Leveraging motor unit spatial activation patterns for channel selection in finger force regression

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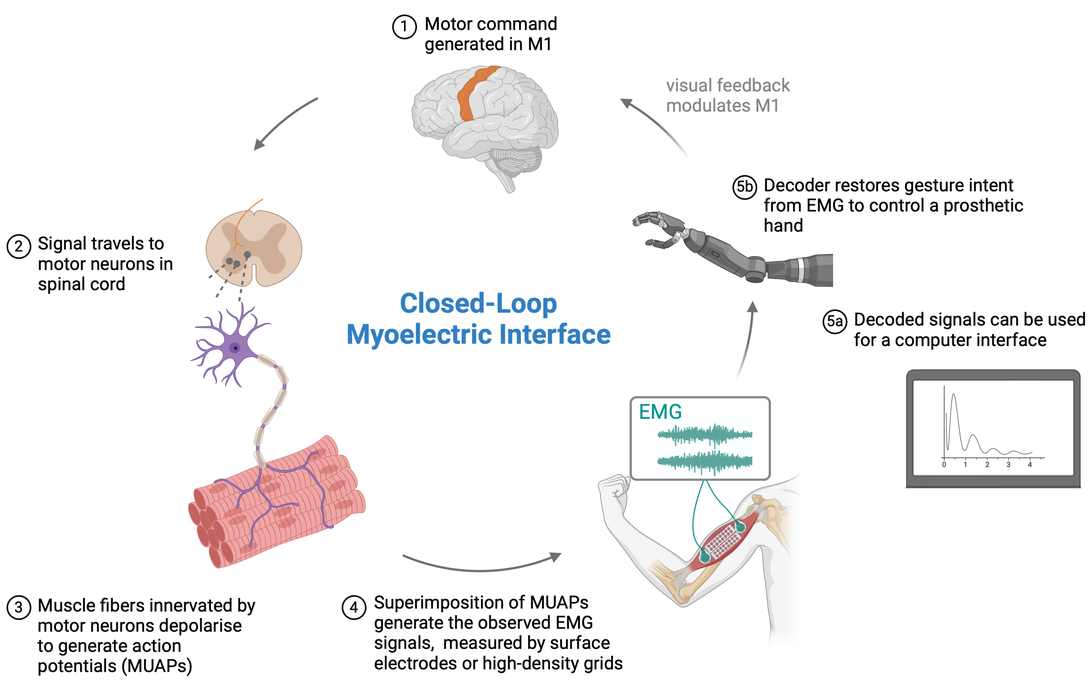

Figure 1: Surface electromyography (sEMG) records the electrical activity of skeletal muscles, enabling a non-invasive interface with the neuromuscular system. sEMG can be recorded with sparse electrode or, more recently, high-density electrode arrays [1].

HYSER RANDOM dataset setup

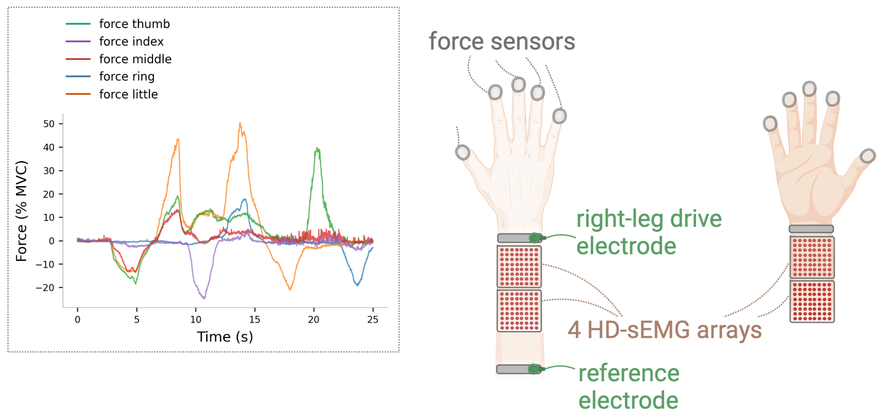

Figure 2: Twenty healthy subjects are fitted with four 8 x 8 sEMG electrode arrays. Individual finger forces are also recorded with five force sensors. Subjects performed five 25-second trials of free isometric finger contractions on two different days, without any prescribed force trajectories [2].

How many channels are sufficient for robust individual finger force estimation?

