

# Medical Image Processing in MATLAB

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**Abstract**— Engineers have been actively developing tools to detect tumors and to process medical images. Medical image segmentation is a powerful tool that is often used to detect tumors. Many scientists and researchers are working to develop and add more features to this tool. This paper is about detecting Brain tumors from Medical images using an interface Matlab. Brain tumor is introduced as life-threatening diseases and hence its need to detect this diseases fast and accurate. Automatic detection of tumors in medical images is motivated by the necessity of high accuracy when dealing with a human life. Also, the computer assistance is demanded in medical institutions due to the fact that it could improve the results of humans in such a domain where the false negative cases must be at a very low rate. Brain tumors can be detected manually by experts from the Magnetic Resonance Imaging (MRI) images. Magnetic Resonance Imaging (MRI) is the most advisable one since it does not use ionizing radiation and it also provides greater contrast between different soft tissues of the human body. Processing of Magnetic Resonance Imaging (MRI) images is one of the techniques to diagnose the brain tumor. This paper describes the strategy to detect and extract brain tumor from patient's MRI scan images. First it takes the pre-processing, segmentation, morphological operation, watershed segmentation and calculation of the tumor area and determination of the tumor location. The user interface of the application is developed using Matrix Laboratory (MATLAB).

**Keywords:** MRI of Brain Scans, Segmentation, Brain Tumor, MATLAB, editor, image processing, Tumors, Medical image. Morphological Operations MRI.

