A Comprehensive Study of Motor Imagery EEG-Based Classification Using Computational Analysis

Justin McCorkle, Andrew Kalaani, Rami Haddad

Department of Electrical & Computing Engineering – Georgia Southern University

Abstract: Brain computer interfaces (BCI) are systems that integrate a user's neural features with robotic machines to perform tasks. BCI systems are very unstable still due to Electroencephalography (EEG) having interference from unanticipated noise. Using Independent Component Analysis (ICA), a novel variable threshold model for noise feature extraction. The de-noised EEG data is classified with a high accuracy of more than 94% when using artificial neural networks. The effectiveness of the proposed variable threshold model is validated by the significant reduction in the variance of user classification accuracy across multiple sessions. Nonetheless, based on the variance and classification, subjects are further categorized into two groups. The lower classification accuracy group is found to have an increased variance in its classification accuracies. To confirm these results, a Kaiser Windowing technique is used to compute the signal-to-noise ratio (SNR) for all subjects and a low SNR is obtained for all EEG signals pertaining to the group with the low classification accuracy. This study not only establishes a direct relationship between classification accuracy, classification accuracy variance, and SNR, but also presents classification results that are significantly higher than the accuracies reported by prior studies using the same EEG dataset.

Keywords: Electroencephalogram, EEG, Brain-Computer Interface, BCI, Independent Component Analysis, ICA, Neural Networks, Signal-to-Noise Ratio, SNR