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Advance Method for Brain Tumor Classification

Dipanshu N. Masalkar,
Research Student
Dept. of Computer Engineering
Sinhgad Academy of Eneinrreing, Kondhwa, Pune, India
dipanshuchoude@gmail.com

Mr. Shitole A.S.,
Assistant Professor
Dept. of computer Engineering
Sinhgad Academy of Eneinrreing, Kondhwa, Pune, India
shitole_ajit@yahoo.com

***Abstract*—** Detection and classification of tumor from MRI brain image is becoming most challenging area to research. This paper describe the proposed system for brain tumor detection and classification along with the help of Artificial neural network. This proposed system includes several steps segmentation for tumor detection , feature extraction , dimensionality reduction of extracted feature for removing redundant features and classification of tumor. Previously this decision is taken manually by humans with the help of MR (Magnetic resonance) or CT (Computerized Tomography) scan image of brain. But the time require for this is more and result may not be accurate. Image may contain some noise due to error in machine performance which will result in inaccuracy and becomes hazardous to patient suffering from this disease. Artificial intelligence and image processing have enormous growth in medical research field with the help of neural network and fuzzy logic. In this paper Probabilistic Neural Network is used for decision making which is followed by Image Preprocessing with Gaussian Filter Method, Image segmentation and detection by using Threshold Based Segmentation Method, Feature extraction by Gray Level Co-occurrence Matrix (GLCM)features, and Dimensionality reduction by Principal Component Analysis. Main advantage of this method is that it will give fast and accurate result with the help of training data set and it reduces time and computation power.

Keywords- *Brain tumor classification, Probabilistic Neural Network, Gaussian Filter, Gray Threshold Based Segmentation, Gray Level Co-occurrence Matrix, Principal Component Analysis.*

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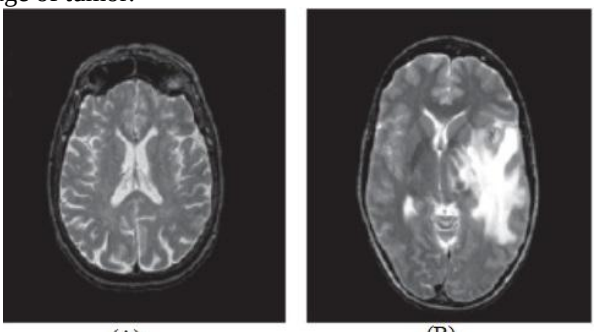
I. INTRODUCTION

Abnormal growth of cells developed inside human body is called as Tumor. Brain Tumor is an intra-cranial solid neoplasm occurs within the brain or the central spinal canal. Brain tumor is implicitly serious and life-ominous disease because brain is very fragile part of human body to treat for. However, Brain tumors can be malignant that is cancerous or benign that is non-cancerous. Treatment of brain tumor depends on proper diagnosis and depends on the different factor like the type of tumor, location, size and state of development.

MRI is technique used to measuring density of photons in tissue; it is based on fundamental property of photon that spins and possesses magnetic movement. It is done to visualize the internal structure of human body, gives superior image quality. Useful information is reveled from MR image and it helps in proper diagnosis. MR image of brain gives only the visual internal picture of the brain. Fig 1 shows the normal MR brain image and image with tumor. Early and proper detection of tumor is the key for the proper treatment. Previously stage of tumor is used to be detected manually with the help of observation of image by doctors and sometimes it takes more time and sometimes results may inaccurate. There are many different types of brain tumor and only experienced and expert doctor can able to give the accurate result. So we require accurate diagnosis tool for proper treatment. Proper diagnosis tool should include detection, segmentation and classification of MRI brain image. Detection involves finding the presence of tumor; segmentation involves the detection of size and location of tumor and classification involves the detection of stage of tumor.



(A) (B)

Now a day's many computer added tool is used in medical field. These tools possess a property of quick and accurate result. Using the benefit of Artificial intelligence and image processing a tool that will detect and classify the brain tumor can be developed. Input image to this system is Brain MR Image which is taken by MRI scanner.

Remaining paper is organized as organized as follows II gives Literature Survey,III proposed method, IV explains Algorithm for tumor classification, V Computational Details And Expected Result and ends with VI Conclusion.

II. LITERATURE SURVEY

In various recent research on segmentation , feature extraction and classification of MR brain image many different combination of segmentation and classification is used by various auther.

Discrete cosine transform for segmentation and Probabilistic neural network for classification is developed in matlab by author D. Sridhar and evaluation was performed on 20 set of images dividing in to different combination of test set and training set of data.
Where as PCA for feature extraction is used along with the PNN by author Mohd Fauzi Othman and evaluation was performed on 20 set of images .In system proposed by author C. Nageswara rao NN and K-NN classifier is used for classification. In this double classification is used for accuracy check . where accuracy given by NN is from 66% to 98.2 % and by K-NN 80% to 100%. Where in some system SVM is used for classification.
Reference [4] and [5] explained the different ANN algorithm for the brain image classification.

