 DOI: 10.3217/978-3-99161-050-2-184

Intraoperative detection and classification of speech neural signals using the Layer 7 Cortical Interface

Shiyu Luo[1], Miguel Angrick[1], Kurt Lehner[1], Katrina Barth[2], Jackie Dister[2], Josh Miller[2], Daniel N. Candrea[1], Rohit Ganji[1], Elton Ho[2], Benjamin Rapoport[2], Youssef Comair[1], Nathan E. Crone[1,*]

[1]Johns Hopkins University, Baltimore, MD; [2]Precision Neuroscience, New York City, NY

*600 N. Wolfe Street, Baltimore, MD. E-mail: ncone@jhmi.edu

Introduction: Brain-computer interfaces (BCIs) based on electrocorticography (ECoG) have seen broadening usage in clinical trials to augment and restore communication and control abilities for severely paralyzed individuals [1, 2]. Previous studies have shown that increased density of the electrodes can contribute to higher decoding accuracy from intraoperative data [3]. For these high-density grids, locating the ideal implantation site can be crucial for obtaining relevant information for decoding. It is therefore important to develop methods that can help assess implantation success and guide grid repositioning if necessary. This requires training and testing neural decoding models in real time during implantation surgery. However, it is not yet known whether detecting and classifying speech is possible in real time during awake surgery using high-density µECoG grids.

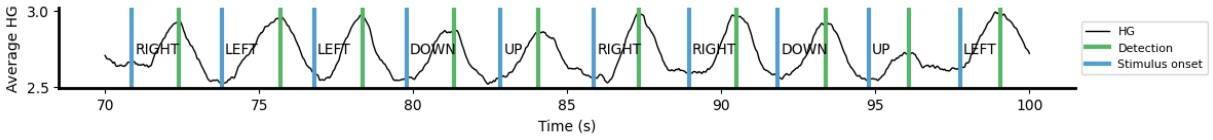

Figure 1. Example of real-time speech detection results. Black trace is the average high gamma (HG) energy across all channels. Blue vertical lines represent stimulus onset, Green vertical lines represent detection.

Material, Methods, and Results: The 1024-channel Layer 7 Cortical Interface (Precision Neuroscience, NY, [4]) was temporarily placed on ~1.5 cm^2 of the face motor area of a participant with no speech impairments during an awake craniotomy for tumor resection. The participant performed a word repetition task where they spoke one of four words out loud. An online speech detection model was designed to identify energy increases in the high-gamma band (70-170 Hz). A real-time classification pipeline was developed to segment the trials, train a neural network model with the growing dataset online, and make classification decisions with the best available model at that time.

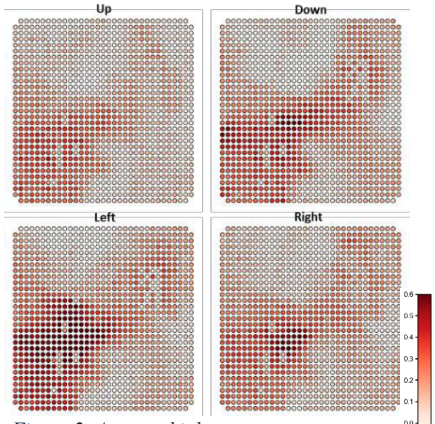

Figure 2. Average high gamma energy across trials for each stimulus.

Conclusion: Real-time speech detection and classification is feasible using the Layer 7 cortical interface in a data-limited setting such as awake neurosurgical procedures.

Acknowledgments and Disclosures: We would like to thank the study participants who volunteered their time for this study. KB, JD, JM, EH, and BR have a financial interest in Precision Neuroscience.

References:

[1] S. L. Metzger *et al.*, "A high-performance neuroprosthesis for speech decoding and avatar control," *Nature*, vol. 620, no. 7976, Art. no. 7976, Aug. 2023, doi: 10.1038/s41586-023-06443-4.
[2] M. J. Vansteensel *et al.*, "Longevity of a Brain–Computer Interface for Amyotrophic Lateral Sclerosis," *New England Journal of Medicine*, vol. 391, no. 7, pp. 619–626, Aug. 2024, doi: 10.1056/NEJMoa2314598.
[3] S. Duraivel *et al.*, "High-resolution neural recordings improve the accuracy of speech decoding," *Nat Commun*, vol. 14, no. 1, p. 6938, Nov. 2023, doi: 10.1038/s41467-023-42555-1.
[4] M. Hettick *et al.*, "The Layer 7 Cortical Interface: A Scalable and Minimally Invasive Brain–Computer Interface Platform," Jan. 30, 2024, *bioRxiv*. doi: 10.1101/2022.01.02.474656.

Published by Verlag der Technischen Universität Graz