Linking muscle activity and motion trajectory

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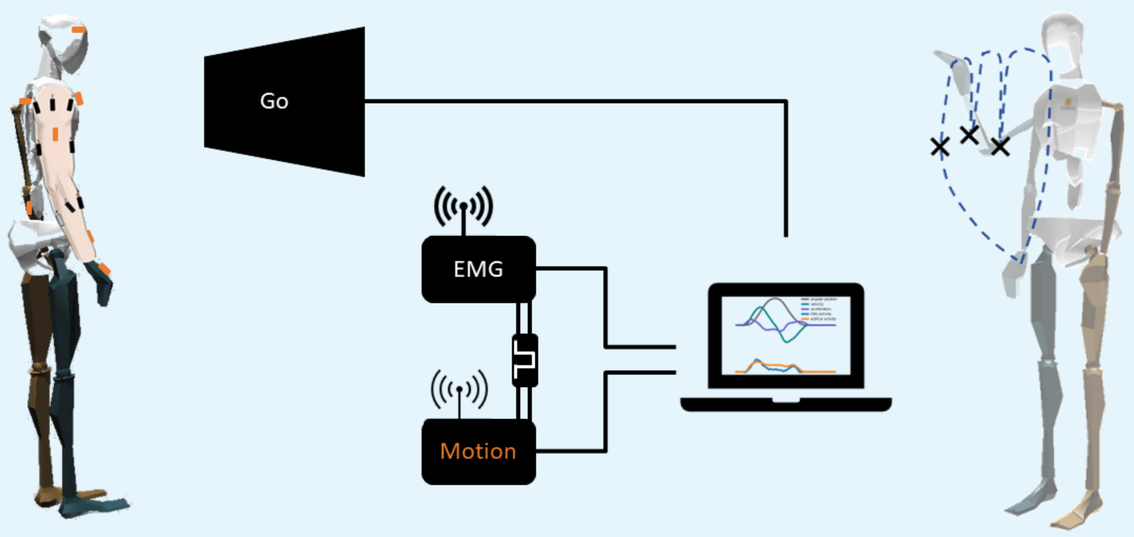
Motivation

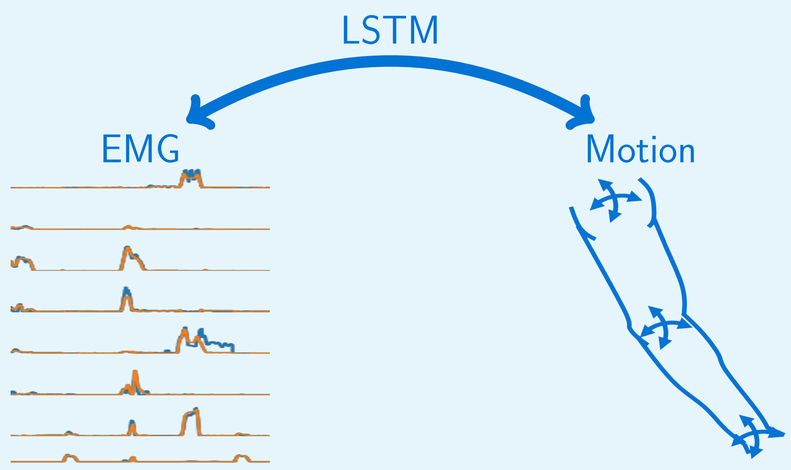
Human motion is very complex and flexible, and the mechanism behind is not yet fully understood. We propose a generative model that predicts the upper limb muscle activity driven by various motion parameters [1]. This model is motivated by the motion planning process in the central nervous system. This process incorporates the current body state from sensory systems and previous experiences, which might be represented as pre-learned inverse dynamics that generate associated muscle activity. We further demonstrate [2] that this model can also be used to predict the reverse from muscle activity to motion data, allowing motion intention prediction ideal for prosthetic control schemas.