III. PROPOSED METHOD

In this proposed system the work carried out in various stages. System starts with the input of Training set of MR brain image data of different types of tumor and test set of MR brain image data of normal brain or abnormal brain. In next stage preprocessing is done on both images to remove noise. Then feature extraction is done for training set of data, then dimensionality reduced to remove redundant feature and saved in hidden layer of PNN for classification. Segmentation is done ontest set of data to detect presence of tumor in test set of data. If present then it goes for next step that is feature extraction and dimensionality reduction of feature to remove redundant feature. Final result will give classification of test set of data. Figure 2 shows proposed system architecture.

IV. ALGORITHMS FOR TUMOR CLASSIFICATION

A. *Gaussian Filter*

Sometimes images captured are corrupted and contains noise due to random variations in intensity, illumination, or have poor contrast and can't be used directly. So to remove the noise from MR image Gaussian Filter is used. Therefore transformation of pixel intensity values to obtain certain image characteristics, enhancement for improving contrast and Smoothing to remove noises as well as template matching to detectsknown patterns can be done by using Gaussian filter method. In general sliding mean or box filter noise reduction method is used in which the pixel value is replaced by the mean of neighbouring pixel values. Gaussian Filter method is similar to this but neighbouring pixel values is given with different weighting defined by spatial Gaussian distribution. In this method the Gaussian function at every point of image is non zero which means that each pixel of image is calculated using this method.
Formula for calculating value of pixel value for 2-D Gaussian Filter is as fallows [13].

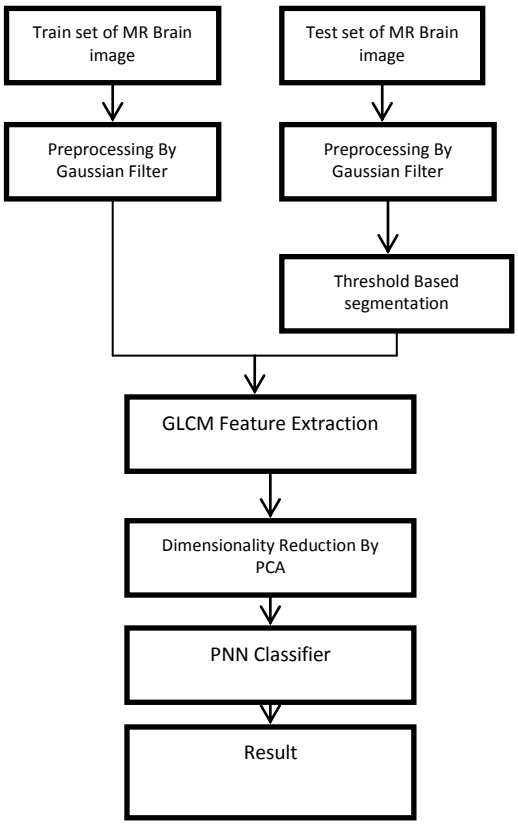


Figure 2: System Architecture

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Formula for calculating value of pixel value for 1-D Gaussian Filter is as fallows [13].

$$G(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{x^2}{2\sigma^2}}$$

Where x is distance from the origin in the horizontal axis and y isdistance from the origin in the verticalaxis. σ is standard deviation of Gaussian Distribution.

B. *Threshold Based segmentation*

Presence of tumor is detected by Threshold based segmentation method. Segmentation is done by using pixel based Thresholding method. In this method intensity value of pixel is used for partition. In gray scale image Threshold value is given to threshold function and value below is change to 1 for representing tumor and 0 for representing the background. Formula for representing threshold value is given as

$$G(v) = \begin{cases} 0 & if\ v < t \\ 1 & if\ v \geq t \end{cases}$$

Where v represents gray value and t represents threshold value.

