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MR Image classification using adaboost for brain tumor type

Astina Minz
Department of CSE
MATS College of Engineering & Technology
Raipur (CG)
minzastina11@gmail.com

Prof. Chandrakant Mahobiya
Department of CSE
MATS College of Engineering & Technology
Raipur (CG)
Cmahobiya@mats.ac.in

***Abstract*—**In medical diagnostic application, early defect detection is a crucial task as it provides critical insight into diagnosis. Medical imaging technique is actively developing field inengineering. Magnetic Resonance imaging (MRI) is one those reliable imaging techniques on which medical diagnostic is based upon. Manual inspection of those images is a tedious job as the amount of data and minute details are hard to recognize by the human. For this automating those techniques are very crucial. In this paper, we are proposing a method which can be utilized to make tumor detection easier. The MRI deals with the complicated problem of brain tumor detection. Due to its complexity and variance getting better accuracy is a challenge. Using Adaboost machine learning algorithm we can improve over accuracy issue. The proposed system consists of three parts such as Preprocessing, Feature extraction and Classification. Preprocessing has removed noise in the raw data, for feature extraction we used GLCM (Gray Level Co- occurrence Matrix) and for classification boosting technique used (Adaboost).

Keywords—AdaBoost, Feature Extraction, Machine learning, Magnetic Resonance Imaging, Segmentation, Texture Features.

I. INTRODUCTION

As we know that the human body isorganic matter made up of cells. From biology, we know that these cells grow and divide in order to form new cells. These newly formed cells help in keeping the body healthy. But if this cell grows uncontrollably then it results in tumor forming. Tumors are of two kinds, benign and malignant. Benign tumors are non-cancerous and are less harmful. Whereas malignant tumors are cancerous and harmful. Medical diagnosis using image data includes a technique like X-ray, CT scan, and MRI. Especially MR imaging technique is interesting as it uses magnetic field vectors measurement and generatesansuitable excitation of strong magnetic fields and radio frequency pulses in the nuclei of hydrogen atoms present in the water molecules of a patient's body. The only difference between MRI and another technique is that it is radiation free. Evaluation of brain is done by the radiologist using MRI. MR imaging is a powerful technique to detect a tumor in the brain. Conventionally human inspection was done to detect tumors in MR images, and it is very time consuming. But with the advancement in modern AI system and emerging machine learning techniques, we can solve this problem intelligently, without any human intervention.

For getting high precision and accuracy in results Automaticrecognition of tumor in MRI images is essential as we are dealing with human lives.

Many machine learning techniques can be used for classifying MR images for brain tumor detection. Few of those are ANN, SVM, KNN, and SOM. But the results of those techniques prone to many problems such as Outlier, error rate, mis-classification which we have to address. For this purpose, Adaboost algorithms are very popular and are highly recommended. Basically Adaboost helps the learner atthe decision boundary to classify the data point which is in doubt by boosting their parameter.

In this paper, an effectiveautomatic classification method for brain MRI is projected usingthe Adaboost machine learning algorithm. The supervised machine learning algorithm is used for classification of brain MR image.

II. LITERARTURE SURVEY

Komal Sharma et.al. [1]in their work shows how the machine learning algorithm is useful in detecting tumor in magnetic resonance imaging. Their results show 98.6% classification rate using MLP (Multilayer Perceptron) and 97.6% using Naïve Bayes. They used GLCM as a feature extractor and texture feature such as energy, contrast, correlation, homogeneity is used to detect tumor characteristics.

Ms. Suchita Goswami et.al. [2] Proposed a system based on unsupervised learning based Neural Network for brain tumor detection. They used ICA for feature extraction and SOM for classification. Segmentation is done by using k-means clustering algorithm to segment the brain into different tissue. Their result shows 98.6 % accuracy archived using this method.

