

A Review on Body Movement Classification Using Motor Imagery EEG

Rinkal G. Shah

P.G. Student, Department of Biomedical Engineering, Government Engineering College, Gandhinagar, Gujarat, India

ABSTRACT: Imagination of various limb movements for patient suffering from several physical hindrances, Brain computer interfaces (BCI) offers analysis of motor imagery EEG which can be shown a new way of communication. Motor imagery data for body movement classification like left hand, right hand, toe, and tongue movement are available on Physionet ATM or BCI competition datasetIII. Using different Feature extraction and classification method we can get best result for body movement classification.

KEYWORDS: Motor imagery EEG, event related desynchronization/ event related synchronization (ERD/ERS), Independent component analysis (ICA), Support vector machine (SVM).

I. INTRODUCTION

In now days, EEG (Electroencephalography) is widely used as a digital signal processing for diagnosis of various application. electroencephalography (EEG) signals has now been popularly used in a wide variety of applications such as seizure detection/prediction, motor imagery classification, mental task classification, emotion classification, sleep state classification, and drug effects diagnosis^[1]. EEG is quite small signal which can measured electrical activity of brain generated by nerve firing in the brain which usually contain physiological & non physiological artifacts. These artifacts typically have much higher amplitude than brain signals so it produces great difficulty to interpret the EEG signal.

Brain computer interface (BCI) has a power to translate the neural command extracted from EEG signal into machine language. So improvement in analysis of EEG signal is goal of many researchers. EEG signals of motor imagery can be seen as a new way of communication for persons suffering from severe physical handicaps^[2]. Motor imagery is a mental task in which the subject imagines that he is doing an action. Motor imagery classification is very important for certain patients^[1]. While most other research focused on discriminating EEG signals between left hand, right hand, toe, and tongue imagined movement^[3].

In the EEG signal, event related potential is closely related with the neural activity on the cerebral motor cortex. When the human sensory system gets or feels a certain external stimulation, the corresponding regions of cerebral cortex will produce potential and change in event related potential. Researches show that both sides of the brain hemisphere will have a certain frequency band (μ rhythm/ β rhythm) ERP signal and make EEG power spectrum strengthened (event related synchronization) and weakened (event related desynchronization) when human imagining or doing left-right hand movement^[4].

Sr. No.	Hand movement imagined by brain	Power spectrum	ERD(event related desynchronization) position	ERS(Event related synchronization)
1	Left	Weak	Right hemisphere of the brain	Left hemisphere of the brain
2	Right	Strong	Left hemisphere of the brain	Right hemisphere of the brain

Table courtesy:[4]

ERD phenomenon appears in the left hemisphere of the brain and ERS phenomenon appears in the right when the brain imaging the right hand movement. ERD phenomenon appears in the right hemisphere of the brain and its power

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly Peer Reviewed Journal)

Vol. 5, Issue 2, February 2016

spectrum is weakened. Meanwhile, ERS appears in the left hemisphere of the brain and makes its power spectrum strengthened^[4].

In this paper next section described the review of various methodologies for right & left hand imagery movement analysis.

II. METHODOLOGY

A. EEG Data acquisition

There are number of ways to collection of raw EEG data, which are described below.

- The raw EEG datasets are available in PhysioNet^[10] by the developers of the BCI2000^[11] instrumentation system.
- BCI Competition 2003 Data set III, provided by the brain computer interface research center of Austria Graz University
- Fraunhofer FIRST (Intelligent Data Analysis Group) and University of Medicine Berlin (Neurophysics Group) with two classes: right hand and right foot motor imageries data's are available.

B. Channel selection for motor imagery dataset

The main purpose of the channel selection process is threefold: (i) to reduce the computational complexity of any processing task performed on EEG signals by selecting the relevant channels and hence extracting the features of major importance, (ii) to reduce the amount of over fitting that may arise due to the utilization of unnecessary channels, for the purpose of improving the performance, and (iii) to reduce the setup time in some applications. Filtering techniques, Wrapper techniques and Embedded techniques are three most useful channel selection technique for motor imagery data^[1].

