Tumor detection with EEG Signals using Wavelet Transform

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***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 curtained 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)

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1. 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 form 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 revel information of existence of primary brain tumor. My paper proposes an automated tool to classification of EEG signal for brain tumor detection.

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

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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. Ziegaus, 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.

Flow work

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

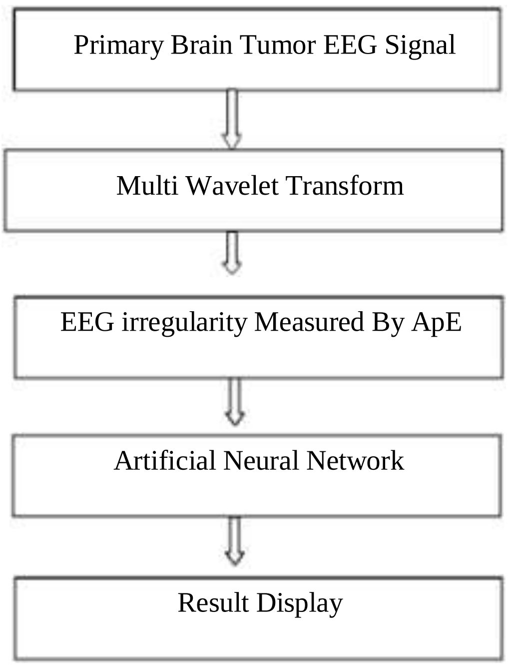

Figure 1:Flow Diagram

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)(nx. The decomposed low pass filter outputs are denoted as A1,A2,A3,A4 and A5 the decomposed high pass filter outputs are denoted as D1,D2,D3,D4 and D5 The following figure shows the decomposition structure of 5 MWT. Using this structure, the decomposition stage of EEG signal is calculated

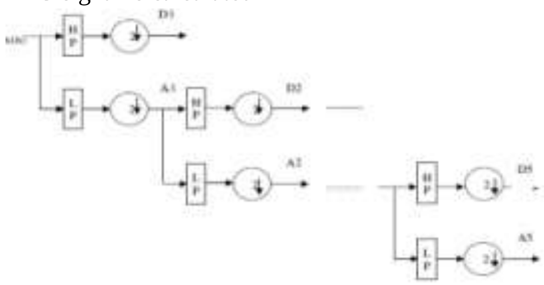

figure 2: Decomposition of MWT

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

AD1, AD2, AD3, AD4 and AD5

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) ,............n(N)].

2.Fix window length m and tolerance rr

3. Form a sequence of vector
$X(1), x(2),.....x(N - m + 1)$ m dimensional vectors are defined by $x(i) =[u(i), u(i + 1),........, u(i + m - 1)]$

For i=1,2…N-m+1.

4. Using sequence $x(1), x(2),.....x(N - m + 1)$

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.

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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.

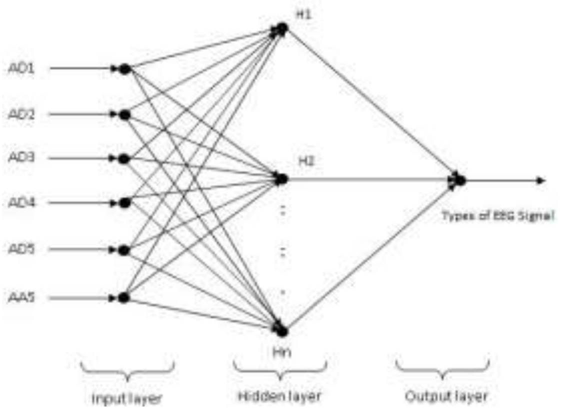


Figure 3: Neural Network architecture.

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 asW1 , 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.

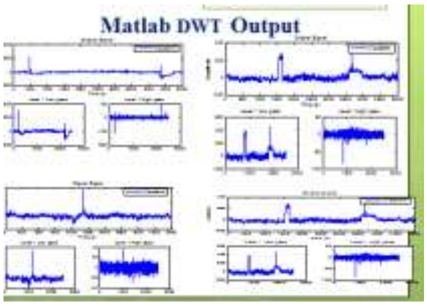
Once the training process is completed, then, the network is trained for classifying the EEG signal. After the training process, the next process of neural network

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.

Execution of Project

The input data of the EEG machine is in the from of the numeric value. That numeric value is given to the MATLAB and in the matlab input DWT is applied. The large Input signal is converted to N stages DWT signals. Now with the help of the Entropy calculation the N Stage Entropy is calculated and the entropy value is given to the Neural Network. In the same way various Tumor and NonTumor Database is checked in a single matlab program through excel sheet . The Neural Network used in this project is LVQ propagation Neural Network.

Results:



Entropy for Single Data Sample

Ad1	0.0432
Ad2	0.0173
Ad3	0.0538
Ad4	0.0432
Ad5	0.0619
Aa5	0.0363

a Entropy Values For first Frame.

Ad1	0.652
Ad2	0.0173
Ad3	0.0130
Ad4	-0.0138
Ad5	0.0359
Aa5	0.0351

Entropy Values For Second Frame.

Ad1	0.566
Ad2	0.0120
Ad3	0.0619
Ad4	0.024
Ad5	0.0359
Aa5	0.0478

Entropy Values For Third Frame.

Ad1	0.139
Ad2	0.022
Ad3	0.0365
Ad4	-0.129
Ad5	0.0125
Aa5	0.158

For BP

29 Samples correctly detected from Tumor Samples and 36 Samples correctly detected from Normal Samples through overall 40 and 40 samples respectively.

TP=65 ,FP=0,TN=80,FN=15

For LVQ

37 Samples correctly detected from Tumor Samples and 40 Samples correctly detected from Normal Samples through overall 40 and 40 samples respectively.

TP=77,FP=0,TN=80,FN=3

Accuracy

Final Results:

Sensitivity	Back Propagation (%)	LVQ (%)
Normal	**90**	**100**
Abnormal(Tumor)	**72.5**	**92.5**

Table Sensitivity Table

Parameter	Back Propagation	LVQ
Accuracy	**81.25**	**96.25**

Table Accuracy Table

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 propogation. 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.

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