Walaa Hussein Ibrahim et.al [3] used neural networkto classify MRI images. They used PCA (Principle component analysis) technique to reduce dimensionality in data. They used dataset from CIPR database and 3x58 images were used for training and testing the algorithm. The classification accuracy that they get was 96.33%.

Dipali Joshi et.al. [4] Projected a system based on classification of brain cancer by means ofartificial neural network. For feature extraction they used GLCM. For preprocessing is done using image processing technique such as histogram enhancement, morphological operation. Neuro fuzzy classifier is used to classify the brain tumor into

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different classes. Their results show that their system is efficient enough to classify different brain tumor.

A. Prabin et.al. [5] Projected a system built on Adaboost classifier to diagnose brain tumor in MR images. They used the wavelet transform and the level set method for feature extraction while classification is done using Adaboost classifier. Their results show that the accuracy rate of Adaboost classifier is better than compared leading tumor classification methods such as Feed forward neural network (FFNN) and radial basis function (RBF). For dimensionality reduction PCA method is used.

Sahar Ghanavati et.al.[6] Proposed a method based on Adaboost classifier to detect brain tumors in MR images. For image modalities they used a gadolinium contrast agent. For classification feature such as deformation, intensity, shape, symmetry and texture feature were used. Training and testing perform on the multimodal MR images. The result shows that system performs well with 90.11% accuracy.

V. Trinadh babu et.al.[7] Proposed a system based on neural network based Adaboost algorithm to detect a tumor in brain MRI. They proposed an improved patient self-reliant tumor clustering scheme using Adaboost procedure. The database used is BRATS2012 dataset. The result shows that their segmented outcomes are more persistent and on average performs for the patients.

Prachi Gadpayle et.al. [8] Proposed a system based on brain tumor detection in magnetic resonance imaging where they have used BPNN and KNN as a classifier. For feature extraction GLCM technique is used. They obtained parameter such as Energy, Contrast, Entropy, Homogeneity, Inverse Difference Moment, and Dissimilarity using GLCM. Results show KNN has 70% accuracy for unseen images and BPNN has 72.5% accuracy for unseen images.

III. PROPOSED METHOD

As per literature survey, it was found that automatic brain tumor recognition is very essential as high accuracy is needed when human life is involved. Automaticrecognition of tumor in MR images includes feature extraction and classification via machine learning algorithm. In this paper, an automatic approach to spot brain tumor is presented as shown in fig. 1.

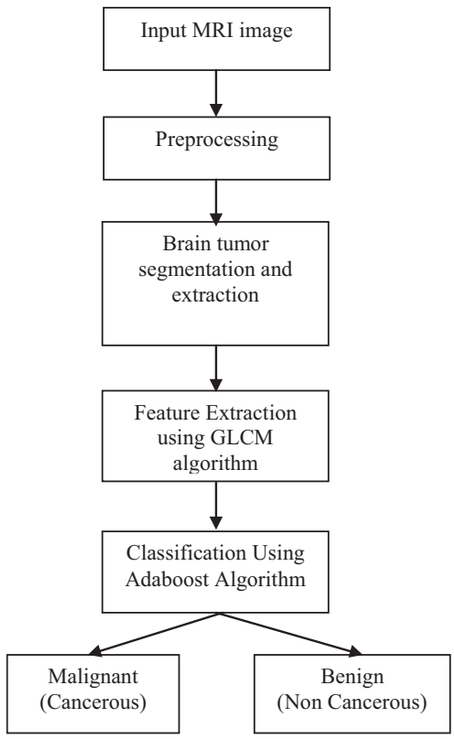

Fig. 1. Proposed Method for Brain Tumor Detection in MR images

a. Image Acquisition

The MRI brain images are acquired and are given as input to the preprocessing stage. The illustration brain MR images are shown in Fig 2.