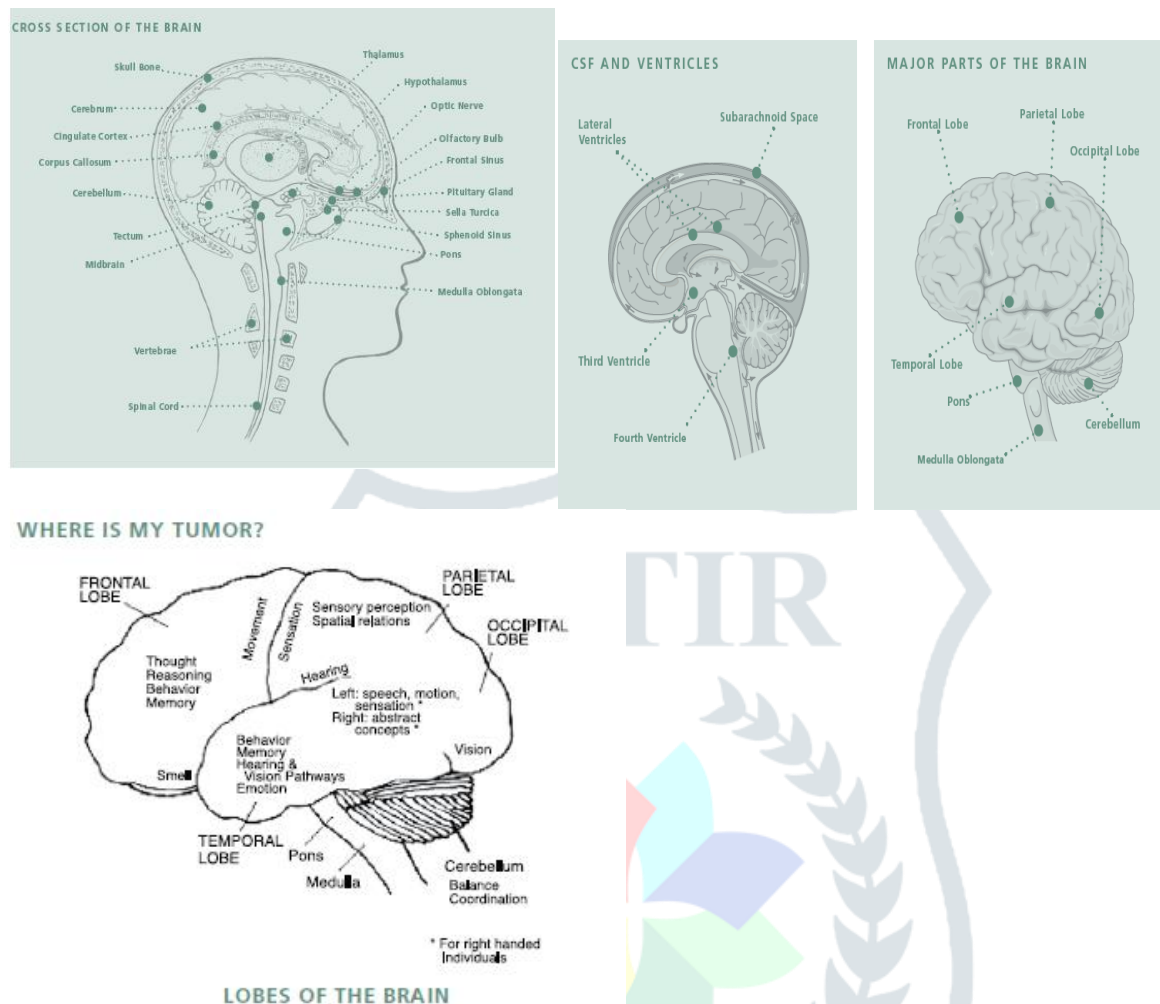
## I. INTRODUCTION

Image processing has moved into the mainstream wave, not only in the engineering world; but also to the public. Personal computers now are able to handle large amount of graphics and images with ease. The fast network system and modem transfer rate are able to transfer images just in a fraction of time. Image manipulation software becomes a general and common item on personal computers. For example, Image Processing Toolbox in MATLAB provides a comprehensive set of reference-standard algorithms and graphical tools for image processing, analysis, visualization, and algorithm development. User can perform image enhancement, image deblurring, feature detection, noise reduction, image segmentation, geometric transformations, and image registration without serious difficulties.

Brain tumor segmentation is a recent research in field of biomedical application. Image segmentation is the process of partitioning an image into different clusters. The goal of image segmentation is a domain independent decomposition of an image into distinct regions such as color, intensity, brightness, textures etc. An important step in segmentation is to extract the region of area in which we are interested in.

Brain tumor is unwanted growth of diseased/abnormal cell in brain in uncoordinated fashion. Brain Tumor rises the intracranial pressure within the skull which affect the region of white matter (WM), Gray matter (GM), Cerebrospinal fluid(CSF). Brain is the CPU of world's most complicated bio-computing machinery, which act as the center of thoughts, emotions, wisdom, communication, coordination of muscular movements from sense organ(pain, taste, sight, hear, touch) etc. The brain tumor having various symptoms like tumor size, type and location. Tumor can affect any part of brain and it affect, depending on which part it is affected.

Brain tumor is of two types either it is Benign or it is Malignant Tumor.



### • Benign Tumor:

Benign tumors are non-cancerous cells, which do not invade in surrounding healthy tissue. The growth is very slowly and the periphery or edge of benign tumor can be clearly visualized. Benign brain tumor are sometimes life threatening when it press the sensitive region of brain.

### • Malignant Tumor:

Malignant tumors are cancerous cells, which do invade in surrounding healthy tissue and spread to other part of brain or spine. In this tumor grows very faster and more fatal than benign tumor. The edge do not clearly visualized due to penetration in nearby cells.

### ➤ Diagnosis

#### MAKING A DIAGNOSIS

Your doctor begins the diagnosis by taking your medical history and asking you to describe your symptoms, including how long you have had them, when they occur, the order of their appearance, if they seem to be brought on by something in particular and if they seem to be getting worse. Then your doctor will perform a basic neurological examination in the office. If the results of your neurological examination lead the doctor to suspect you have a brain tumor, a scan will be ordered or you might be referred to a neurological specialist for additional testing including scans, X-rays or laboratory tests.

### ➤ IMAGING

Imaging takes the place of conventional X-rays, which do not show tumors located behind the hard bones of the skull or spine. The most commonly used imaging methods for diagnosis and follow-up are Computerized Tomography (CT) and Magnetic Resonance Imaging (MRI).

Both CTs and MRIs use computer graphics to create an image of the brain. During a scan, an injection of a special contrast material (dye) is given to make abnormal tissue more obvious. Contrast materials are able to highlight abnormalities such as tumors because the dye concentrates in diseased tissues due to the leakiness of blood vessels in and around brain tumors.