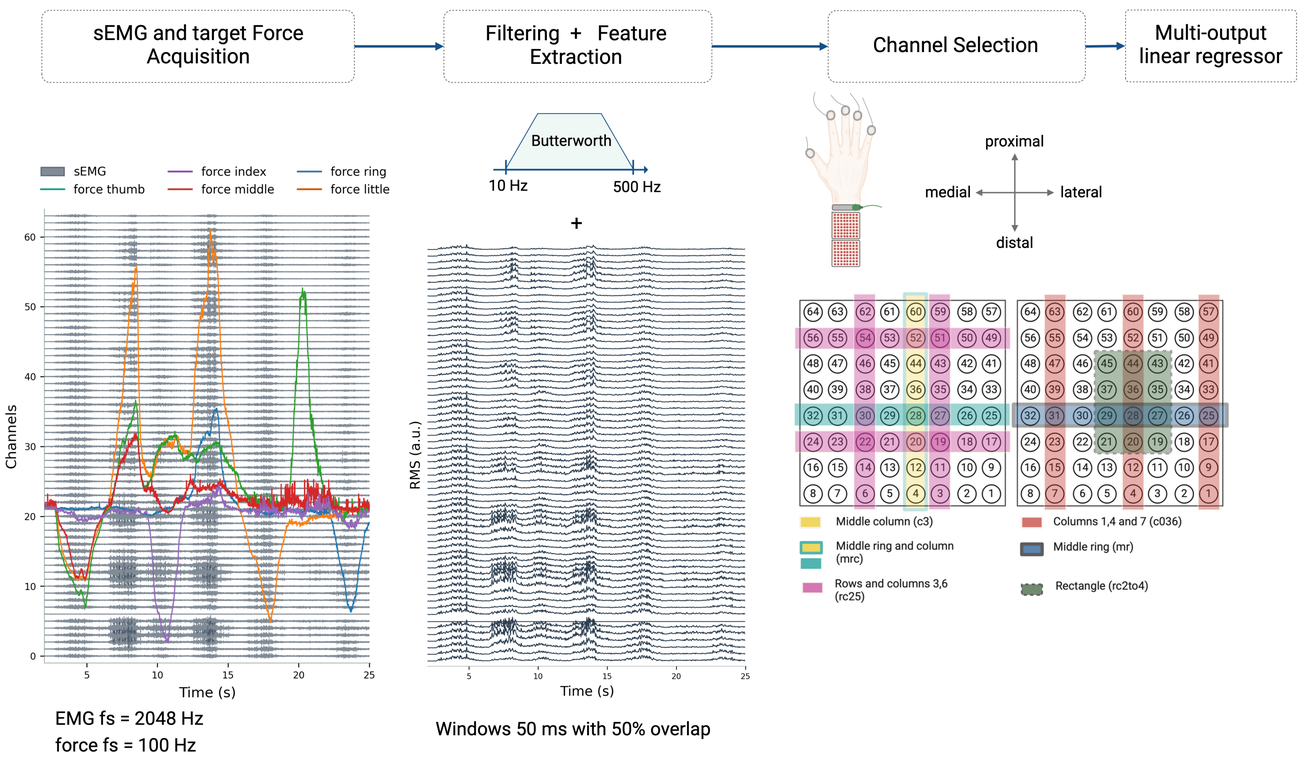

Figure 3: sEMG processing pipeline: sEMG signals are first filtered, RMS feature is extracted for each channel. Channels with large RMS are replaced by the mean RMS of their neighboring channels. Lastly, force decoding performances of multi-output linear regressors combined with the various channel selection strategies are compared.

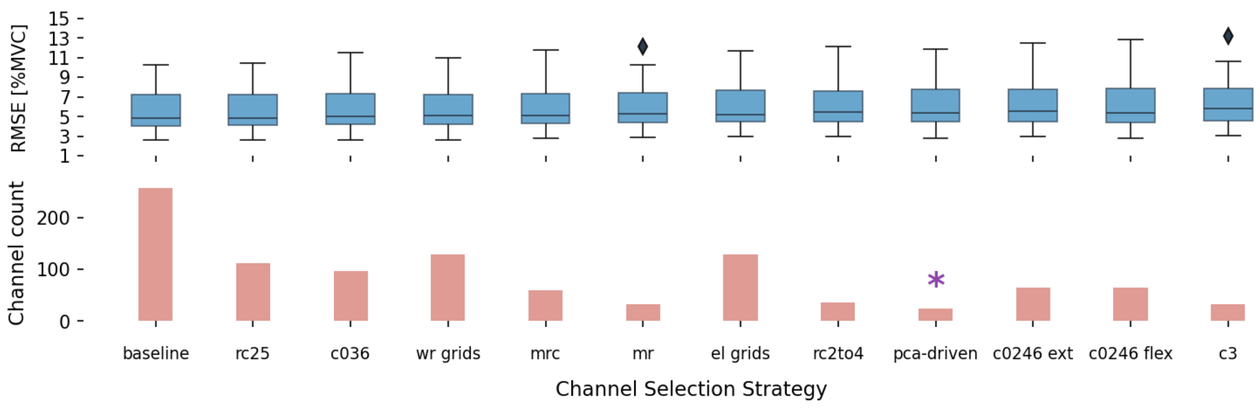

Figure 4: Distribution of mean cross-validation RMSE (top) and channel count (bottom) for each channel selection strategy. Cross-validation RMSE are averaged across the two days for all subjects. (*): PCA-based strategy yields varying channel counts across subjects and days.