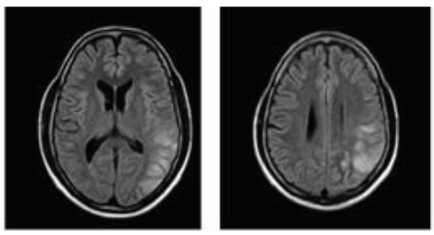

Fig. 2. Illustrations of brain MR image

b. Preprocessing

Preprocessing is desired as it deliversan improvement in image data which improves some of the image features which are vital for additional processing. The pre-processing stages that are applied to MR image are as follows:

The RGB MR image is transformed to grayscale image and then median filter is applied for noise elimination from brain MR images as shown in figure 3(b). The noise is eliminated for further processing as high precision is desirable.

The brain MRI is segmented by using the thresholding technique. The segmentation is the technique which divided the image into different segment and select the useful part for further processing. [9]

c. Feature Extraction:

Feature vector reduces representation set of large data. It consists of information of the extracted feature from the image. Transformation of such an input data into sets of features is called feature extraction [5]. In this stage, the important features required for image classification are extracted. The segmented brain MR image is used and texture features are extracted from the segmented image which illustrate the texture property of the image. These features are extracted using GLCM algorithm. The GLCM texture feature extraction process is very modest as using alesser number of gray levels shrink the size of GLCM which decreases the computational cost of the algorithm and at the same time conserves the high classification rates. The GLCM features are used to differentiate between normal and abnormal brain.Texture comprehends some vital information about the surface structural arrangement.

22 features were extracted for proposed technique, few of them are described as follows.

1. Energy:

The energy is the measure of uniformity between the pixels. Range=[0,1]

The energy is the measure of uniformity between the pixels.

$$\text{Energy} = \sum_{i,j} p(i,j)^2 \dots\dots\dots\dots (1)$$

2. Contrast:

Contrast is the measure of difference in luminance to make object distinguishable. Range=[0,1]

$$\text{contrast} = \sum_{i,j} |i-j|^2 p(i,j) \dots\dots\dots (2)$$

3. Correlation:

Correlation is the measure of the relation between the neighbor pixels. Range=[-1,1]

$$\text{Correlation} = \sum_{i,j} \frac{(i,j)p(i,j)-\mu_x\mu_y}{\sigma_x\sigma_y} \dots\dots\dots (3)$$

4. Homogeneity

The homogeneity measures of closeness of the element distribution in GLCM to GLCM diagonals. Range=[0,1]

$$\text{Homogeneity} = \sum_{i,j} \frac{1}{1+(i-j)^2} p(i,j) \dots\dots\dots (4)$$

Where, i, j are pixels and p(i,j) is the pixel value

Thus to categorize the brain as normal or abnormal, the MRI brain images are aquired, preprocessed and segmented by using different techniques.

d. Classification

The Machine learning algorithms are used for classification of MR brain image either as normal or abnormal. The main aim of ML algorithms is to automatically learn and make intelligent conclusions. Adaboost algorithm is use for classification in the proposed approach. Adaboost is a supervised learning algorithm. The detailed algorithm is explained below

Input: Data set $D = \{ (x_1 , y_1) ,(x_2 , y_2) ,\dots..,(x_m , y_m) \}$

Base learning algorithm $\mathcal{L}$

Number of learning rounds T.

Process:

1. $D_1(i) = 1/m.$ % Initialize the weight distribution
2. for $t = 1,\dots.,T:$
3. $h_t = \mathcal{L}(D , D_t)$; % Train a learner ht from D using distribution Dt
4. $\mathcal{E}_t = \Pr_{x\sim D_{t,y}} I[h_t(x) \neq y]$; % Measure the error of ht
5. if $\mathcal{E}_t > 0.5$ then break
6. $\alpha_t = \frac{1}{2} \ln(\frac{1-\mathcal{E}_t}{\mathcal{E}_t})$; % Determine the weight of h_t
7. $D_{t+1}(i) = \frac{D_t(i)}{Z_t} \begin{cases} \exp(-\alpha_t) & if\ h_t(x_i) = y_i \\ \exp(\alpha_t) & if\ h_t(x_i) \neq y_i \end{cases}$
   $= \frac{D_t(i)\exp(-\alpha_t y_i h_t(x_i))}{Z_t}$ % Update the distribution ,
   where Z_t is the normalization which enable D_{t+1} to be distribution
8. end

