

# Brain Tumor Detection and Multiclass Classification from MR Images

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**ABSTRACT:** Image processing is an active research area in which medical image processing is a highly challenging field. Brain tumor is a serious life altering condition. It is the major cause of death among all other type of cancer during these days. Proper diagnosis can prevent life of a patient to some extent. Medical imaging techniques are used to image the inner portion of human body for medical diagnosis. MRI is widely used technique in detecting brain tumor. Image segmentation plays a significant role in image processing as it helps in the extraction of suspicious region from medical images. Even though many brain tumor segmentation methods and classification methods have been presented, Multiclass classification is still challenging due to complex characteristics of brain tumor, such as high diversity in tumor appearance and tumor boundaries. This paper deals with ability of CCL based watershed segmentation to extract tumor and next phase of system deals with multiclass classification of tumor using Artificial Neural Network (ANN) algorithm for MRI images of different patients.

**KEYWORDS:** ANN; MRI (Magnetic Resonance Imaging); Brain Tumor; CCL; Watershed segmentation.

## I. INTRODUCTION

Brain tumor is the uncontrolled growth of abnormal tissue in brain or central spin that can disrupt the normal brain function. There are two types of tumors malignant (cancerous) tumors and benign tumors. Cancerous tumors can be divided into primary tumors that start within brain and secondary tumors that have spread somewhere else, known as brain metastasis.

Brain and other nervous system cancer is the 10<sup>th</sup> leading cause of death for men and women. It is estimated that 16,700 adults (9620 men and 7080 women) will die from primary cancerous brain and CNS tumor in this year. The WHO issued the most widely used grading scheme that classifies the tumor in four grades. Astrocytoma, Meningioma, Glioblastoma, Medulloblastoma, Metastatic melanoma are the 5 type of primary tumors which belongs in these grades. These are primary brain tumors and are named according to the type of cells or the part of brain in which they begin. Astrocytoma is one of the tumor arises from star shaped glial cells called astrocytes. It most often arises in the cerebrum. Meningioma arises in the meninges i.e. on the layers of brain, it can be of any grades I, II or III. It is usually benign and slow growly. Glioblastoma is a low grade glioma. It is develops from astrocytoma. Medulloblastoma is a malignant tumor belongs to grade glioma. Metastatic melanoma is a kind of malignant tumor and is a dangerous skin cancer.

Imaging is an essential tool of medical science to visualize anatomical structures of human body. There are different imaging techniques such as X-ray, CT, MRI, PET etc. Computed tomography (CT) combines multiple X-ray projections taken from different angles to produce detailed cross sectional images of areas inside the body. Positron Emission Tomography (PET) is a nuclear imaging technique that provides information about how tissues and organs functioning. X-ray is one of the oldest and commonly used form of medical imaging. MRI has proven to be highly effective in diagnosing a number of conditions by showing difference between normal and affected tissues. Images

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obtained from MRI scanning are of three types which are axial, sagittal, coronal slices. MRI images consist of many sequences namely T1-w, T2-w, FLAIR, STIR, DWI, ADC, etc. Each sequence has its own features like in T2-w the tumor is seen in grey colour where as in T1-w it is seen in white colour. In this work we selected T2-w images.

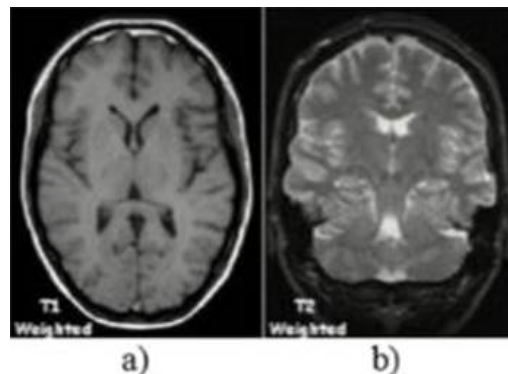


Fig.1. Brain MR Images from Axial Plane a) T1-w, b) T2-w

## II. LITERATURE SURVEY

Tumor segmentation from MR images is one of the important tasks. There are several methods existing for segmentation. Some of them are Clustering, Thresholding, Edge based segmentation etc.