C. Signal preprocessing

As EEG signals are known to be noisy and non stationary, filtering the data is an important step to remove the unnecessary information from the raw signals. **Band pass filter** is used to remove the DC (direct current) shifts and to minimize the presence of filtering artifacts at epoch boundaries. And a **Notch filter** is used to remove the 50 Hz line noise.

Automatic Artifact Removal (AAR) and blind source separation (BSS) method are sometimes use for electrooculography (EOG) & electromyography (EMG) artifacts removal. **The Independent Component Analysis (ICA)** spatial filter is also a very good algorithm which is applied on related channels for noise reduction and isolation of both artifactually and neutrally generated EEG sources.

D. Feature extraction methods.

EEG signals recorded from channels C3 and C4, over sensory-motor cortices; activated during movement imagination. In order to extract characteristics of EEG signals, different wavelet families; Daubechies, Symmlet and Coiflet; are utilized for EEG segment decomposition into frequency sub bands^[5].

Fast Fourier transform (FFT)^[6], band power^[7], common spatial pattern (CSP)^[8]. The autoregressive model (AR)^[9] or multivariate autoregressive model (MVAR), the wavelet transform for time frequency analysis are also some of the very popular and useful feature extraction techniques.

E. Feature Classification methods

Classification of EEG features are very important part of signal processing, The classification can be achieved by several classifiers such as Linear discriminant analysis (LDA), Neural networks (NN), Support vector machine (SVM), Multilayer perception (MLP) classifier, which are mostly used for classification, but in recent days machine learning algorithm such as **support vector machine** is widely used for further classification.

III. RESULT & DISCUSSION

This paper is described various methodology for better classification of motor imagery data. EEG signal processing requires step by step implementation for the desired output. Identify important feature from the denoised signal is the

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly Peer Reviewed Journal)

Vol. 5, Issue 2, February 2016

first and necessary step for further processing. Having larger number of the feature set lead to the proper classification of signal.

The paper represent methodology for the offline EEG signal analysis, From the above review we can say that there are various methodology available for preprocessing of EEG data, but independent component analysis(ICA) is widely used method for motor imagery dataset, as well as it is also useful for feature extraction using **EEGLAB** toolbox. **Wavelet packet analysis** combined with **independent component analysis** method can also effectively enhance the imagination ERD/ERS action EEG signals characteristics, and provide great purport to **Back propagation** (BP) network & **support vector machine** (SVM) classifier to identify EEG patterns related to two types of movements. If transform the EEG signal of imaging left-right hand movement into the signal of the participants in wheelchair, imaging the wheelchair turn left or right. Then, make these correct recognition results into external command of the brain-computer interface. So as to control the intelligent wheelchair to move according to user's intent and help the disability elders or disabled people achieve self-reliance in everyday life^[4].

IV. CONCLUSION

In this paper, we can survey many different feature extraction and classification methods, but for imagined body movements with better classification the accuracy of various classifiers is an important factor. For better accuracy purpose of features like time-frequency, power, ERP's the SVM classifier is most efficiently used classifier.

