IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Human Journals
**Research Article**
June 2017 Vol.:6, Issue:4


# Classification of Electroencephalograph Signal Using Support Vector Machine for Alzheimer Disease

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INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
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**[*1]Samruddha D. Shirude, [2]S. T. Patil**

*[1]Student, Vishwakarma Institute of Technology, Pune.*

*[2]Professor, Vishwakarma Institute of Technology, Pune.*

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| **Submission:** | 2 June 2017 |
| **Accepted:** | 7 June 2017 |
| **Published:** | 25 June 2017 |

HUMAN JOURNALS

**www.ijsrm.humanjournals.com**

**Keywords:** Electroencephalograph (EEG), Machine Learning (ML), Support Vector Machine (SVM), Brain Computer Interface (BCI), Alzheimer Disease(AD)

**ABSTRACT**

Electroencephalograph (EEG) is a non-invasive technique which is useful for detecting brain disorder. As Electroencephalograph is not difficult and complex to use. This electroencephalograph technique is useful in many application like neuromarketing, social interaction, human factors etc. But proposed work is based on Brain Computer Interface and useful in clinical diagnosis. In the procedure of detection of brain disorder present or absent it is essential to understand and to study the underlying series patterns. In proposed work, performing analysis of EEG signals to detect Alzheimer Disease. Many systems use Fourier Transform to take electroencephalograph signal in frequency domain only. Also, it is useful to extract features of signals. In this work, Wavelet transform is used to take the signal in time as well as frequency domain. To extract features of EEG signals, Wavelet Transform is useful. Based on applicable features of EEG signals, classify the EEG signals and predict results. To classify EEG signal through advanced machine learning algorithms using different frequency band and detecting brain disorder. To classify these signals with relevant features Support Vector Machine is used. Support Vector Machine is applicable to classify signals on the basis frequency as a feature and to detect Alzheimer Disease. Statistical features are calculated by taking an average of the frequency band of each channel of EEG cap. Average of frequency which is input to classifiers. For classification, Machine Learning algorithms are used with promising accuracy.

**INTRODUCTION-**

Nowadays, Population increases with increasing number of diseases. Neurogenerative is the major group of diseases which affect on the memory of elder people. Alzheimer's disease is brain disorder which affects on memory. It is found that due to dead brain cells person lost his memory. Generally, It happens after the age of 70 years old. Electroencephalograph (EEG) is a noninvasive technique which is useful to record electrical brain activity. In this work, electroencephalograph (EEG) is used to detect Alzheimer’s disease. Electroencephalograph (EEG) is capturing electrical brain activity across the scalp, generated by the firing of neurons in the brain. Electroencephalograph follows 10-20 standard system. The motivation for this project, work on EEG signal analysis to enhance the understanding of Digital Signal Processing (DSP) & Machine Learning. EEG analysis provides a way to advance this knowledge about the DSP & Machine Learning. As of now, there is no system which describes the earliest detection of brain disorder. Brain waves are classified into four types on the basis of frequency.

**Table 1-Classification of frequency ranges**

| Type | Range | State |
|---|---|---|
| Delta(δ) | 0.5 Hz to 4 Hz | Severe |
| Theta(θ) | 4 Hz to 8 Hz | Moderate |
| Alpha(α) | 8 Hz to 13 Hz | Mild Moderate |
| Beta(β) | >13 Hz | Mild |

In this work, the wavelet transform is used to represent EEG signal in time as well as in frequency domain. Wavelet Transform is a mathematical method to understand highly dimensional and non-stationary EEG signal. The wavelet transforms having the property of time as well as frequency domain. Many researchers work on EEG signal classification to predict mental state of human being. There are many machine learning algorithm for classification of EEG signals. Several algorithms have been investigated for purpose or increasing the classification rate and accuracy.[6].

**Related Work:-**

1. As there are many novel technologies like DIMENSION (Diagnostic Method of Neuronal Dysfunction), NAT (Neuronal Activity Topography) which are based on fluctuations in EEG. But these therapies are only applicable for the limited data set.

2. There are many methods used for feature extraction like Fourier transform and short time Fourier transform. But these techniques shows EEG signals in frequency domain only.Also due to alteration in signal whole Fourier series is affected which can affect on Classification and prediction of disease. Fourier transform waves are not specially localized.

3. For the feature extraction if the time domain analysis is used then there is no information about where frequencies are located in time.

