AUTOMATED SEGMENTATION AND CLASSIFICATION OF MAGNETIC RESONANCE IMAGES FOR BRAIN TUMOR DETECTION

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Abstract

In this paper an approach for automated segmentation and classification of magnetic resonance images for brain tumor detection has been developed. The input image is first pre-processed to reduce the noise present and then Segmentation is carried out to isolate the tumor region. Different approaches for segmentation are analyzed and compared. Otsu approach is considered for final segmentation. Texture features were extracted from GLCM. Other features computed using corner detection are fast features, Harris Corner Detection. Thus a total of six features are extracted for each suspicious region. A Neural Network is trained using back propagation method to classify the tumor according to its grade type. The proposed method gives reasonable results for the tested images.

Keywords: *Classification; MRI Images; Preprocessing; Segmentation; and Tumor*

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1. INTRODUCTION

Abnormal growth of cells in the brain is referred to as brain tumor which is a deadly disease if not cured on time. Death rate among people has increased due to diseases like brain tumor. Doctors have to check manually the location of tumor by using CT scan images. Sometime they cannot detect proper location of tumor so the treatment is badly affected.

A tumor can be defined as enlargement of abnormal brain tissues which cannot be controlled by the normal forces that regulates its growth[1].The brain tumor can be identified by using image processing. There are two types of tumor benign and malignant. Benign is non cancerous tumor that grows slowly in brain and stays in one place. In this paper Grade 1 (Pilocytic) and Grade2 (Low Grade) are benign tumors, Malignant is cancerous tumor that grows rapidly in large area and it spread in wide area. Grade3 (Analplastic) and Grade4 (Glioblastomamultiforme) are malignant tumor. Today doctors can cure the disease of patients quickly by using automatic machines but it is not a trivial task to identify the exact location of tumors automatically.

In this paper we have proposed an approach that could be used to identify the tumor at an accurate position by using various image processing operations.

The system also minimizes human intervention to reduce human errors while keeping the accuracy offered by fully automated approach. Rest of paper is organized as follows: section II present review of related literature proposed methodology in section III results are described in section IV. Finally conclusions and future work are given in section V.

2. RELATED WORK

A lot of work has been done in this area of segmentation and classification of MRI images for detecting brain tumor. In [2] authors have done pre-processing by applying many filters like Arithmetic, Gaussian, high pass, low pass etc. to achieve reduction of noise.

In [3] different methods of segmentation are compared on the basis of completeness, correctness and accuracy. The approaches used for segmentation are rated for degree of accuracy on the scale of 1 to 10.If the degree of accuracy is less than 5, that approach is not considered further. According to authors Otsu approach is the best one.

In [4] the abnormal MRI images are classified according to tumor grade type with their size, area using neural network. They have used textural features that are extracted based on gray level Co-occurrence Matrix.

In [5] authors have used region growing based texture method. They have selected threshold Level for intensity value and the neighbor values that satisfy the threshold is selected for region growing.

In [6] authors detect the tumor at different levels. They have used median filtering for to reduce noise and perform edge detection using canny filter. Segmentation is done using histogram clustering where the tumor affected image is divided into quadrants. A threshold value is set, based on this value tumor is detected. Morphological operators with disk structuring element is used for post-processing.

3. PROPOSED METHODOLOGY

To apply image processing techniques for tumor detection, pre-processing needs to be carried out as lot of noise is present in input MRI images. The flowchart representing the steps is shown in figure 1

3.1 Pre-Processing

Pre-processing is process to enhance quality of input images. In this image is first converted into grey scale and different filters like arithmetic, median and Gaussian are applied. In this paper we tested all these filters and found out that median filter gives the best output in terms of noise removal.

3.2 Segmentation

Segmentation is the process of dividing the digital image into multiple segments to simplify or change the representation of an image to aid easy analysis. In this step we need to identify regions that are susceptible to be a tumor. For this, techniques ranging from thresholding using Otsu approach, region based segmentation, clustering and watershed segmentation are applied. It is very important to correctly segment MRI Image as the results of this stage affects the further processing.

Clustering: It is the process of grouping objects into sets based on some similarity measure. It is used in various areas such as data mining, pattern recognition etc. K-means and Fuzzy Clustering have been implemented in this step.

*K-Means***:** K-means is the unsupervised learning algorithm for clusters and it is used in the grouping of image pixels according to their characteristics.

*Fuzzy Clustering***:** is used to segment an image. In this process partial membership is given to each pixel value given in the image. The membership value of fuzzy set is defined as range value from 0 to 1. It is multi valued logic that allows intermediate values to get the fuzziness of image.

Watershed Segmentation: is based on topographic representation of image in this watershed lines are defined to segment the image on the basis of regional minima. For this step color based marker to segment the image.