#### ➤ CT Scan

This scan combines an X-ray device with a computer. For some types of tumors, CT images are obtained both with and without contrast enhancement to provide important additional information.

If contrast is used, it is usually injected after a few pictures are taken. The patient lies on a table that slides into a doughnut-shaped opening. The CT scanner circles the head so the X-rays penetrate the brain from many directions. Absorption of the X-rays varies with the type of tissue being scanned. Thousands of thin cross-section readings are fed into the computer, which transforms the information into a picture. The CT scan is probably the most routinely used imaging technique for diagnosis and follow-up of many tissue abnormalities. Recent studies on the radiation exposure caused during CT scans are helping doctors to redefine when a CT scan versus another type of scan is most appropriate.

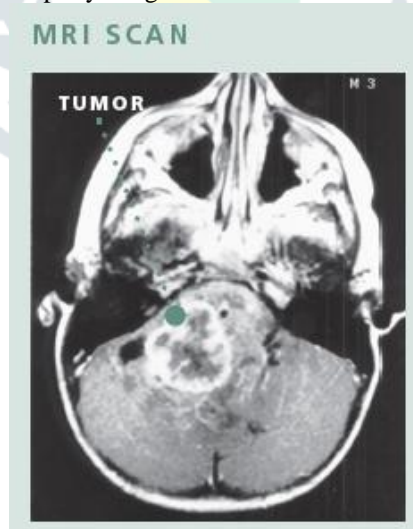
#### ➤ MRI Scan

The MRI is a tunnel-shaped piece of equipment. Some pictures are taken before the contrast injection. If contrast is used, it will be injected prior to the completion of the scan. The patient lies on a table that slides into the tunnel. Inside the scanner, a magnetic field surrounds the head and a radio frequency pulse is introduced to the area. No X-rays are used. The magnetic field causes atoms in the brain to change direction. The radio frequency pulse causes another change of direction. When the pulse stops, the atoms relax and return to their original position. During relaxation, the atoms give off energy in differing amounts and at different intervals of time. Antennas pick up these signals and feed them into a computer, which assembles a picture. Because different atoms have their own characteristic radio signals, the computer can distinguish between healthy and diseased tissue.

Patients with some cardiac monitors, pacemakers or some types of surgical clips cannot undergo MRI scanning because of the magnetic fields. For those who are claustrophobic, sedation or open MRI scanners may be an option.

There are several different types of MRIs now available. Some of these are commonly used (such as fast MRI) while others are still being developed (such as diffusion tensor imaging).

An MRI offers images with excellent anatomical detail that provides clarity of the small structures in the brain, but the images often lack quantitative or finely measurable, information. Because of this lack of very fine measurable detail, it can take a while before the effectiveness of drug therapies can be imaged. Researchers are working toward new scanning techniques that will more rapidly image treatment effects.



### III. PROBLEM FORMULATION

Imaging has become an essential component in medical research and clinical practice. A wide variety of image processing techniques have been used in medical field for image analysis. This employs a large number of visual and physiological features, a fact which usually impedes the training process.

Brain tumor detection is a serious issue in imaging science. Generally, the severity of disease decide by size and type of tumor. An important step in analysis of brain MRI scan image is to extract the boundary and region of tumor. To solve the problem, the proposed work describes the strategy for detection, segmentation and feature extraction of brain tumor part inexpensive format using MATLAB software. This software based approach aims to introduce an algorithm for detecting and segmenting the brain tumor from normal brain using basic image processing operations, segmentation, feature extraction in MATLAB.

This survey focused on identifying specific software packages; and its advantages and disadvantages of using it. On the other hand, this survey also tries to communicate with software vendors in discussing on how technological problems can be resolved. The survey is very important in order to develop the software tools to give new learners the ability to analyze biomedical data to support the discovery and advancement of biomedical knowledge.

