Vellore Institute of Technology

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FALL SEMESTER 2021-22

CSE4019 Image Processing

Project Component – Review 1 Document

BRAIN TUMOR DETECTION

Using Digital Image processing

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INDEX

BRAIN TUMOR DETECTION

USING DIGITAL IMAGE PROCESSING

ABSTRACT

Biomedical Image Processing is a growing and demanding field. The primary goal of medical imaging is to extract meaningful and accurate information from these images with the least error possible. Tumor Segmentation includes the use of several different techniques. The whole process of detecting brain Tumor from an MRI can be classified into four different categories: Pre-Processing, Segmentation, Optimization and Feature Extraction.

So We have done thorough work on the topic 'Using Image processing methods to detect 'Brain tumour'. It is responsible for nearly one million deaths each year Therefore the accurate detection of brain tumour in blood is important aspects in the medical field. We have done a thorough study of all the 10 research papers, compared them based on their methods, matrix, etc. We identified that the main challenge was the accuracy. So we aim to develop an image processing based efficient system for a quick and accurate detection of Brain tumour based on the information gained from the analysis on morphology and colour based pixel discrimination technique.

INTRODUCTION

This project proposes two different methodologies to segment a tumor from an MRI image and determine the type of tumor. For this one segmentation and one clustering techniques have been implemented. Each MRI image is passed through an imaging chain where the image is preprocessed to remove noise and is further enhanced to improve the contrast of the image.

This paper proposes two different techniques which are then applied on the image to extract the tumor. These segmentation techniques include SOM Clustering and SVM Classification. Applying each of the segmentation techniques allows us to determine the most appropriate method to segment the tumor from each of the images. The tumor region represents the pixel values for the foreground points extracted using the ginput() command from a texture image. The texture image is generated by applying the rangefilt() method.

In order to enhance the texture characteristics of the image, smoothing filter is applied to the texture image. In this project, the major challenge faced was to locate and extract the proper tumor region from the image. Due to several lighting issues, unnecessary white portions were present in the image which could wrongly be segmented as a tumor. Also the unwanted noise and reduced contrast displays several regions from the image that are falsely claimed as a tumor. Another challenge faced was degraded quality of the MRI image due to several problems that would have occurred during the acquisition stage.

KEYWORDS:

Image Segmentation, Support Vector Machine, Self-Organized Mapping, MRI, MATLAB :-

- Literature survey

- Problem definition
- Software architecture diagram
- Work plan
- MATLAB code and output
- conclusion

LITERATURE SURVEY:

In Medical diagnosis, robustness and accuracy of the prediction algorithms are very important, because the result is crucial for treatment of patients. There are many popular classification and clustering algorithms used for prediction. The goal of clustering a medical image is to simplify the representation of an image into a meaningful image and make it easier to analyse. Several Clustering and Classification algorithms are aimed at enhancing the prediction accuracy of diagnosis process in detecting abnormalities

LINK

https://vitacin-my.sharepoint.com/:x:/g/personal/lakshya_vaswani2020_vitstudent_ac_in/EcHscT62ocNNop_x1PvS4vwBgGhZ-2-NsBn6-SGTI7ASrw?e=taxGB0

