Detection of Primary Brain Tumor Using Neural Network and Wavelet Transform Present in EEG Signal

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Abstract— The Brain tumor is one of the most dangerous diseases of brain. The brain contains about 10 Billion or more than that of working brain cells. Damaged brain cells are diagnosed themselves by dividing themselves which makes more cells. Normally, these types of turnover take place in an proper and very much controlled manner. If, for some reason, the process gets out of control, the cells will continue to divide, which creates a lump, which produces a tumor. Brain tumors are broadly categorized into two types, primary and secondary brain tumor. The detection of primary brain tumor (Gliomas) is possible by analysing EEG signals. This paper, proposes a very unique technique for classification EEG signal for detection of primary brain tumor detection, which is combination of multi-wavelet transform and artificial neural network. Irregularities in the EEG signals are measured by using the simple technique called as Approximate Entropy. The proposed technique is implemented, then tested and after that it is compared with existing method based on performance indices such as sensitivity, specificity, accuracy; results are promisingly accurate.

Index Terms— Artificial Neural Network (ANN), Brain tumor, Classification, electroencephalogram (EEG), Wavelet Transform..

I. INTRODUCTION

Brain electrical activities are recorded using EEG clinical test. The human brain is the most complex object ever known. It is basically soft, delicate, and spongy mass of tissue. Brain tumor can also damage healthy cells by crowding other parts of the brain and causing brain swelling and inflammation within the skull. The complex brain tumor can be separated into two general categories depending on the tumors origin, their growth pattern. Primary brain tumors originate in the brain itself or in tissue close to it.

This paper proposes an automated tool to classification of EEG signal for brain tumour detection. In general, the EEG signals carry information about abnormalities or responses to certain stimulus in the human brain. However, EEG signals are highly contaminated with different artifacts, both from the subject and from the equipment interferences. Initially, this type of artifacts which are present in the EEG signal are removed using adaptive filtering being a non-invasive low cost procedure, the EEG is an attractive tumor diagnosis method on its own.

The EEG signals absorb a great deal of information about the function of the brain. EEG acquired from scalp electrodes, is a superposition of a huge amount of electrical potentials arising from a number of sources (including brain cells i.e. neurons and artifacts

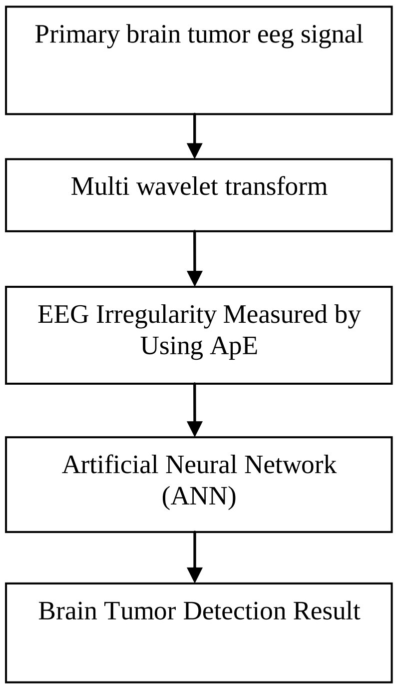

Figure 1. Block Diagram of Methodology.

II. ELECTROENCEPHALOGRAPHY (EEG)

Electroencephalography is the neurophysiologic measurement of the electrical activity of the brain using electrodes placed which is placed on the scalp. The resulting traces are defined as electroencephalogram (EEG) and they represent an electrical signal from a large number of neurons. The EEG is itself brain non-invasive an established procedure frequently used for diagnostically purposes. The greatest advantage of EEG is fast processing speed. Complex patterns of the neural activity can be recorded occurring within fractions of a second after a stimulus has been administered. EEG can determine the relative strengths and positions of electrical activity in different brain regions.

