Brain Tumor Detection using ANNs

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Abstract: ***Brain tumor is inherently serious and life-threatening disease. Brain tumor is an abnormal growth of cells within the brain or inside the skull, which can be cancerous or noncancerous. Early detection and classification of brain tumors is very important in clinical practice. With recent development in the medical engineering and instruments, EEG instruments are able to record the brain electric activities with high accuracy, which establishes EEG as a primary tool for diagnosing the brain abnormalities. This paper represents earlier detection of brain tumor using artificial neural networks (ANNs).EEG signals carry the information of human brain. But EEG signal is contaminated with artifacts. These artifacts are removed by adaptative filtering. Then the spectral analysis method is applied for extracting generic features in an EEG signal. Fast Fourier Transform for spectral analysis is used to separate the signal features present in noise. The clean EEG is obtained and fed to feed forward back propagation neural network .Hence early detection of brain tumor is necessary.***

Keywords: Electroencephalogram (EEG), brain tumor, artifacts, adaptive filtering artificial neural network, feedforward backpropagation neural network.

1. Introduction

The brain is an incredibly complex organ. Brain tumors are abnormal and uncontrolled proliferations of cells. Some originate in the brain itself, in which case they are termed primary. Others spread to this location from somewhere else in the body through metastasis, and are termed secondary. Primary brain tumors do not spread to other body sites, and can be malignant or benign. Secondary brain tumors are always malignant. Brain tumors are, in fact, the second leading cause of cancer- related deaths in children and young adults.

An electroencephalogram (EEG) is the manifestation of brain activity recorded as changes in electrical potentials at multiple locations over the scalp. At present EEG is becoming an important tool in studying and recognizing several neurological disorders. However contamination of EEG activity by electrocardiogram (ECG), respiration, eye movements, blinks muscles and line noise remains a serious problem for EEG interpretation and analysis [2].

An electrooculogram (EOG) generated by eye movements and blinks is found to be most significant and common interfering artifacts in EEG. Since the eye movements are difficult to suppress over a sustained recording course [10]. It becomes extremely important to eliminate the eye blink artifacts without distorting the underlying brain activity [5].

2. Method for Brain Tumor Detection

The method is composed of three phases-1) Artifacts removal 2) Feature extraction and 3) Brain tumor detection using feed forward back propagation neural network.

As EEG signal is contaminated with artifacts so EEG signals are subjected to the process of artifacts removal, which involves adaptive filtering and spectral estimation using Fast Fourier Transform (FFT).To get the filtered output, the data are convolved with the filter coefficients. Then the features are extracted by applying Fast Fourier Transform (FFT). The output of the FFT provides the power spectral values. The spectral analysis of EEG during shows the frequency range. The clean EEG signal after removal of artifacts is fed to the feed forward back propagation neural network for organized training and testing [2].

A. Artifacts Removal

To remove line interference, EOG, ECG artifacts from EEG signal, the proposed system makes use of adaptive filtering. The intent of an adaptive filter is to vary the coefficients of linear filter, and thus its frequency response, to produce a signal similar to noise detected in the signal. The adaptive process comprises of the minimization of a cost function, which is used to find out the filter coefficients. Generally the adaptive filter tunes its coefficients to reduce the squared error between its output and a primary signal. The filters converge to the Weiner solution in stationary conditions. In non-stationary circumstances, the coefficients will vary with time, corresponding to the signal variation, thus converging to an optimum filter [11]. Fig.1 illustrates the typical block diagram of an EOG noise canceller using adaptive filtering.

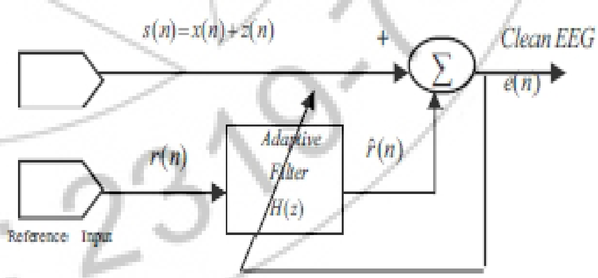

Figure 1: EOG noise canceller system using adaptive filtering [8]

The primary input to the system $s(n)$ is modeled as a combination of background EEG $x(n)$ and the effect of EOG artifacts $z(n)$ on the EEG signal. Reference input to the system $r(n)$ is the EOG signal picked up by an electrode. Reference input and the noise component of primary input are correlated in some unknown way. $h(m)$ represents a finite impulse response (FIR) filter of length M . Adjusting the coefficients of the filter, the noise canceller produces an output signal $e(n)$ which is an estimation of background EEG $x(n)$[8].

$e (n) = s (n)\hat{r}(n)$
where

$$\hat{r}(n) = \sum_{m=1}^{M} h(m) r(n+1-m)$$

B. Features Extraction using FFT

Spectral analysis methods are the main source of solving the convolution of generic feature extraction embedded in an EEG signal by assuming short stationary and study energy content of EEG channels in conventional frequency bands adopted by human rater's physicians. (Delta: below 3.5 Hz, Theta: 4 -7.5 Hz, Alpha: 8- 13 Hz and Beta: 13 - 40 Hz). The proposed system implies Fast Fourier Transform for spectral analysis. The use of FFT is to find frequency components of a signal buried in a noisy time domain signal. The functions $Y = FFT(x)$ and $y = IFFT(X)$ implement the transform and inverse transform pair given for vectors of length N by:

$$X(k) = \sum_{j=1}^{N} x(j)\omega_N^{(j-1)(k-1)}$$

$$x(j) = (1/N)\sum_{k=1}^{N} X(k)\omega_N^{-(j-1)(k-1)}$$

where ,

$\omega_N = e^{(-2\pi i)/N}$, is a N^{th} root of unity.