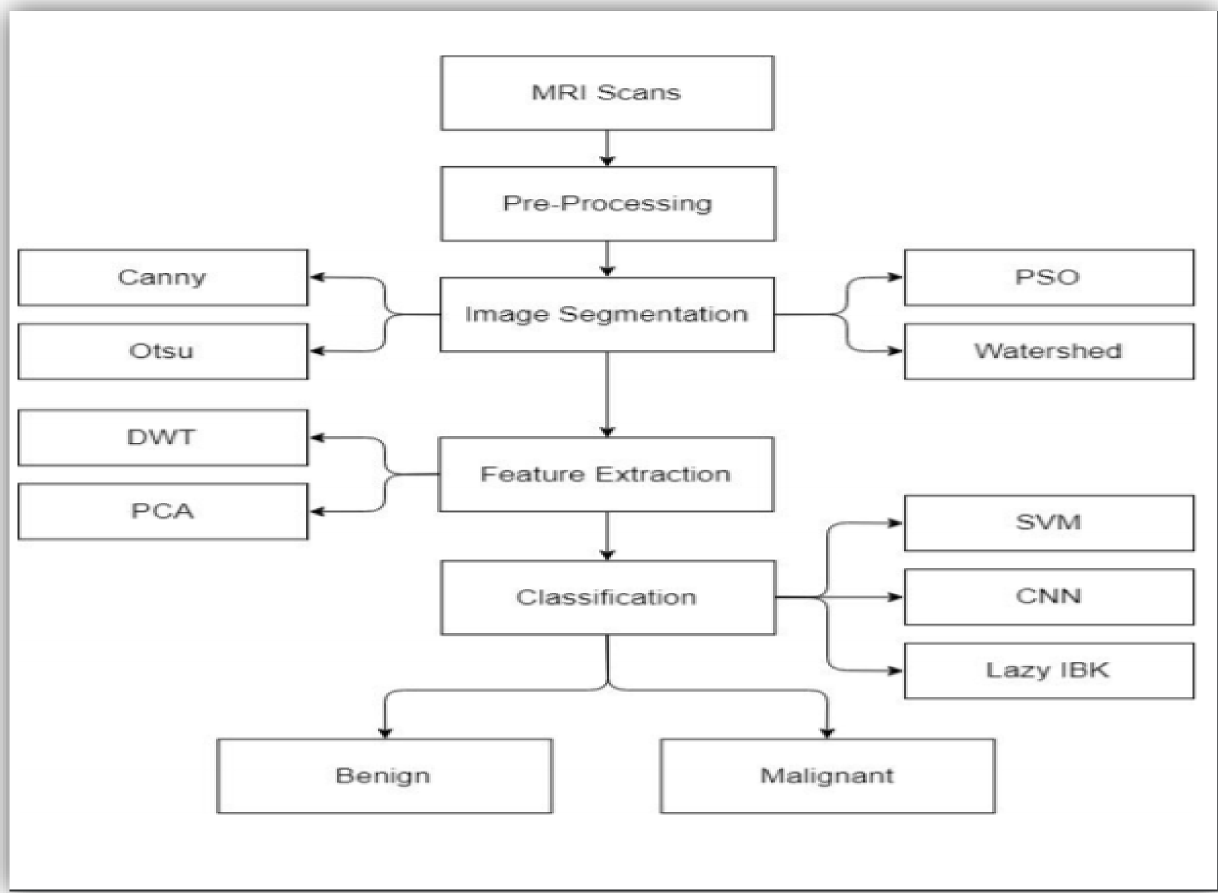
PROBLEM DEFINITION

Our study deals with automated brain tumor detection and classification. Normally the anatomy of the brain is analysed by MRI scans or CT scans. Our system aims to detect the tumor from the given MRI scan and also finds the accuracy for different segmentation techniques.

OVERVIEW:

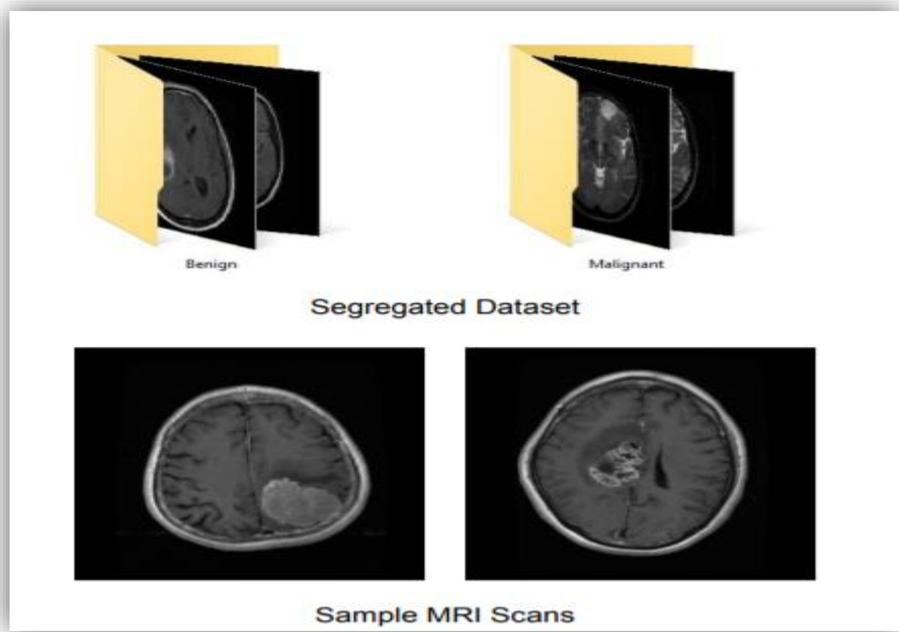
MODULES	CONTENTS
MODULE-1	RGB conversion
MODULE-2	Bit plane slicing
MODULE-4	FEATURE EXTRACTION • DWT • PCA
MODULE-6	Segmentation • OTSU • Watershed • Canny • PSO Morphological operation • Erosion • Dilation
OTHER TOPICS	• SVM • CNN • LAZY IBK

