

# A Framework for Brain Tumor Classification and Grade Detection from Magnetic Resonance Image

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## Abstract

Brain tumor is a serious disease and numbers of affected people are drastically increasing day by day and researchers are focused on detection and classification of such types of severe diseases so that appropriate diagnosis can be provided to patient. In medical science, manually detection of brain tumor using medical resonance image by radiologist or neurosurgeon is tedious and time consuming procedure. One can save the time and energy of radiologist/ neurosurgeon by proving a framework which will automatically and reliably classify and detect the grade of tumor. The aim of this paper is to present a structure which not only classify the tumor as benign or malignant but also specify the grade of tumor. This framework comprises of different image processing and machine learning algorithm like pre-processing, segmentation, feature extraction and classification. At the end of this paper algorithm wise outcome is presented and evaluation of framework is carried out using different evaluation measures.

## Keywords

*Brain Tumor, Brain Tumor Segmentation, Magnetic Resonance Imaging, Thresholding.*

## Introduction

In medical science, Medical Resonance Image (MRI) is one of the widely used imaging techniques which is reliable and safe in order to detect the brain tumor. MRI is carried out using a magnetic field and radio waves to create a complete image of the brain which can further used to test different conditions of brain like swelling, tumor, cysts, infection and bleeding conditions. MRI is extensively used by analysts to assess the tumors [1] [2] but huge amount of data produced by such imaging technique prevents manual segmentation. Manual segmentation of such images is time consuming, tedious and prevents the use of precise quantitative measurements. In diagnosis of tumor, the precise, accurate detection of size & volume of brain tumor is more important in addition to its location. It's the need of the hour to make use of computer-aided tools in medical science so that aforementioned phenomenon can be carried out automatically and reliably.

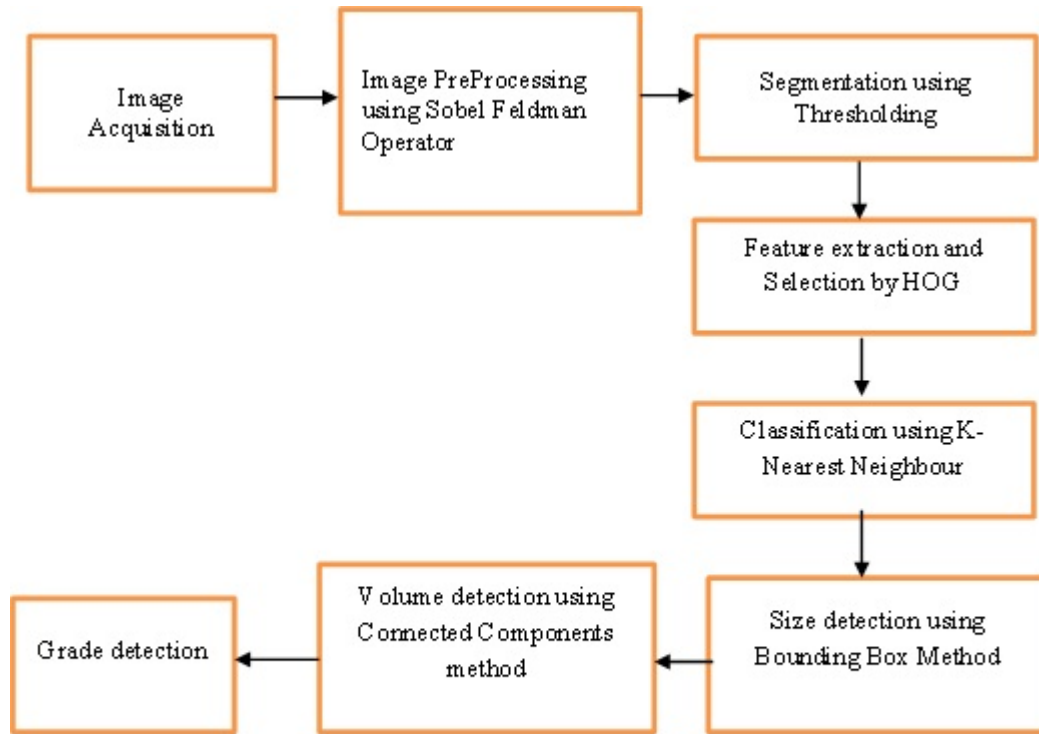
This paper presents a framework which not only classifies the tumor as benign or malignant but also provides the grade information of the tumor. Benign tumors does not contain cancerous cell and not spread to other parts of the body but can increase in size. Malignant tumor can spread to other parts of the body and more harmful as compare to benign so it must be removed as early as possible. The grade of a tumor [3] [4] is detected by its features and the way the cells look under a microscope. After rigorous assessment of tumor its grade can be categorized as follows:

- Grade I: Here the tissue is classified as benign and cells look like normal brain cells, and are slow growing and unlikely to spread. They can often be cured with surgery.
- Grade II: Here the tissue is classified as malignant and cells are less likely to grow and spread but the chances to come back after treatment are there.
- Grade III: Here tissue is classified as malignant and cells look different from normal cells and are actively growing. These tumors are more likely to have rapidly dividing cells but no dead cells. They can grow quickly.
- Grade IV: Here tissue is classified as malignant and cells look most abnormal [5] and tend to grow quickly. In addition, the tumor has blood vessel growth and areas of dead tissue. These tumors can grow and spread quickly.

## Motivation and Contributions

Manually assessment of tumor to know its location, size and grade requires time and efforts hence role of image processing and machine learning techniques are increasing in medical analysis. Various state of art approaches available to detect brain tumor or to classify the tumor as benign or malignant but proposed work focus on a complete framework to know the location, size, volume, type and grade of tumor. This framework is comprises of

different modules name as Preprocessing, Segmentation, Feature Extraction, Classification, Size Detection, Volume Detection and Grade Detection as shown in fig.1.



**Figure 1: System Architecture**

Pre-Processing module removes the noise, outliers [8] and high frequency artifacts from the image in addition to removal of the name of the patient, age and other labeled information. During preprocessing, Sobel Feldman operator [9] which is also known as the Sobel operator or Sobel filter is used. This filter especially focuses on edges of objects hence it is a well-known edge detection technique. In this approach the gradient of image intensity at each pixel within the image is computed and then the direction of the largest increase from light to dark is discovered along with the rate of change in that direction.

Image segmentation is one of fundamental technique of image processing where image at hand is divided into multiple parts and labeling of each pixel is done in such a way that they share the same characteristics. The image segmentation is done by using thresholding [10] which creates binary images from grey-level image by inverting all pixels below some threshold to zero and all pixels above that threshold to one. This step makes it easy to further analyze and extract meaningful information and ignores the irrelevant part of image.

Once the area where tumor is present is available then using feature extraction technique that area is transformed into a feature vector. This process is done by Histogram oriented Gradients (HOG). The size of an image is represented by width x height x 3 (channels) which is converted into a feature vector/array of length n using feature descriptor. The feature vector produced by HOG is fed into an image classification algorithm.

Classification algorithm learns different patterns from feature vectors and predicts the label for an unseen instance. K-Nearest Neighbor [11] classification algorithm is used for the purpose of classification and regression. The outcome of this algorithm can be interpreted as a posterior probability of the input pattern belonging to a particular class. As the k increases the confidence in prediction improves.

After classification and localization, size detection of tumor is carried out using boundary box method which provides the width and height of tumor.

