OPEN ACCESS

International
Journal
Of Modern Engineering Research (IJMER)

Review on Removal of Ocular Artifact from Multichannel EEG Signal

[1]Snehal Ashok Gaikwad, [2]K.P.Paradeshi
[1]*P.G.Student, Department of Electronics, PVPIT Budhgaon, Sangli, Maharashtra, India.*
[2]*Associate Professor, Department of Electronics, PVPIT Budhgaon, Sangli, Maharashtra, India.*

Abstract:- The Electroencephalogram (EEG) is a biological signal that represents the electrical activity of the brain & is measured by placing electrodes on the scalp. Eye-blinks and movements of the eyeballs Signals produce unwanted electrical signals these unwanted signals are collectively known as Ocular Artifacts (OA) and these are 10-100 times stronger than EEG signal which is being recorded. Artifacts are noises introduced to an electroencephalogram (EEG) signal by patient's movements. Generally, OA introduce the stronger peak in EEG signal. These are of the order of milli-volts and they defile the EEG signals which are of the order of micro-volts. The frequency range of EEG signal is 0 to 64 Hz and the OA occur within the range of 0 to 16 Hz. Removing artifacts from EEG signal may aid the work of doctors, because artifacts disturb their attention. There are different methods to remove artifacts. Then only removing it's to obtain clean EEG signal.

Keywords:- Electroencephalogram (EEG), Electrooculargrum (E0G), Ocular Artifact (OA), ICA, Wavelet.

I. INTRODUCTION

The Electroencephalogram (EEG) is a biological signal that represents the electrical activity of the brain & is measured by placing electrodes on the scalp (hair or face skin). EEG measures voltage fluctuations that occur because of ionic current flows within the neurons of the brain. In clinics, EEG recording done usually about 20 to 40 minutes, where multiple electrodes placed on the scalp. Scalp EEG activity shows oscillations at a variety of frequencies. EEG applications range from brain-computer interface (BCI) systems to clinical\ diagnosis of neurological disorders and monitoring depth of anesthesia. Four major frequency ranges (waves) are identified in EEG that are called delta, theta alpha, and beta [11].

Brain activities recorded using the Electroencephalogram is affected by various activities such as ocular activity, muscle activity, power line interfaces or heart beat activity. Artifacts are noises introduced to an electroencephalogram (EEG) signal. The raw EEG data is contaminated with numerous high frequency (atmospheric thermal noise and power frequency noise) and low frequency noise (eye movements, respiration and heart beats) known as artifacts. There are different types of Artifacts and are:

1. Cardiac artifacts 2.Electrode artifacts 3.External device artifacts 4.Muscle artifacts 5.Ocular artifacts [2].

Eye-blinks and movements of the eyeballs Signal produce electrical signals that are collectively called as Ocular Artifacts (OA) and these are 10-100 times stronger than EEG signal which is being recorded. OA introduce the stronger peak in EEG signal of milli-volt and they contaminate the EEG signals which are of the order of micro-volts. The frequency range of EEG signal is 0 to 64 Hz and the OA occur within the range of 0 to 16 Hz. Eye movement cause a change in electric fields surrounded by eyes & these distort the electric fields over the scalp.

A variety of methods have been proposed for correcting ocular artifacts. Removing artifacts from EEG signal may help for the work of doctors, because artifacts disturb their attention. There are different methods to remove artifacts but a WAVELET and ICA method is a software system used to identify and remove the position of Ocular Artifacts zones in contaminated EEG signal to obtain clean EEG signal.

II. RELEVANCE

Brain Activities recorded using Electroencephalogram is affected by various artifacts such as ocular activity (eye blinking, fixations and saccades). While measuring EEG subject may ask to avoid excessive muscle movement but it is infeasible for subject to avoid the eye blinks and eye movement as it is part of natural biological phenomenon. Only by observing EEG signal human can identify artifact corrupted portion but that is not efficient because it cannot remove the corrupted signal so, there is need for detection and removal of ocular artifacts so, many researchers present several methods to remove noise.

Proposed method is intended to achieve good performance by combining two methods to denoise EEG signal. This algorithm is effective for detection and removal of ocular artifacts by preserving important details.

III. LITERATURE REVIEW

There are several different methods to remove ocular artifacts from EEG signal but these methods do not give best solution to remove artifacts from EEG signal. Hence to obtain best result or best solution, the combination of ICA method and Wavelet method can be formed which remove the ocular artifact from EEG signal.

