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Presentation Title: Intra- and inter-subject variability of synchrony for current and optimal Laplacian estimates using t-Lead electrodes on human electroencephalogram data

Research Focus: Biomedical Engineering

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Abstract:

Recent research showed that optimal coefficients (6, -1) maximizing the accuracy of Laplacian estimation via tripolar concentric ring electrode (CRE), with dimensions similar to those of t-Lead (CREmedical, Kingston, RI), differ from currently used coefficients (16, -1) [1]. To assess the impact of this difference, linear time and frequency domain synchrony measures were applied to resting electroencephalogram from six healthy subjects revealing high signal synchrony [2]. Two bipolar Laplacian estimates (each ring minus the central disc) were also added to the analysis. The aim of this study was to address one of the future work directions from [2] to assess intra- versus inter-subject variability in both signal synchrony measures for the three comparison pairs involving Laplacian estimate via the larger bipolar CRE since they corresponded to the highest standard deviation values [2]. This is significant not just in terms of confirming consistency with results obtained in [2] but also in terms of demonstrating that even in case of greater variation it is not inter-subject that might have indicated an issue with this dataset.

The resting human electroencephalogram dataset was adopted from [2]. Intra- and inter-subject variability were assessed using individual boxplots for each subject. A boxplot is a graph of data sets consisting of a line extending from the minimum to a maximum value, with three quartiles represented by a box.

Overall results were consistent with those obtained in [2]. Even higher consistency in maximum cross-correlation and average full spectrum coherence values was observed between the subjects than in the case of optimal versus suboptimal tripolar Laplacian estimates. This further indicates

that most of the variation in the data might be intra-subject (i.e. between data segments for individual subjects) rather than inter-subject (i.e. between human subjects), despite the higher variation/standard deviation in these three comparison pairs. Maximum cross-correlation for subject 4 appears to be higher than those corresponding to the rest of the subjects same as in [2]. Moreover, subject 5 consistently corresponded to the highest average full spectrum coherence. Furthermore, the lowest values for both maximum cross-correlation and average full spectrum coherence were observed for subject 6. Finally, subjects with highest and lowest intra-subject variation differed widely across the dataset (maximum cross-correlation: subjects 3 versus 1 respectively, average full spectrum coherence: subjects 5 versus 4 respectively).

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[1] O. Makeyev, Y. Ye-Lin, G. Prats-Boluda, and J. Garcia-Casado, “Optimizing Laplacian Estimation for the Finite Dimensions Model of a Commercial Tripolar Concentric Ring Electrode and Comparing It to the Optimal Electrode Configuration via Finite Element Method Model-ing,” presented at the 9th International Electronic Conference on Sensors and Applications session Applications, 2022. Accessed: Oct. 11, 2023. [Online]. Available: https://sciforum.net/manuscripts/13324/manuscript.pdf

[2] A. Benally, O. Makeyev, Y. Ye-Lin, G. Prats-Boluda, and J. Garcia-Casado, “Time and Frequency Domain Synchrony of Current and Optimal Laplacian Estimates via T-Lead Electrodes on Human Electroencephalogram Data,” in *2024 IEEE Sensors Applications Symposium (SAS)*, Jul. 2024, pp. 1–5. doi: 10.1109/SAS60918.2024.10636394.