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*Research Article*

# Brain tumor detection using texture feature analysis based on MRI images

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***Abstract***

*Magnetic Resonance Image (MRI) gives an internal structure body. MRI is widely used for brain tumor detection. A brain tumor can have different shapes and can occur at different locations inside the brain. Tumors are of mainly two types of benign and malignant. Cancerous tumors are called malignant tumors, which can spread in surrounding tissues. Non-cancerous tumors are called benign tumors, which can be removed surgically. Traditionally brain tumor detection is done by radiologists, which is time-critical and depends upon the availability of skilled radiologists. This paper presents a brain tumor detection method using image processing and machine learning techniques. The proposed method follows preprocessing, segmentation, feature extraction, and classification stages. GLCM texture features and Local Binary Pattern (LBP) features are taken into consideration for classification. This approach is evaluated on publicly available MRI datasets using SVM and Random Forest with accuracy 92% and 93%, respectively.*

***Keywords:*** *Brain tumor detection; Structural MRI; Image processing; Machine learning; k-means*

## Introduction

Proper functioning of the brain is essential to living a healthy life.Brain cancer is caused by cancerous tissues that grow inside the brain region. Brain tumor affects the normal functioning of the brain. The abnormal growth of cells creates a tumor. Cancerous tumors are called malignant tumors that can spread in surrounding tissues. Benign tumors are noncancerous tumors. Brain cancer is considered a hazardous one as it has a low survival rate compared to other types of cancers. Magnetic Resonance Image (MRI) gives an internal structure of the body. It is a non-invasive technique that uses a magnetic field and radio-frequency pulses to image the interior body parts. Brain MRI shows soft brain tissues clearly.MRI is mainly of three different types T1, T2, and FLAIR, according to brain tissue contrasts.MRI appears in three orientations, namely axial, coronal, and sagittal.

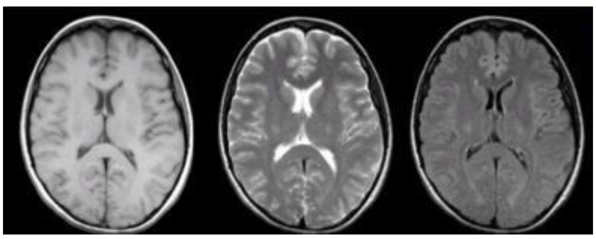

Fig 1 : T1 weighted,T2 weighted and FLAIR images

This research work focuses on axial orientation, which is taken from neck to head. The types of MRI sequences are shown in Fig 1.

## Literature Survey

Several machine learning methods have been proposed for brain tumor detection through MRI. MRI images are acquired from publicly available datasets. Preprocessing techniques include filtering, morphological operations, and pixel subtraction methods. MRI images contain variations in an image called as noise. For noise removal median filtering method is used by most of the researchers.[1-5]. Median filtering removes the noise without changing the orientation of the original image. Segmentation of the specific tumor region is a very crucial one as it is important for brain cancer detection. MRI image is first converted to grayscale, and threshold-based segmentation techniques are applied to separate out tumor regions from brain tissue [6, 7, 8]. A Selvapandian et al. has done image enhancement using the Contourlet Transform.[14] Unsupervised algorithms like fuzzy c-means, k-means give better segmentation results for MRI as it separates gray matter(GM), white matter(WM), and cerebrospinal fluid(CSF) by selecting the proper value of k.[9-11]. R. Lavanyadevi et al. used a k-means segmentation technique to separate out tumor regions.[4].

Most of the researchers use the Gray Level co-Occurrence Matrix (GLCM) texture features. It is the second-order statistical feature extraction method, which gives 14 texture features like energy, co-relation, contrast, etc. Wavelet features are extracted using a Discrete Wavelet Transform (DWT), which gives features in terms of approximation coefficients. S.Shekhar et al. used wavelet features using DWT [15]. Few researchers have used automatic features from using a convolution neural network (CNN). It is observed that automatic CNN features, along with handcrafted features, give better performance. [9,16].

Traditional machine learning algorithm SVM is used by most of the researchers for binary classification [17-19].SVM with a linear kernel shows better performance for a small data set. Deep learning methods like CNN, PNN have given better accuracy for MRI image classification.[20-21].For small datasets transfer learning approaches with pre-trained Google Net, the VGG network is used for brain cancer detection[22,23]. A combination of neural network and fuzzy inference system, Adaptive Neuro-Fuzzy Inference System (ANFIS) is used by A Selvapandian et al. for tumor-normal and abnormal tumor classification [14].

## Proposed Methodology

Brain tumor images can be obtained used Computer Tomography (CT) scan, Positron Emission Tomography (PET) scan, and Magnetic Resonance Images (MRI) scan image modalities. The proposed methodology uses an MRI scan for brain tumor detection as it is a non-invasive technique to get images of the internal brain region.The brain tumor detection system consists of four stages preprocessing, segmentation, feature extraction, and classification. The detailed architecture of the brain tumor detection system is given in Fig 2.

*A. Architecture*

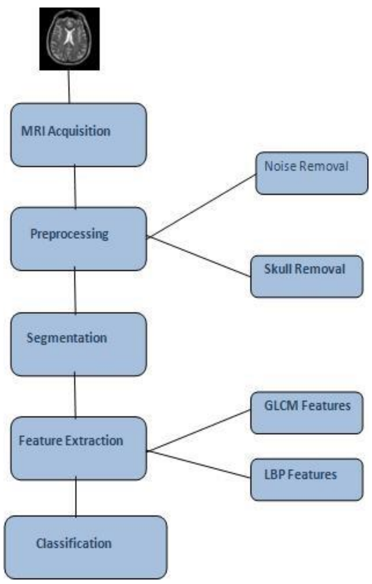


Fig 2: Brain tumor detection Architecture

Detailed modules are described below:

**Module 1**: MRI Acquisition MRI scans produce three types of sequences-T1 weighted, T2 weighted, and FLAIR (Fluid attenuated inversion recovery) depending upon the brain tissue contrast. For this research work, T2 weighted MRI images are acquired from publically available dataset.T2 weighted MRI has a bright cerebrospinal fluid (CSF); hence it is easy to locate the brain tumor.

