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Classification of Brain Tumour in Magnetic Resonance Imaging (MRI) using Probabilistic Neural Network

Gaurao Mate[1]
Dept. of E&TC
SGB Amravati University
Email:gauravmate14@gmail.com

Prof.M.A.Khan[2]
Dept. of E&TC
SGB Amravati University
Email:makram999@rediffmail.com

***Abstract**:*

Brain magnetic resonance segmentation and detection is a very complex problem in the field of medical imaging in spite of various present methods. MR image of brain can be possibly divided into sub regions especially soft tissues such as gray matter, white matter and CSF. Tumor segmentation and classification is an important but time consuming task if computed by human expert but if we automated this process we can reduce this time with better accuracy. The computer aided diagnosis algorithm has been designed to increase the accuracy of tumor detection and classification so as to replace the conventional time consuming techniques. The propose algorithm has been designed to detect and classify the tumor into cancerous, non-cancerous and highly cancerous with help of probabilistic neural network.

***Keywords** : Segmentation, PNN, classification, detections*

I. Introduction

Brain tumor occurs when there is abnormal growth of cells within brain. There are two mains types of brain tumor one is cancerous and other is benign. Cancerous tumors can be further classified into primary and secondary. The primary one starts within brain and secondary spread from somewhere else. Many diagnosis techniques may be performed for early detection of brain tumors like computer tomography positron emission tomography and MRI.

The various imagine operations such as histogram equalization, segmentation, image enhancements , morphological operations and features extractions has been developed for detection of brain tumor in MRI of patients[1].In adults , it is more challenging considering diverse demographics, socio-economic system, delivery of care, etc [4].

In this paper we proposed a mechanism to segment an image using saliency detection based on quaternion sparse reconstruction model, modified fuzzy c means during training and saliency detection based on quaternion sparse reconstruction model, modified fuzzy c means, K means clustering during testing . Feature extraction could be done on segmented image to extract features like color map, extended histogram descriptor, Sobel operator to get the features extracted. The extended histogram descriptor, Sobel operators are merging to get single edge map. Edge map and color map are nothing but the edge and color histogram [8]. The features has been saved to database with the decisions whether the image is cancerous, non cancerous or highly cancerous. Finally the features extracted are compared with input image features extracted using PNN to decide cancerous, non cancerous or highly cancerous. The whole system has been developed into training and testing phase. And system was found to be efficient in classification and detection of abnormality.

II. Proposed Work:

The proposed algorithm shows how different segmentation, feature extraction and probabilistic neural networks work to get the result

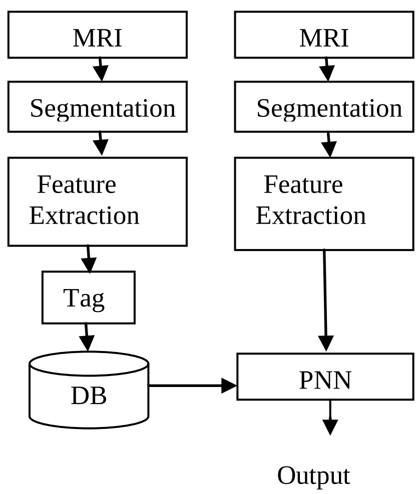

Figure 1: Flow Diagram

1) MRI:

Magnetic resonance image provides a high resolution and accurate partitioning of soft tissues also it is sensitive to the characteristics of particular diseases, therefore it is especially suitable for diagnosis of the brain tumor. Comparing to the other techniques such as CT/PET MRI is most cost efficient.

2) Preprocessing:

Acquired brain MRI volumes consist of non brain tissue parts of the head such as eyes, fat, spinal cord or brain skull. The segmentation/removal of brain tissue from non brain tissue in MRI is commonly referred as skull stripping, and it is an important image processing step in many Neuro image studies. Many studies have reported that differences in skull stripping would lead into unexpected results in the tissue classification if skull or eyes are included as brain tissue [10].

3) Segmentation:

Segmentation is used to subdivide an image into its region of objects and it's an important tool in medical image processing. Though identifying all the pixels belonging to an object segmentation of that object is tough task. Segmenting brain from MRI is utmost important as MRI consist of volumetric information regarding to tissue structure. In this paper we used saliency map and modified FCM segment an image into useful regions.

a) Saliency Map:

The saliency map is useful to extract the salient object from an image. It's an important mechanism for humans to absorb critical information from an object effective especially in the scene of complex environment. Due to the growth of image information it becomes more significant to automatically extract salient regions from image. Itti et al motivated to define visual attention model as center-surround contrast based on multiscale image analysis where a salient regions pops out from scene/image due to differ from its neighboring regions in the appearance of color, intensity and orientation [2].

Here we used saliency detection using quaternion sparse reconstruction to detect the salient regions in image. Quaternion are the number system which is four dimensional extensions of the two dimensional complex number, helps to rotate an image. The sparse representation of an image consist of lesser non zero values to get sparse representation of an image.