**Clustering:** In clustering, data is divided into several groups. Each group contains similar objects. Therefore, similar image components can be grouped to detect the tumor region. But the disadvantage is that it will produce different results for different number of clusters [3].

**Thresholding:** Thresholding based image segmentation partitions the image into different pixel groups by comparing each pixel value with a threshold value. The disadvantage is that the segmented region can be smaller or larger than the actual which depends on the selected threshold value. There may be failure to find an accurate threshold value [4].

**Edge Based Segmentation:** Brain tumor can be detected using histogram equalization and edge detection process. Robert, Prewitt and Sobel methods are suggested for edge detection. Among these Sobel method is more suitable for edge detection of brain tumor because it has small mean and standard deviation [5].

Keeping in mind about the limitation of existing brain tumor segmentation methods, we decided to check the ability of CCL based watershed segmentation to detect the tumor. Watershed segmentation [7] uses intensity parameter to segment the images. The method emphasizes that segmentation is available to all type of data set. So we decide to detect tumor from different type of MRI images and classify those using ANN classifier. SVM is used for multiclass classification and ANN is used [4] to detect any one type of tumor. So here we are checking whether ANN classify the tumor types efficiently or not.

## III .SCOPE OF RESEARCH

Detecting the presence of tumor from MRI in a fast, accurate, and reproducible way is a challenging problem. It is a big challenge to modify the system so that it provides a quality software to detect tumor and its type for any MRI sequence. Here the scope of the system further be improved to classify other types of cancers. The system can also be modified to use other types of images like PET, MRS, CT sets.

## IV. METHODOLOGY

The work carried out involves processing of MRI images of brain cancer affected patients from nearby hospital for detection and classification of tumors. The image processing techniques like image enhancement, image segmentation and extracting features are done. Watershed segmentation [1] is used for image segmentation and ANN [7] classification

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algorithm is used for classification of tumor. The system is designed to be user friendly by creating proper Graphical User Interface(GUI).

**Sample data collection:** Even though we got nearly 100 images from hospital, it includes various conditions of brain namely pituitary macroadinoma, hyper acute hemorrhage, acute infarct etc. But our area of interest was 5 type tumor classification by WHO. So we selected required images. Also we collected images from the site (<http://radiopaedia.org/cases/>) which is suggested by the doctor.