2.1 Normal and Abnormal EEG waveforms

When EEG waveforms is recorded for a patient who is awake or rest with eyes closed, a wave of about 1hz in frequency is continuously generated from the occipital region in almost symmetrical fashion in left and right side of the brain while it becomes larger just like the tide rises and falls. This wave is called alpha wave is considered as a standard wave of a normal patient captured over a few seconds.

Patterns in an abnormal patient usually include the appearance of a spike, sharp wave and slow wave complex. Between these abnormal waves an irregular slow wave appears and the background waveform is disturbed. Fig 2 and 3 shows normal and abnormal EEG waveforms

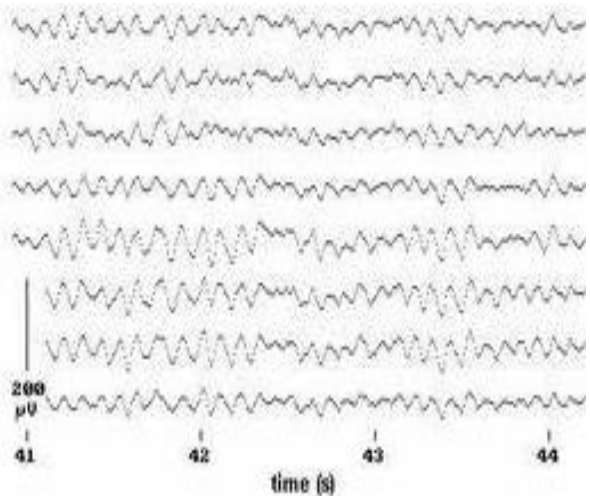

Figure 2. Normal EEG waveform

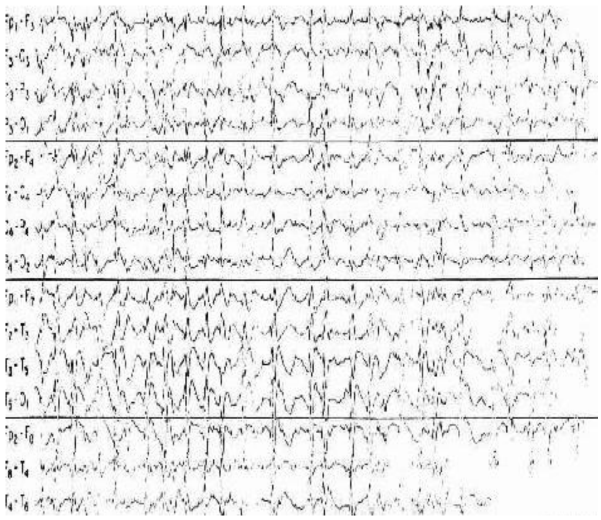

Figure 3. Abnormal EEG waveform

III. DATA PREPROCESSING

The EEG signal needs to be pre-processed in order to achieve the correct classification. The techniques to refine the data suitable for analyzing are included under the pre-processing technique. Size normalization, noise elimination and resampling are the normal techniques in pre-processing. Normally, size of the images varies. It is better to re-size the image to a fixed size so that classification of size affecting recognition results can be avoided. The Pre-processing in the brain tumor detection system involves the following two steps. In the first step, resizing of the image is done.

The EEG images obtained will not be of same size and they need to be converted to a standard size. This is required so that the set of features obtained for all the EEG images will be same

IV. WAVELET TRANSFORM AND DECOMPOSITION

In this project we are combining the multi wavelet transform and feed forward neural network with for better result in detection of primary brain tumor present in eeg signal. For this project we are using multi wavelet transform decomposition for low pass filter and high pass filter. Firstly we are combining EEG signal with wavelet transform. The combination can be shown in following figure which is obtain using matlab 10.1