**Module 2**: Preprocessing-MRI scan uses a magnetic field and radio-frequency pulses to image the internal body part. Hence variations may get introduced in MRI. Noise removal techniques like median filtering, skull removal methods like morphological operations are used in the preprocessing step.

**Module 3**: Segmentation- Segmentation of tumor region is the most critical part of brain cancer detection. In the proposed methodology, an unsupervised k-means algorithm is used to segment out the tumor region from brain tissues.

**Module 4**: Feature extraction-Feature extraction refers to measuring distinguishable properties of the image, which can be further used for classification. Texture gives surface characteristics of the image like size, shape, density, etc. The statistical texture feature is used to analyze the spatial distribution of gray values in the image.

Gray Level co-occurrence Matrix (GLCM) is a second-order statistical method to give texture features. It creates a co-occurrence matrix to calculate the frequency of occurrence of a pixel with gray level values. In this work, GLCM described by Haralick is used. It gives 14 texture features like contrast, co-relation, variance, entropy, etc.

Local Binary Pattern (LBP) describes the texture characteristics of the surface. Texture regularity is defined based on the LBP histogram shape distribution.LBP value is calculated for all pixels, and a histogram is formed to determine texture features. 26 LBP texture features are considered for this work.

**Module 5**: Classification is used to detect brain tumors from healthy brain MRI images. Combining feature vector including Gray Level co-occurrence Matrix (GLCM) texture features and Local Binary Pattern (LBP) features is given as input to the classifier. It is observed that the SVM classifier with a linear kernel gives better accuracy than other machine learning classifiers.

Brain tumor detection system can be developed using machine learning techniques with the above described five modules It can be used as a supporting system for radiologists for brain cancer detection.

*Algorithm*

Brain tumor detection system consists of following steps:

Step 1: Acquire brain MRI images from publically available dataset.

Step 2: Noise removal using median filtering method.

Step 3: Skull removal using morphological operations.
Step 4: Segmentation using k-means clustering method with value of k=3
Step 5: GLCM texture feature extraction using Haralick framework
Step 6: LBP texture feature extraction
Step 7: Combined feature vector is given to SVM and Random forest for classification.
Step 8: Performance is analyzed in terms of confusion matrix and accuracy.

RESULT AND DISCUSSIONS

**Dataset Details**: Brain MRI images are taken from publically available Kaggle dataset [24]. It contains 253 T2 weighted images, out of which 98 images are normal MRI, and 155 MRI images are tumorous. This dataset contains MRI images with different pixel sizes. For uniformity, images are resized to 256*256 pixel size.

### Experimental Result

The proposed system is evaluated using two machine learning classifiers SVM, and Random Forest.5 fold cross validation is applied and tested with two SVM, kernels-Linear, and RBF. It is observed that SVM with a linear kernel gives good accuracy of 93% while SVM with RBF kernel has given 65% classification accuracy. The random forest has given 92% accuracy. The feature vector consists of 40 features, which include 14 GLCM texture features and 26 LBP texture features. Sample MRI images and segmented MRI images are shown in Fig 3 and Fig 4, respectively.

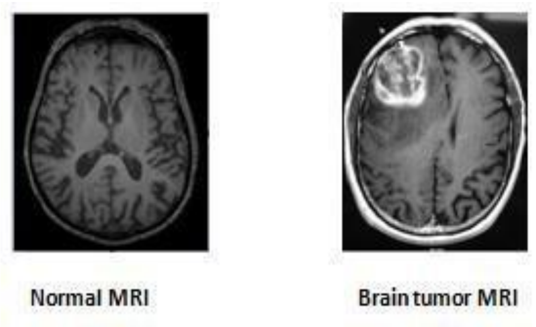


Fig 3: Sample MRI images

Fig 4: Segmented Image

Dataset is divided into 75% training data and 25% testing data for the Random Forest classifier. For SVM classifier,5 fold cross-validation used with Gamma and C parameters as 0.001 and 1, respectively.
Experimental analysis for SVM and Random Forest classifiers is given in Fig 5

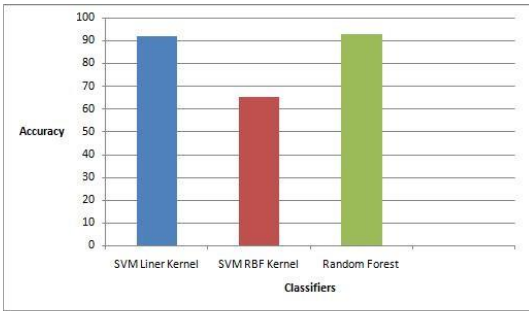


Fig 5. SVM and Random Forest Accuracy

### Conclusion

This research work proposes a brain tumor detection system using texture features.2 dimensional grayscale MRI images are used for the experiment. The proposed method is composed of 5 modules: image acquisition, preprocessing, segmentation, and classification. Previous work for brain tumor detection uses mostly GLCM features. In this paper, GLCM and LBP combining texture features are used. It is observed that combining texture features give better accuracy (92%) as compared to a single texture feature. The proposed method can be used as a decision support system for radiologists for brain.

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