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Detection and Classification of Brain Tumor using Radial Basis Function

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Abstract

Aim: This paper proposes the automatic support system for detecting the tumor cells by analyzing the scalp EEG by means of RBF technique. **Objectives:** To acquire the EEG signal from the various electrodes. The artificial neural network will be focused to split up the EEG signal whether cyst i.e. tumor or regular. **Methods:** The EEG signal is been acquired from the subject using EEG scalp electrodes. The various features such as mean, variance, co-variance, Eigen values and Eigen vectors are extracted from those signals using the Principal Component Analysis. Radial Basis Function (RBF) networks are feed-forward networks which uses a supervised training algorithm are used for function approximation, time series prediction and system control. The RBF is used to train and classify the signal whether the subject is normal or suffering from abnormalities. **Results:** The features are been extracted using the Principal Component Analysis and the features are skilled. Thus the acquired signals are been classified as cyst or normal. **Conclusion:** Thus in this paper an automatic system is been developed for diagnosing the tumor cells by means of analyzing EEG signal which is non-invasive method. It can also extend for analyzing other diseases seizures of epilepsy, Alzheimer's disease.

Keywords: EEG, Neural Network, Principal Component Analysis, Radial Basis Function

1. Introduction

Brain is an idiosyncratic organ in our body which is consists of 10^{11} computing elements called neurons. The process of recording the electrical activity of the brain is termed as Electroencephalogram or EEG signal that is of frequency 0.2Hz-30Hz. It comprises of alpha, beta, delta, theta waves known as brain waves. The scalp EEG is non-invasive and it gives the real time monitoring of brain function. Along with EEG is in additive with various artifacts and noise. The standard scrutiny takes too much/pace, unreliable and feel necessity for trained person for finding diagnostic errors. For the EEG analysis neural network plays an important role to estimate the functions that do not have explicit mathematical models. Our brain is the magnificent organ and it is the command center for all nervous system, which is constitute of forebrain, midbrain and hindbrain. Cerebrum is the largest division of the brain which is divided into 2 hemispheres: left and right. Each hemisphere is prorated into four convexities: frontal, parietal, temporal and occipital. The frontal lobes is located deep to frontal bone of skull (i.e. behind our forehead in motor cortex) whose functions are memory formations, emotions, personality, decision making/reasoning, planning, speech. Boca's area is located on the left frontal lobe which controls facial neurons, speech and language comprehension. The parietal portion is stationed deep-seated to the parietal bone of the skull (i.e. at top and to rear of head in sensory cortex) whose functions are senses and integrates sensation, tactile sensory, right/left organization, object naming. The occipital lobe is placed rooted to the occipital bone (i.e. at back of our head in Visual cortex) whose functions are processing, synthesis, perception of eyesight and optical stimulant, mainly for vision[1,2]. The temporal lobe is located deep to the

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temporal bone of skull (i.e. on the sides of the brain in auditory cortex) whose functions are auditory functions, organization/comprehension of language, face recognition, music awareness. The Wernicke's area is located on the area of left temporal lobe muddled in dialect awareness and expression.

1.1 Tumor

The tumor can be benign and will not develop into cancer. A brain tumor can grow in any part of the brain. These cells can be either cancerous (or) non cancerous[2]. The cancerous cells are named as malignant and non cancerous cells are termed as benign. It is a swelling, incendiary, cyst expansion which is anomalous prosperity of cells which recur after commence impetus has been detached. The symptoms are not being manifested; dizziness, vomiting, personality changes, gait abnormalities, sensory loss, visual field changes and seizures[3]. The tumor can be diagnosed by CT, MRI and Tissue autopsy: lymph bulge, organ, skin, bone, bone marrow, PET, X-rays and Fluoroscopy which has the following:

Disadvantages of above methods are:

- CT is inevitable radiation exposure..
- Causes allergic reactions.
- Mild itching (or) hives (small bumps on skin).
- Shortness of breath.

1.2 Bio-Signal

It is defined as any signal measured and monitored from a biological being. It is also known as electrical bio-signals (or) bio-electrical signals are the electrical currents provoked by electrical signals contrast across a tissue, organ (or) cell system. The various types of bio-signals are EEG, ECG, EMG, EOG, GSR, HRV[4]. Neuro-signal: Neuro means brain. Neuro–signal is signal related to brain. Common approach to obtain neuro-signal processing information is an EEG.

