

Review on Wavelet Transform Based EEG Analysis for Primary Tumor Detection

Ankush A Surkar

M.TECH student (Communication), Department of
Electronics & Telecommunication Engineering
Priyadarshini College Of Engineering, Nagpur

E-mail: ankushsurkar@rediffmail.com

Assistant Professor, Department of Electronics &
Telecommunication Engineering
Priyadarshini College Of Engineering, Nagpur

E-mail: nambatkar@gmail.com

Asst. Prof. Nitin Ambatkar

Abstract-The Brain tumor harmful disease of brain. 10 Billion or more working cells contained in a brain cells. Normally, damaged cell turnover takes place in an orderly and controlled manner. If in curtailed condition the process gets out of control then the cells will continue to divide and developing into a lump, that causes a tumor. Brain tumors are classified into two types that is primary brain tumor and secondary brain tumor. The detection of primary brain tumor which is also called as Gliomas is possible by analyzing EEG signals. This paper, proposes a method to classification EEG signal for detection of primary brain tumor detection, that is combination of multi-wavelet transform and artificial neural network. Uncertainty in the EEG signals is measured by using the Approximate Entropy. The proposed method will implemented, tested and compared with existing method based on performance indices such as sensitivity, specificity, accuracy; results are promising with accuracy of upto 80%.

Keywords: Approximate Entropy (ApE), Artificial Intelligence (AI) Brain tumor ,Gliomas, Electroencephalogram (EEG), Multi-wavelet transforms (MWT), Neural Network (NN)

I. INTRODUCTION

The brain contains approximately 10,000,000,000 working brain cells. That is called as neurons and make over 13,000,000,000,000 connections with each other to form the most complex organic structure on the planet.. Cells in different parts of the body may look and work differently and most of them repair themselves in the same way through by dividing to make more cells. Normally, this takes place in an orderly and controlled manner. If, in any condition, the process gets out of control, the cells will continue to divide, developing into a lump and tumor is generated. In general neurologists use Computer Tomography (CT) imaging techniques for diagnosis of brain tumors as it has high accuracy in initial diagnosis of the primary stages. However such scans stand short and when analyzing the physiological functioning of the brain as a whole, both at the time of initial diagnosis or as part of a long term management of the patient. For such purpose, EEG has been used to render a clearer overall view of the brain functioning at initial diagnosis stages. In brain Tumor diagnostics, EEG is most relevant in assessing how the brain responds to treatments (e.g. post operative).

Because of a non-invasive and low cost procedure, the EEG is an attractive tumor diagnosis method on its own. It is a good tool for the gliomatumor series. The important point of the method is, EEG in vascular lesions is abnormal from the onset of symptoms and in a case of CT only become abnormal on the third or fourth day or after week. So the EEG is, however less successful in detecting brain stem tumors and meningioma series. Many researchers are working to develop an automated tool which can easily

analyses the EEG signal and the reveal information of existence of primary brain tumor. My paper proposes an automated tool to classification of EEG signal for brain tumor detection.

II. RECENT RESEARCH WORKS

. Lots of research works present in the literatures that make use of EEG signal for identification of brain tumor. Important papers are reviewed below, for detailed review refer [15]. Murugesan, M. Sukanesh, R [5] shows a smooth method for automated system which forms a efficient detection of brain tumors in EEG signals using artificial neural networks (ANNs). The ANN shows in the proposed technique is feed forward back propagation neural network. At first, adaptive filtering is applied to remove the artifacts present in the EEG signal. Subsequently, generic features present in the EEG signal are removed by using spectral estimation. Spectral analysis is achieved by using Fast Fourier Transform that removes the signal features hidden in a wide band of noise. The clean EEG signal information thus obtained is used as training input for the feed forward back propagation neural network. The trained feed forward back propagation neural network when mixed with a test EEG signal, effectively detects the presence of brain tumor in the EEG signal. The experimental process demonstrate the effectiveness of the proposed system in artifacts removal and brain tumor detection. Seenwasen Chetty, Ganesh K. Venayagamoorthy [7] proposed The ANN based EEG classifier to distinguish between the EEG signal of a normal patient and that of a abnormal brain tumor patient. The results show that an artificial neural network is able to find and distinguish between an abnormal and normal EEG signal, and classify them perfectly as brain tumor and