Independent component Analysis (ICA) is a technique in which observed random data are linearly transformed into components and these are considered to be independent from each other. The method suggested by Christopher J. James, et al [4] is temporally constrained ICA algorithm, which can extract signals that are statistically independent and are constrained by some reference signal so, single Independent Component can be extracted based upon prior expectations of desired signal. This method is fast on multichannel recordings. Another method of ICA implemented by Li Da, et al [5] is subspace ICA (SICA). To separate the EEG and EOG sources SICA is done using vector kurtosis. The Method discussed by Takahiro Ikuno, et al.[6] does not require any offline training. In this method first, the occurrence of a blink is detected by observing the EEG signal then the interval that contains the blink is set and ICA is applied then the Blink components obtained by ICA is determined by the kurtosis. After that, blink artifact components are removed and the EEG has been rebuilt using the other independent components obtained by ICA. DELORME, *et al*. [7] developed a graphical method for rejection of independent components and noisy single data trials based on their statistical properties. They used three high-order statistical measures for each component obtained by ICA is: The entropy of the activity of component, the kurtosis of the component's activity, and the kurtosis of the spatial projection of the component. By setting an adequate rejection threshold, the artifactual components semi-automatically were detected and rejected. An automatic eye blink suppression based on ICA was proposed by DELSANTO, *et al* [7] used mean square difference between the FFT of the eye blink waveform model and each segment of the Fp1 raw data channel. They found there is different distance distribution for eye blink and non eye-blink after that defining an appropriate threshold distance, the eye blink on the raw data is detected. Then the eye blink component obtained by ICA is identified based on the spatial topographic criteria.

Wavelet Transform can be used to study the time-frequency maps of EOG contaminated EEG. Tatjana Zikov et.al [9] proposed method on basis of wavelet denoising technique for removal of ocular artifacts in EEG. V.Krishnaveni et.al [9] proposed various non-adaptive thresholding methods using different threshold limit and thresholding function for ocular artifact correction. V.Krishnaveni, S.Jayaraman, S.Aravind, V.Hariharasudhan, K.Ramadoss[9] presents a method to automatically identify slow varying OA regions and applying wavelet based adaptive thresholding algorithm based on Stein's Unbiased Risk estimate(SURE)only to identified OA zones, which avoids the removal of background EEG information. Adaptive thresholding applied only to the OA zone does not affect the low frequency components in the non-OA zones and also preserves the shape (waveform) of the EEG signal in non-artifact zones which is of very much importance in clinical diagnosis. Here Discrete Wavelet Transform is applied to EEG with HAAR wavelet as basis function to detect OA zone. Also Stationary wavelet transform is applied for removing ocular artifacts. Chunyu Zhao, Tianshuang Qiu [10] has developed the Wavelet-Enhanced Canonical Correlation method in which canonical components are obtained through CCA decomposition of the raw EEG signals. The first found canonical components are related to O.A. for each set respectively and are transformed through DWT then Wavelet thresholding is carried out to recover the cerebral activities that are leaked into this artifact component.

IV. ICA + WAVELET METHODOLOGY

The use of only ICA method is disadvantageous because ICA performance depends upon number of samples as if number of samples are small it is difficult the estimation of parameters. Also another difficulty is ICA operates in time domain and Wavelet analysis is time-frequency technique, hence to overcome limitation, the ICA and Wavelet methods are combined for noise reduction. Cantero et al. [11] assessed the performance of four independent component analysis (ICA) algorithms (AMUSE, SOBI, Infomax, and JADE) to apart myogenic activity from EEG during sleep. Castellanos and Makarov [11] introduced wavelet enhanced ICA, only eye-blink and ECG artifacts were analyzed. S. Jirayucharoensak P. Israsena [12] gives method of artifact removal using ICA and Lifting Wavelet Transform in that, ICA do source separation procedure by Infomax – ICA algorithm and LWT do Wavelet decomposition on all independent components derived from ICA to detect EOG and EMG artifacts. Finally inverse LWT and inverse ICA combine independent component into artifact free signal. Dan-hua Zhu et al. [1] used Sample Entropy (SampEn) method to efficiently identify the blink independent components (IC). The method proposed by Ruhi Mahajan and Bashir I. Morshed uses SampEn and they decompose the blink ICs with HAAR Wavelet and threshold only the wavelet coefficients corresponding to the artifactual activity to zero. Thus, the loss of neural activities occurred in the blink ICs are minimized. Hosna

Ghandeharion, H.Ahmadi-Noubari [2] discussed a method in which a combination of ICA and wavelet-based noise reduction is utilized for detection and removal of O.A. in that they use FastICA algorithm and Discrete wavelet transform. The method proposed in [3] is Automatic Identification and removal of Ocular Artifacts using Improved Adaptive Predictor Filtering. In that they propose a hybrid de-noising method combining DWT and an Adaptive Predictor Filter. The feature of this method is use of APF, based on adaptive autoregressive model for prediction of waveform of signals in O.A. zones.

