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DEVELOPMENT OF EFFECTIVE ALGORITHM FOR REMOVAL OFEMG 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 Methodsare 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 algorithmthat is useful to obtain clean EEG signalby removing EMG artifacts .

Index Terms: EMG,Artifacts,ICA,CCA.

I. INTRODUCTION:

Facial muscles movements generatean electrical large amplitude signals known asElectromyogram (EMG).EMG signals appear inthe Electro-encephalogram (EEG) signal as noise or artifact.Pure EEG signal is generated by brain activities. Artifactsignals cause serious problems in pure EEG signalsidentification and interpretation for clinical diagnosisapplications. Activities in each part of the brain make specific signals. If the artifactscontaminate the EEG data, identifyingthe brain activities would be limited. Therefore the artifactsshould be removed by a proper method until the pure EEGsignals 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.

<u>The internal artifacts can be broken down as follows:</u>

- **A.** Eye blink: It is represented by a low frequency signal of frequency less than 4Hz 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 a low frequency signal of frequency less than 4Hz 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 artifactsare abstruse the electrical activities of the brain. These artifactsaffect the detection of EEG features for example mu and beta rhythms.

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

The electroencephalogram (EEG) signals are genrally contaminated with electrophysiological potentials belonging to muscle contraction which occurs duetoteeth squeezing, chewing and frowning. These muscle artifactsabstruse theEEG and alsocomplicate the interpretation of the EEG. It could make theinterpretation unfeasible.Various methods are available for EMG artifact removal, aiming to get clean and un-altered EEG signal.

II. RELEVANCE:

Brain Activities are recorded using Electroencephalogram is affected by differentartifacts. These artifacts can be the result of some muscular activities such as teeth squeezing, chewing, jaw clenching. Only by observing EEG signal human can identify artifact corrupted portion.stillit isnot efficient because only artifact identification is not sufficient. Hence , there is need for detection and removal of theseEMG artifacts. Many researchers presented several methods to remove artifacts.

Somecommon EEG signal processing algorithms do extractthe signal amplitude or analyze the power spectrumof the signal. Analysis were performed on differentfrequency bands of the signal.These bands are deltaband (less than 4 Hz), thetaband (4 to 8 Hz), alphaband (8 to 12 Hz), betaband (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. Morabitostatedthat ,ICA is a method which finds a linear non-orthogonal coordinatesystem in the multivariate data. Boththe second and higher order statistics of the original data determine the directions ofthe axes of the co-ordinate system .[14]ICA is a blind source separation (BSS) technique whererecorded signals are separated into their independent integral components or sources . BSS is based on a large class ofunsupervised learning algorithms aiming to estimatesources and parameters of a mixing system. property required to run the ICA technique states that the numberof 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 anumber of assumptions those includessquare mixing,linear mixing, and stationary mixing [6]. More specifically, ICA leads to theextraction of a muscular activity (EMG signal). Also, when therecorded 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 thatDWT approach enables us to remove electrocardiographicartifacts that are present in fewmyoelectric recordings.DWT method and ICA method can be used to removeartifacts in a surface electromyography (sEMG). This joint use of both DWT and ICA enclose theadvantages of both techniques. Extended removal of theartifacts in the clinical applications is made possible bythe Wavelet-IndependentComponent Analysis (WICA) .When thesetechniquesapplied separately, fail to do so [12].

New method for muscleartifact removal in EEG is used by RabeyaFerdousy and Anisul Islam Choudhory. It is based on the statisticalCanonical Correlation Analysis. WhereCanonical Correlation Analysis(CCA) is applied as a blindsource separation (BSS) technique, referred asBSS-CCA. BSS-CCA, assumes that sources aremutually uncorrelated[7].

Manoj Kumar Mukul and FumitoshiMatsuno demonstrated wavelet based method using DWT forEEG signal de-noising. It is quite more powerful compared to Blindsource separation based Independent component analysis. The input signal is decomposed into sub band components by DWT. Flexiblecontrol over the resolution are provided by Wavelet analysis.withthisneuro-electriccomponents along with events are localizedin time, space andscale.Wavelet transform accuratelyresolves EEG into specific time and frequency componentsleading to several analysis applications [8].

Toremove the EMG artifacts from the single channel EEG signals, Ajay Kumar Maddirala, RafiAhamedShaik proposed a new grouping technique to extractefficiently the desired component from the contaminated EEGsignal by setting a threshold. First, single channel signal ismapped into multichannel signal or data. Second,using covariancematrix of the multichannel data,the orthogonal eigen-vectors are estimated by singular value decomposition(SVD) .SVDsets an arbitrary thresholdwhich are used to create the subspace corresponding to theEEG signals. After identification of the subspace, the EEG signals areextracted by projecting the multichannel data onto thissubspace and by reverse process of embedding. Proposed method is applied on synthetic noisy sinusoidalsignals and EEG signals contaminated by the EMG artifacts. The proposed method efficiently removesthe EMG artifacts without alteration of the desired components [2].

An adaptive filtering method is proposed by SaeidMehrkanoon, MahmoudMoghavvemi, HosseinFariborzitoremove these artifacts signals from EEG signals. This method uses horizontal EOG (HEOG), vertical EOG (VEOG), and EMGsignals as three reference digital filter inputs. The artifact removal is real-time and is implemented by multi-channel Least Mean Squarealgorithm. The resulting EEG signals showartifact free EEG data [10].

ICA isa premium signal processing technique that uses highorder statistics. It separatesIndependent components from measurements.ICA performs a decomposition ofthe observed multichannel signals into independent components, by using an optimizationalgorithm.Wavelet Transform (WT) is a sub-branch ofapplied mathematics that emerged in the mid 1980's. WT has beenhighly used in signal processing, image processing,and speech recognition. Wavelet analysis hasvery good localization properties in both time andfrequency domains.The theory of wavelet threshold de-noising isbased on the multiresolution analysis of wavelettransform. We can select a set ofthresholds and apply them to the signals at each ofthe scales. Then by using inverse wavelettransform we can reconstruct a new signal [11].

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

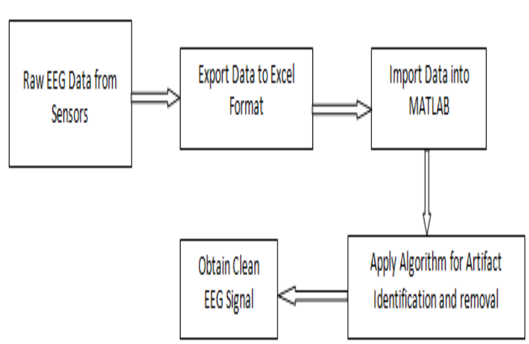
IV. PROPOSED WORK:

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 forproposed work.



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