healthy patient respectively. This is possible to achieved with the help of ANNs as they are able to learn the patterns in a normal and abnormal EEG signal. ANN gives a approximately 100% classification success rate with both normal and abnormal EEG. Munther A.Dahleh, Fadi N. Karameh [8] deals with the automated system to identify the space occupying lesions on the brain using EEG signals. EEG features are extracted with the help of wavelet transform for different tumor classes and classification by selforganizing maps. Dr (Mrs.).R. Sukanesh and M. Murugesan[6] both proposed a technique for classification of electroencephalogram (EEG) signals which have a credible cases of brain tumor. The classification technique support vector machine is utilized in the proposed system for detecting brain tumors. Adaptive filtering is used to removed the artifacts present in the EEG signal. Then for extracting generic features embedded in an EEG signal the spectral analysis method is used. To separate the signal features which are buried in a wide band of noise Fast Fourier Transform is used. The radial basis function-support vector machine is trained using the clean EEG data obtained. With proper testing and training, they effectively classify the EEG signals with brain tumor. Ch. Ziegeus, Ch., Lang, Elmar and Schulmeyer and Habl, M. and Bauer, F [10] presented a technique to find and characterize brain tumors. They removed location arifactual signals, applied a flexible ICA algorithm that does not rely on a priori assumptions about the unknown source distribution. They found that tumor related EEG signals can be isolated into single independent ICA components. Such signals where not observed in corresponding EEG trace of normal patients.

III. PROPOSED METHOD

The proposed method uses MWT and ANN to classify the EEG signal for primary brain tumor detection. The below block diagram shows flow of proposed methodology.

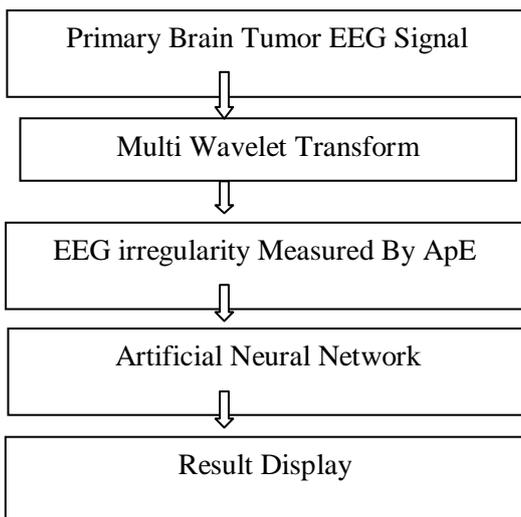


Figure 1: Proposed Flow Diagram

The EEG signal without any affect is given as an input to MWT then the EEG signal is decomposed and the irregularities of the signal are determined by using the ApE method. After that the ApE output is trained by using Feed Forward Neural Network (FFNN) and result is shown. The proposed system was evaluated with samples of EEG data recorded from patients. Of which, some samples correspond to EEG data with brain tumor and the remaining samples correspond to EEG data without brain tumor

Multi-Wavelet Transform Technique.

In MWT decomposition, the input signal is denoted as $x(n)$. The decomposed low pass filter outputs are denoted as A_1, A_2, A_3, A_4 and A_5 the decomposed high pass filter outputs are denoted as D_1, D_2, D_3, D_4 and D_5 The following figure shows the decomposition structure of 5 MWT. Using this structure, the decomposition stage of EEG signal is calculated

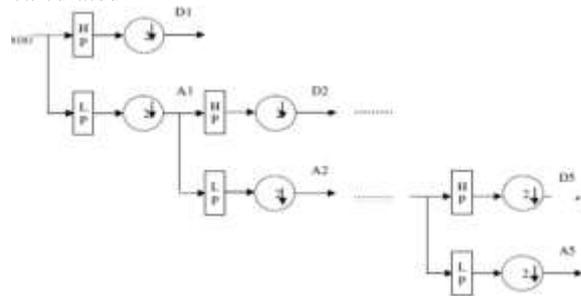


Figure 2: Decomposition of MWT

e 2: Decomposition of MWT

The decomposition of MWT signals is calculated by using the following formulas. The decomposition of low frequency component is calculated as,

$$A_{i-1} = \sum_k H_k A_{i,2k+n}$$

The decomposition of high frequency samples component is calculated as

$$D_{i-1} = \sum_k G_k D_{i,2k+n}$$

Using the above two formulas, the decomposition of samples signal MWT is calculated

Approximate Entropy Method:

Approximate entropy (ApE) is a method used for quantifying the amount of regularity and the unpredictability of fluctuations over time-series data. The output of ApE is denoted as

$$AD_1, AD_2, AD_3, AD_4 \text{ and } AD_5$$

The irregularities of the EEG signal are calculated by following the below procedure.