In this study, the practice item of image processing software package was focused on Matlab application. Several imperatives were identified to be addressed by the survey:

- 1) To discover the current visualization practice in Image Processing Tools Package in Medical Imaging in MATLAB biomedical image processing techniques.
- 2) To relay current general and subject specific technological limitations. In this paper, an effective medical image processing for image processing is presented through survey result. Several aspects like the speed of the processing and ease of use are considered while the processing is being done. This is to make sure the software package does not only process the raw image for further analysis, but it is also able to manage the image data effectively and provides accurate and reliable scientific information.

#### IV. METHODOLOGY

The algorithm has three stages, first is pre processing of given MRI image second is Post - Processing third is showing the result. The algorithm starts by reading the input brain MR/CT image and converting it into grey scale image. There are three major steps in the approach. The first step is image pre-processing, the second step is post-processing. Fig. 1 shows the steps included in system for brain tumour detection using threshold & watershed segmentation.

The part of the image containing the tumor normally has more intensity then the other portion and we can assume the area, shape and radius of the tumor in the image. We have used these basic conditions to detect tumor in our code and the code goes through the following steps:

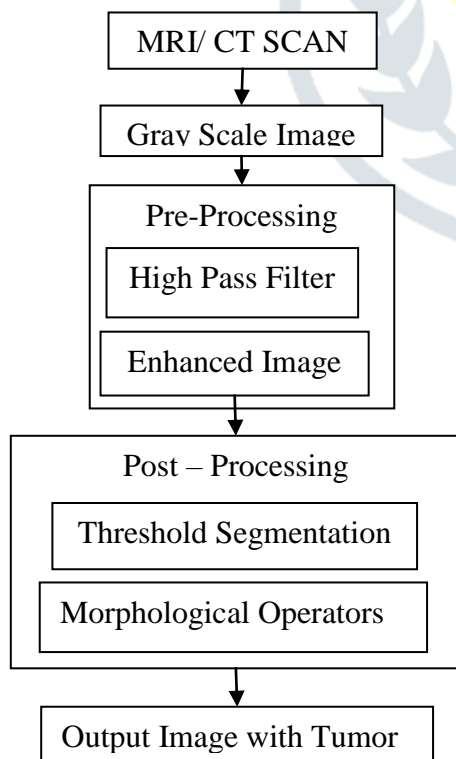


Fig. 1. Block Diagram for Brain Tumour Extraction



- Taking an MRI image as an input
- Convert it to gray scale image and obtain the maximum intensity.
- Adjusting the MRI image using the max intensity level in order to avoid excess data.
- Detecting the boundary of head cross section by converting MRI image to binary image.
- Calculating the area of the head cross section
- Detecting the boundary of head cross section after converting the adjusted image to binary image.
- Eliminating the boundary and detecting the tumor affected region
- Showing the performance parameter of tumor affected image and normal image
- Calculating the area of tumor.

The program is created in MATLAB which accepts the MRI image in file format and converts it in data format using the functions `uigetfile()` and `imread()`.

### 2.1 Grayscale Conversion

Red, Green, Blue provides computational complexities and still does not provide guaranteed better results. Therefore Grayscale images are preferred in image pre-processing. The conversion of a RGB to grayscale image is done by using the function `rgb2gray (image)`.

#### • Image Pre-processing

In this phase image is enhanced in the way that finer details are improved and noise is removed from the image. The first step is to get the MRI image and application of pre-processing steps. There are various methods which come under this step, we will be dealing with only grey scale and filters. Basically preprocessing is done to remove noise and blurring as well as ringing effect in order to get the enhanced and much clear image for our purpose. The filter which we have used is high pass filter but as we are working on image samples that are required for the medical purpose. The high pass filter has to be passed with mask for better image.

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### 2.2 Preprocessing of Grayscale Image

Pre-processing of MRI images is the primary step in image analysis which performs image enhancement and noise reduction techniques to enhance the image quality. The accuracy and convergence rate of such techniques must be significantly high in order to ensure the success of the subsequent steps. In this work, the importance of such approaches is highlighted in the context of Magnetic Resonance (MR) brain image classification and segmentation. In this work, suitable pre-processing techniques are developed to remove the skull portion surrounding the brain tissues. The experimental results are analysed in terms of segmentation efficiency for pre- processing and distance measure for feature extraction techniques. For the pre-processing high pass filter is are use.