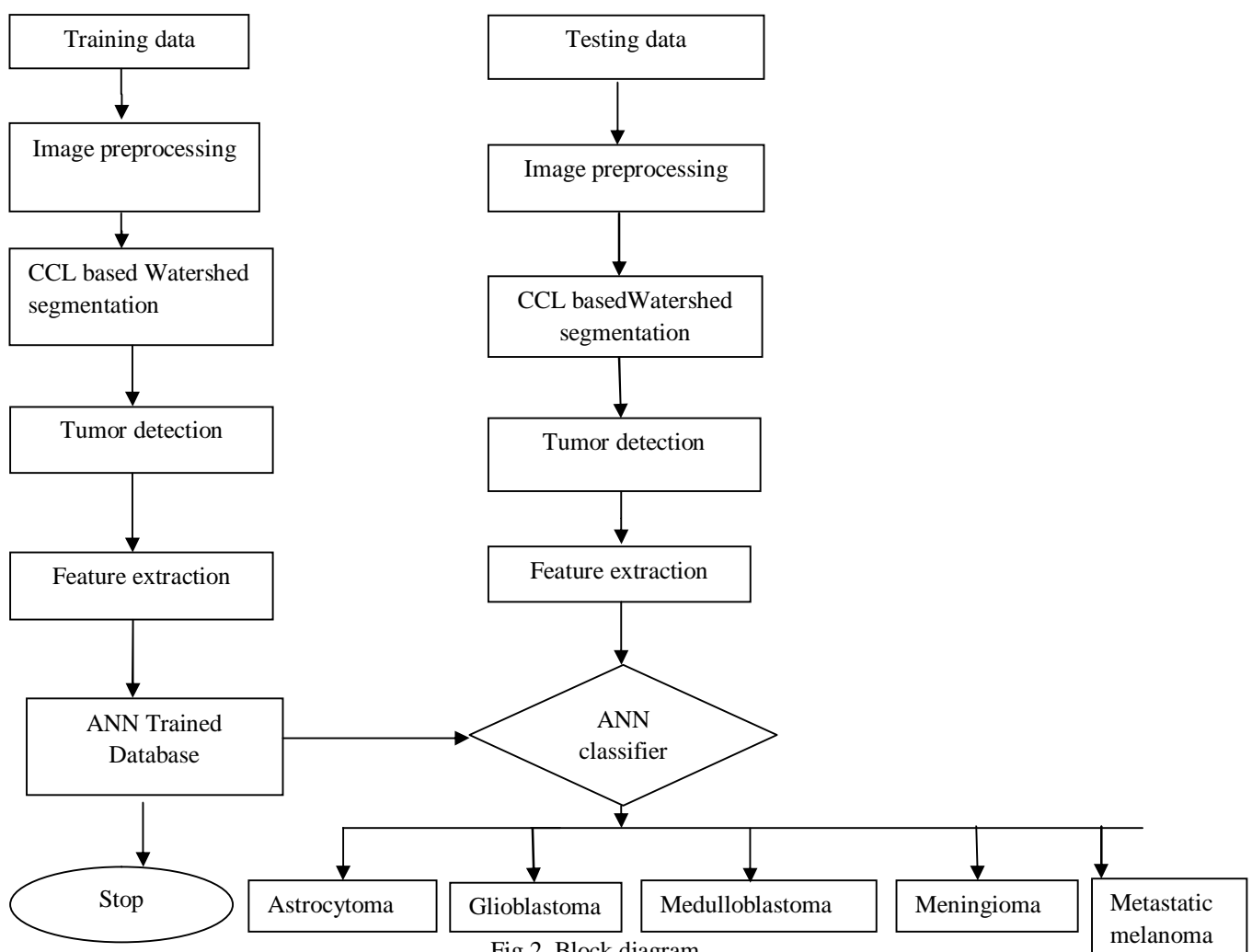


Fig 2. Block diagram

**Image Preprocessing:** is necessary that the MRI image should be processed before detection of the tumor. This includes removal of noise and sharpening the edges of the image. For this, the color image converted into gray scale image. Then the image is filtered using median filtering in order to remove the noise. After that the image is converted into binary image by thresholding. Skull stripping is performed on binary image to remove the skull region.

**Watershed Segmentation:** Watershed segmentation[1] process consists of two catchment basins which are separated by a ridge line. If water is falling on the surface, the water will get collected in catchment basins. The image is converted into another image whose catchment basins are the objects or regions we want to identify.

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CCL (Connected Component Labeling) groups pixels of image into connected components. The connected components have the same pixel intensity value. Regions of adjacent pixels which have the same intensity values are grouped. Therefore, by using water segmentation the tumor region is detected.

**ANN Classifier:** ANN (Artificial Neural Network) is used to classify five types of tumor, Astrocytoma, Meningioma, Glioblastoma, Metastatic melanoma and Medulloblastoma. ANN is a network consisting of nodes. It has an input layer, hidden layer and an output layer. ANN algorithm works on training phase and testing phase.

Different features extracted from the tumor image are used in the training phase[7]. It includes mean, Standard deviation, area and boundary region of tumor. Intensity variations in the image are obtained as the mean and standard deviation. Extracted features are used for training of ANN. The multiplying weighting factor between input node and output node is changed during training phase. After training phase this weight is fixed and then testing can be done. In testing phase ANN's are used to classify unknown input images and it results the type of tumor.

## V. EXPERIMENTAL RESULT

In this study tumor portion is detected using watershed segmentation and five types of brain tumor classified based on the grade defined by WHO. The whole simulation carried out in MATLAB platform.

