

Brain Tumor Segmentation and Classification using Neural Network and SVM for MRI Images

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Abstract— Medical imaging techniques gains its importance with the increase in the need of automated & efficient diagnosis of brain tumor. MRI brain tumor segmentation is difficult procedure to segment tumor area from MRI images because of inconsistency of anomalous tissues. As there are number of techniques are already presented for effectively segmentation of brain tumor but still it is not achieved the required level of accuracy, abnormalities classification is not predictable. The whole process incorporates the steps- preprocessing, segmentation with Lab color space & then feature extraction using GLCM matrix like energy, entropy, contrast etc. These features are trained and tested using SVM & Neural Network to classify the images into normal and abnormal & then abnormal into different tumor grades.

Key words: MRI, Pre-Processing, Segmentation, Classification, Feature Extraction

I. INTRODUCTION

The brain is the anterior most part of the central nervous system. The function and structure of the brain need to be studied non-invasively by doctors and researchers. The body is made up of many types of cells. Each type of cell has its individual functions. Most of the cells in the body grow and the divide in an orderly way to form new cells as they needed to keep the body healthy and working properly[1]. When cells lose their ability to control their growth, they divide too often & without any order. Then these extra cells form a mass of tissue called tumor. Tumor is defined as the abnormal development of the tissues. Brain tumor is any intracranial mass created by abnormal and uncontrolled cell division. MRI is a medical imaging technique which provides rich information about the human soft tissues of the body. It is used to produce high quality images of the parts enclosed in the human body [2]. MRI is useful in neurological(brain), musculoskeletal and oxcological(cancer) imaging because it offer much greater contrast between diverse soft tissues of the body than the computed tomography(CT). Brain tumor is classified into three main categories:1) Benign 2) Pre-malignant 3) Malignant

A. Tumor Grades

The Tumor grade gives description how abnormal the cells look. It determines how quickly the tumor will grow & how it is different from normal cells look[3]. The details of different grades are: Grade 1, Grade 2, Grade 3 & Grade 4. Higher the grade more abnormal the cells & more malignant & more difficult to remove the tumor.

II. PROPOSED METHODOLOGY

The whole process of tumor detection is shown in figure 1. The input is applied to the system which takes MRI as input

and then preprocessing is done to enhance the image & segmentation techniques are applied on the image to extract the nodule from the image & then the features are extracted from nodules so that the classification is done based on their properties.

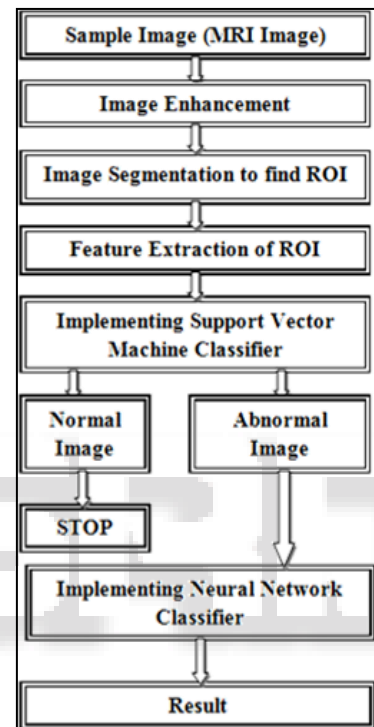


Fig. 1: Flow Diagram of Proposed Algorithm

A. Preprocessing

Preprocessing of MRI images is the first step in the proposed technique. Image enhancement is done by Gaussian filter to enhance the boundaries of the image. This step helps in improve the accuracy in detecting the tumor [4]. It will enhance the finer details of image.

B. Segmentation using Lab Color Space

In this project the segmentation is done using Lab color space. A lab color space is a segmentation technique with color opponent space. It has dimension L which indicates that lightness and a and b dimensions for color dimensions [5]. It is based on CIE XYZ color space coordinates. Lab color space can be calculated from the XYZ space.

The following steps for L*a*b Segmentation

- Step I: Read the Image
- Step II: Calculate sample colors in L*a*b color space for each region.
- Step III: Classify each pixel using nearest neighbor.
- Step IV: Display results of nearest neighbor color classes.
- Step V: Display a* and b* values of Labeled colors.

C. Feature Extraction

Texture contains important information about the structural arrangement of surfaces. The textural features based on gray-tone spatial dependencies have a general applicability in image classification[6]. From the GLCM matrix the different features are extracted and are applied as input to the SVM and then Neural Network. The extracted features are as follows:

- Contrast: It is the difference between the highest and the lowest values of a contiguous set of pixels. It measures the amount of local variations present in the image.

$$\text{Contrast}(\text{con}) = \sum_i \sum_j (i - j)^2 g_{ij}$$

- Energy: It measures the textural uniformity that is pixel pair repetitions. It detects disorders in textures.

$$\text{Energy}(\text{eng}) = \sum_i \sum_j g_{ij}^2$$

- Entropy: This statistic measures the disorder or complexity of an image [7]. The entropy is large when the image is not texturally uniform and many GLCM elements have very small values.