- 1 Calculate N data points from the signal
 $n = [n(1), n(2), \dots, n(N)]$.
2. Fix window length m and tolerance rr
3. Form a sequence of vector
 $X(1), x(2), \dots, x(N - m + 1)$ m dimensional vectors are defined by $x(i) = [u(i), u(i + 1), \dots, u(i + m - 1)]$
 For $i = 1, 2, \dots, N - m + 1$.
4. Using sequence $x(1), x(2), \dots, x(N - m + 1)$
5. Calculate natural algorithm for each value.
6. Calculate and for increasing the m up to its fixed value ApE calculated by below formula
 $ApEn = fm(rr) - fm+1(rr)$

The irregularities of signal mostly depend on the ApE value. ApE value for each sub-signal of the decomposed data signal with MWT is calculated to get a feature vector. These ApE value is then applied as input to the neural network and the training dataset is generated.

In this paper feed forward propagation is used and depending on the result there will be changes to use back propagation network also.

Training of Neural Network:

In the present work, a feed-forward neural network (FFNN) is used for identifying the types of EEG signal.

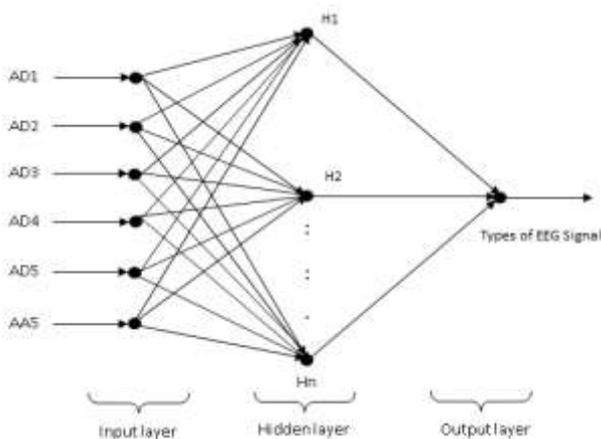


Figure 3: Neural Network architecture.

FFNN consists of three layers that are input layer, hidden layer and output layer. The input to input layers of neural network are AD1, AD2, AD3, AD4 and AD5

The n numbers of hidden layers H1, H2...Hn are nodes of hidden layer, the neural network process takes place in this hidden layer. The training of the neural network is

performed with the help of back propagation algorithm. The output of neural network is used to determine the types of EEG signal. Figure. 3 show the neural network training structure. The multiwavelet output signal is trained and the training dataset is generated for primary brain tumor detection. The weight between input and hidden layer is denoted as W1, the weight between hidden and output layer is denoted as W2. The weight adjustment depends on the output requirement of the required generated system.

The formula for weight adjustment between the layers is $W_{ji}(n + 1) = W_{ji}(n) + DW_{ji}(n)$ The neural network output is calculated.

Once the training process is completed, then, the network is trained for classifying the EEG signal. After the training process, the next process of neural network is testing. In this testing phase, an input signal is applied and then the types of EEG signal are calculated. From these types of EEG signal, the primary brain tumor can be detected.

Proposed Work

Proposed work is to deal with the Entropy Value of the wavelet transform method. Then the entropy value is given to the neural network where proper ordering of weight management is done. The result analysis of the network is done by the regular method of neural network where terms like Sensitivity, Specificity, Accuracy, Precision is observed. From this stage we are able to fine the input signal is the normal signal or tumor signal.

IV. CONCLUSION

This paper, proposes a method to classify EEG signal as normal and primary brain tumor, with the help of combination of multiwavelet transform and artificial neural network feed forward propagation. Uncertainty in the EEG signals is measured by using the Approximate Entropy level. The proposed technique is implemented and tested on data obtained from Samples of EEG signals, proposed and exiting methods compared. Work is progress to enhance implemented method to achieve 100% accuracy for identification of primary brain tumor.