**2.3 Image Segmentation** After pre-processing segmentation is applied to partition the image into multiple segments (sets of pixels, also known as super pixels) to simplify the representation of an image into something that is more meaningful and easier to analyse. Image segmentations typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics.

**2.3.1 Threshold Segmentation** Thresholding method replace each pixel in an image with a black pixel if the image intensity  $I(i,j)$  is less than some fixed constant  $T$  (i.e.  $I(i,j) < T$ ), or a white pixel if the image intensity is greater than that constant. Hence this method is based on a clip level (threshold value) to turn a gray-scale image into binary image.

**2.3.2 Morphological Operation** Morphological technique is used to probe an image with a small shape or template called a structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighbourhood of pixels. Some operations test whether the element "fits" within the neighbourhood, while others test whether it "hits" or intersects the neighbourhood. It is the collection of nonlinear operations related to the shape or morphology of features in an image.

### 2.3.3 Watershed Segmentation

Watershed segmentation is a gradient-based segmentation technique. It considers the gradient map of the image as a relief map. It segments the image as a dam. The segmented regions are called catchment basins. Watershed

segmentation solves a variety of image segmentation problem. It is suitable for the images that have higher intensity value. Watershed segmentation is caused over segmentation. To control over segmentation, marker controlled watershed segmentation is used. Next unit calculates the area of the tumor region and locates the centre in the form of rows and columns. The area is specified in pixels. Furthermore with the help of this information the tumor location in terms of brain terminology can be specified. Mainly if the sagittal plane is considered, the location of tumor in the brain can be specified more easily. After all the operations the extracted tumour would be shown in output axes of UI. In output image tumour will be shown in terms of watershed ridges. The watershed segmentation takes random color in the background and in the tumor to separate them.

a) Taking an MRI image as an input

To read an image for processing we have used the 'imread' command. The example reads one of the sample images '[filename,pathname] = uigetfile({'\*.bmp';\*.tif';\*.gif';\*.png'},'Pick an Image File');' and stores it in an array named I.

```
I = imread([pathname,filename]);
```

If the file (sample image) is not in the current folder, then the full path with the filename will have to specify. The text string '\*.bmp';\*.tif';\*.gif';\*.png' specifies the format of the file by its standard file extension. For example, 'gif' is specified for Graphics Interchange Format files., The 'informat' function can be used to see a list of supported formats, with their file extensions. If imread cannot find a file named 'filename', it looks for a file named 'filename.fmt'.

b) Convert it to gray scale image and obtain the maximum intensity

Using 'rgb2gray' command in MATLAB MRI Images is converted into gray scale image.

```
gray = rgb2gray(I)
```

'rgb' means Red, Green and Blue. The brightness level for this color is represented in decimal from 0 to 255 or binary from 00000000 to 11111111. In grayscale image black color is represented by R=G=B=00000000 and white color is represented by R=G=B=11111111. This image processing technique is called 8-bit gray scaling.

c) Adjusting the MRI image using the max intensity level in order to avoid excess data

In order to adjust (eliminate excess data) the gray scaled image we have used the built-in function imadjust:

```
K1 = imadjust(J,[0.55 0.8],[,]);
```

Which actually adjust the intensity values in grayscale image J to new values in k1 such that 1% of data is saturated at low and high intensities of J. This increases the contrast of the output image k1.

d) Converting MRI Image to binary image in order to detect the boundary

```
img = im2bw(I, level);
```

Converting the adjusted grayscale image to a binary image the output image `img` replaces all pixels in the input image with luminance greater than level with the value 1 (white) and replaces all other pixels with the value 0 (black). Specifying level in the range [0, 1], regardless of the class of the input image. The function 'graythresh' can be used to compute the 'level' argument automatically. Specifying level= 5 for the function `im2bw`. To use this interactive syntax, `img` must be a 2-D image.

#### e) Algorithm -: K-Means Clustering

**Iterative K-Means Clustering** The K-means algorithm is a simple, iterative hill-climbing method. It can be expressed as follows.

Form K-means clusters from a set of n-dimensional vectors.

