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MATLAB Based Brain Tumour Extraction Using Artificial Neural Network

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Abstract- Brain tumour is the major cause of mortality among children and adults. The chance of survival can be greater when the tumour is detected correctly at its early stage. This paper presents a neural network techniques for the classification of magnetic resonance brain image. The proposed technique consists of three stages, features extraction from gray scale MR Image using gray level co-occurrence matrix, MR image segmentation using k-mean clustering method and classification of MR Image into normal and abnormal (tumourous) image using feed-forward neural network. This technique have been developed on MATLAB version 7.5.0 platform.

Keywords- *Brain Tumor; MRI; Segmentation; Feature Extraction; GLCM; Artificial Neural Network; MATLAB.*

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I. INTRODUCTION

Brain cancer can be counted among the most deadly and intractable diseases. Tumours may be embedded in regions of the brain that are critical to orchestrating the body's vital functions, while they shed cells to invade other parts of the brain, forming more tumours too small to detect using conventional imaging techniques. Brain cancer's location and ability to spread quickly makes treatment with surgery or radiation like fighting an enemy hiding out among minefields and caves.

In recent years, the occurrence of brain tumors has been on the rise. Unfortunately, many of these tumors will be detected too late, after symptoms appear. It is much easier and safer to remove a small tumor than a large one. About 60 percent of glioblastomas start out as a lower-grade tumor. But small tumors become big tumors. Low-grade gliomas become high-grade gliomas. Once symptoms appear, it is generally too late to treat the tumor. Computer-assisted surgical planning and advanced image-guided technology have become increasingly used in Neuro surgery [1].

- Types of Tumour

There are three general types of Tumour: 1. Benign 2. Pre-malignant 3. Malignant

1. Benign Tumour

A benign tumor is a tumour which does not expand in an abrupt way; it doesn't affect its neighbouring healthy tissues and also does not expand to non-adjacent tissues.

2. Pre-Malignant Tumour

Premalignant Tumour is a precancerous stage. It is considered as a disease, if not properly treated it may lead to cancer.

3. Malignant Tumour

Malignancy is the type of tumour, which grows worst with the passage of time and ultimately results in the death of a person.

The proposed system is an efficient system for detection of tumour and classification for given MRI images in normal and tumorous image. The method of detection and classification work is carried out during the process is explained. This method is developed in MATLAB environment in order to check for applicability of proposed method.

II. PROPOSED METHODOLOGY

The proposed algorithm starts by reading the input brain MR image and converting it into grey scale image. There are three major steps in the proposed approach. The first step is image pre-processing, the second step is feature extraction using GLCM [5], the third step is classification using feed forward neural network. Fig. 1 shows the steps included in proposed system for brain tumour detection using artificial neural network.

1. Image Acquisition

Images are obtained using MRI scan and these scanned images are displayed in a two dimensional matrices having pixels as its elements. These matrices are dependent on matrix size and its field of view. Images are stored in MATLAB and displayed as a gray scale image of size 256*256. The entries of a gray scale image are ranging from 0 to 255, where 0 shows total black color and 255 shows pure white color. Entries between this range vary in intensity from black to white [6].

For the implementation of this application we need to have the images of different patients in our database in order to

identify their condition. The MRI image is stored along with our main file from various sources.

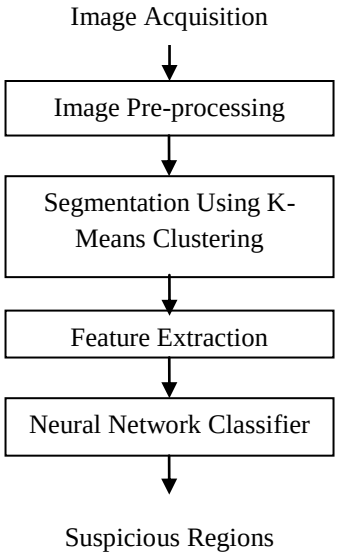

Figure 1 . Steps for the brain tumor extraction using artificial neural network

2. Image Pre-processing

In this phase image is enhanced in the way that finer details are improved and noise is removed from the image. The first step is to get the MRI image and application of pre-processing steps. There are various methods which come under this step, we will be dealing with only grey scale and filters. Basically preprocessing is done to remove noise and blurring as well as ringing effect in order to get the enhanced and much clear image for our purpose. The filter which we have used is median filter but as we are working on image samples that are required for the medical purpose. The median filter has to be passed with mask for better image.

3. Image segmentation using k-means clustering

In our project we are using k-means clustering for to segment the brain tumour purpose. In this method, we are grouping the data and to select the mid value, then we are cluster the data in k-means cluster the grouping data are also present in another group of data, but fuzzy and c-means method it is not possible to group same data present in another cluster so we are avoiding fuzzy c-means and c-means clustering algorithm, instead we used k-means clustering method [4].