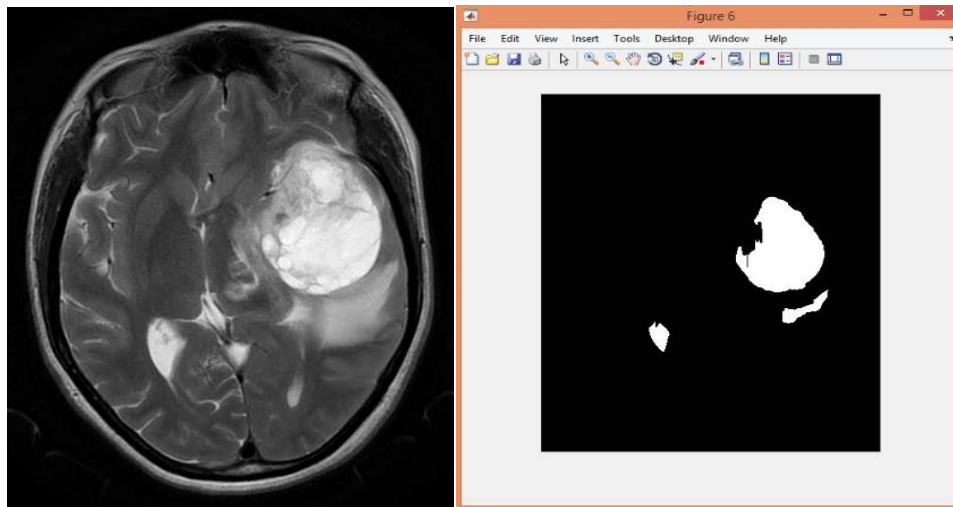


Fig.3 (a) Test image (b) Detected Tumor using watershed segmentation

Workspace	
Name	Value
a	8.4958e+03

Fig.4 area of tumor shown in no of pixel

Fig 3 (a) shows the test image and fig 3 (b) shows detected tumor portion from the test image. fig (4) shows area of detected tumor portion which is shown in fig 3 (b) image. It is shown in number of pixels.

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The main features for classification of tumor are intensity and position of tumor. Considering these features classified the five types of tumors.

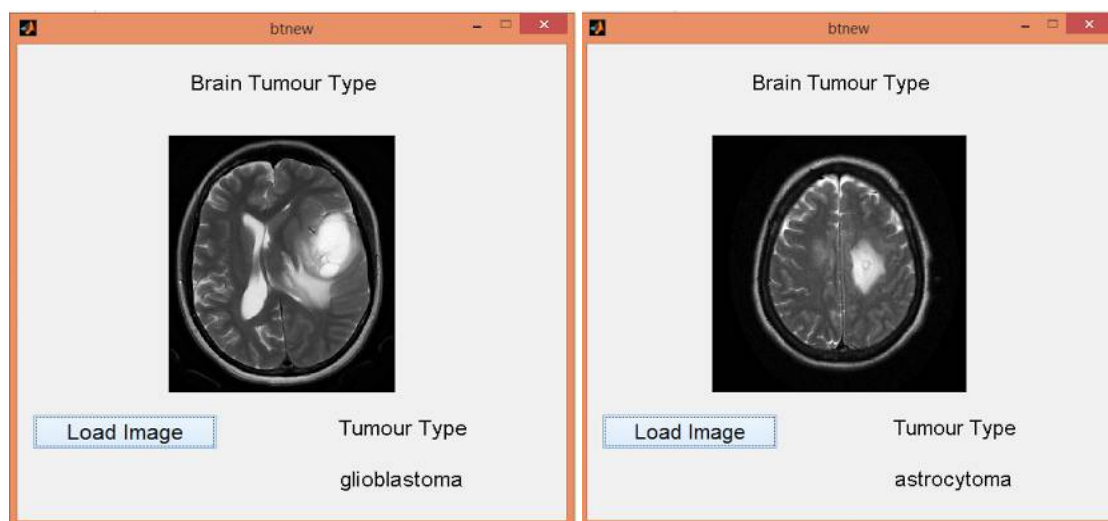


Fig 5. Simulation results for different types of tumor (a) Glioblastoma (b) Astrocytoma

The fig 5 shows correct simulation result for glioblastoma and astrocytoma type tumor. We have to load the image. It is done by pressing on the load image button thus we get the tumor type. Glioblastoma is an intra-axial lesion.