Software Architecture Diagram



MRI Scans
Pre-Processing
Image Segmentation
Canny
Otsu
PSO
Watershed
Feature Extraction
DWT
PCA
Classification
SVM
CNN
Lazy IBK
Benign
Malignant

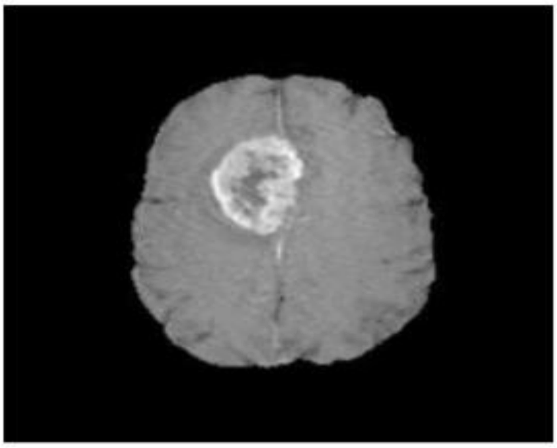
MRI SCANS:



Benign
Malignant
Segregated Dataset
Sample MRI Scans

MRI scans of brain are taken as the input for all training and testing purposes. The images are Grayscale and are resized to 256x256 px for processing. It is assumed that all the images given input to the system are either Benign (Non-cancerous) or Malignant (Cancerous). The images are separated into two labelled folders for training and testing purpose only.

SEGMENTATION:



Original MRI Scan

Segmented Tumor Image

Segmentation is the most crucial step in identification of Tumor. This step extracts the tumor from the MRI scans which is then sent for extracting features.

Following are the segmentation algorithms that have been implemented:

1. Canny Algorithm
2. Otsu Algorithm
3. Watershed Algorithm
4. PSO Algorithm

➢ Canny Algorithm:

Edge detection is the approach used most frequently for segmenting images based on abrupt change in intensity. The canny edge operator works in a multi stage process. Canny algorithm is capable of yielding a totally unbroken edge for the posterior boundary of the brain.

➢ Otsu Algorithm:

Otsu's thresholding is a non - linear operation that converts a grayscale image into a binary image where the two levels are assigned to pixel those that are below or above the specified threshold value. The algorithm assumes that the image contains two classes of pixels following bi-modal histogram:

- Foreground pixels
- Background pixels

It then calculates the optimum threshold separating the two classes so that their combined spread (intra-class variance) is minimal and inter-class variance is maximal.

➢ Watershed Algorithm:

Watershed segmentation is a gradient - based segmentation technique. It assumes that any grayscale image can be viewed as a topographic surface where:

- High intensity denotes peaks and hills
- Low intensity denotes valleys

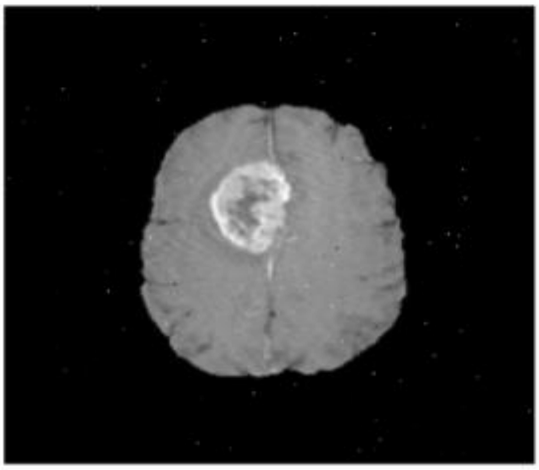
It is suitable for the images that have higher intensity value. This approach may give over-segmented result due to noise or any other irregularities in the image.

➢ Particle Swarm Optimization (PSO) Algorithm :

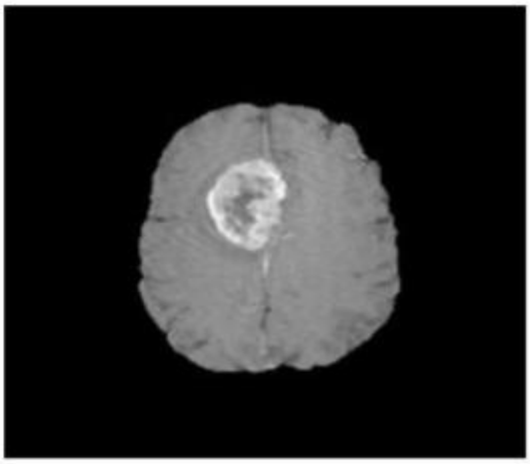
Particle Swarm Optimization (PSO) algorithm is based on swarm intelligence. All particles have a fitness value evaluated by a fitness function and a velocity data that orients their fights.