- STEPS FOR K-MEANS:

a) Give the no of cluster value as k.
b) Randomly choose k cluster centres.
c) Calculate mean or centre of the cluster.
d) Calculate the distance between each pixel to each cluster centre.
e) If the distance is near to the centre then move to that cluster.
f) Otherwise move to next cluster.
g) Re-estimate centre.
h) Repeat the process until the centre doesn't move.

4. Feature Extraction

Texture features or more precisely, Gray Level Co-occurrence Matrix (GLCM) features are used to distinguish between normal and abnormal brain tumors. Five co-occurrence matrices are constructed in four spatial orientations horizontal, right diagonal, vertical and left diagonal (0°, 45°, 90° and 135°.) A fifth matrix is constructed as the mean of the preceding four matrices, From the mean co-occurrence matrix obtained, we have to extract the 8 different statistical features and these extracted features is applied at input of neural network. This features are as follow.

(i) CONTRAST

Contrast is defined as the separation between the darkest and brightest area.

$$Contrast = \sum_{i,j=0}^{n-1} P_{ij}\ (i-j)^2$$

(ii) CORRELATION

Correlation is computed into what is known as the correlation coefficient, which ranges between -1 and +1.

$$Correlation = \sum_{i,j=0}^{n-1} P_{ij}\ \frac{(i-\mu)(j-\mu)}{\sigma^2}$$

(iii) HOMOGENITY

Homogeneity is defined as the quality or state of being homogeneous.

$$Homogenity = \sum_{i,j=0}^{\bar{n}-1} \frac{P_{ij}}{1+(i-j)^2}$$

(iv) ENTROPY

Entropy is a measure of the uncertainty in a random variable.

$$Entropy = \sum_{i,j=0}^{N-1} -ln(P_{ij})P_{ij}$$

(v) ENERGY

It provides the sum of squared elements in the GLCM .Also known as the uniformity or the angular second moment.

$$Energy = \sum_{i,j=0}^{N-1} (P_{ij})^2$$

(vi) VARIANCE

The variance defines the variation of intensity around the mean.

$$Varience = \sum_{i,j=0}^{N-1} P_{i,j}.(i-\mu)^2$$

Where,

$$\text{Mean, } \mu = \sum_{i=0}^{N_g-1} i.p(i)$$

(vii) MAXIMUM PROBABILITY

This is simply the largest entry in the matrix, and corresponds to the strongest response. This could be the maximum in any of the matrices or the maximum overall.

$$\textit{Maximum Probability} = \max_{i,j} p(i, j)$$

(viii) DISSIMILARITY

$$\textit{Dissimilarity} = \sum_{i,j=0}^{N-1} P_{i,j} * |i - j|$$

6. Neural network Classifier

A Neural network classifier (Feed forward neural network.) is used to detect candidate-circumscribed tumour. Generally, the input layer consists of eight neurons corresponding to the eight features. The output layer consists of one neuron indicating whether the MRI is a candidate circumscribed tumour or not, and the hidden layer changes according to the number of rules that give best recognition rate for each group of features.

- The Structure of a Feed forward Neural Network

Fig. 2 illustrates a typical feed forward neural network with a single hidden layer.

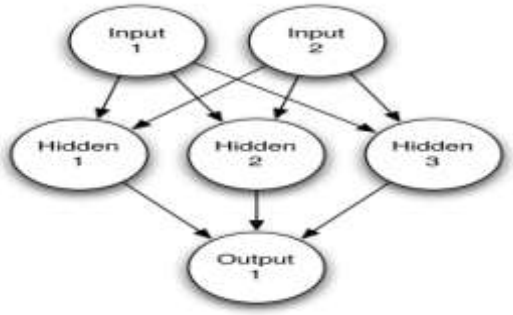

Figure 2 . Feed forward neural network (single hidden layer).

Most neural networks passes the output of their layers through activation functions. These activation functions scale the output of the neural network into proper ranges.

There are total three activation function provided that can be used are

a) The Sigmoid Function

$$f(x) = \frac{1}{1+e^{-x}}$$

b) Hyperbolic Tangent Activation Function

$$f(x) = \frac{e^{2x}-1}{e^{2x}+1}$$

c) A Linear Function

$$f(x) = x$$

III. EXPERIMENTAL RESULTS

In this paper, the pre-processing stage performs image enhancement. The median filter is used for image enhancement, it is used to remove the noise in an image. It is better than mean filter, Weiner filter, Gaussian filter. In image segmentation k-means clustering method is used which gives more accurate result, using the K-means algorithm, it has an advantage of less computing time. In other words, the partitioned clustering is faster than the hierarchical clustering.