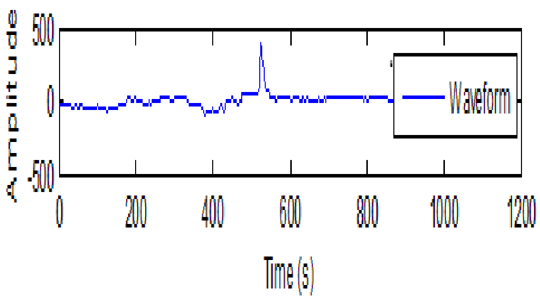

Figure 4. Applying wavelet to EEG signal

4.1 Multiwavelet Transform Decomposition

In MWT decomposition, the input signal is denoted as The decomposed low pass filter outputs are denoted as $A_1A_2A_3A_4$ and A, and the decomposed high pass filter outputs are denoted$D_1D_2D_3D_4$ and D_5 The following figure shows the decomposition structure of 5 MWT. Using this structure, the decomposition stage of EEG signal is calculated. The decomposition of MWT is calculated by using the following formulas. The decomposition of low frequency component is calculated as,

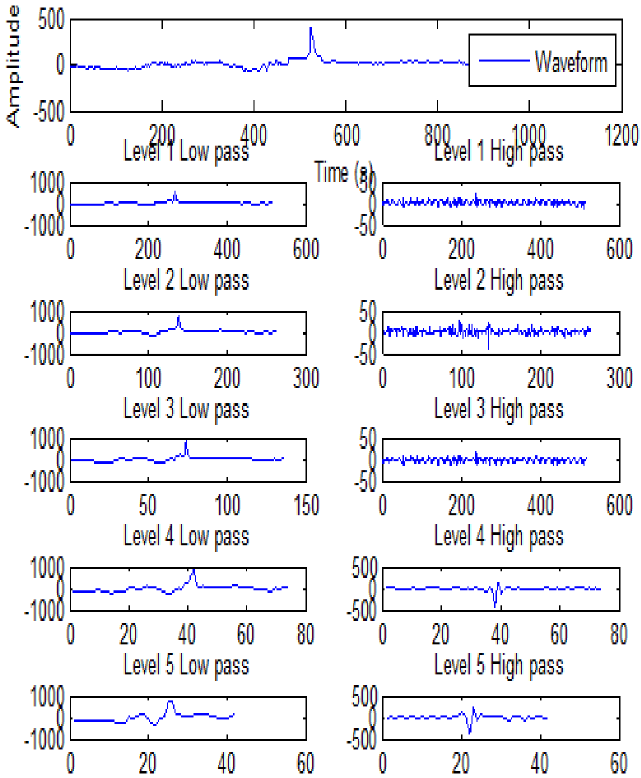

Figure 5. Decomposition of MWT with EEG signal

V. APPROXIMATION ENTROPY METHOD

The EEG signal without any art affect is given as an input to MWT, the EEG signal is decomposed and the irregularities of the signal are determined by using the ApE process. Then the ApE output is trained by using Feed Forward Neural Network (FFNN) and result is displayed. The proposed system was evaluated with 325 samples of EEG data recorded from patients. Of which, 163 samples correspond to EEG data with brain tumor and the remaining 162 samples correspond to EEG data without brain tumor. Then the irregularities of the EEG signal are calculated by following the below procedure.

1. Calculate N data points from the signal i.e. The irregularities of signal depend on the ApE value. ApE value for each sub-signal of the decomposed data with MWT is calculated to form a feature vector. These ApE value is then applied as input to the neural network and the training dataset is generated. In the present work, a feed-forward neural network (FFNN) is used for identifying the types of EEG signal. In MWT decomposition, the input signal is denote as . The decomposed low pass filter outputs are denoted as , and the decomposed high pass filter outputs are denoted .and D The following figure shows the decomposition structure of MWT. Using this structure, the decomposition stage of EEG signal is calculated (nx A A A 1 2 3 4D D D D 1 2 3 4 A) The decomposition of MWT is calculated by using the following formulas. The decomposition of low frequency component is calculated as, Using the above two formulas, the decomposition of MWT is calculated Approximate entropy (ApE) is a technique used to quantify the amount of regularity and the unpredictability of fluctuations over time-series data. The output of ApE is denoted as