**METHODOLOGY:**

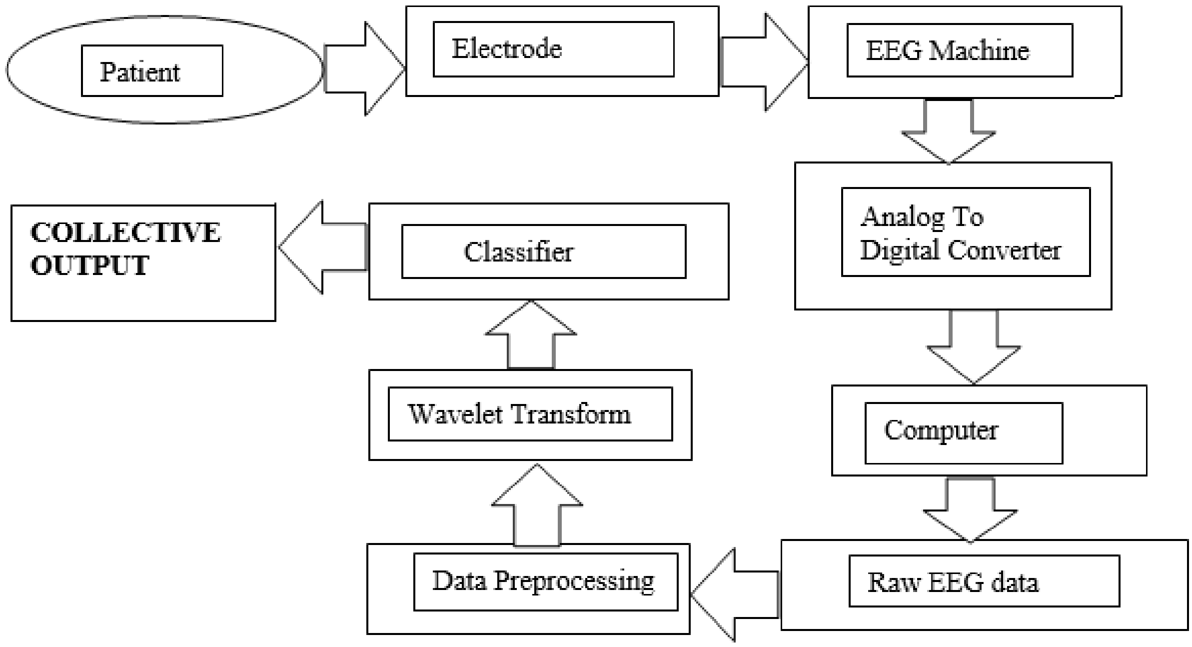


**Fig.1 Framework of Proposed System**

**Steps involve in Brain Computer Interface:**

**1. Data Acquisition**: Silver/Silver chloride (Ag/AgCl) electrodes are used to record brain activities using EEG cap. By connecting these electrodes on the scalp, electrical brain activities are recorded.

**2. Signal Processing:** - After recording the EEG signals which contain the noise and artifact. So that there is need to clean them. In this step, noise and artifacts are removed i.e. clean these EEG signal.[6]

**3. Feature Extraction: -**In this step, extract EEG signal's features as attributes using wavelet transform.

**4. Classification: -** In this step, relevant attributes of EEG signals are classified to detect mental state (normal or abnormal).As there are many classification algorithms in machine learning but here we discuss the SVM classifier.

**5. Detection of brain disorder: -**In detection step, frequency >30Hz that person is 'normal'. If frequency <30Hz, person is 'abnormal'.

**Feature Extraction:**

In Feature Extraction, Wavelet transform is used to extract features of EEG signals. To show or represent EEG signals in the time domain is the somewhat time-consuming task. While Wavelet Transform is used for feature extraction of signal and to show or represent it in time as well as frequency domain. The wavelet transform is the general mathematical method for EEG signal processing in many Brain Computer Interface application. The main function of the Wavelet transform is act as artifact removal which divides the signals into frequency band as per requirements. Wavelet transform consisting of two functions wavelet function and scaling function which shows below:

$$f(t) = \Sigma 2^{\frac{j}{2}} c(k).\Phi(2^j t - k) + 2^{\frac{j}{2}} d(k).\Psi(2^j t - k) \quad \ldots\ldots\ldots.. (1)$$