Fig. 3 shows the basic GUI layout of the proposed system.

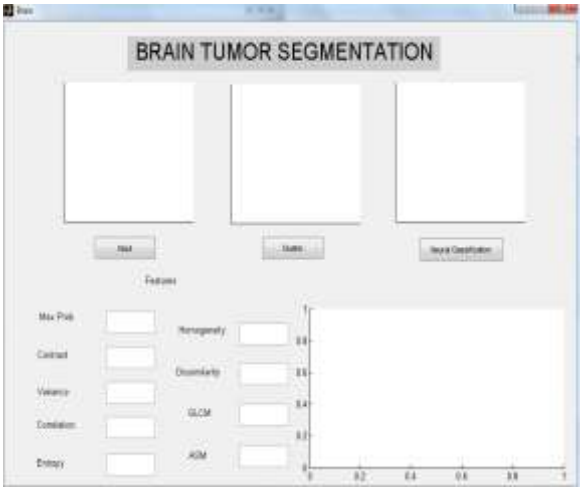

Figure 3 . The basic layout of the proposed system.

In the proposed system the image is first loaded as shown in the fig. 4.

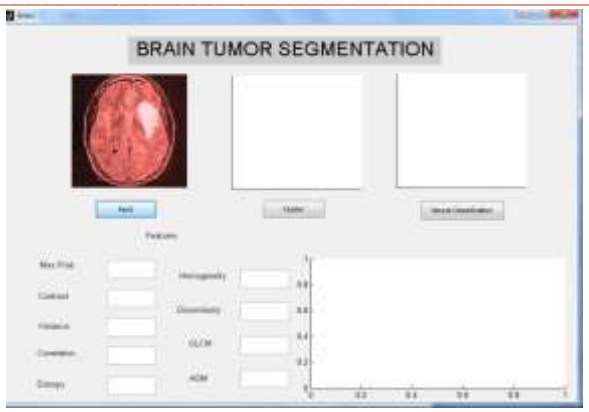

Figure 4 . An image is loaded.

Fig. 5 shows the GUI with cluster image, extracted features value, tumor part and graph of normalized histogram, sum of distribution and distribution of intensity among the pixels of input MR brain image.

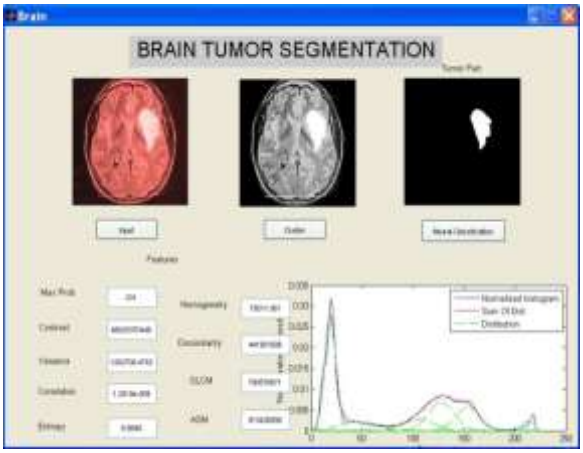

Figure 5 . Brain tumor segmentation

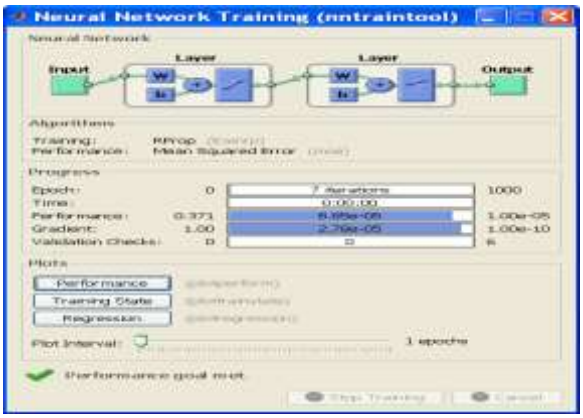

Figure 6 . Training of feed forward network

Figure 7 . Decision of Feed forward Classifier

IV. CONCLUSION

Image processing plays vital role in today's world. It has important application in biomedical field. The proposed system is developed for the diagnosing of tumour from magnetic resonance imaging pictures of the brain. This method makes the diagnosing in many phases. In the pre-processing stage filtering is performed on brain MR images. In image segmentation stage K-mean clustering method used to segment an MR image. After that texture features are extracted from gray scale MR image using GLCM method, these extracted features are given as input to artificial neural network for classifying MR image into normal and abnormal (tumorous) image.

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