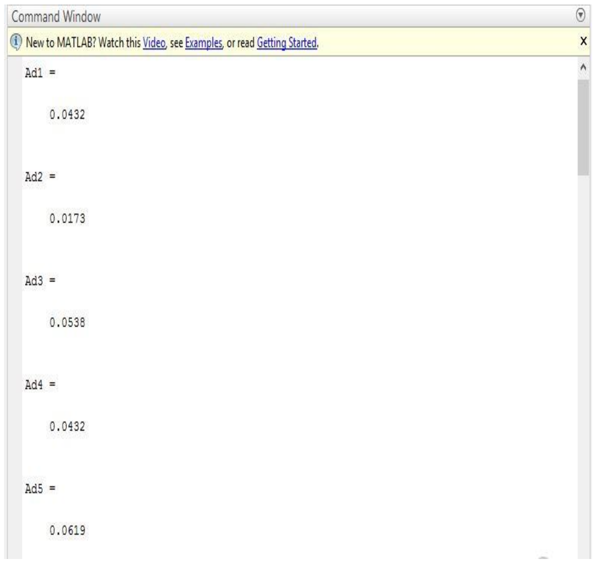

Figure 6. Calculated Result of ApE

VI. NEURAL NETWORK

Artificial neural networks are biologically inspired classification algorithms that consist of an input layer of nodes, one or more hidden layers and an output layer. Each node in a layer has one corresponding node in the next layer, thus creating the stacking effect. Artificial neural networks are the very versatile tools and have been widely used to tackle many issues. Learning Vector Quantization

This is particularly useful for pattern classification problems.(LVQ) is a supervised version of vector quantization that can be used when we have labelled input data. The formula for weight adjustment between the layers is

- $\Delta w_j=\beta(x - w_j)$:if X is classified correctly
- $\Delta w_j=-\beta(x - w_j)$:if X is classified Incorrectly

VII. CONCLUSION

The proposed technique describes a novel Method which uses the Wavelet features and Artificial Neural Network for the detection of brain tumor from EEG waveform. The experimental result shows that brain tumor EEG images as well as healthy EEG images are recognized correctly. We have applied wavelet transform to EEG signals. The main goal behind this is to assist the researchers in the field of EEG signal analysis to understand the available methods and adopt the same for the detection of neurological disorders associated with EEG. After applying MWT to the EEG signal decomposition has been carried out correctly. The advantage of using EEG waveform is that it reduces computational time.

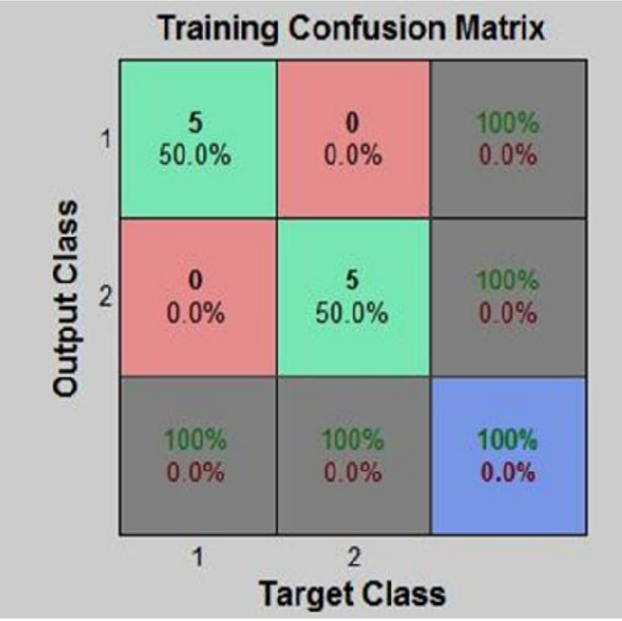

Figure 7. Training Confusion Matrix

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