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An Approach for classification in detecting tumor in Brain MRI images using GMM and Neural Network classifier

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Abstract— Image classification is a process of classifying an image based upon the training given to a classifier. There are various purposes of classification but in this work a Brain MRI image is taken as input and is mainly classified into three class's malignant tumor and benign tumor and non tumor by using Neural Network classifier. Here a Gaussian Mixture model is used for the purpose of segmentation. First the input MRI image is taken and is pre-processed using weiner filter and it is then segmented into four regions namely the white matter, Gray matter, Cerebrospinal fluid and the high intensity tumor region. After segmentation is done from the tumor region statistical and shape based features are extracted from the tumor region. Based on these extracted features the neural network classifier will be trained to classify a image into tumor affected (Benign or Malignant) or not affected. During the testing phase a unknown image is considered and the pre-processing steps will be applied and then it will be segmented and Features will be extracted by using Gray Level Co-Occurrence matrix (GLCM) and based on the extracted features it will be compared and the Neural network classifier classifies it into either tumor affected or not affected and thus helps in the computer aided diagnosis of Brain MRI images into tumor affected (benign, Malignant) or not affected.

Key words- Classification, Segmentation, Pre-processing, Magnetic Resonance Imaging, Neural network classifier, Gray level Co-occurrence Matrix (GLCM), Gaussian Mixture Model

I. INTRODUCTION

Brain tumor occurs when abnormal cells from within the brain [11]. There are two main types of tumors mainly Malignant and benign. Cancerous tumors can be classified into primary tumors that start within the brain and secondary tumors that have spread from somewhere else known as brain metastasis tumors. The cause of most brain tumors remains unknown. Risk factors that may be occasionally be involved include a number of inherited conditions known as neurofibromatosis. In this work a computer assisted automated classification of the brain tumor is done to classify the given brain MRI image into tumor affected or tumor not affected is considered. This automation of the classification process will definitely assist the doctors in comparing their manual results with the results produced by the system and can ensure the level of accuracy in their process. In this work the input Brain MRI image is preprocessed to enhance the quality of the image and then there is segmentation of Gray matter, White matter and cerebrospinal fluid (CSF) and the high intensity tumor cluster [1] is also segmented by using the Gaussian Mixture model. Then statistical, intensity and shape based features will be extracted by using Gray level Co-occurrence matrix. Based on these extracted features the neural network classifier will be trained and it performs the automatic classification.

A. Purpose of the work
To Enhance the quality of the input Brain MRI image.
To effectively perform the segmentation of the brain MRI image in an automatic way.
To effectively perform the classification of the Brain MRI image.

B. Objective of the work
To enhance the quality of the input MRI image by using weiner filter.
To segment the Exact tumor region by using the GMM Model.
To Extract Features by using GLCM
To classify the input image into tumor affected both malignant and benign or not affected by using Neural Network Classifier.

The overall organization of this research paper is as follows. Section II deals with the work related to the classification and segmentation in the brain MRI images. Section III Deals with the overall design of the system. Section IV presents the set up required for performing the experiments. Section V outlines the Results obtained after conducting the experiment. Section VI concludes the work with prospective scope for future research.

II. RELATED WORK

Natteshan N.V.S, Angel Arul jothi in their research work, "Automatic Classification of Brain MRI Images Using SVM and Neural Network Classifiers" have developed a Computer Aided diagnosis system for automatically classifying the Brain MRI images using SVM and Neural Network classifier and they preprocessed the MRI image using Weiner Filter and enhanced the contrast of the image using Contrast Limited Adaptive histogram Equalization and segmented the tumor region using a Modified FCM algorithm and extracted 35 features using GLCM and GLRL and then trained both SVM and Neural Network classifier and compared the performance of both the classifiers.

Ar. Kavitha et al., In their work, "An efficient approach for brain tumour detection based on modified region growing and neural network in MRI images" Proposes an effective modified region growing technique for detection of brain tumor. Modified region growing utilizes a intensity constraint. A quantity rate parameter is a constraint used in their evaluation process. Sensitivity, accuracy and precision values were used.

E.B troy et al., in their work, "Gray-Level Manipulation experiments for texture analysis" describes some gray-level manipulation techniques which involve changing the gray level distribution within the picture and a method for extracting relatively noise free objects from a noisy background. The main use of these methods is to preprocess a textural scene for subsequent analysis or classification.

S.Sindhumol Et al, in their work, "Abnormality Detection from Multispectral Brain MRI using Multi resolution Independent Component Analysis" had considered both synthetic and real and abnormal data from T1-weighted, T2-Weighted, proton density, fluid attenuated inversion recovery and diffusion weighted MRI sequences are considered for detailed evaluation of the method. Tanimato index, sensitivity, specificity and accuracy of the classified results are measured and analyzed for brain abnormalities.

