Adam et al. SpringerPlus (2016) 5:1036
DOI 10.1186/s40064-016-2697-0

SpringerPlus

RESEARCH Open Access

Evaluation of different time domain peak models using extreme learning machine-based peak detection for EEG signal

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Abstract

Various peak models have been introduced to detect and analyze peaks in the time domain analysis of electroencephalogram (EEG) signals. In general, peak model in the time domain analysis consists of a set of signal parameters, such as amplitude, width, and slope. Models including those proposed by Dumpala, Acir, Liu, and Dingle are routinely used to detect peaks in EEG signals acquired in clinical studies of epilepsy or eye blink. The optimal peak model is the most reliable peak detection performance in a particular application. A fair measure of performance of different models requires a common and unbiased platform. In this study, we evaluate the performance of the four different peak models using the extreme learning machine (ELM)-based peak detection algorithm. We found that the Dingle model gave the best performance, with 72 % accuracy in the analysis of real EEG data. Statistical analysis conferred that the Dingle model afforded significantly better mean testing accuracy than did the Acir and Liu models, which were in the range 37–52 %. Meanwhile, the Dingle model has no significant difference compared to Dumpala model.

Keywords: Extreme learning machines (ELM), Electroencephalogram (EEG), Peak detection algorithm, Peak model, Pattern recognition

Background

Peak detection algorithms are prominently used for event classification in various physiological signals such as in electroencephalograms (EEG) for diagnosing epilepsy (Acir 2005), photoplethysmograms (PPG) for monitoring heart rate (Elgendi et al. 2013), and in EEG (Adam et al. 2014b) or electrooculograms (EOG) in the particular application of tracking eye gaze events (Barea et al. 2012). In all of these common applications, peak detection is commonly the first step in signal processing. For example, semi-automatic diagnosis of epilepsy can be based on the frequency of peaks detected in the EEG recording during a given time interval. A similar approach is used for identifying eye blink events, a frequent source of interference in EEG recordings.

Detecting a peak indicative of a particular event in the EEG signal is challenging due to the non-stationary nature of the signal relative to the baseline amplitude, time, and different user. A signal peak identified as a point of highest signal amplitude lying between