3.3 Feature Extraction

Feature Extraction refers to the process of computing important characteristics from an image such that the features carry enough information about the image. They should be easy to compute in order for the approach to be feasible for a large image collection and rapid retrieval [7].Different features computed in this work are gray-level-co-occurrence, (GLCM) based features, corner features using Harris detector, fast features.

3.4 Morphological Analysis

The Morphology refers to the properties of shape and structure of any objects that can contain features in the image. Basic morphological operators are erosion and dilation [8].

In this paper morphological operators (Erosion, Dilation) are used as an aid for detecting tumor. It reduces and enhances the region of interest (ROI-Area containing tumor) and thus increases the accuracy for determining the accurate position.

3.5 Classifications

Classification is used to classify the abnormal brain tumor images according to their grade i.e. it is grade1, grade2, grade3 and grade4. In classification MRI images are trained and classify using back-propagation algorithm which gives the best result than the other algorithms [4]. There are four types of tumor grade that are:
Pilocytic (Grade I): is benign tumor in which the tumor starts growing slowly in the brain. Texture of tumor is whitish in color.

Low grade (Grade II): is benign tumor in which the tumor grows slowly in brain and likely to spread.

Anaplastic (Grade III) **:**It is malignant tumor that spread from one place to another place in wide area.

Glioblastomamultiforme (Grade IV): It is malignant tumor in which the tumor grows aggressively than other grades. Size of tumor is contrast and cover maximum area of brain.

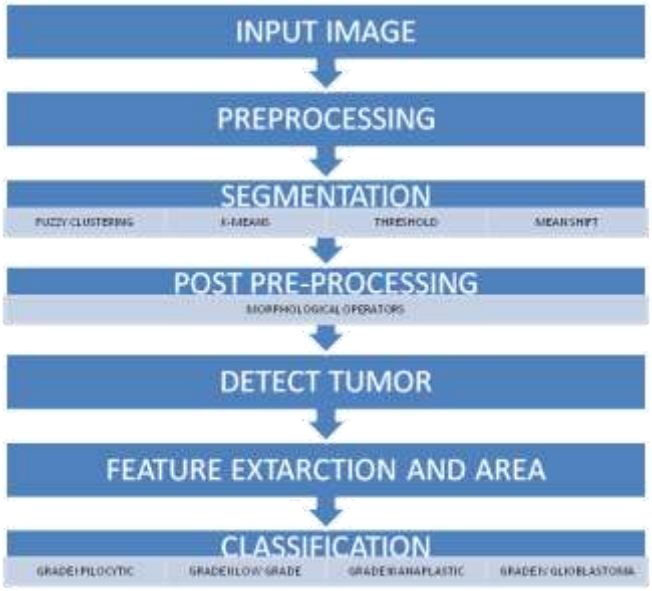


Fig 1 Proposed Algorithm

4. RESULTS

For this work, a set of 70 MRI images were obtained from a hospital. The images are pre-processed to reduce noise. Different approaches for segmentation are applied to identify the suspicious region. The Otsu's method gives the best results in terms of correctly segmenting the tumor area. Texture features were extracted from GLCM. Other features computed using corner detection arte fast features, Harris corer detection. Thus a total of six features are extracted for each suspicious region. A Neural Network is trained using back propagation method to classify the tumor according to its grade type. The proposed method gives reasonable results for the tested images. Figure 2 shows the step-wise results for a sample of 3 input images.

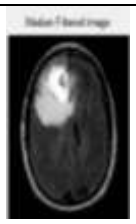
Original Image			
Pre-Processing			
Segmentation			
Classification	Grade III	Grade III	Grade IV
Detect Tumor			

Fig 2. Results of pre-processing, segmentation, classification and tumor detection

In order to evaluate the algorithm the accuracy of segmentation is computed which is defined by the formula given as

$$\text{Accuracy (\%)} = \frac{\text{Number of Images Correctly Segmented}}{\text{Total Number of Images in Database}} \times 100$$

In Table 1 the accuracy of different segmentation approaches are compared. The best results are obtaining Otsu Segmentation

Table 1: Comparision of Segmentation Methods

S.N.O	Segmentation Method	Accuracy
1.	K-means	15%
2.	Fuzzy Clustering	87.5%
3.	Watershed	77.5%
4.	Otsu	95%

5. CONCLUSION

The main objective of this paper is to identify the exact location of tumor. Median Filter is used to remove noise and the suspicious tumor region is identified by using Otsu segmentation Texture features were extracted from GLCM. Other features computed using corner detection arte fast features, Harris corer detection. Thus a total of six features are extracted for each suspicious region. Morphological operators (Erosion, Dilation) are used for post processing as they help to enhance the tumor area. The tumor is classified according to their grade, grade1, grade2, grade3 and grade4 using neural network. To extract the correct location of tumor morphological operators are applied**..** The system is able to efficiently segment and classify the tumor.

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