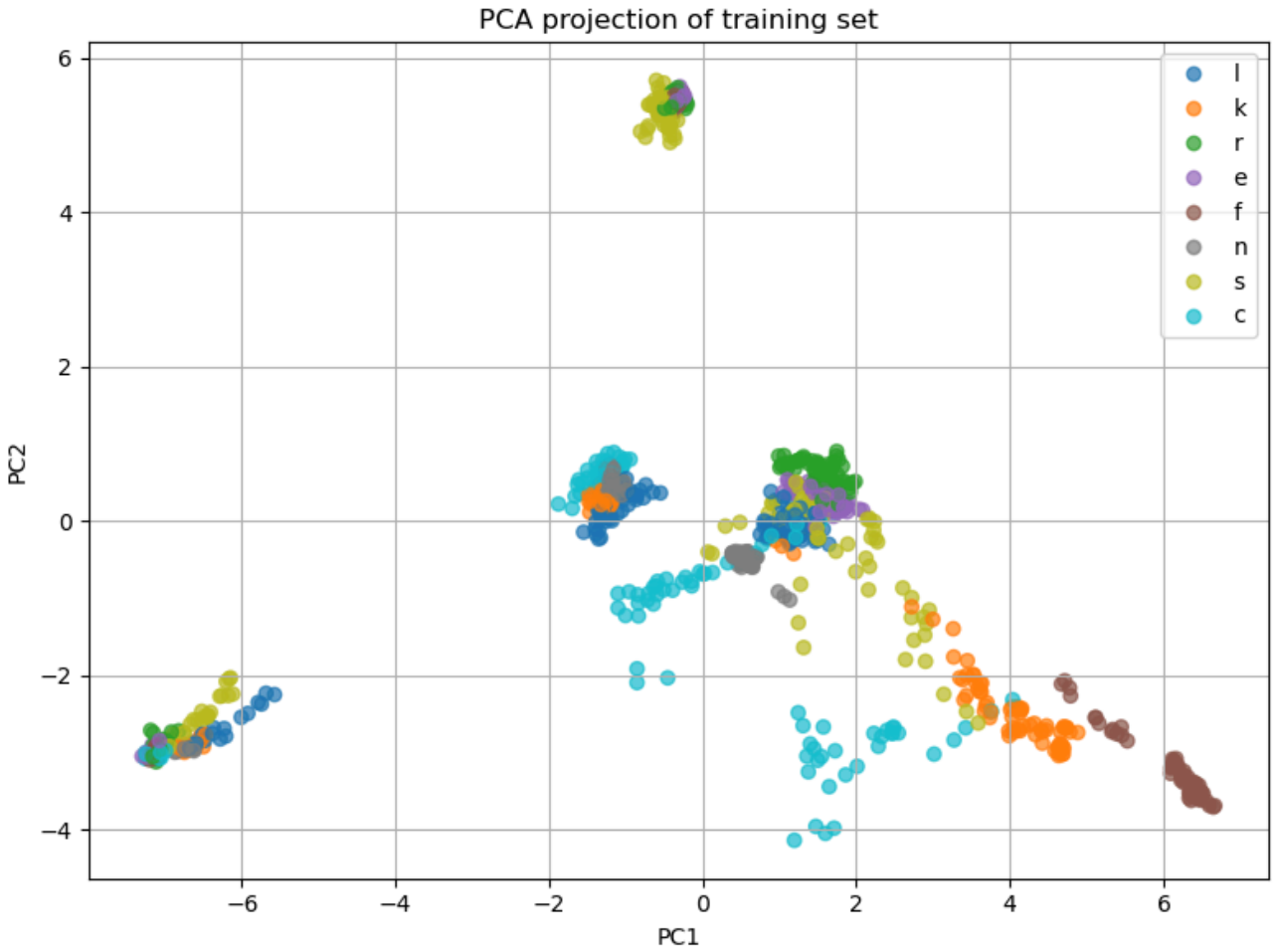
- Tested a simple CNN for 4-classes classification. The achieved accuracy was less than SVM **(CNN only reaches 53% in offline)**, so this option was dismissed for the early state of the project, as I believe many more than 20 samples per class would be needed. However, I don't have experience in CNNs, so this remains to be further discussed as a potential classificator in later states.

7-Classes Online Classification

- I am stuck in this section.
- I started recording 30 samples of each class: left, left-front, front, right-front, right, swallow, clench, none (equivalent to no movement). Then, I repeated the offline classification, obtaining **94.9% of offline accuracy.**
- While recording, I found the "clench" movement to be painful, so I removed one of the classes. This way, the **offline accuracy increased up to 97.7%.**

- The new trained Random Forest classifier was tested online, achieving around **15% of online accuracy.** Currently, I am trying to find the problem and increase the accuracy.
- **Training pipeline:**
    - Data is recorded with 3 channels in the submental area. **The movement is continuous, not discrete.**
    - Tested two approaches: (A) filtering the windows or (B) filtering the whole signal. Both reach similar offline accuracy. I selected the (A) approach because I have implemented the online classification with window segmentation.
    - For each annotation timestamp, create 5 windows with time offset [0, -2*offset, -offset, offset, 2*offset]. This way there are more windows to train.
    - Filter: bandpass. Removed Z-score.
    - Get features. Added 4 more features.
    - Predict with RF using feature scaling.
- **Testing pipeline (real and fake):**
    - **To avoid having to repeat the same movements, I faked the online accuracy test with one recording I didn't use for training.**
    - The pipeline is exactly the same as the training, using the saved classifier (RF) and the save feature scaler.
    - The windows are buffers of 250 samples, as in the training.
    - The next buffer is 150 samples overlapped with the previous buffer.
- **Things that I tried and didn't improve the online accuracy**
    - Recording exactly in the same tooth position and on the same day, one for training and one for testing.
    - I repeated all recordings with discrete movements (not continuous). I got high offline accuracy, but still bad online accuracy.
    - Adding even more features, removing feature scaling and adding Z-score.
    - Tried SVM and KNN.
    - Training with and without offset windows.
    - Changing the bandpass filter.
    - Filtering techniques from this paper: [Surface Electromyography Signal Processing and Classification Techniques - PMC]
- **Why is the online classifier not working properly? Possible reasons:**
    - The training data is actually clustering in different positions for the same label. According to the PCA analysis, it seems that the classifier is overfitting (see image below).

- The amplitude of the signals varies between recordings, even if done on the same day. I should find a way to normalise it.



Next Week

- [ ] Online classifier
  - [ ] Discover why the online classification is currently so bad.
  - [ ] Validate classifier generalizability (train/test split, cross-validation)
  - [ ] Test with other users.
- [ ] Unity XR setup
  - [ ] Discuss VR setup, inputs and actions. Should the user move around the VR world, control a UI or select/interact with an object?