III. AN APPROACH FOR CLASSIFICATION IN DETECTING TUMOR IN BRAIN MRI IMAGES USING GMM AND NEURAL NETWORK CLASSIFIER

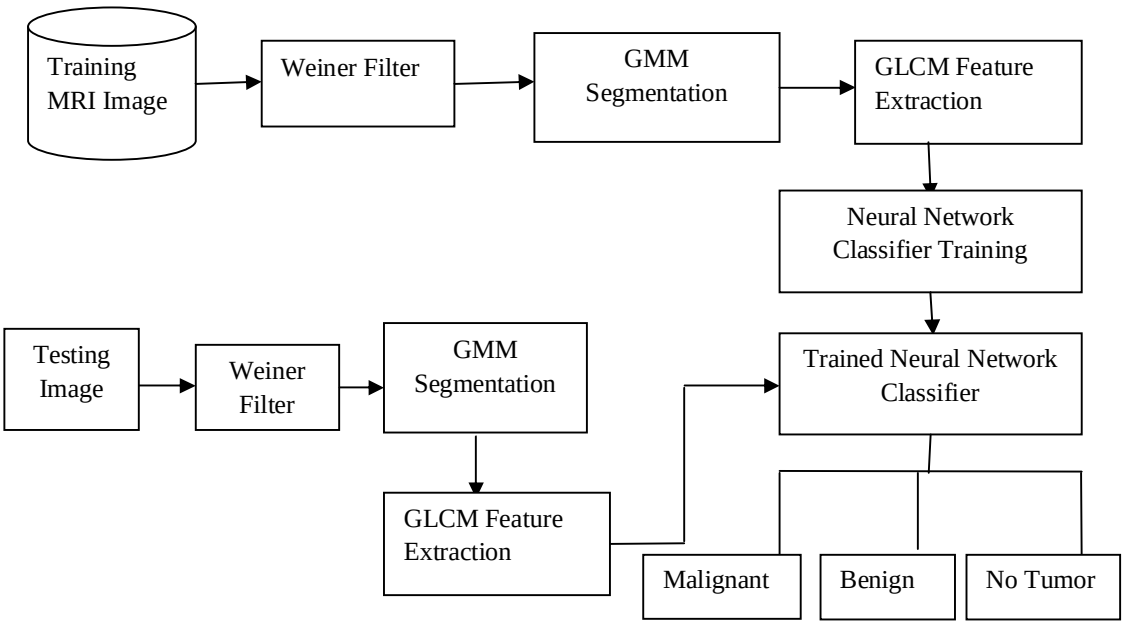

Fig. 1 Overall Architecture for Testing and training of Neural Network classifier

A. Description of the Architecture

There are two important phases in this system, they are testing and Training phase. When the neural network is trained with a input data set then it becomes a trained neural network classifier [1]. So after it became a trained classifier it can classify a given input image during the testing phase into Malignant, Benign and No tumor based on the features on which it was trained. So in the Training Phase first the input image from the dataset is given and then the clarity of the image is enhanced by using Weiner filter, then Gaussian Mixture model algorithm is used to segment the given input image into Gray Matter, Cerebrospinal Fluid, White Matter, Tumor region [1]. Gray level co-occurrence matrix is used to extract statistical features from the input image. Then These features are used to train the Neural network classifier and then in this work a variation of Hidden nodes is done and the accuracy is measured for the classifier and the results are tabulated.

IV. EXPERIMENTAL SETUP

There are two experiments conducted with Neural network classifier with varying Hidden Nodes [1] and the same steps are performed and there are 50 Non tumor images and 6 Tumor images are used for the purpose of the experiment and the images were taken from Cancer Imaging Archive [2].

V. EXPERIMENTAL EVALUATION AND RESULTS

The parameters like Sensitivity, specificity, Precision and accuracy are used to evaluate the performance of the Neural Network Classifier. Sensitivity or recall: Sensitivity or recall Measures the actual positives which are identified as such [5]. And this sensitivity is described by the following formula in equation 1.

$$\text{Recall} = TP/(TP+FN) \quad (1)$$

Specificity: Specificity measures the actual negatives which are identified as such and it is described by the equation 2

$$\text{Specificity} = TN/(TN+FP) \quad (2)$$

Precision: Precision measures the positive predictive rate [6]. And it is described by equation 3

$$\text{Precision} = TP/(TP+FP) \quad (3)$$

Accuracy: Accuracy of the classifier can be defined as how well a classifier can predict a condition [6] and it is given by equation 4

$$\text{Accuracy} = (TP+TN)/(TP+TN+FP+FN) \quad (4)$$

True Positive (TP): The classification result of CAD system is positive in the presence of the tumor.
True Negative (TN): The classification result of CAD system is negative in the absence of tumor.
False Positive (FP): The classification result of CAD system is positive in the absence of tumor.
False Negative (FN): The classification result of CAD system is negative in the presence of tumor [4].

Table I - DATA SET USED

SNO	Total No of images	Image type	Tumor images	Non Tumor images
1	56	DICOM	6	50

Table II- PERFORMANCE EVALUATION OF NEURAL NETWORKS WITH DIFFERENT HIDDEN NODES

SNo	No Of Hidden nodes	Accuracy	Specificity	Precision	Recall
1	50	0.7240	0.7120	0.7220	0.7670
2	75	0.7736	0.7090	0.7178	0.7753
3	100	0.7960	0.6980	0.7063	0.7684

VI. CONCLUSION AND FUTURE SCOPE

An approach is provided by neural network classifier for effectively classifying the given brain MRI image into Malignant, benign or not tumor. Here in this work weiner filter is used for enhancing the quality of the image. GLCM is used for extracting the statistical, shape based 10 features are extracted and the neural network classifier is trained with these features and there is variation of hidden nodes and it is found that Neural network with more hidden nodes has more accuracy. As a future scope of research some other filters like median can be used and other segmentation methods can be used to segment the tumor region. And a comparison of accuracy with SVM, Neural network classifier and KNN classifier can be done.

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