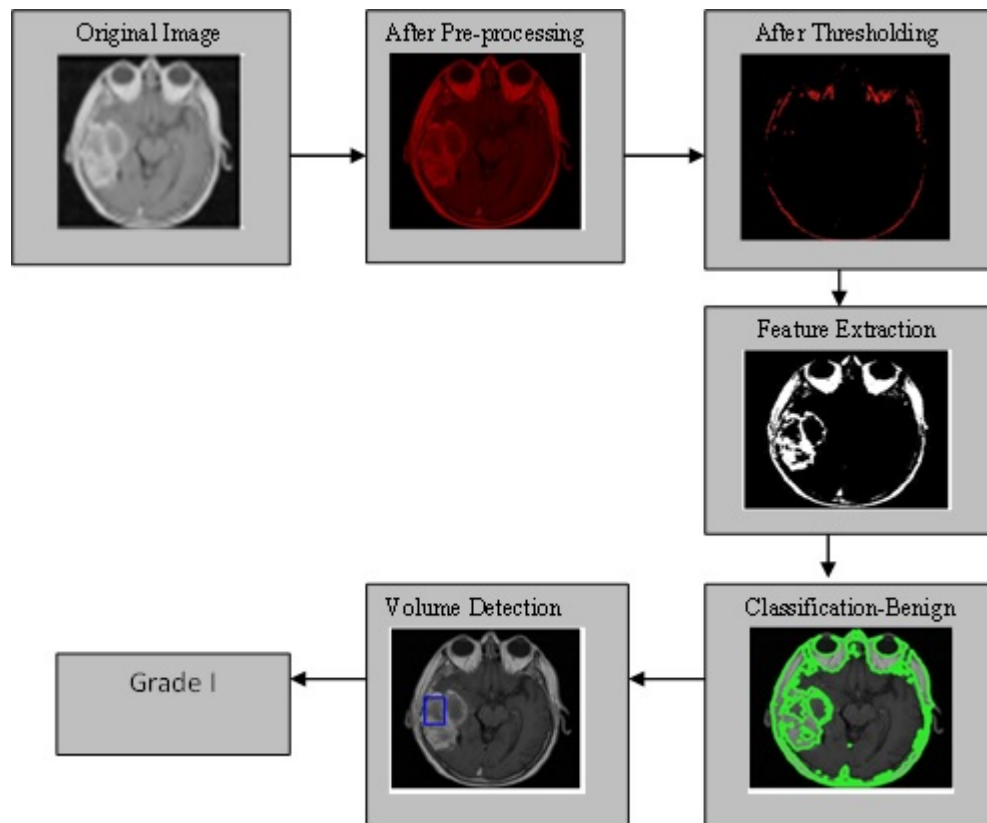
Volume detection is carried out using two different approaches, first approach make use of 3D slicer tool[12] where 2D image converted into 3D image and second approach make use of connected components method. Finally, the Grade of the tumor is detected using the size, volume and type of tumor as parameters.

## Results and Discussion

For experiment and validation tools like OpenCV (Open Source Computer Vision Library), NetBeans are used. The images are obtained from Brain Tumor Segmentation Challenge 2013 database and T1 axial MRI images are only considered for evaluation purpose. Fig.2. shows the results of each module of proposed system.

The performance of any classification model is measured by using some metrics. For experimental purpose and comparative analysis, different evaluation measures as explained below are considered. The confusion matrix is the primary evaluation measure to observe the performance of classification model. All other evaluation measures are computed from confusion matrix. The most commonly used terms in confusion matrix are:

1. True positives (TP): Model gives the prediction positive and their true value is positive.
2. True negatives (TN): Model gives the prediction negative and their true value is negative.
3. False positives (FP): Model gives the prediction positive and their true value is negative. Such type of error is called as "Type I error."
4. False negatives (FN): Model gives the prediction negative and their true value is positive. Such type of error is called as "Type II error."



**Figure 2: Module Wise Outcome**

For quantitative analysis, true positive rate (Sensitivity) and true negative rate (Specificity) are computed from above parameters. Table 1 shows the quantitative analysis of proposed framework.

Images	Sensitivity	Specificity	Accuracy
1	93.8	96.8	95.9
2	91.9	97.8	94.4
3	96.8	93.2	95.1
4	96.5	94.3	95.8
5	91.2	94.3	93.1

**Table 1: Quantitative Analysis of Evaluation Measures**

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### Conclusion

A framework for the brain tumor detection is described in this paper is efficient and fully automated and useful in medical applications especially for radiologist and neurosurgeon. Prominent techniques of image processing and machine learning are employed in creation of this framework. Experiments on different images prove the validity of system. An important scope would be use of T2 axial MRI images and other evaluation metric for evaluation purpose.

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