DEVELOPMENT OF EFFECTIVE ALGORITHM FOR REMOVAL OF EMG ARTIFACTS FROM EEG SIGNAL

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ABSTRACT: There are various methods such as, Adaptive Filtering, Blind Source Separation, Transform Based Methods, Empirical Mode Decomposition. Combination Methods are also available for EMG artifact removal using variety of algorithms. It is challenging task to remove artifacts without loss of data (EEG signal). We develop an efficient algorithm that is useful to obtain clean EEG signal by removing EMG artifacts.

Index Terms: EMG, Artifacts, ICA, CCA.

I. INTRODUCTION:

Facial muscles movements generate electrical large amplitude signals known as Electromyogram (EMG). EMG signals appear in the Electro-encephalogram (EEG) signal as noise or artifact. Pure EEG signal is generated by brain activities. Artifacts cause serious problems in pure EEG signal identification and interpretation for clinical diagnosis applications. Activities in each part of the brain make specific signals. If the artifacts contaminate the EEG data, identifying the brain activities would be limited. The artifacts should be removed by a proper method until the pure EEG signals and data are extracted.

These artifacts are divided into two types, external and internal. The external artifacts are generated from environment equipments. It includes power line or light fluorescent. The internal artifacts are arisen from body activities like eye movement, eye blinks or muscular activity.

The artifacts can be broken down as follows:

A. Eye blink: It is represented by a low frequency signal of frequency less than 4 Hz with lower propagation, that can be significant in amplitude. It is a symmetrical activity generally located on front electrodes FP1, FP2.

B. Eye movement: It is a low frequency signal of frequency less than 4 Hz along with a higher propagation. Here eyes represent dipole and their movement cause an alteration of the electrical field. It has a dissymmetry between two hemispheres.

C. Forehead movement: It is a high frequency signal of frequency greater than 13 Hz because of its muscular origin. Slight electrodes displacement is observed on low frequency generally frequency less than 4 Hz.

D. Jaw clenching: It is a high frequency muscular activity of frequency greater than 13 Hz. It may happen on some low frequencies. These artifacts are highly contaminated sources to the EEG signals.

E. Electromyography (EMG):

Electromyography (EMG) artifacts are highly contaminated sources to the electroencephalogram (EEG) signals. Research groups often assume that the EEG only are affected by the EEG activity at frequencies higher than 15 Hz.

The Electroencephalogram (EEG) signals are generally contaminated with electrophysiological potentials belonging to muscle contraction which occurs duetoteeth squeezing, chewing and frowning. These muscle artifacts abstruse the EEG activity at frequencies higher than 15 Hz.

The EEG could make the interpretation unfeasible. Various methods are available for removing EMG artifacts, aiming to get clean and un-altered EEG signal.

II. RELEVANCE:

Brain Activities are recorded using Electroencephalogram is affected by different artifacts. These artifacts can be the result of some muscular activities such as teeth squeezing, chewing, and jaw clenching. Only by observing EEG signal human can identify artifact corrupted portion still without efficient because only artifact identification is not sufficient. Hence, there is need for detection and removal of these EMG artifacts. Many researchers presented several methods to remove artifacts.

Some common EEG signal processing algorithms do extract the signal amplitude or analyze the power spectrum of the signal. Analysis were performed on different frequency bands of the signal. These bands are delta band (less than 4 Hz), theta band (4 to 8 Hz), alpha band (8 to 12 Hz), beta band (12 to 30 Hz), and gamma band (greater than 30 Hz). Each frequency band was accredited to specific brain functions [3].

There are different methods available for artifact removal. These methods include Adaptive Filtering, Blind Source Separation, Transform Based Methods, Empirical Mode Decomposition and Combination Methods. The proposed algorithm uses combination method.

III. LITERATURE REVIEW:

A. Greco, D. Costantino, F.C. Morabito stated that ICA is a method which finds a linear non-orthogonal coordinates system in the multivariate data. Both the second and higher order statistics of the original data determine the directions of the axes of the co-ordinate system [14]. ICA is a blind source separation (BSS) technique where recorded signals are separated into their independent integral components or sources. BSS is based on a large class of unsupervised learning algorithms aiming to estimate sources and parameters of a mixing system. Property required to run the ICA technique states that the number of recorded signals must be greater than or equal to the number of underlying sources.
This is very important property of ICA. The ICA technique has a number of assumptions those includessquare mixing, linear mixing, and stationary mixing [6]. More specifically, ICA leads to the extraction of a muscular activity (EMG signal). Also, when there recorded signals are corrupted by the cardiac activity, it reconstructs ECG separately. Several methods of ICA were applied on EEG signals for artifact removal [15].

