High-gamma band event detection improves stability of finger trajectories decoded from ECoG-LMP activity

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Introduction: It has been repeatedly shown that finger movement trajectories can be decoded from electrocorticography (ECoG) grids placed on the hand motor cortex [1]. However, even state-of-the-art methods exhibit instabilities between finger movement events (see Fig. 1). We propose a novel methodology that improves stability by modulating trajectories predicted from Low Motor Potentials (LMPs) by movement-related events predicted from gamma band activity.

Methods: Two Block-Term Tensor Regression [2] models are trained, one on LMP (< 3.5 Hz) ECoGs with data glove trajectories, and another on high gamma band (> 60 Hz) ECoGs with binarized trajectories, yielding, respectively, single finger trajectory estimates $x_{lmp}(t)$ and $x_\gamma(t)$. Equation (1) summarizes how the trajectory of a given finger is corrected into $y(t)$ using thresholded $x_\gamma(t)$ estimates:

$$y(t) = f\big(x_{lmp}(t), x_\gamma(t)\big) = \begin{cases} C, & x_\gamma(t) \le \text{threshold} \\ x_{lmp}(t) \times x_\gamma(t), & x_\gamma(t) > \text{threshold} \end{cases} \qquad (1)$$

with C and the threshold subject- and finger-dependent parameters estimated through cross-validation thereby optimizing the cross-correlation between predicted and expected trajectories.

Results: The proposed method, when applied to Dataset 4 of BCI competition IV [3] with ECoG recordings of rapid single finger repetitions, yielded an average correlation coefficient of 0.56, in line with the state-of-the-art relying on multiband ECoG activity [2] or, in addition, on Riemannian-space features [4]. However, the stability during rest is quite different (Fig. 1). For example, for subject 1, the proposed method returns an average variance of 0.011, which is much lower than the 0.03 variance of decoder [2].

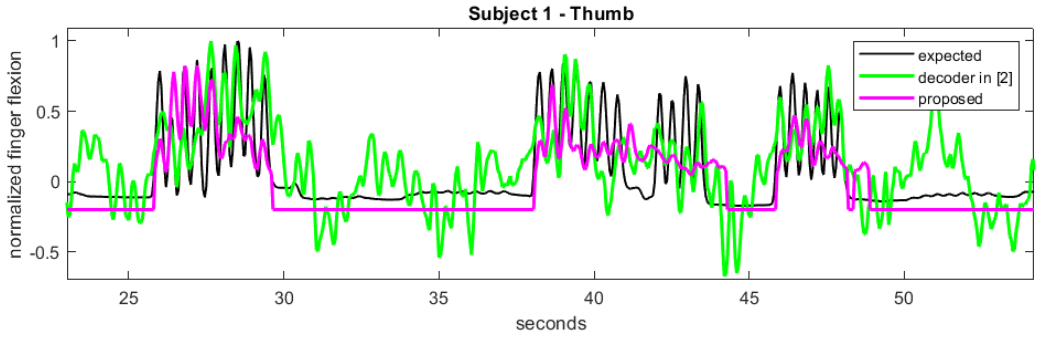

Figure 1: *Expected thumb trajectory (black) and trajectories decoded using the proposed (pink) and the state-of-the-art method [2].*

Discussion: The improvements in stability obtained by the proposed method suggest that high gamma band activity distinguishes rapid finger movements from rest whereas LMPs codes for finger trajectories.

References

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