PSO algorithm starts with a group of random generated solutions (particles) and optimal solution is investigated iteratively. Out of the 4 segmentation algorithms used, PSO gives the best segmentation results.

PRE-PROCESSING:



Before Pre-processing with Noise



After Pre-processing without Noise

Median filtering is a common image enhancement technique for removing salt and pepper noise. Weighted median filtering technique gives better results compared to median filter, adaptive filter and spatial filter.

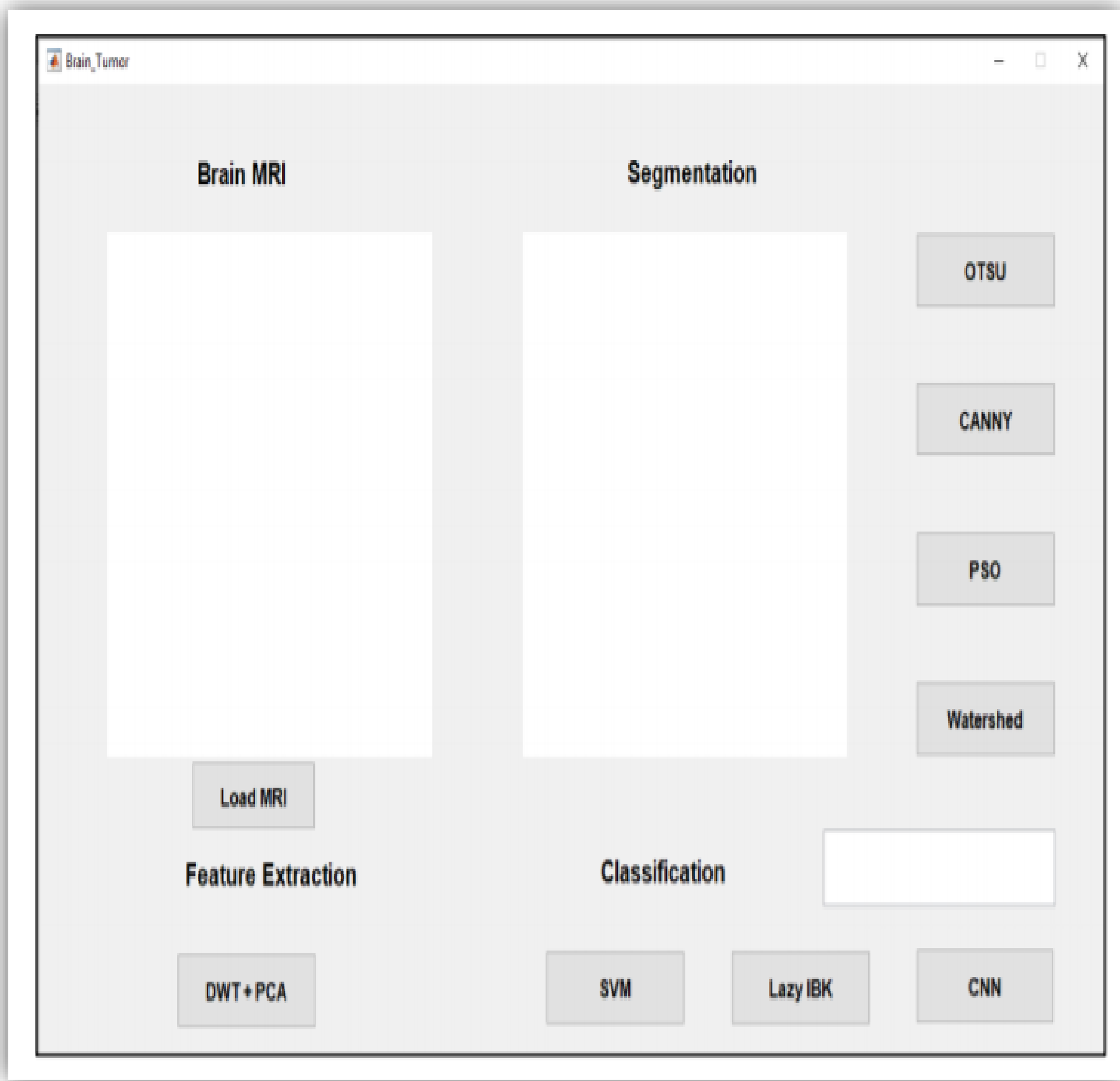
Gaussian filter is also used to smooth the image and get rid of noise.