REFERENCES

- [1] TurkeyAlotaiby, Fathi E Abd El-Samie, Saleh A Alshebeili and Ishtiaq Ahmad, "A review of channel selection algorithms for EEG signal processing" Journal on Advances in Signal Processing, 2015.
- [2] J.R. Wolpaw, T.M. Vaughan and E. Donchin, "EEG based communication prospects and problems," IEEE Transactions on Rehab. Engineering, vol.04, pp. 425-430, 1996.
- [3] G. Schalk et al. "Decoding two-dimensional movement trajectories using electrocorticographic signals in humans," Journal of Neural Engineering, vol. 4, pp. 264-275, 2007.
- [4] SuolinDuan, TingtingXu, Wei Zhuang, Dan Mao, "The Feature Extraction of ERD/ERS Signals Based on the Wavelet Package and ICA." 11th world congress on Intelligent Control and Automation, IEEE, July 2014.
- [5] Homri Ines, Yacoub Slim and EllouzeNoureddine "EEG Classification using Support Vector Machine." IEEE 10th International Multi-Conference on systems, signals & Devices, 2013.
- [6] P. Mark, K. Aleksandar, "Feature Extraction in development of brain-computer interface: a case study," Proceedings of the 20th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 2003.
- [7] N. Brodus, F. Lotte, and A. Lécuyer, "Comparative Study of Band-Power Extraction Techniques for Motor Imagery Classification," IEEE Symposium on Computational Intelligence, Cognitive Algorithms, Mind, and Brain (SSCI'2011CCMB), pp. 1-6, 2011.
- [8] H. Ramoser, J. Muller-Gerking and G. Pfurtscheller, "Optimal spatial filtering of single-trial EEG during imagined hand movements," IEEE Trans. Neural Syst. Rehabil. Eng, vol.08, no.4, pp.441-446, 2000.
- [9] C.W. Anderson, E. Stolz, and S. Shamsunder, "Discriminating mental tasks using EEG represented by AR models," in IEEE 17th Annual Conference Engineering in Medicine and biology Society, vol.02, 1995.
- [10] A. L. Goldberger, L. A. N. Amaral, L. Glass, J. M. Hausdorff, P. C. Ivanov, R. G. Mark, J. E. Mietus, G. B. Moody, C.-K. Peng, and H. E. Stanley, "PhysioBank, PhysioToolkit, and PhysioNet: Components of a New Research Resource for Complex Physiologic Signals," Circulation, vol. 101, pp. e215-e220, 2000.
- [11] G. Schalk, D. J. McFarland, T. Hinterberger, N. Birbaumer, and J. R. Wolpaw, "BCI2000: a general-purpose brain-computer interface (BCI) system," IEEE Transactions on Biomedical Engineering, vol. 51, pp. 1034-1043, 2004.
- [12] TurkeyAlotaiby, Fathi E Abd El-Samie, Saleh A Alshebeili, Ishtiaq Ahmad, "A review of channel selection algorithms for EEG signal processing." Journal on Advances in Signal Processing, Springer, 2015
- [13] Homri Ines, Yacoub Slim and EllouzeNoureddine "EEG Classification using Support Vector Machine." IEEE 10th International Multi-Conference on systems, signals & Devices., 2013.
- [14] Ching-Chang Kuo, William S. Lin, Chelsea A. Dressel and Alan W.L. Chiu, "Classification of Intended Motor Movement using Surface EEG ensemble Empirical Mode Decomposition." 33rd Annual International Conference of the IEEE, 2011.
- [15] Chong Liu, Hong Wang, Zhiguo Lu "EEG Classification for Multiclass Motor Imagery BCI." 25th Chinese Control and Decision Conference, IEEE, 2013.
- [16] Naoki Tomida, Toshihisa Tanaka, Shunsuke Ono, Masao Yamagishi, Hiroshi Higashi, "Active Data Selection for Motor Imagery EEG Classification," IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, 2015.,
- [17] So-Youn Park, Ju-Jang Lee "EEG Feature Extraction and Classification Using Data Dimension Reduction." IEEE, 2008.
- [18] Shi-Yun Shao, Kai-Quan Shen, Chong-Jin Ong, Xiao-Ping Li, "Automatic Identification and Removal of Artifacts in EEG Using a Probabilistic Multi-class SVM Approach With Error Correction", IEEE 2008.
- [19] O. A. Padierna Sosa, Y. Quijano, M. Doniz, J. E. Chong Quero, "Development of an EEG signal processing program based on EEGLAB." IEEE, 2011.
- [20] E. Urrestarazu, J. Iriarte, M. Alegre, M. Valencia, C. Viteri, and J. Artieda, "Independent Component Analysis Removing Artifacts in ictal recordings," Epilepsia, vol. 45, pp. 1071-1078, Sep. 2004.