Unified Fusion Network Model for EEG Signals

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Abstract

Advancements in brain-computer interface (BCI) technology emphasize the need to understand brain signals in emotions and social interactions. Electroencephalograms (EEG) are essential for analyzing brain activity and diagnosing neurological disorders but suffer from low signal-to-noise ratios and high noise levels, hindering accurate interpretation. To address this, we propose a unified information-theoretic framework for optimizing EEG signal representation and fusion learning. Guided by this framework, we developed EEG-FNN, a Fusion Neural Network model that integrates raw EEG data with Gramian Angular Field (GAF) transformations through an innovative attention-driven fusion technique. This approach captures diverse neural activity patterns, significantly improving the ability to distinguish neurological states. Experimental validation on short-duration BCI and long-duration clinical datasets demonstrates that EEG-FNN outperforms existing methods, achieving higher accuracy and robustness, thus confirming its potential as a reliable tool for EEG analysis.

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