Setup



- a total of **20** motions with **18** repetitions, 5 subjects

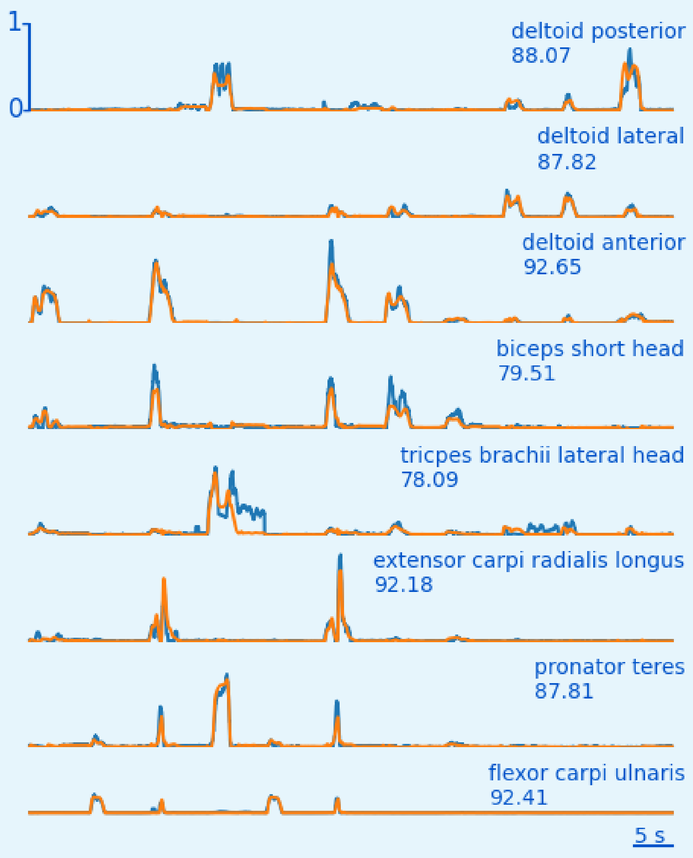
Method



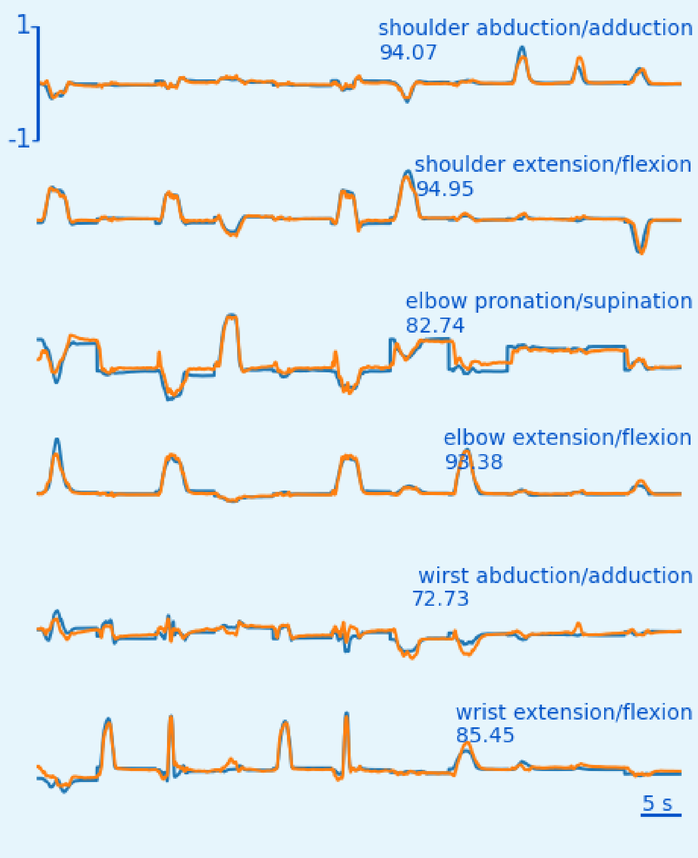
- motions includ simple 1D motions, combinations, and complex motions across multiple joints and DoF mimicing daily activities

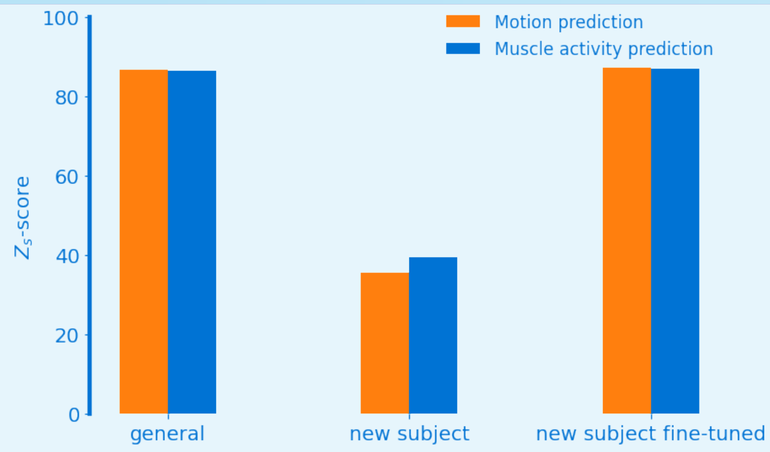
Results

motion to muscle



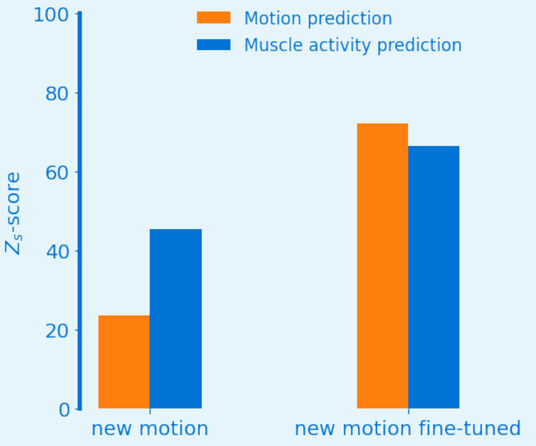
muscle to motion





$$Z_s = 100 \cdot \left(1 - \frac{\sum_{i=1}^{n}(y_i - x_i)^2}{\sum_{i=1}^{n}(y_i - 0)^2}\right)$$

Left: original muscle activity (blue) and generated data (orange). **Right:** original motion (blue) and generated data (orange), form the fine-tuned model.



Discussion

- These generative models can effectively predict muscle activity given kinematic parameters and vice versa
- The general model enables a good prediction across different subjects
- When it comes to prediction for new subjects, the fine-tuned model benefits significantly from the transfer learning approach
- Both models are able to generate artificial data for new motions
- Reversibility indicates a relation between angular motion and muscle activity

Reference and Acknowlegdment

[1] Marie Dominique Schmidt, Tobias Glasmachers und Ioannis Iossifidis. „From Motion to Muscle“. In: *arXiv preprint arXiv:2201.11501* (2022) [2] Marie Dominique Schmidt, Tobias Glassmachers und Ioannis Iossifidis. „From Muscle to Motion“. In: *progress* (2022)

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