DOI: 10.3217/978-3-85125-962-9-113

Decoding hand kinematics from brain-wide distributed neural recordings

M.C. Ottenhoff[1*], M. Verwoert[1], S. Goulis[1], A. Colon[2], P. Kubben[1], M. Shanechi[3], O. Sani[3] and C. Herff[1]

[1]Neurosurgery, School of Mental Health and Neuroscience, Maastricht University, Maastricht, Netherlands
[2]Epilepsy Center Kempenhaeghe, Kempenhaeghe, Netherlands
[3]Ming Hsieh Department of Electrical Engineering, Viterbi School of Engineering, University of Southern California, Los Angeles, California, USA
*Universiteitssingel 50, 6229ER Maastricht, Netherlands. E-mail: m.ottenhoff@maastrichtuniversity.nl

Introduction: Recent studies suggest that the cortical homunculus is ready for an update.[1] It seems as though several body integration centers exist within the motor cortex that receive input from areas distributed throughout the brain.[1] These integration centers contain highly decodable information[2], raising the question whether the areas that provide input to these centers contain similarly decodable information. In previous work, we started to explore whether it is possible to decode movement-related information from distributed recordings[3] and show that this is indeed possible for both executed and imagined movements. Here, we extend this work from a trial-based classification problem to continuous decoding of hand kinematics using depth electrodes implanted throughout the brain.

Materials, Methods and Results: We developed a continuous movement task in which the participant had to move their hand to target locations in a 3D space using an UltraLeap motion tracker. The targets were displayed on a screen, where the size of the cursor determined the depth axis (towards and away from the screen). We included multiple participants implanted with multiple depth electrodes for their epilepsy clinical treatment. We recorded as much data as possible per patient over multiple sessions, depending on available time, skill and participant well-being (minimum of 25 targets). After preprocessing, we trained and reconstructed hand kinematics using the preferential subspace identification algorithm[4], and reached reconstruction correlations significantly above chance.

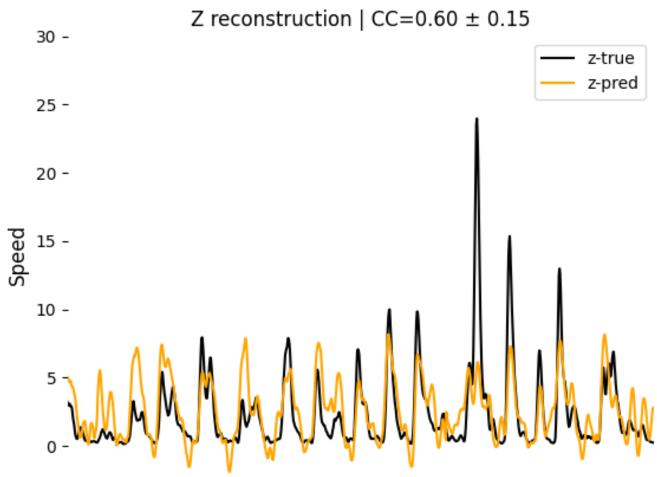

Figure 1. Example speed reconstruction of one participant.

Discussion: These preliminary results suggest that continuous decoding of hand kinematics is possible from distributed recordings. Variations in decoding performance indicate that some areas contain more information relevant to continuous hand movements compared with other regions. However, even for some participants where correlations between the neural signal and hand trajectory were low, the decoder was able to achieve significantly above chance performance.

Significance: The results may identify new brain areas that contain movement-related information, as well as uncover decodable distributed motor-related networks.

1. Gordon, E. M. *et al.* A mind-body interface alternates with effector-specific regions in motor cortex. 2022.10.26.513940 Preprint at https://doi.org/10.1101/2022.10.26.513940 (2022).
2. Willett, F. R., Avansino, D. T., Hochberg, L. R., Henderson, J. M. & Shenoy, K. V. High-performance brain-to-text communication via handwriting. *Nature* **593**, 249–254 (2021).
3. Ottenhoff, M. C. *et al.* Executed and imagined grasping movements can be decoded from lower dimensional representation of distributed non-motor brain areas. 2022.07.04.498676 Preprint at https://doi.org/10.1101/2022.07.04.498676 (2022).
4. Sani, O. G., Abbaspourazad, H., Wong, Y. T., Pesaran, B. & Shanechi, M. M. Modeling behaviorally relevant neural dynamics enabled by preferential subspace identification. *Nat. Neurosci.* **24**, 140–149 (2021).

Article ID: 144500