1. Set `ic` (iteration count) to 1.
2. Choose randomly a set of K means `m1(1);m2(1); : : : ; mK(1)`.
3. For each vector `xi` compute `D(xi;mk(ic))` for each `k = 1; : : : ;K` and assign `xi` to the cluster `Cj` with the nearest mean.
4. Increment `ic` by 1 and update the means to get a new set `m1(ic);m2(ic); : : : ;mK(ic)`.
5. Repeat steps 3 and 4 until `Ck(ic) = Ck(ic + 1)` for all `k`.

#### Algorithm -: K-Means Clustering

##### i) Calculating tumor affected area

Using 'max' command in MATLAB largest elements along different dimensions of an array of a tumor is calculated. A loop is used for calculating the area of tumor cross-section.

```
for i = 1: kk
```

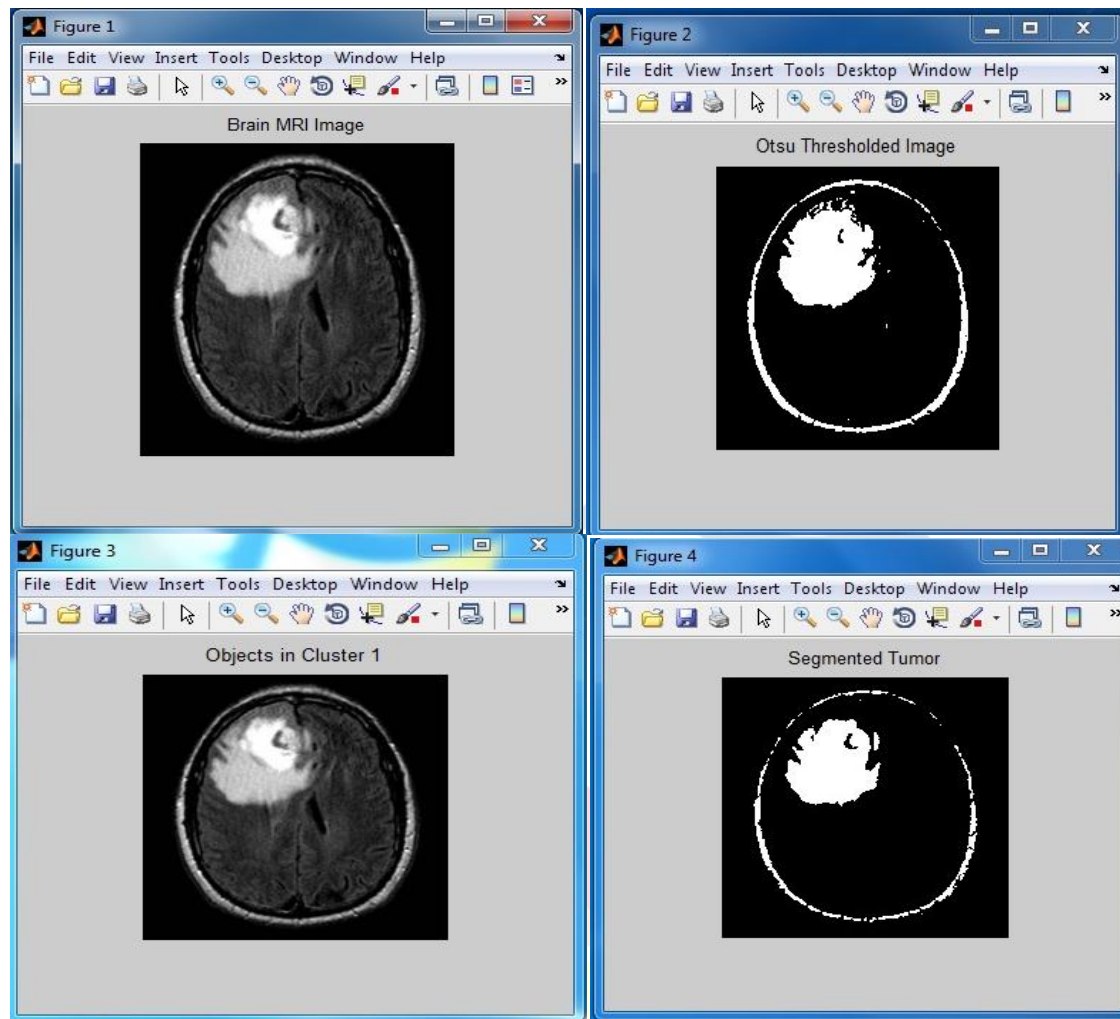
```
tumor_area=tumor_area+stats(i).Area ;
```

```
end
```

'for' command executes block of code specified number of times and 'end' command terminate block of code, or indicate last array index.