Where $\Phi(2^j t - k)$ and $\Psi(2^j t - k)$ are scaling and wavelet function. In above equation, the first term shows approximation f(t) based on index j(0) which is the index of scale. The second term adds more detail using the smoother scale. Scaling and Wavelet coefficients are calculated as below:

$$c^j(k) = \int f(t).\Phi(2^j t - k).dt \quad \ldots\ldots\ldots\ldots.(2)$$

$$d^j(k) = \int f(t).\Psi(2^j t - k).dt \quad \ldots\ldots\ldots\ldots\ldots(3)$$

Where φ(t) & ψ(t) are respectively, the scaling (approximation) & wavelet (detail) coefficient in the DWT. The frequency axis is divided into intervals towards the lower frequencies while the bandwidth-length decreases exponentially. The set of wavelet defined a special filter bank which can be used for signal component analysis and resulting wavelet transform coefficient can be further applied signal features for its classification.[6]

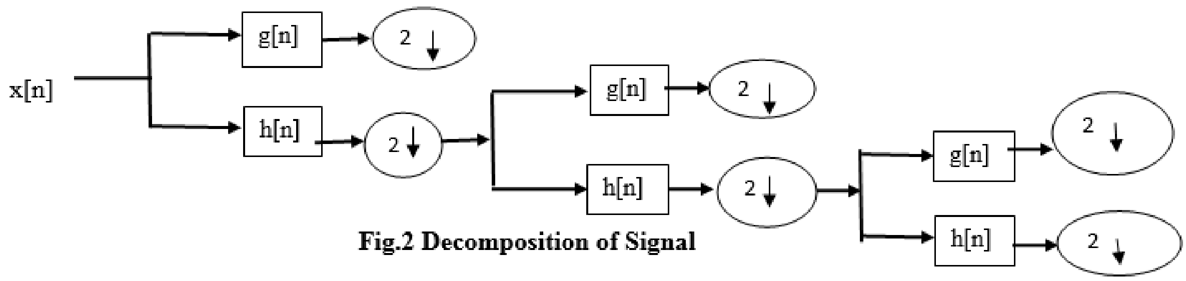


**Fig.2 Decomposition of Signal**

**Classification:-**

As features extracted from the signal, then classify signals according to frequency bands and detect the normal and abnormal person. Classification can be performed by using machine learning classification algorithms. But due to some problems in BCI classifier related to data size. Features come from various channels in different time intervals. So that when training data set is smaller than feature vector's size then classifier gives the poor result.

**Support Vector Machine:-**

The hyperplane is used by Support Vector Machine to detect or predict the class. As SVM selects hyperplane which one maximizes the margins i.e. distance from closest trained data. As Support Vector Machine uses regularization parameter C that is able to accommodate outliers and allows errors on trained data set. Such SVM is able to classify data set using linear boundaries and is known as linear SVM.

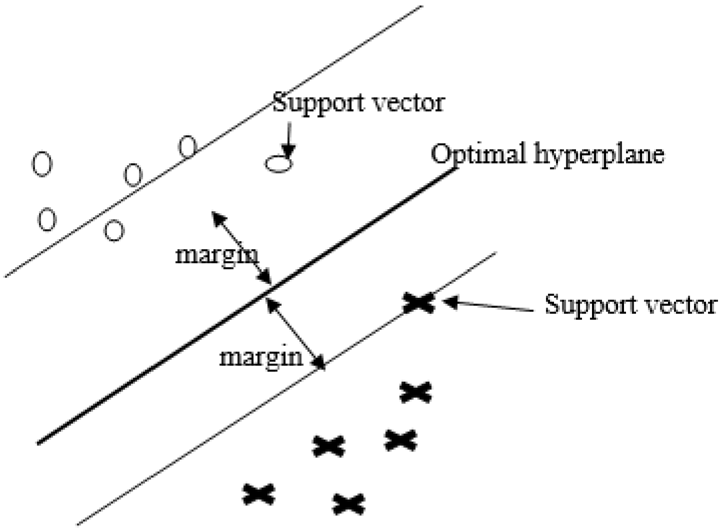


**Fig. 3 SUPPORT VECTOR MACHINE AND HYPERPLANE GENERALIZATION**

This classifier has been applied with success to BCI problems. It is able to create nonlinear decision boundaries by using kernel type. It consists in implicitly mapping the data to another space, generally of much higher dimensionality, using kernel function K(x,y).The kernel generally used in BCI research is Radial Basis Function kernel.

$$k(x,y) = \exp(-\frac{||x-y||^2}{2\sigma^2})$$

Pros and Cons of Classifiers:

Support Vector Machine:-

Pros-

1. Provides maximized margin (degree of separate) in training data.

2. Due to the use of the kernel SVM is flexible in threshold attributes.

3. No need to train data again and again.

4. Gives the best result for BCI application those contain noise

5. Error rate is low

6. BCI EEG data contain high dimensionality, therefore, SVM gives good results in the case of high dimensionality and smaller training set.