1.3 EEG

Electroencephalograph (EEG)[5] is the method of measuring and recording neuro-signal by using electrodes placed on scalp[5]. EEG machine was 1st introduced by Hans Berger in 1929[6]. Mu wave is of frequency 8Hz-13Hz[7]. In 1950's Gian Emilio chatrian showed the amplitude of mu waves which is also known as comb (or) wicket rhythm (or) arciform[8–10].

1.4 Feature Extraction

Feature extraction is the collection of relevant information from the signal. In this project the feature is been extracted by using Principal Component Analysis[11].

1.5 Principal Component Analysis

It is most common form of factor analysis. It was introduced by Pearson (1901) and Hotelling (1933) to describe the variation in the data's[12].

2. Methodology

The methods used in this study are described in the following sections.

The EEG signal were been recorded for various subjects and it stored in the digital forms. The various features are extracted using the PCA technique as follows:

2.1 PCA Algorithm

As of to the functional diagram shown in Figure 1, the features of the recorded signals are been extracted using the PCA technique. The flow diagram of the PCA algorithm is shown in the Figure 2.

- Input.
- Subtract the mean.
- m = mean (T,2)
- temp = double (T(:,i))-m;
- Calculate the co-variance matrix.
- L = A'*A;
- Calculate the eigen trajectory and Eigen codes of the co-variance matrix.
  - [V D] = eig(L);
  - L_eig_vec = [L_eig_vec V(:,i)];
  - Eigenfaces = A*L_eig_vec;

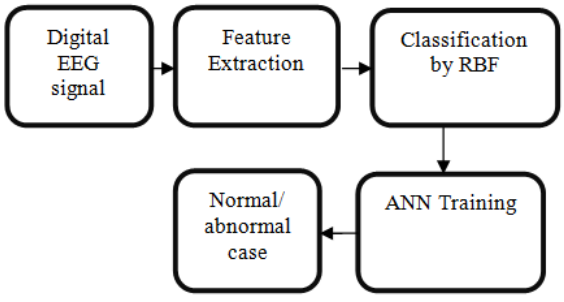


Figure 1. Functional block diagram of the proposed system.

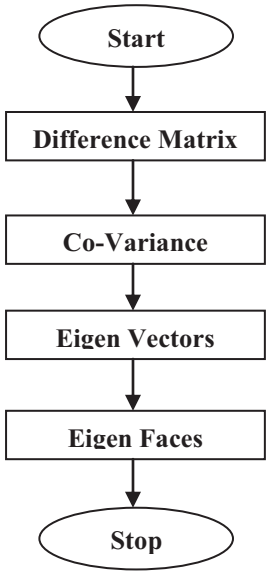


Figure 2. Algorithm flow of the PCA.

- Picking the peripheral & design a feature vector.
- Collect the new data set.

2.2 Radial Basis Function

The next step in the proposed system is to classify and train the extracted signal. We use RBF network as described in the below Figure 3 to train and test the signals of EEG. Broomhead and Lowe in 1988 were the 1st to exploit RBF to design the neural networks[12]. Cover in 1965 developed a pattern classification dispute cast in a high dimensional space is allegedly than in a small spatial space[13]. Learning is of 2 stages: using two methods such as unsupervised methods, supervised methods[14]. The basic RBF is of three-layer network, as shown in Figure 3. The boot up layer is simply a fan-out layer and no dispose of is required[15]. The extra or hidden layer functions as non-linear aligning from input space to a high dimensional space i.e., where pattern becomes lingual divisible. Output layer is final layer that performs a simple weighted sum with true crop[16]. If the RBF network is need for activity approximation (matching a real number) then this output is fine.

The main features of RBF are as follows and shown in the above Figure 3. They are 2 layer feed forward network. RBF consists of a set of hidden layer. MLP is used to implement the output nodes. Training/Learning is very fast. Networks are very good at interpolation. It covers even smaller regions also. It is much faster than BPN since it has 2 stages of learning. The different learning algorithms are:

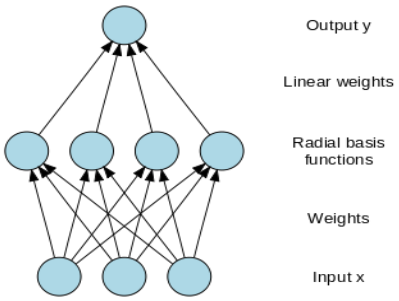


Figure 3. Architecture of RBF network.