$$\text{Entropy}(\text{ent}) = -\sum_i \sum_j g_{ij} \log_2 g_{ij}$$

- Variance: This statistic is a measure of heterogeneity and is strongly correlated to first order statistical variable such as standard deviation.

$$\text{Variance}(\text{var}) = \sum_i \sum_j (i - \mu)^2 g_{ij}$$

- Homogeneity: It measures image homogeneity as it assumes larger values for smaller gray tone differences in pair elements.

$$\text{Homogeneity}(\text{hom}) = \sum_i \sum_j (1/(1 + (i - j)^2)) g_{ij}$$

- Skew: The Skewness is a measure of asymmetry of the probability of a real valued random variable about its mean.

$$\text{Skew}(\text{skew}) = \sum_i \sum_j (i - \mu)^3 g_{ij} / \sqrt{\text{var}}^3$$

- Kurtosis: The kurtosis is a measure whether the data is peaked or flat as relative to normal distribution.

$$\text{Kurtosis}(\text{Kurt}) = \sum_i \sum_j (i - \mu)^4 g_{ij} / (\text{var})^2$$

D. Classification using SVM & Neural Network Classification

SVM is a supervised classifier learning algorithm. It has two stages: training and testing. The basic SVM takes a set of input data and predicts for each given input which of two classes forms the output, making it a non-probabilistic linear classifier [8]. SVM locates the hyper plane that largely separates the decision function into two classes for the difficult dataset i.e. whether the image is normal or abnormal. Neural networks are efficient classifiers for tumor classification. The back propagation algorithm is product learning rule for a feed forward multilayer neural network [9]. This algorithm first initializes all neuron weights in the network. Inputs are applied to the network and the input vector is feed forwarded to determine neuron outputs. The outputs are compared with target response and error is computed. The overall error is minimized at each stage through neuron adjustments. It improves the accuracy of brain tumor detection. The neural network gives output as grades.

III. EXPERIMENTAL RESULTS

In this paper, the preprocessing stage performs image enhancement using Gaussian filter. Image segmentation using Lab color space which gives accurate results which further used for classification into grades. To analyze the performance of proposed algorithm the accuracy is calculated.

- Accuracy: It is the probability to correctly identified individuals i.e. it is the proportion of true results, either true positive or true negative. It is computed as:

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}} * 100$$

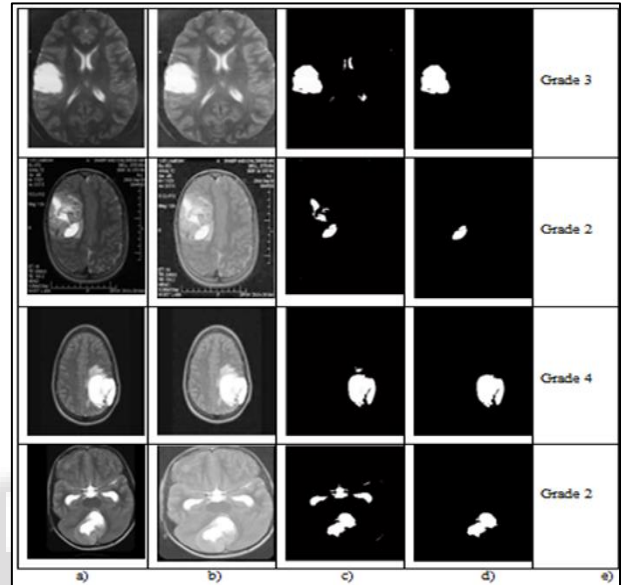


Fig. 2: Experiments results (a) input image (b) Enhanced image (c) segment image (d) tumor image (e) grade of tumor

IV. COMPARISON

The performance of our proposed algorithm using lab segmentation, SVM & Neural Network classification is graphically illustrated in figure below. The experimental results prove that accuracy of our proposed methodology is to higher than other conventional methodologies. The overall accuracy is 96%. The grade classification gives efficient results.

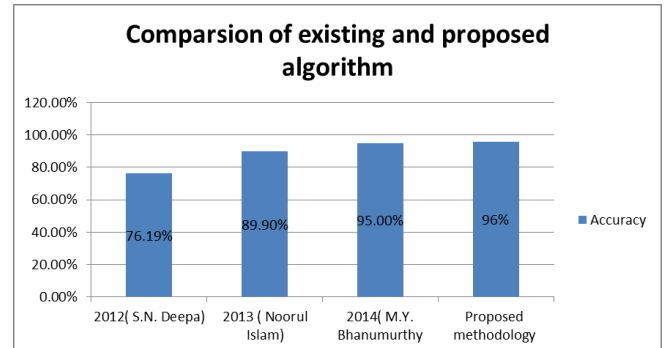


Fig. 3: Grade classification gives efficient results.

V. CONCLUSION

This paper has presented new technique to enhance the accuracy in the detection of tumor in brain from MRI scan. These techniques are able to detect major tumor in brain.

The future scope will be detecting multiple tumors. In future the technique for detecting multiple tumors will be presented and more accurately classifying the class of tumor and also to find out the location of tumor i.e. in which part of brain that tumor exists.

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