Cons-



1. High Complexity O(n^2).

2. In the testing phase, SVM performance is low.

3. Memory wastage.

**RESULTS AND DISCUSSION**

In this work, we captured EEG signals of normal and Alzheimer's Disease's person in order to detect Alzheimer Disease. EEG signal recording was divided into sub frequency band such as alpha, beta, delta, theta using Wavelet Transform. Then this frequency sub-band classify by using Support Vector Machine.

Dataset:-

The dataset of EEG signal used for this system is collected from UCI repository which contains normal and AD person, by using 8 channel EEG cap. That means EEG signal recorded using 8 channel. This dataset contains 8 channel data for each person and each channel consists of 256 samples with its amplitude.

**Performance Analysis of classifiers:-**

**Table 2-Performance of classifier**

| No. of Samples | Accuracy |
|---|---|
| 20 | 85% |
| 30 | 90% |
| 31 | 90.3226% |
| 33 | 90.9091% |

**Table 3-Evaluation of classifier**

| No. of trained Signal | No. of tested Signal | Correctly classified | Misclassified | Accuracy |
|---|---|---|---|---|
| 33 | 33 | 30 | 3 | 90.9091% |

**Analysis of Classifiers:**

It can be easily represented Support Vector Machine achieve the highest accuracy (90.9%).Support Vector Machine gives balanced classification.

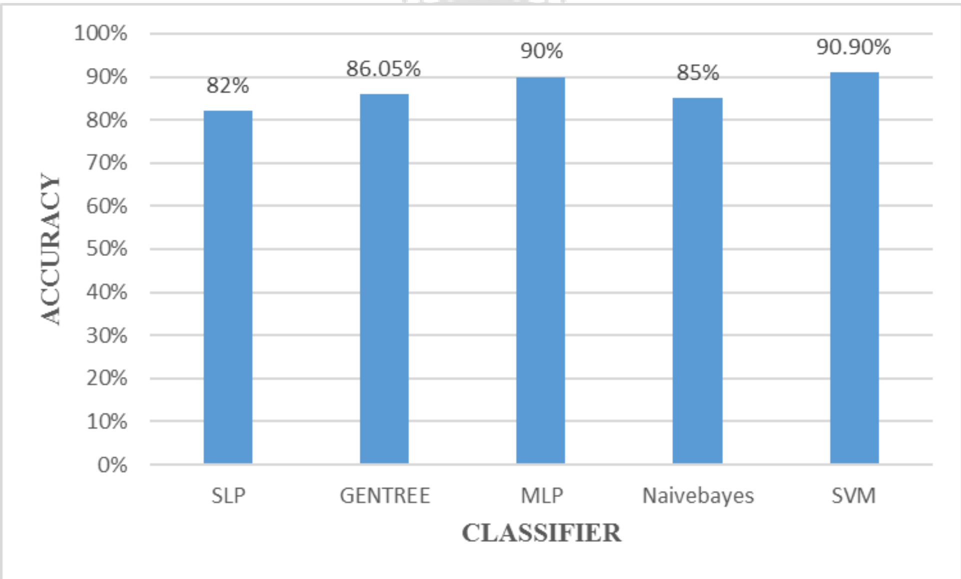


**Fig. 4 Classifier Performance**

**Future Scope:-**

In proposed work, we tested results for detection of Alzheimer Disease by using Support Vector Machine. In this proposed work, 8 channel EEG signal system is used for the brain-computer interface. This process can become easy and more accurate if more channels system is used e.g 16 channel for analysis and implementation. Also, it can be performed by using 4 channel EEG system.