### III. Result and Discussion

Next figures show the images as an output. i.e. grayscale image, high pass filtered image , threshold image, watershed segmented image, Finally input image and extracted tumour from MRI image. For this purpose real time patient data is taken for analysis. As tumour in MRI image have an intensity more than that of its background so it become very easy locate it and extract it from a MRI image. Following is the first MRI image which the input to this programme.



**Watershed Algorithm (Performance Table)**

Sr. No.	Image	Area	radius	perimeter	MSE	PSNR	Execution Time
1	img1.jpg	59086	138.31	867.27	8.68	29.15	5.42
2	img2.jpg	192156	240.79	1512.95	8.36	29.08	3.56
3	img3.jpg	64750	154.25	999.19	8.76	29.17	2.00
4	img4.jpg	46628	118.51	744.66	6.55	31.97	1.59
5	img5.jpg	45700	170.72	758.56	8.56	29.94	1.76
6	img6.png	146968	218.34	1371.87	3.52	37.24	2.35
7	img7.jpg	50235	126.45	794.52	8.86	29.30	2.22
8	img8.jpg	36490	141.76	752.21	8.55	29.63	1.55
9	img9.jpg	501648	126.64	765.73	8.46	29.60	2.34

**k-means clustering algorithm (Performance Table)**

Sr. No.	Image	Area	radius	perimeter	MSE	PSNR	Execution Time
1	img1.jpg	56494	135.83	853.46	8.81	29.23	5.66
2	img2.jpg	181076	240.07	1508.46	8.96	29.08	2.90
3	img3.jpg	73237	152.82	960.25	8.86	29.17	2.65
4	img4.jpg	42820	116.74	733.54	6.42	31.97	3.01



5	img5.jpg	45361	120.16	754.99	8.11	29.04	2.29
6	img6.png	146815	217.55	1466.95	3.50	37.24	2.75
7	img7.jpg	49474	125.49	788.48	8.73	29.36	2.34
8	img8.jpg	37649	109.61	688.74	8.43	29.30	2.29
9	img9.jpg	54907	126.27	793.43	8.43	29.60	2.43

These tables show the results obtained by the proposed algorithms watershed algorithm and k-means clustering algorithm. These algorithms are implemented on different images taken from the laboratory for our research work. Calculation of area, radius, perimeter, mse, psnr and time taken is shown.

#### IV. CONCLUSION

Brain tumor is one of the mainly life-threatening diseases and hence its detection should be fast and accurate. MRI images are very important for detecting the existence and outlines of tumors. In this paper, a brain tumour MRI image is applied to pre-processing and after that tumour is extracted by morphological and watershed segmentation processes. The medical image segmentation has difficulties in segmenting complex structure with uneven shape, size, and properties. In such condition it is better to use unsupervised methods such as edge detection algorithm. For accurate diagnosis of tumor patients, appropriate segmentation method is required to be used for MRI images to carry out an improved diagnosis and treatment. The brain tumor detection is a great help for the physicians and a boon for the medical imaging and industries working on the production of MRI imaging. For detecting the survival and outlines of tumors from the brain tissue in the magnetic resonance imaging (MRI) is very important, therefore combination of both modified texture based region growing and segmentation is used for detection of brain tumor.

#### V. FUTURE SCOPE

In near future, a database can be created for different patients having different types of brain tumours and locate them. Tumour growth can be analysed by plotting graph which can be obtained by studying sequential images of tumour affect. Possible extension of the presented work could use more features. It would be beneficial to connect the system to cloud storage of patient's information in hospital. This application can be extended to accessibility and usability through mobile phones. If this application is developed to analyse all types of MRI scans of same patient and result of all scans are integrated, it can suggest appropriate treatment and medication as well.

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