At the end, In WICA methodology first step is identifying an ocular artifact component within EEG data then develop a threshold. After that mark the Independent Components for denoising, if artifacts are less than threshold. Then secondly carry out wavelet for denoising to obtain artifact free signal. The whole signal is reconstructed by applying inverse ICA and Inverse Wavelet, to get pure signal.

V. CONCLUSION

There are several methods to remove ocular artifacts from EEG signal. But still removal of ocular Artifacts is challenging task to obtain pure EEG signal. Here main objective is detect and remove the ocular artifacts from EEG signal. There are different several methods for removal of ocular artifact but these methods do not give best solution to remove artifacts from EEG signal. Hence to obtain best result or best solution, the combination of ICA method and Wavelet method can be formed which remove the ocular artifact from EEG signal. The proposed method can also be considered for other types of EEG artifacts.

REFERENCES

[1]. Ruhi Mahajan and Bashir I. Morshed, "Sample Entropy Enhanced Wavelet- ICA Denoising Technique for Eye Blink Artifact Removal from Scalp EEG Dataset", 6th Annual International Conference on Neural Engineering ,pp.6 – 8 ,Nov.2013.

[2]. Hosna Ghandeharion, H.Ahmadi-Noubari, "Detection and Removal of Ocular Artifacts using Independent Component Analysis and Wavelets", Proceedings of the 4th International Conference on Neural Engineering, April 29 - May 2, 2009.

[3]. Qinglin Zhao, Yujun Shi, Yang Li, Philip Moore, Minghou Sun and Hong Peng **"**Automatic Identification and Removal of Ocular Artifacts in EEG-Improved Adaptive Predictor Filtering for Portable Applications",IEEE Transactions on nanobioscience,VOL.13,NO.2, June 2014.

[4]. Christopher J. James and Oliver J. Gibson, "Temporally Constrained ICA: An Application to Artifact Rejection in Electromagnetic Brain Signal Analysis", IEEE Transactions on biomedical Engineering, VOL. 50, NO. 9, Sept 2003.

[5]. Li Da,Wu Jin,Zhang Jiacai ,"An EOG Artifacts Correction Based on Subspace Independent Component Analysis", 2010 International Conference on Computational Intelligence and Security.

[6]. Takahiro Ikuno, Yoshinori Katayama, Keiji Iramina, **"**Selection and removal of artifacts in EEG based on independent components**",** The 2011 Biomedical Engineering International Conference (BMEiCON-2011).

[7]. Hosna Ghandeharion and Abbas Erfanian, **"**A Fully Automatic Method for Ocular Artifact Suppression from EEG Data Using Wavelet Transform and Independent Component Analysis", Proceedings of the 28th IEEE EMBS Annual International Conference,Aug 30-Sept 3, 2006.

[8]. Jui-Chieh Liao and Wai-Chi Fang, "An ICA-Based Automatic Eye Blink Artifact Eliminator for Real-Time Multi-Channel EEG Applications", IEEE International Conference on Consumer Electronics (ICCE), 2013.

[9]. V.Krishnaveni, S.Jayaraman, S.Aravind, V.Hariharasudhan, K.Ramadoss "Automatic Identification and Removal of Ocular Artifacts from EEG using Wavelet Transform", Measurement science review,Volume 6, Section 2, No. 4, 2006.

[10]. Chunyu Zhao, Tianshuang Qiu," An Automatic Ocular Artifacts Removal Method Based On Wavelet-Enhanced Canonical Correlation Analysis",33rd Annual International Conference, Aug 30-Sept 3, 2011.

[11]. Nadia Mammone, Fabio La Foresta, Francesco Carlo Morabito, "Automatic Artifact Rejection from Multichannel Scalp EEG by Wavelet ICA", IEEE Sensor journal, VOL. 12, NO.3, March 2012.

[12]. S. Jirayucharoensak P. Israsena, "Automatic Removal of EEG Artifacts Using ICA and Lifting Wavelet Transform", International Computer Science and Engineering Conference (ICSEC): ICSEC 2013.

[13]. Anusha Zachariah, Jinu Jai, Geevarghese Titus ,"Automatic EEG Artifact Removal by Independent Component Analysis Using Critical EEG Rhythms", 2013 International Conference on Control Communication and Computing (ICCC).

[14]. John W. Kelly,Daniel P. Siewiorek, Asim Smailagic, Jennifer L. Collinger, Douglas J. Weber, andWei Wang, "Fully Automated Reduction of Ocular Artifacts in High-Dimensional Neural Data", IEEE Transaction on biomedical Engineering,VOL.58, NO.3, March 2011.

[15]. Ruhi Mahajan and Bashir I. Morshed," Unsupervised Eye Blink Artifact Denoising of EEG Data with Modified Multiscale Sample Entropy, Kurtosis and Wavelet-ICA", IEEE Journal of Biomedical and Health Informatics, 2013.