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PII: S0165-0270(16)00031-5
DOI: http://dx.doi.org/doi:10.1016/j.jneumeth.2016.01.014
Reference: NSM 7432

To appear in: *Journal of Neuroscience Methods*

Received date: 29-4-2015
Revised date: 11-1-2016
Accepted date: 12-1-2016

Please cite this article as: Andrew Myrden, Tom Chau, Feature clustering for robust frequency-domain classification of EEG activity, *<![CDATA[Journal of Neuroscience Methods]]>* (2016), http://dx.doi.org/10.1016/j.jneumeth.2016.01.014

Feature clustering for robust frequency-domain classification of EEG activity

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Abstract

Background: The analysis of electroencephalograms is often performed in the frequency-domain. These analyses typically involve the computation of spectral power either over pre-defined frequency bands (e.g. theta, delta, alpha, and beta bands) or over a large number of narrow frequency ranges. However, the former technique ignores variability in these frequency bands over time and between participants while the latter ignores the significant redundancy between these powers.

New Method: This paper details an unsupervised feature extraction method for EEG data that uses a clustering of features to agglomerate narrow-band spectral powers based on their similarities. This method computes a set of analogues to the traditional frequency bands that are data-driven and participant-specific. A fast 1correlation-based filter was used to identify which of these agglomerated features were most useful for each investigated classification problem.

Results: The new feature clustering algorithm was used to detect changes in three mental states and to detect the performance of three mental tasks. Balanced classification accuracies approaching or exceeding 70% were attained for all classification problems.

Comparison to Existing Methods: Classification accuracies attained by this algorithm were compared to those attained by two frequency-domain algorithms that did not employ clustering - a wide-band algorithm based on the spectral power within the theta, delta, alpha, and beta bands and a narrow-band algorithm based on the spectral power within 1-Hz ranges. Overall, the feature clustering algorithm was statistically superior to both alternative algorithms.

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