The MRI scanning machines are very precise with almost no noise in the images.

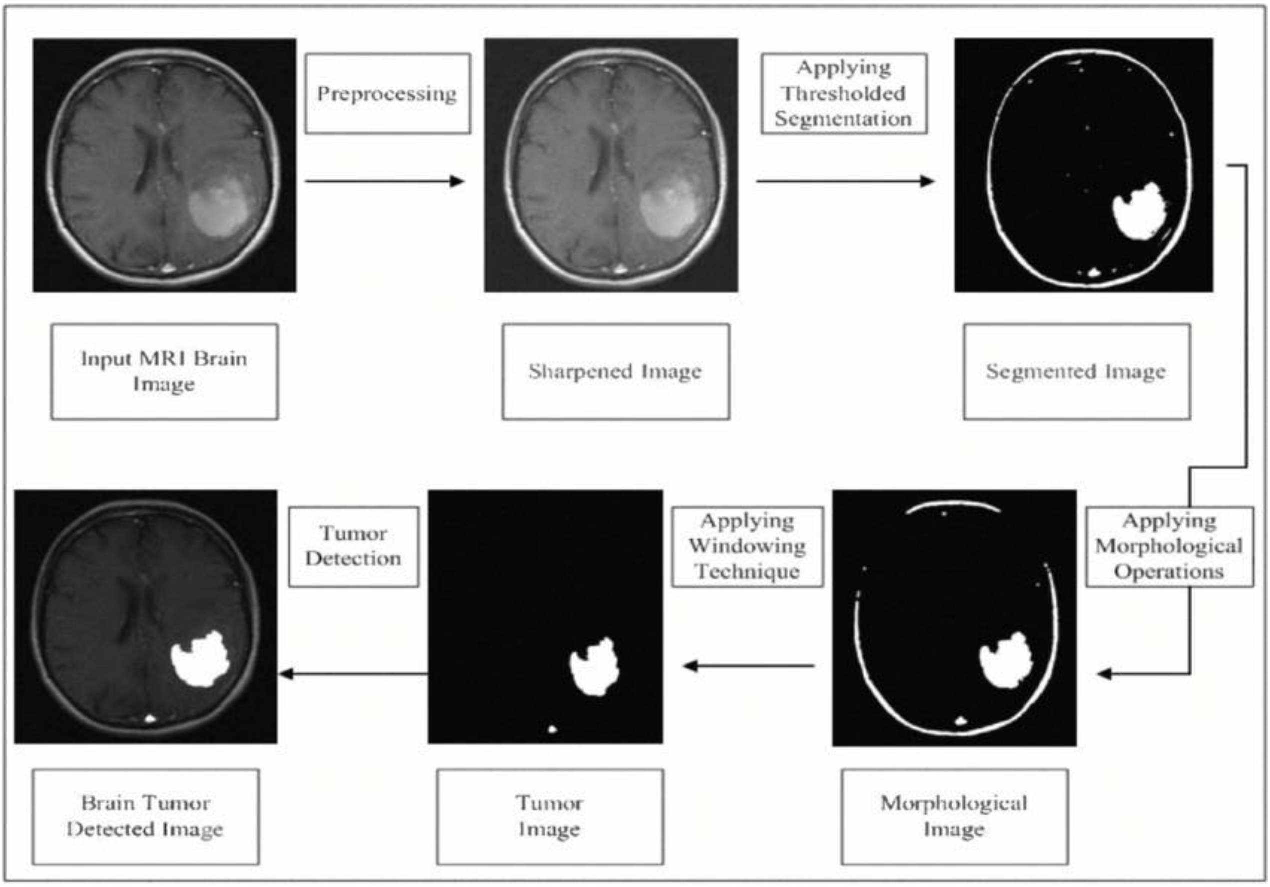
Database Requirements:

The database will contain the predicted data and the actual perceived data, as a percept sequence. The database consist of MRI brain scans taken as input data, that are loaded to the system for training and classification, which are updated itself every time the patient database increases. Only the physician and neurosurgeons will have access rights to modify this database so that sensitive information does not leak.