More than one object can be shown in segmentation using Multiple Threshold Based Segmentation Method. In which

multiple threshold values are used to represent pixel intensity. And it is given by

$$G(v) = \begin{cases} 0 & if\ v < t_1 \\ 1 & if\ t_1 \le v < t_2 \\ . & \\ . & \\ n & if\ t_n \le v \end{cases}$$

C. Gray Level Co-occurrence MatrixFigures and Tables

Gray Level Co-occurrence Matrix (GLCM) is used for feature extraction of MR image. Feature of image based on pixels and its neighboring pixels are extracted by image GLCM matrix is formed contains the textural feature based on two pixel intensity values. Details about overall texture content of image are given by parameters calculated by the GLCM of original gray image. Feature based on pixel and its neighboring pixel is extracted by GLCM (i, j). It is a two dimensional function ,composed of n horizontal direction pixels and m of vertical direction pixels and horizontal and vertical co -ordinates of the image is given by i , j. $0 \le i \le m \le j \le m$ where total pixel number is $m \times n$. First the intensity of pixel and its neighbouring pixel is calculated for entire image. For getting more reliable texture feature multiple GLCMs are computed for different Rotations of θ at 0°, 45°, 90°, and 135° which can give spatial relationship between neighbouring pixel. After calculation of GLCMs of image, it is used to calculate contrast, energy, homogeneity, and co-relation of image which uniquely describes the images. This method reduces the computational complexity.

Formula for calculating contrast intensity is[3]

Contrast=$\sum_{i=1}^{n}\sum_{j=1}^{m}(i-j)^2 GLCM(i,j)$

Energy is measured by[3]

Energy= $\sum_{i=1}^{n}\sum_{j=1}^{m}(GLCM(i,j))^2$

Homogeneity gives the spatial distribution and closeness of gray level[3]

Homogeneity=$\sum_{i=1}^{n}\sum_{j=1}^{m}\frac{GLCM(i,j)}{1+|i-j|}$

Correlation is gives the relation between the pixel and its neighbouring pixel according to its contrast, energy and homogeneity [3].

Correlation=$\sum_{i=1}^{n}\sum_{j=1}^{m}\frac{\{i\times j\times GLCM(i,j)-\{\mu_x\mu_y\}}{\sigma_x\times\sigma_y}$

Where μ_x, μ_y is the mean and σ_x, σ_y is the standard deviation of GLCM x row and y column.

D. Principal Component Analysis

In this step we are going to reduce the dimension of MRI image. Images though small in size are having large dimensionality this leads to very large computational time, complexity and memory occupation. This is done by using Principle component Analysis Method. In this step feature extracted from GLCM is given to PCA. Data that is redundant can be reducing to artificial variables called as principal component (PC). PC is the observed variable which is optimally weighted and linearly combined. It is the linear transform which rotate the axis of image space along line of maximum variance. Greatest amount of variation variable combination give the first PCA. Second PCA give next greatest variable combination and which is derived from the first PCA. And there can be many possible rotations for reduction.

E. Probabilistic Neural Network

In this stage the test MR image is compared with the training MR image and gives output training MR image which is similar to test image. For classification purpose Probabilistic Neural Network (PNN) is used. PNN is supervised feed forward neural network derived from Bayes classifiers. Where Parzen calculator is used for classification which uses probability density function (pdf) for each class of training sample. If training sample is increased then classification goes near to density function of the class.

For each class using training sample on the basis of pdf Parzen calculator takes a classification. The Bayes rule for classification for class i is given by

$$p_i f_i(x) > p_j f_j(x)$$

Where p_i and p_j is the prior probability of presence of identical feature of class i and j. And $f_i(x)$ and $f_j(x)$ is pdf of class i and j.

Where $f(x)$ is the submission of Gaussian probability distribution function.

. Architecture of PNN consists of four layer input layer, pattern layer, submission layer, Output layer.

1. *Input layer*

Feature vector of training dataset and test data set is given to the input layer. There are many nodes to the input layer which is connected to the pattern layer.

2. *Pattern layer*

To each training input layer node pattern layer node is connected. Pattern node consists of processing element and it should be trained once. Count of processing element should be same for better classification. Pattern node is connected to each class of weight vector which is multiplied with the input vector. Weight vector is trained vector. This will do a comparison between input vector and processing element. Product results in to the closeness of the class. Following is the equation for calculating product. Where W_i is weight of the processing element and ip_i is input feature from input layer connected to that particular pattern node.

$$p_i = W_i \times ip_i$$

This p_i should be passed through the activation node calculated by formula given below.

$$exp[(p_i - 1)/_{\gamma^2}]$$

3. *Submission layer*

Output from pattern is given to the submission node. It simply gives the submissions of activated class pattern. And it is given by following formula.

$$c_j = \frac{\sum_{i=1}^{N} e^{\frac{(p_i-1)}{\gamma^2}}}{N}$$

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Where N is number of training set example p_i is hidden node activation γ is smoothing factor.

Feature vector of training and test set of data will be the input to the PNN classifier, following are steps of PNN algorithm

Feature vector of training set is available and the class to which it belongs is defined.

The following are the steps for setting up the PNN.

1. Read in the feature vector and the defined class number.
2. Sort them into the x sets where each set should contain single class of vectors.
3. Gaussian function to be defined for each x set which will concentrate on each feature vector in set x. Define the summed Gaussian output function.