V. ACKNOWLEDGMENT

I am thankful to my project guide for guidance and encouragement in carrying out this project work. I also wish to express my gratitude to other staff members who are rendering their help during my project work

REFERENCES

- [1] J.D. Bronzino, "Biomedical Engineering Handbook", New York: CRC Press LLC, Vol. I, 2nd edition 2000
- [2] D.Bradbury, "Volunteer's Guide to an EEG", Institute Of Neurology Wellcome Department Of Imaging Neuroscience,
- [3] <http://www.fil.ion.ucl.ac.uk/EEGvolunteerguide.pdf>

- [4] <http://www.brain-surgery.com/primer.html>
- [5] Murugesan, M. Dr. (Mrs.). Sukanesh, R “Automated Detection of Brain Tumor in EEG Signals Using Artificial Neural Networks”, IEEE Conference on Advances in Computing, Control, & Telecommunication Technologies, 2009. Act 09. Trivandrum, Kerala
- [6] M. Murugesan and Dr. (Mrs.) R. Sukanesh “Towards Detection of Brain Tumor in Electroencephalogram Signals Using Support Vector Machines” International Journal of Computer Theory and Engineering, Vol. 1, No. 5, December, 2009
- [7] Seenwasen Chetty, Ganesh K. Venayagamoorthy “An investigation into the Detection of brain tumours using electroencephalography (EEG) signals with Artificial neural networks” Computational Intelligence Group, Department of Electronic Engineering M L Sultan Technikon
- [8] Fadi N. Karameh, Munther A. Dahleh “Automated Classification of EEG Signal in Brain tumour diagnostics” IEEE Proceeding of the American Control Conference, Chicago, Illinois. June 2000.
- [9] Rosaria Silipo, Gustavo Deco and Helmut Bartsch “Brain Tumour classification Based on EEG hidden dynamics” Elsevier Inc journal Intelligent Data Analysis, Vol 3, Issue 6, Pages 413-514 (December 1999).
- [10] Habl, M. and Bauer, Ch. and Ziegeus, Ch., Lang, Elmar and Schulmeyer, F. “Can ICA help identify brain tumor related EEG signals?” Proceedings /ICA 2000, Second International Workshop on Independent Component Analysis and Blind Signal Separation: Helsinki, Finland, June 19 - 22, 2000. Unspecified, pp. 609-614. ISBN 951-22-5017-9.
- [11] Lawrence J. Hirsch “Continuous EEG Monitoring in the Intensive Care Unit: An Overview” Journal of Clinical Neurophysiology, Volume 21, Number 5, October 2004
- [12] Small, Joyce Graham Bagchi, Basu K. Kooi, Kenneth A. Electroencephalography and Clinical Neurophysiology, Vol 13, Issue 2, Pages 193-207, April 1961
- [13] I. Omerhodzic, S. Avdakovic, A. Nuhanovic, K. Dizdarevic “Energy Distribution of EEG Signals: EEG Signal Wavelet-Neural Network Classifier” International Journal of Biological and Life Sciences, 6:4 2010
- [14] David A. Peterson, James N. Knight, Michael J. Kirby, Michael H. Thaut and Charles W. Anderson “Feature Selection and Blind Source Separation in an EEG-Based Brain-Computer Interface” EURASIP Journal on Applied Signal Processing, 2005:19, 3128–3140
- [15] Sharanreddy and Dr. P. K. Kulkarni “Review of Significant Research on EEG based Automated Detection of Epilepsy Seizures & Brain Tumor”, International Journal of Scientific & Engineering Research, Volume 2, Issue 8, Aug-2011, ISSN 2229-5518
- [16] Sharanreddy and Dr. P. K. Kulkarni “Literature Survey on EEG based Automatic Diagnosis of Epilepsy seizures & Brain Tumor using WT and ANN” International Conference on Biomedical Engineering (ICBME2011), Dec 10-12, 2011, Manipal, India.
- [17] Sharanreddy and Dr. P. K. Kulkarni “Necessity for Automated Analysis of EEG Signal for Detection of Multiple Neurological Disorders” International Conference on Evolutionary Trends in Information Technology (ICETIT 2012), Sep 15-17, 2012, VTU Belgaum, India.
- [18] Technology (ICETIT 2012), Sep 15-17, 2012, VTU Belgaum, India.