USER INTERFACE:

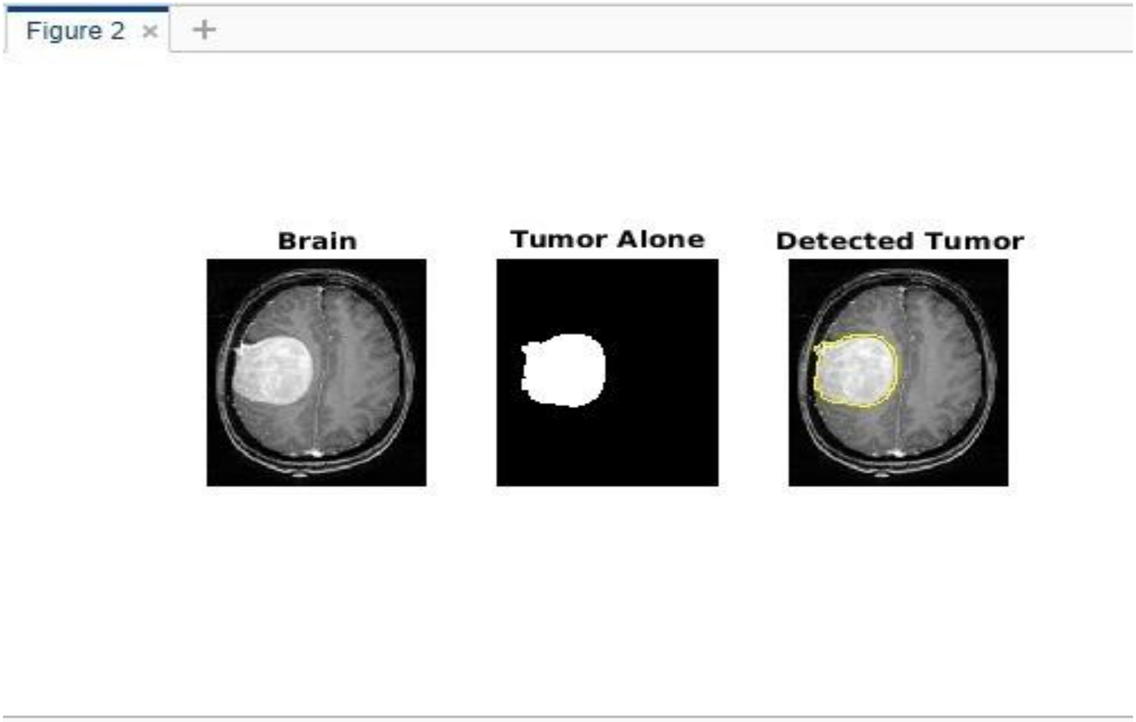


PROCESSES INVOLVED FOR REQUIRED OUTPUT



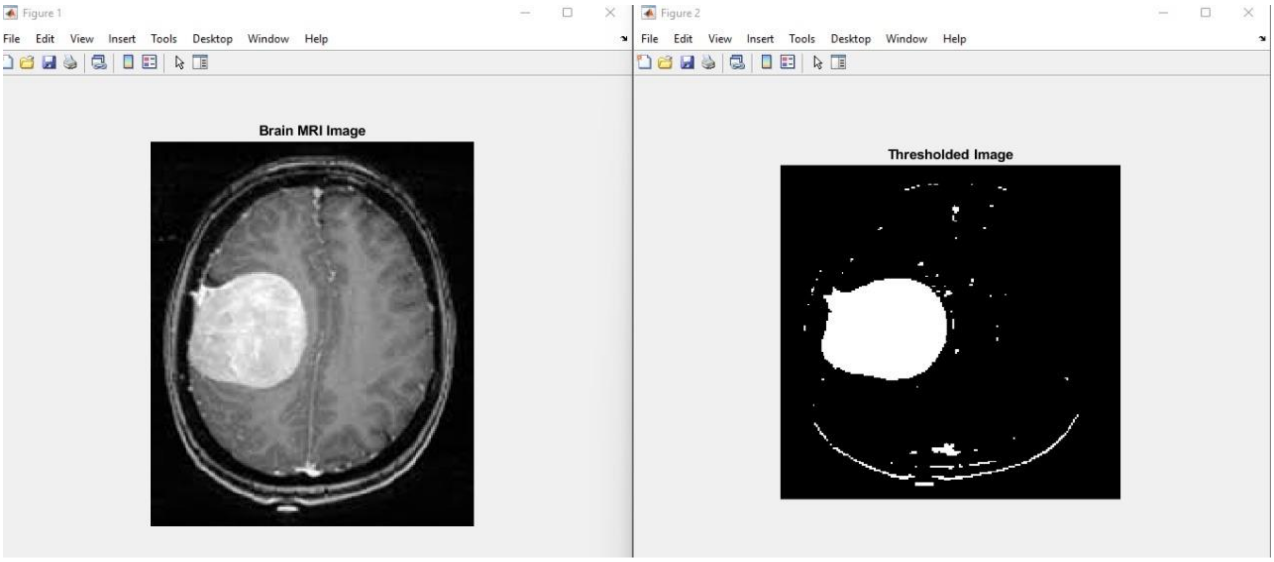
OUTPUTS

When only Tumor is to be Detected.