## CONCLUSION

In Brain-Computer Interface, EEG is the noninvasive technique which will be useful in clinical diagnosis by detecting dead brain cells and useful for society. In the brain-computer interface, EEG is the simple and reasonable method for interfacing between brain and computer. EEG signals based on the frequency, the signal can be classified into different bands of frequency. In the proposed method the Wavelet transform is used for the feature extraction, because of the advantages of this on time as well as frequency domain analysis. In proposed method, Alzheimer disease is detected on the basis of frequency bands by using classification algorithm in machine learning algorithm.

## REFERENCES

1. Toshimitsu Musha Brain Functions Laboratory, Inc., Yokohama, JAPAN," Fluctuational analysis of EEG signals allows detection of AD(Alzheimer's Disease) in the early stage," *2015 Int. Con. on Noise and Fluctuations (ICNF)*
2. AbdullahBasuki Rahmat, Keiji Iramina" Classification of multiclass EEG Signal Related to Mental Task using Higuchi Fractal Dimension and 10-Statistics,"2015
3. M.R.Hasan, M.I.Ibrahimy S.M. A Motakabber, Shahajahan Shahid," Classification of multichannel EEG signal by Single Layer Perceptron Learning Algorithm,"2014
4. Joseph McBride, Xiaopeng Zhao, Nancy Munro, Yang Jiang, Charles Smith, Gregory Jicha;" Scalp EEG signal Reconstruction for detection of Mild Cognitive Impairment And Early AD",2014
5. Mr. C. E. Mohan Kumar, Mr. S. V. Dharani Kumar, Wavelet-Based Feature Extraction Scheme of Electroencephalogram,2014
6. Miss Priyanka G. Bhosale, Prof.Dr.S.T.Patil, "Classification of EEG signals using Wavelet Transform & Hybrid Classifier for Parkinson's Disease Detection," *Int. Journal of Engineering and Science (IJES) Volume 1, Issue 2 2012.*
7. Miss Priyanka G. Bhosale, Prof.Dr.S.T.Patil, "Classification of EEG signals using Wavelet Transform & Hybrid Classifier for Parkinson's Disease Detection." Int. Journal of Engineering Research and Technology (IJERT) ISSN: 2278-0181, Vol 2, Issue 1 January-2013.
8. Haleh Aghajani, Edmond Zahedi, Senior Member, IEEE, Mahdi Jalili, Member, IEEE, Adib Keikhosravi, and Bijan Vosoughi Vahdat," Diagnosis of Early Alzheimer's Disease Based on EEG Source Localization and a Standardized Realistic Head Model",2013
9. V.Podgorelec," Analyzing EEG SIGNALS WITH MACHINE LEARNING ALGORITHM FOR ANALYZING ALZHMEIR DISEASE", 2012
10. Jing Zhou " EEG Data Analysis, Feature Extraction and Classifiers"
11. Mohamed Elgendi, Francois Vialatte, Andrzej Cichoki, Charles Latchoumane, Jaesung Jeong, Justin Dauwels;" Optimization of EEG frequency bands for improved diagnosis of AD",2011
12. Sandhya Joshi, Deepa Shenoy," Classification of Alzheimer's Disease and Parkinson's Disease by Using Machine Learning and Neural Network Methods",2010
13. S. T. Patil, D. S. Borman, D. T. Ingole and Alka Mahajan "Electroencephalograph signal Analysis during Ujjayi pranayama, International Journal of Engineering Research and Industrial Applications (IJERIA), ISSN

0974-518, Vol-II, No-I, 2009. pp-271-278.

14. S. T. Patil, D. S. Bormane and Sandeep Narote, “EEG Analysis for Brain Interface” International Journal of Applied Computing” ISSN- 0974-6277, Vol-2, Issue –I, 2009. PP- 13-15.

15. D. S. Bormane, S T Patil “Pearl ensemble classifier Decision”, Journal of Wavelet Theory and Applications, **Print ISSN 0973-6336,** Vol-3, N0-1, 2009. pp-25-28.

16. S T Patil, D S Bormane "Slow Cortical Potential signal processing for Brain Computer Interface" International Journal of Systemics, Cybernetics, and Informatics, ISSN: 1690-4524, October 2007.

17. PP-78-85.

18. Ales Prochazka, Jaromil Kukal, Oldrich Vyasta," Wavelet Transform For Feature Extraction and EEG segments signal classification"

19. **S. Y.** Cho', B. Y. Kim2, E. H. Park3, J. W. Kim4, W. W. Whan$, **S.** K. Han', H. Y. Kim3,”Automatic Recognition of Alzheimer Disease with Single Channel EEG Recording”,2003