POSTER
Presentation

Current Versus Optimal Laplacian Estimates via t-Lead Electrodes on Human Electroencephalogram Data

Research Focus: Biomedical Engineering
Presenter: Alana R. Benally, Student
Institution: Diné College
Faculty Mentor and Institution: Oleksandr Makeyev
Author List: Alana Benally[1], Oleksandr Makeyev[1], Yiyao Ye-Lin[2], Gema Prats-Boluda[2], and Javier Garcia-Casado[2]
1. School of STEM, Diné College; 2. Centro de Investigación e Innovación en Bioingeniería (CI2B), Universitat Politècnica de València

Abstract:

t-Lead is a commercial tripolar concentric ring electrode (CREmedical, Kingston, RI, USA), specifically designed for noninvasive electrophysiological measurement applications, including studies involving human subjects. Utilizing the unique ability of concentric ring electrodes to estimate the second spatial derivative (surface Laplacian) at each individual electrode by combining differential voltages recorded between the central disc and the rings with specific coefficients makes them of significant importance in biomedicine. Our recent research showed that optimal coefficients (6,-1) for the electrodes with dimensions similar to the t-Lead are different from the currently used coefficients (16,-1) [1]. This study applies time and frequency domain (cross-correlation and coherence respectively) synchrony measures to human electroencephalogram data to assess the difference due to current and optimal coefficients. This is important since diagnostic value may be impacted by the differences in the estimated Laplacian signal. Two bipolar Laplacian estimates (each ring minus the central disc) were also added to the analysis.

The resting EEG data for six healthy human subjects was adopted from [2], [3]. Cross-correlation coefficients were calculated at lag zero as well as at the optimal lag to account for any time delay between signals. The coherence coefficients corresponding to the frequency range of 1-100Hz were averaged for each segment using Welch's averaged modified periodogram method with an overlapping (50%) Hanning window. Six pairwise comparisons including all combinations of optimal and suboptimal tripolar as well as larger and smaller bipolar Laplacian estimates were performed. Three of the comparisons resulted in very high average cross-correlation and coherence (0.9 to 1.0) while remaining three (all including larger bipolar estimate) did not.

High signal synchrony between tripolar Laplacian estimates could indicate that the difference due to optimal and suboptimal coefficients may not be significant though further investigation is required going beyond synchrony measures. Results for larger bipolar Laplacian estimate are consistent with prior results of Laplacian estimation accuracy increasing as the electrode size decreases.