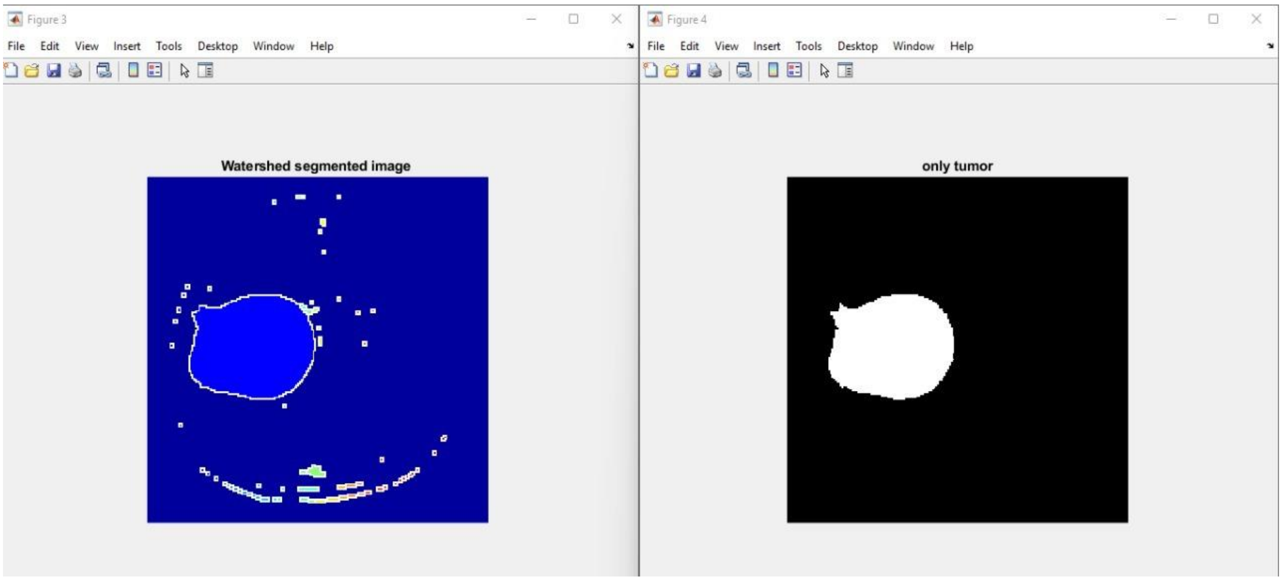


USING 4 DIFFERENT PROCESS

INPUT AND THRESHOLD IMAGE

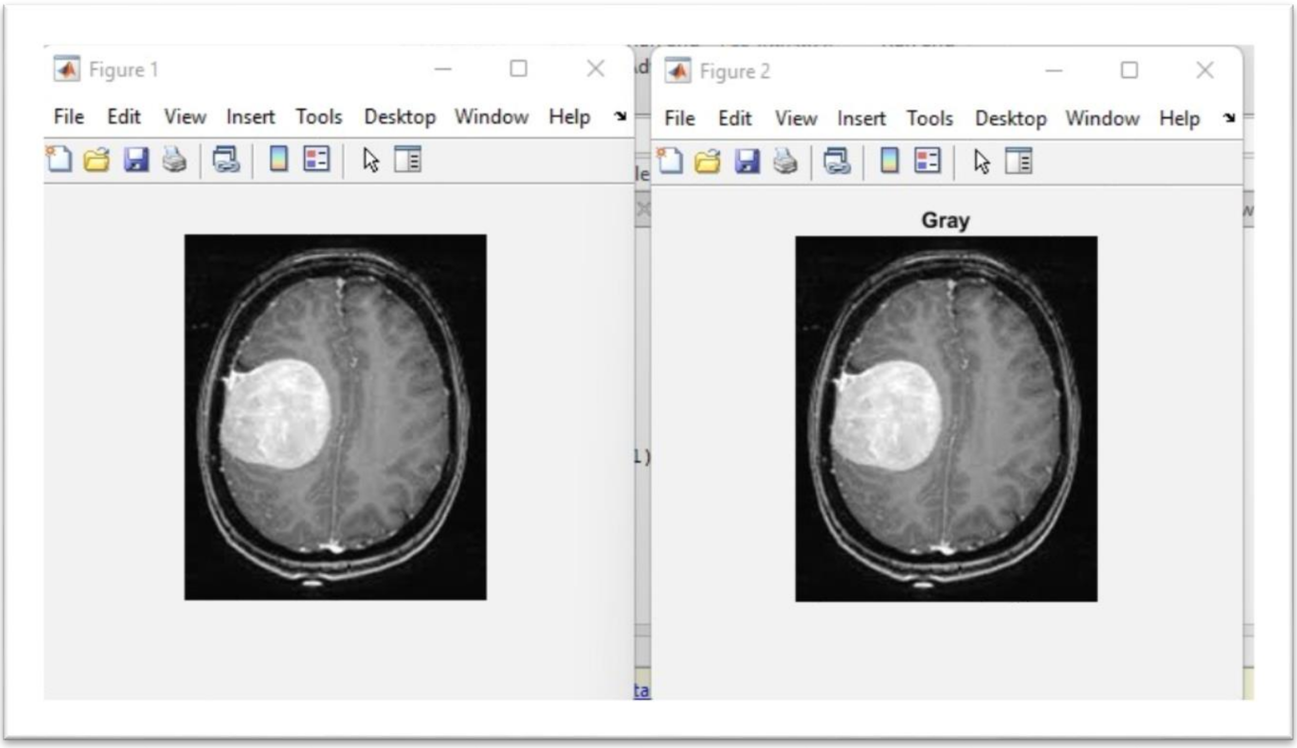