After computing the Fast Fourier Transform, the absolute band power for prominent EEG spectral bands (Delta: 1-4 Hz, Theta: 4-8 Hz, Alpha: 8-13 Hz and Beta: 13-30 Hz) was calculated.

C. Brain tumor detection using feed forward back propagation neural network

In the proposed system the effective detection of brain tumors from EEG signals is accomplished by an ANN feed forward back propagation neural network. The input to feed forward is clean EEG signals. The EEG signal is divided into two categorizes namely, training data and test data.

A feed forward back propagation neural network is chiefly composed of two layers, 1) hidden/first layer and
2) Output/second layer.

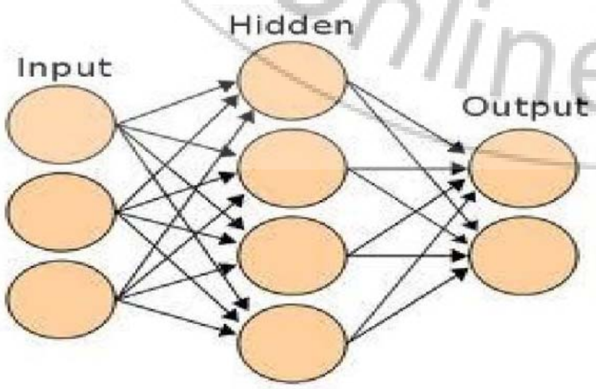

Figure 2: Feed forward Network [11]

Back propagation learning algorithm was used for learning these networks. During training this network, calculations were carried out from input layer of network toward output layer, and error values were then propagated to prior layers. Feed forward networks often have one or more hidden layers of sigmoid neurons followed by an output layer of linear neurons. Multiple layers of neurons with nonlinear transfer functions allow the network to learn nonlinear and linear relationships between input and output vectors. When the net is operating, the activations of non-input neurons are computing using each neuron's activation function. The hidden layer has a *tan sigmoid* (tansig) activation function, and the output layer, has a linear activation function. Therefore, the first layer restricts the output to a finer range, from which the linear layer can generate all values.[7]

3. Results

This section details with the detection of brain tumor. The system is programmed in MATLAB. The input to the system is an EEG signal recorded from patients. The EEG signal is subjected to preprocessing for removing all artifacts. The experimental results demonstrate the artifacts in the EEG signal are eliminated and an efficient classification of the recorded EEG signals is obtained.

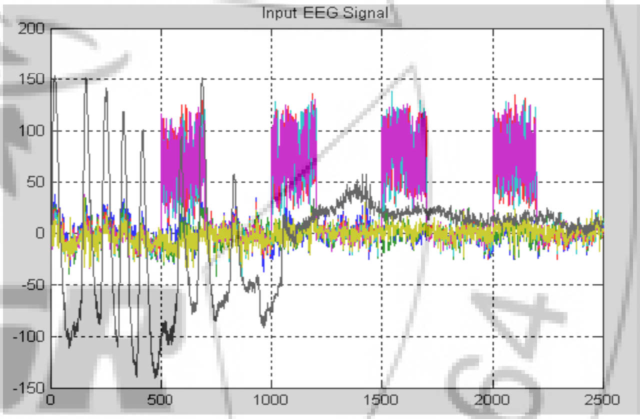

Figure 3: output representation of brain tumor detection input EEG signal

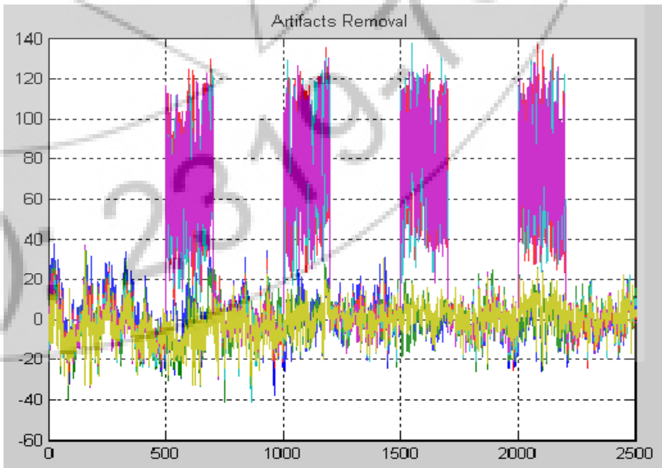

Figure 4: Artifacts removal from input signal

4. Future Scope

Future research in the detection of brain tumor will lead towards improving the accuracy, exactness, and computational speed as well as minimizing the amount of manual interaction. Computational effectiveness will be crucial in real-time processing applications. Thus earlier detection of brain tumor will increase the efficiency.

5. Conclusion

EEG signal is one of the accepted measures of brain activity that has been used immensely for clinical diagnoses and biomedical researches. In our paper we have presented an efficient classification system based on artificial neural network to detect the occurrences of brain tumor in EEG signal analysis. The proposed system approach using ANN as a classifier for detection of brain tumor provides a good classification efficiency as compared to other classifiers.

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