2.3 Learning Algorithm 1

- From the training set select the centers randomly.
- Compute the spread for the RBF function using the normalization method.
- $\sigma = \dfrac{Max\ distance\ between\ any\ 2\ centers}{\sqrt{numbers\ of\ centers}}$

  $= d_{\max} / \sqrt{m1}$
- Weights are computed by means of pseudo inverse.

2.4 Learning Algorithm 2 or Hybrid Algorithm

Clustering algorithm for finding the midway:

- Storing.
- Sampling.
- Finding Similarity matching.
- By Updating.
- Repeat the 4steps again.
- Spreads chosen by normalization.
- LMS algorithm for finding the weights.

2.5 Training Hidden Layer

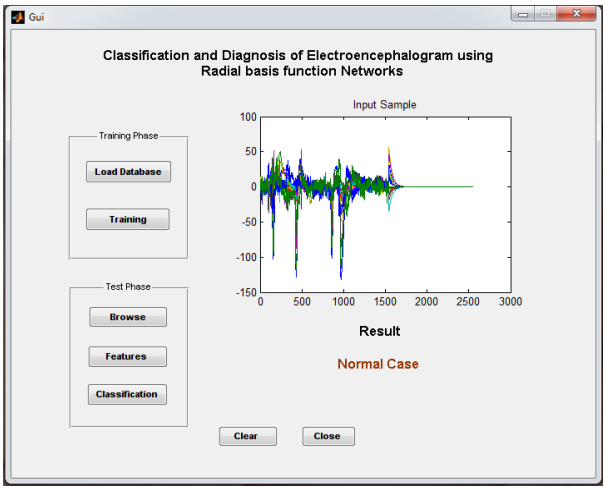
The training is carried in the proposed system by means of neural network as mentioned earlier in the Figure 1. The hidden layer in a RBF network has weights that correspond to the vector representation of the centre of a cluster. These weights are found by using K means or kohonen algorithm. In the unsupervised training number of clusters is set as k in prior and then it finds the best fit to these clusters. First the *k* points are randomly selected in the pattern space. Secondly the distances are found from all of the *k* centres for each set of the training item. The Data's will be assigned from 1 to k. The mean or average values is been found for the items of class 1.

2.6 Training Output Layer

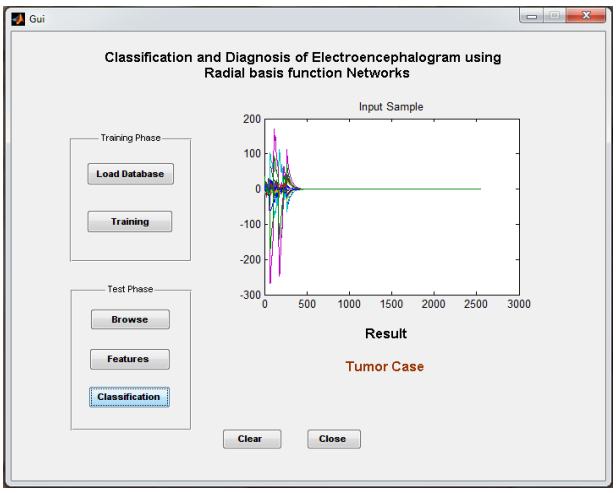
After the training of hidden layer by unsupervised learning, the final step is to skill using a standard gradient descent technique such as the LMS algorithm.

3. Results and Discussions

The features of the signal is been extracted by means of PCA. Thus the extracted features are competent adopting the neural network gizmo. The below Figures 4(a) and 4(b) yields the input signal and fed to the network for testing whether the corresponding signal are normal or abnormal using RBF.



(a)



(b)

Figure 4 **(a)** Output obtained after RBF training and classification for normal case. **(b)** Output obtained after RBF training and classification for tumor case

4. Conclusions

The automatic system has been developed for diagnosing the tumor cells by means of analyzing EEG signal which is non-invasive method. The scalp EEG signal smash a decisive aspect in detecting early stages of tumor, which helps for medical diagnosis also reduces the time consuming and to overcome error occurring due to carelessness of the human as shown in the Figure 4(a) and Figure 4(b). The RBF is used to train and test the signals of the patient.

It gives the result in efficient manner which tells about the normal and abnormal cases. It can also extend for analyzing other diseases seizures of epilepsy Alzheimer's disease.

5. Acknowledgement

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