Output :

$H(x) = \text{sign}(\sum_{t=1}^{T} \alpha_t h_t(x))$

In the classification process weak classifier may generate. This weak classifier may decrease the accuracy of the classifier. In this approach the misclassified samples are corrected by increasing the weights. As a result, we get strong classifier using the Adaboost algorithm.

IV. Experimental Results

The results are assessed using qualitative and quantitative analysis.

a. Qualitative Analysis

The result of the projected system at different stages are shown below

The input MRI is taken from the database.

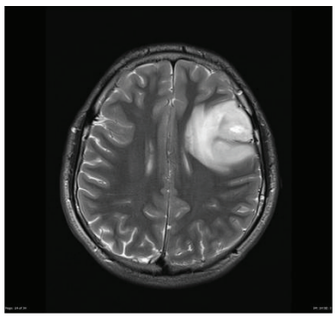

Fig. 3. Input MRI

The input image is preprocessed by using median filter. Basically the median filter smoothens the image and remove the salt and pepper noise.

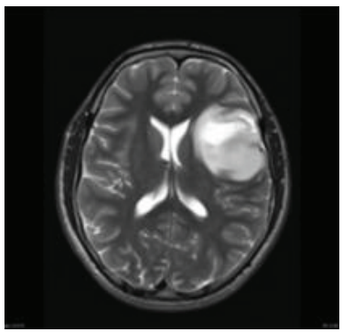

Fig. 4. Preprocessed image

The preprocess image is segmented using thresholding and tumor is detected. The white part in the image shows the tumor region in an MRI.

Fig. 5. Tumor detection

b. Quantitative analysis

The trial was carried out on 50 brain MR images. 22 features are extracted from each image using GLCM technique. These features were classifIed using the Adaboost algorithm. The results of the proposed system are tabulated below

TABLE I. EXPERIMENTAL RESULTS ANALYSIS ON LINEAR KERNAL FUNCTION

ML Algorithm	Total Samples	Sensitivity (%)	Specificity (%)	Accuracy %
Adaboost	50	88.23	62.5	89.90
Neural	50	94.18	31.25	74

As of Table 1, we can find that the classification accuracy is 89.90%

The graph of the performance parameters are shown below

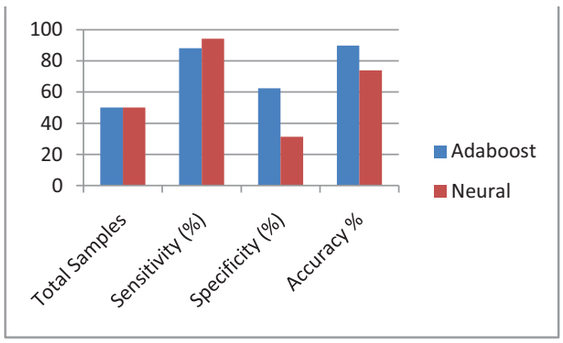

Fig. 6. Graph of performance parameter

V. CONCLUSION

The proposed machine learning algorithm for brain tumor classification uses texture based features. These features were extracted by using GLCM technique. 22 features were extracted from an MRI. For the classification purpose, Adaboost classifier is used and maximum accuracy achieved by proposed system is 89.90%.

In future, we can work of quadratic and polynomial kernel function. And compression result of efficiency in quadratic and polynomial kernel function. And compression between Neural and Adaboost . the accuracy of the system will be increased by increasing training database images. Also the system can be implement for different types of classes like Glioma and Meningioma.

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