$\min \|\dot{x}\|_1 \lambda + \| \dot{y} - \dot{D}\dot{x} \|_2^2$ (1) where $\| \dot{y} - \dot{D}\dot{x} \|_2^2$ represents the saliency map and λ is the regularization parameter. λ should be between 0 and 1 to achieve the desired sparseness.

b) Modified Fuzzy c means:

Here we used the modified fuzzy c means algorithm for bias field estimation and segmentation of MRI data. Because spatial intensity inhomogenity induced by radio frequency coil in MRI is a major problem in computer analysis of MRI [5]. Therefore correction of such intensity inhomogenity oftenly required for each image. The mean values obtained from the saliency map for different color planes are used as a primary input centre in the modified fcm.

c) K-Means:

K means clustering followed by fuzzy c means helpful to get required accuracy. K means clustering partition an image into k-non overlap clusters suitable for large amount of data minimizing objective function such that within clusters sum of squares gets minimized. In k-means we minimize the objective function until it no further minimized.

When using Fuzzy C Means and K means together is a method generated from both fuzzy c-means and k-means but it carries more of fuzzy c-means properties than that of k-means.

4) Feature Extraction:

Features are extracted from the segmented image.

a) Extended Histogram Descriptor:

Extended histogram descriptor is widely used for shape detection [7]. It basically represents the relative frequency of occurrences of five different types of edges in each local area called as sub image. This sub image is defined by partitioning the image space by 4 by 4 non-overlapping blocks. So it creates equal sized blocks irrespective of the size if image. Edges of the image block can be categorized into 5 types: vertical, horizontal, 45 degree diagonal, 35 degree diagonal and non directional edges respectively to get edges**.**

b) Sobel Operator:

Sobel operator is used to perform a 2D spatial gradient measurement and so emphasize the regions of high spatial frequency which corresponds to an edge [7]. It is used to find the approximate absolute gradient value at edge point in an input grayscale image. Sobel operator is consisting of a pair of 3x3 matrixes**.** One matrix is simple and the another is rotated by 90°. Gradient magnitude is given by

$|G|=\sqrt{Gx^2+Gy^2}$ (2)

$\alpha = a\ \tan^{-1}[\frac{Gy}{Gx}]$ (3)

$$\begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix} \quad \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix}$$

Figure 2: Sobel Operator

Sobel operator may be slower with respect to other edge detection operation but it's less sensitive to noise due to its larger convolution kernel that smoothes the image to larger extent. Finally EHD and Sobel are merged so as to produce one edge map.

c) Color Map:

Color map of an image is a plot for black and white image histogram of image is calculated for color image extended histogram [8]. Every pixel in gray image computes the brightness value between 0-255. The histogram graphs pixel count of every possible values of brightness where 0 represents black and 255 represents white.

4) Probabilistic Neural Network:

Neural networks are frequently employed to classify pattern based on learning from example [9].Probabilistic Neural Network is a feed forward neural network which is widely used in classification and pattern recognition problem. PNN is organized into a multilayered feed forward network with four layers: input layer, hidden layer, summation layer and output layer. When an input is present to the first layer computes the distance from the input vector to the training input vectors. This produces a vector where its elements indicate how close the input is to the training input. The second layer sums the contribution for each class of inputs and produces its net output as a vector of probabilities. Finally, a complete transfer function on the output of the second layer picks the maximum of these probabilities, and produces the output as cancerous, non cancerous and highly cancerous.

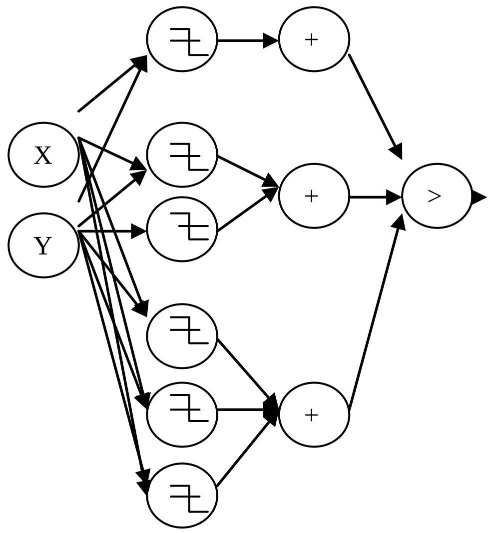

Figure 3: Probabilistic Neural Networks

The Probabilistic neural network is much faster than any other multilayer perceptron network and based on bayes optimal classification.

III. Table 1

DB Image	No. of image tested	No. of Correct image	Delay (mean)	Accurac -y (%)
10	10	8	0.0015	80
20	20	17	0.0344	85
30	30	25	0.0853	87
40	40	35	0.1134	87.5

IV. Conclusion:

In this paper we proposed a system for classification of brain tumor in MRI with the help of Probabilistic Neural Network which works well on the various image data. As the data base increases numbers of errors are going to decreases.

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