Taxonomy on EEG Artifacts Removal Methods, Issues, and Healthcare Applications

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ABSTRACT

Electroencephalogram (EEG) signals are progressively growing data widely known as biomedical big data, which is applied in biomedical and healthcare research. The measurement and processing of EEG signal result in the probability of signal contamination through artifacts which can obstruct the important features and information quality existing in the signal. To diagnose the human neurological diseases like epilepsy, tumors, and problems associated with trauma, these artifacts must be properly pruned assuring that there is no loss of the main attributes of EEG signals. In this paper, the latest and updated information in terms of important key features are arranged and tabulated extensively by considering the 60 published technical research papers based on EEG artifact removal method. Moreover, the paper is a review vision about the works in the area of EEG applied to healthcare and summarizes the challenges, research gaps, and opportunities to improve the EEG big data artifacts removal more precisely.

KEYWORDS

Artifact Removal, DWT, EEG, EEMD, EMG, EOG, ICA

1. INTRODUCTION

The Big Data biological processes have very complex procedures, which imply neural as well as hormonal stimuli and responses. These biomedical signals generally represent a collective electrical signal attained from any organ, signifying a physical variable of interest. To store and handle these Big Data different technologies are frequently applied in the biomedical and health-care field (Luo & Zhao, 2016) to facilitate health-care activities. The energy management for real-time Big Data is a critical issue. Thus, energy and performance trade-off in resource optimized model design for Big Data is discussed in (E. Baccarelli & Stefa, 2016).

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The Biomedical Big Data cover a wide range of the following signal: electrooculogram (EOG), electroneurogram (ENG), electrogastrogram (EGG), phonocardiogram (PCG), carotid pulse (CP), vibromyogram(VMG), vibroarthogram(VAG), electrocardiogram (ECG), electroencephalogram (EEG), and electromyography (EMG). However, most widely used biomedical signals in healthcare applications are ECG, EEG, EMG, and EOG (Jiang & Lin, 2007), (Mowla & Paramesran, 2015).

The EEG signal is able to track changes within millisecond time-span, and is a good tool for analyzing brain activity (Urigüen & Zapirain, 2015). Moreover, this EEG signal is preferred to other signals. Certain physiological signal such as SET tracks changes in the blood circulation and positron emission (PET) measures the change in metabolism which is indirect indicators of electrical activity belonging to the brain, while EEG specifically tests the electrical activity of the brain. This software will assist in pre-processing (Roy & Shukla, 2019), (Bigdely & Robbins, 2016) of the EEG data to enable data sharing, archiving, large-scale machine learning/data mining and (meta-) analysis.

Usually, EEG Signals can be classified based on their frequency, amplitude and shape. The most common classification is based on the frequency of EEG signals (i.e. alpha, beta, theta, and delta) (Chen & Householder, 2018). Figure 1 shows the brain rhythms arranged according to increased frequencies. The brain waves with their frequency band and the corresponding brain activities are revealed in Table 1.

Table 1. Electroencephalography (EEG) Signal Frequency Bands.

Name	Frequency Band (Hz)	Predominantly Brain Activity
Delta	0.5 to 4	Sleeping
Theta	4 to 8	Dreaming, Meditation
Alpha	8 to 13	Relaxation
Beta	13 to 36	Alert/Working Problem Solving
Gamma	36 to 100	Multisensory semantic matching Perceptual function

Figure 1. Fundamental EEG Bands classification. (http://www.yalescientific.org/2013/12/the-brink-of-death-a-new-perspective/)