Once the PNN is set, then feature vector from test data set is given to it for classification as follows.

1. Gaussian function in each class to be fed by input feature vector.
2. Gaussian functional values are computed at the hidden nodes from each set of hidden node.
3. Gaussian functional values of hidden set of node is fed to the single outputnode for that group
4. At each class output node, submission all of the inputs is done and multiply by constant
5. Output node will find maximum value of all functional values that is summed.

V. COMPUTATIONAL DETAILS AND EXPECTED RESULT

Let N be the number of training set of images
N={N1, N2, …., Nn}.
T be the test set of images
T={T1,T2,…..Tn}
After getting feature vector of N And T images , Feature vecture of training set of data is classified in to K Set of classification at PNN classification stage.
K={K1, K2, … , Kn}.
Each class contain different feature vector F.
FK1={F11, F12,…., F1n}
FK2={F21, F22, …. , F2n}
.
.
FKn={Fn1, Fn2, …. , Fnn}.

And depending on the feature vector vector of test image which will be compaired with the feature vector of training image output of classification is given.

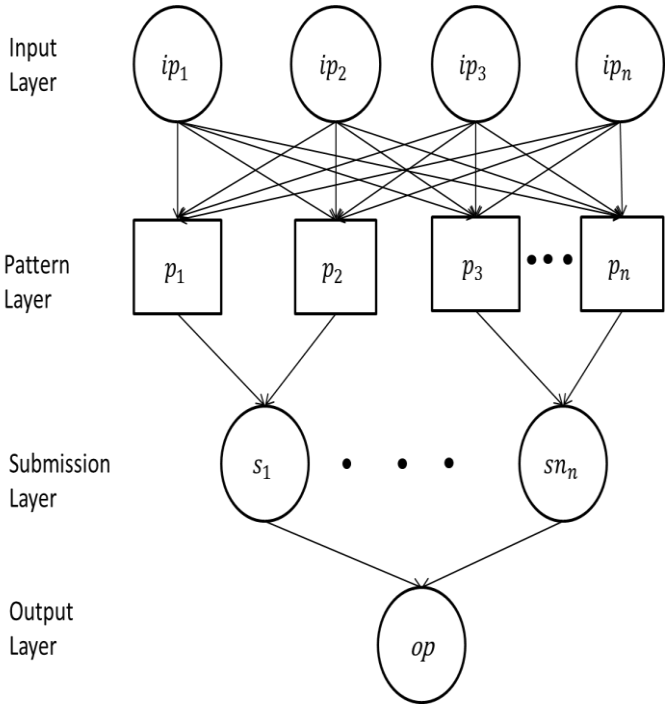

Figure 3 : PNN Architecture

In this process testing will be performed on different number of sample training data set and sample test data set. Classfication technique PNN will be applied to generate resultant output as shown in fig 4.

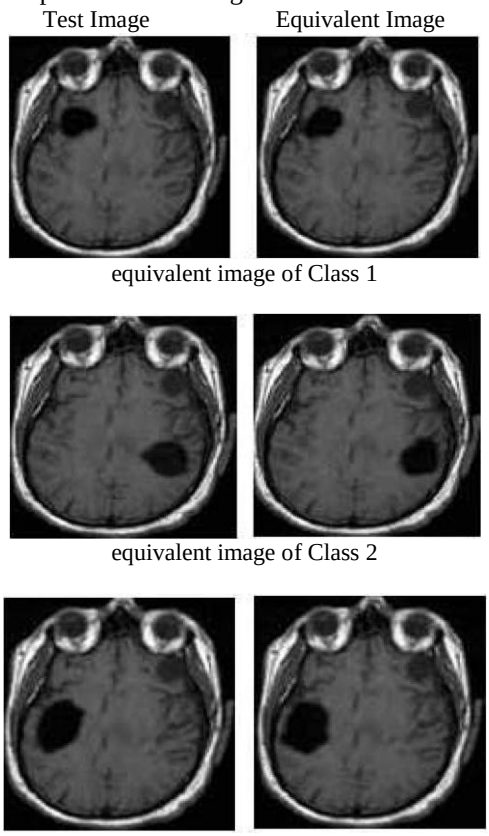

Fig. 4 Expected Resultant Output

1)

VI. CONCLUSION

In this paper method for brain tumor detection and classification is proposed with the help of Gaussian Filter, Threshold Based Segmentation, Gray Level Co-occurrence Matrix (GLCM)features, Principal Component Analysis and Probabilistic Neural Network. This proposed method will detect as well as classify the MR image. If test image is not similar to any training image then image is included in training set data. This method will give fast and more accurate result and helps physician for proper treatment.

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