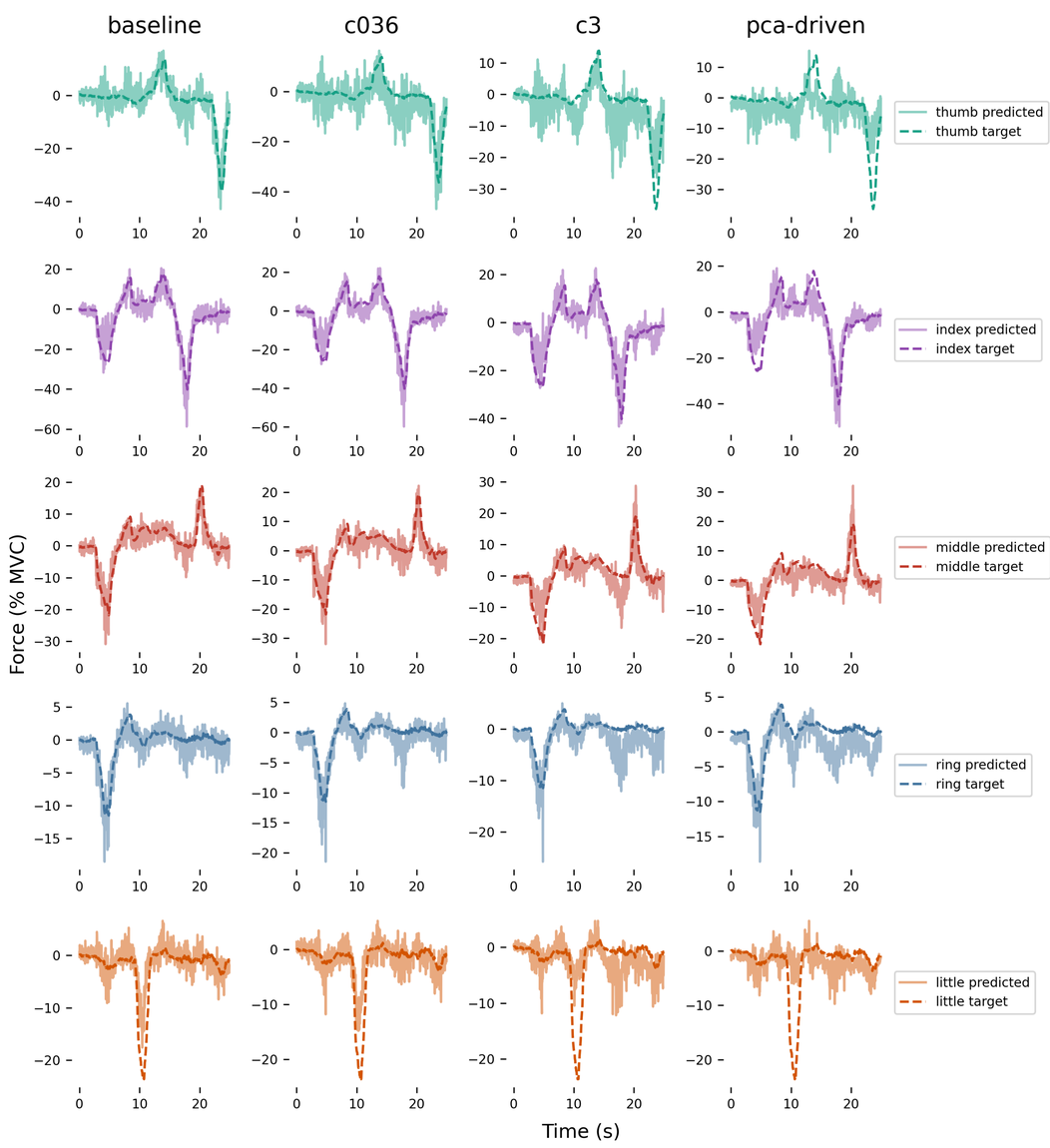

Figure 5: Representative force estimates for all 5 fingers (rows) for Subject 3, day 1 for a single repetition and different selection strategies (columns). Positive MVC indicates finger extension, while negative MVC refers to finger flexion.

Acknowledgement

- All illustrations are created with BioRender.com

References

[1] M. Rojas-Martinez, M. Mananas, and J. Alonso. “High-density surface EMG maps from upper-arm and forearm muscles”. In: *Journal of NeuroEngineering and Rehabilitation* 9 (2012).

[2] X. Jiang et al. “Open Access Dataset, Toolbox and Benchmark Processing Results of High-Density Surface Electromyogram Recordings”. In: *IEEE Trans. on Neural Systems and Rehabilitation Eng.* (2021).