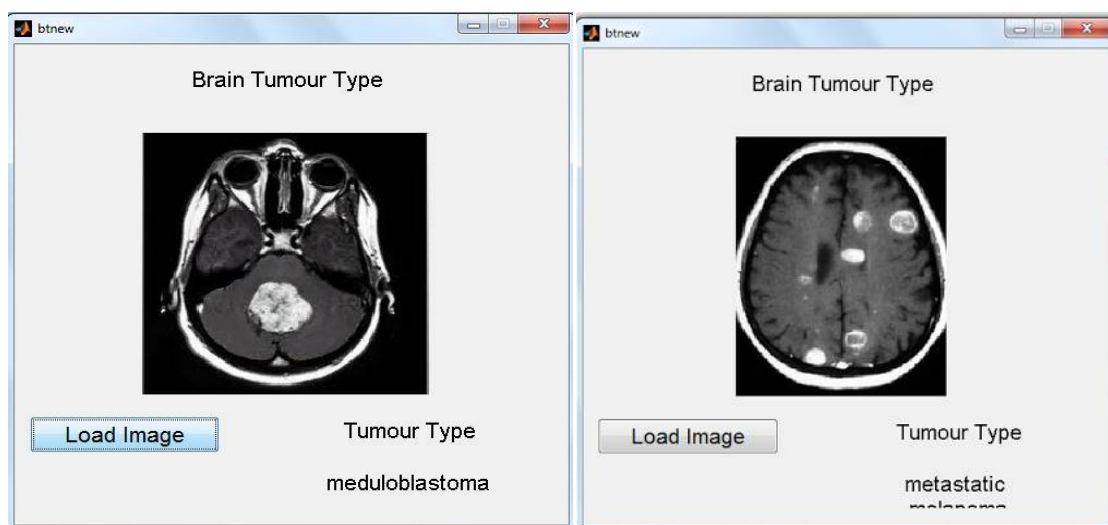


Fig 6. Simulation results for different types of tumor (a) Medulloblastoma (b) Metastatic melanoma

Medulloblastoma is an intra ventricular lesion whereas metastatic melanoma has multiple tumor regions. So it shows multiple variations in intensity.

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Vol. 6, Issue 4, April 2017

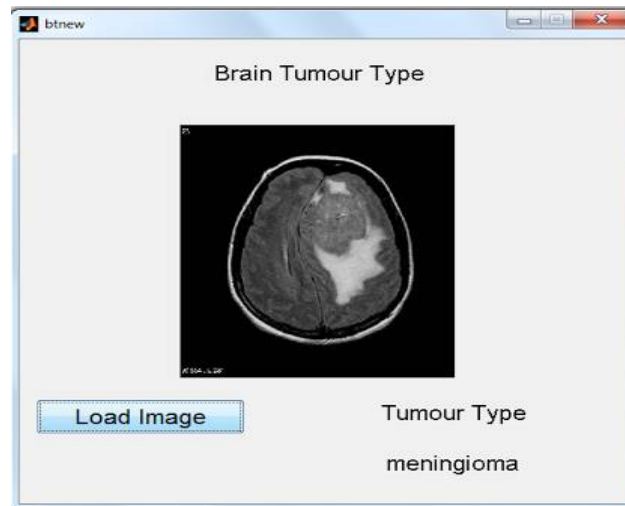


Fig 7. Simulation results tumor Meningioma

In fig 7 meningioma tumor is detected. It is an extra axial lesion.

Images for different type of tumor have tested in the ANN classifier. The accuracy for detecting different type of tumors is shown in table 1.1. The accuracy for each tumor is calculated in percentage using the total number of tumor images tested and the number of images which has got correct output. The accuracy can be improved by enlarging the training dataset.

Table 1.1 Tumor classification results for five types

Tumor Type	Accuracy
Glioblastoma	72.43 %
Astrocytoma	61.34 %
Medulloblastoma	67.68 %
Metastatic melanoma	60.14%
Meningioma	65.56%

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## VI. CONCLUSION

Brain tumor segmentation is effectively achieved by watershed segmentation. Area of tumor portion is also obtained. Its application to several datasets with different tumor sizes intensities and locations indicate that it can automatically detect and segment different types of brain tumors. ANN classifier automatically detect and segments different types of brain tumors, but it will give the accurate result only for large data set. The result is validated by the MRI technician.

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