The method implemented by B. Azzerboni, M. Carpentien and E La Foresta explains that DWT approach enables us to remove electrocardiographic artifacts that are present in few myoelectric recordings. DWT method and ICA method can be used to remove artifacts in a surface electromyography (sEMG). This joint use of both DWT and ICA encloses the advantages of both techniques. Extended removal of artifacts in the clinical applications is made possible by the Wavelet-Independent Component Analysis (WICA). When these techniques applied separately, fail to do so [12].

New method for muscle artifact removal in EEG is used by Rabeya Ferdousy and Anisul Islam Choudhory. It is based on the statistical Canonical Correlation Analysis. Where Canonical Correlation Analysis (CCA) is applied as a blind source separation (BSS) technique, referred as BSS-CCA. BSS-CCA, assumes that sources are mutually uncorrelated [7].

Manoj Kumar Mukul and Fumitoshi Matsuno demonstrated wavelet based method using DWT for EEG signal de-noising. It is quite more powerful compared to Blindsourced separation based Independent component analysis. The input signal is decomposed into sub band components by DWT. Flexible control over the resolution are provided by Wavelet analysis. With the neuro-electric components along with events are localized in time, space and scale. Wavelet transform accurately resolves EEG into specific time and frequency components leading to several analysis applications [8].

To remove the EMG artifacts from the single channel EEG signals, Ajay Kumar Maddirala, Rafi Ahamed Shaik proposed a new grouping technique to extract efficiently the desired component from the contaminated EEG signals by setting a threshold. First, single channel signal is mapped into multichannel signal or data. Second, using covariance matrix of the multichannel data, the orthogonal eigen vectors are estimated by singular value decomposition (SVD). SVD sets an arbitrary threshold which are used to create the subspace corresponding to the EEG signals. After identification of the subspace, the EEG signals are extracted by projecting the multichannel data onto this subspace and by reverse process of embedding. Proposed method is applied on synthetic noisy sinusoidal signals and EEG signals contaminated by the EMG artifacts. The proposed method efficiently removes the EMG artifacts without alteration of the desired components [2].

An adaptive filtering method is proposed by Saeid Mehrkanoon, Mahmoud Moghavvemi, Hossein Fariborzito remove these artifacts signals from EEG signals. This method uses horizontal EOG (HEOG), vertical EOG (VEOG), and EMG signals as three reference digital filter inputs. The artifact removal is real-time and is implemented by multi-channel Least Mean Square algorithm. The resulting EEG signals show artifact-free EEG data [10].

ICA is a premium signal processing technique that uses higher order statistics. It separates independent components from measurements. ICA performs a decomposition of the observed multichannel signals into independent components, by using an optimization algorithm. Wavelet Transform (WT) is a sub-branch of applied mathematics that emerged in the mid 1980’s. WT has been highly used in signal processing, image processing, and speech recognition. Wavelet analysis has very good localization properties in both time and frequency domains. The theory of wavelet threshold de-noising is based on the multiresolution analysis of wavelet transform. We can select a set of thresholds and apply them to the signals at each of the scales. Then by using inverse wavelet transform we can reconstruct a new signal [11].

Rong-bo Huang, Eu-ming Cheung and Shi-ming Zhu presented a parallel architecture of independent component analysis (ICA). It is a hybrid system consisting of two sub-ICA processes. One process takes the high-frequency wavelet observations as its input, during this period the other process takes the low-frequency part. Their results are then combined to generate the final ICA results. The proposed approach utilizes the full observation information. The input data length is divided by two parallel processes. So, it provides fast ICA implementation [16].

IV. PROPOSED WORK:

Objective of this work is to remove EMG artifacts from EEG recordings. Proposed work is to develop a combined algorithm for removing EMG artifacts from acquired raw EEG data. There are different algorithms available for this purpose.

METHODOLOGY:

- Study the existing methods.
- Acquire raw EEG data.
- Develop an algorithm for artifact detection.
- Develop an algorithm for EMG artifact removal.
- Apply it to Raw EEG data.
- Construct the clean EEG data.

Fig. shows step wise procedure for proposed work.
V. REFERENCES:


