

Rescuing Semi-Dry EEG Signals: Comparing Denoising Methods

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With the rapid advancement of clinical neuroscience and Brain-Computer Interfaces, there is an increasing demand for convenient, patient-friendly EEG acquisition methods suitable for diverse environments. Traditional gel-based EEG systems, while reliable, are often cumbersome and time-consuming, whereas dry electrode systems tend to suffer from elevated noise levels. In a previous study, we found that wetting the hair with water (hereafter referred to as the wet condition) significantly reduces electrode impedance and improves both spectral power and functional connectivity measures relative to dry electrode application. In the present study, we systematically evaluated four EEG denoising pipelines under the wet condition. Twenty-two healthy participants underwent resting-state EEG recordings during eyes-open and eyes-closed conditions using wet and gel electrode setups. Each condition included 5 minutes with eyes open and 5 minutes with eyes closed. Gel-based EEG data were manually preprocessed and cleaned using ICA and served as the reference. Four denoising pipelines were applied to the wet EEG data: HAPPE ¹, GEDAI ³, ASR, and pyLossless. Performance was assessed using spectral power, phase-locking value (PLV)-based functional connectivity, and microstate similarity. The results showed that GEDAI cleaned wet data (wet_GEDAI) exhibited the greatest overlap with the gel reference in spectral power. Topographic analyses of the EC/EO alpha-band power ratio showed that wet_GEDAI was the only pipeline showing no significant different channels from gel. Furthermore, wet_GEDAI demonstrated the highest similarity to the gel in PLV connectivity, and produced individual microstate templates with the strongest correlation to the grand mean microstate maps obtained from gel EEG.

References/Citations

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