WATERSHED AND ONLY TUMOR PART

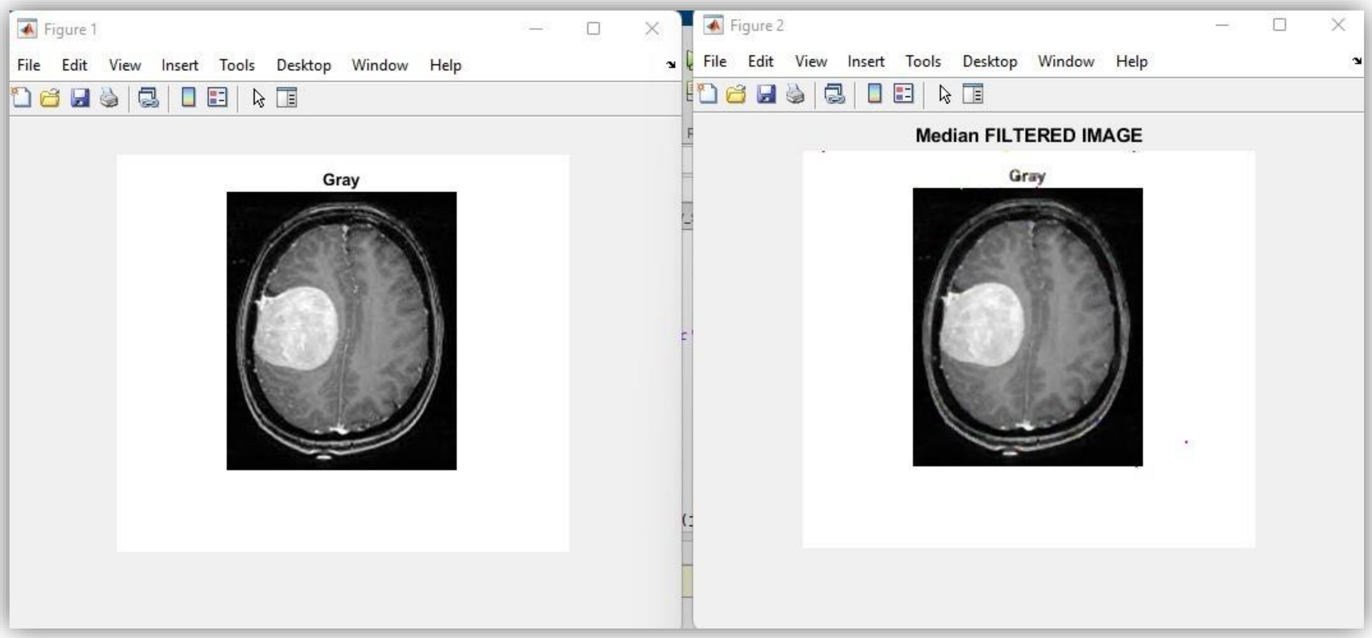


USING SEVERAL PROCESSES

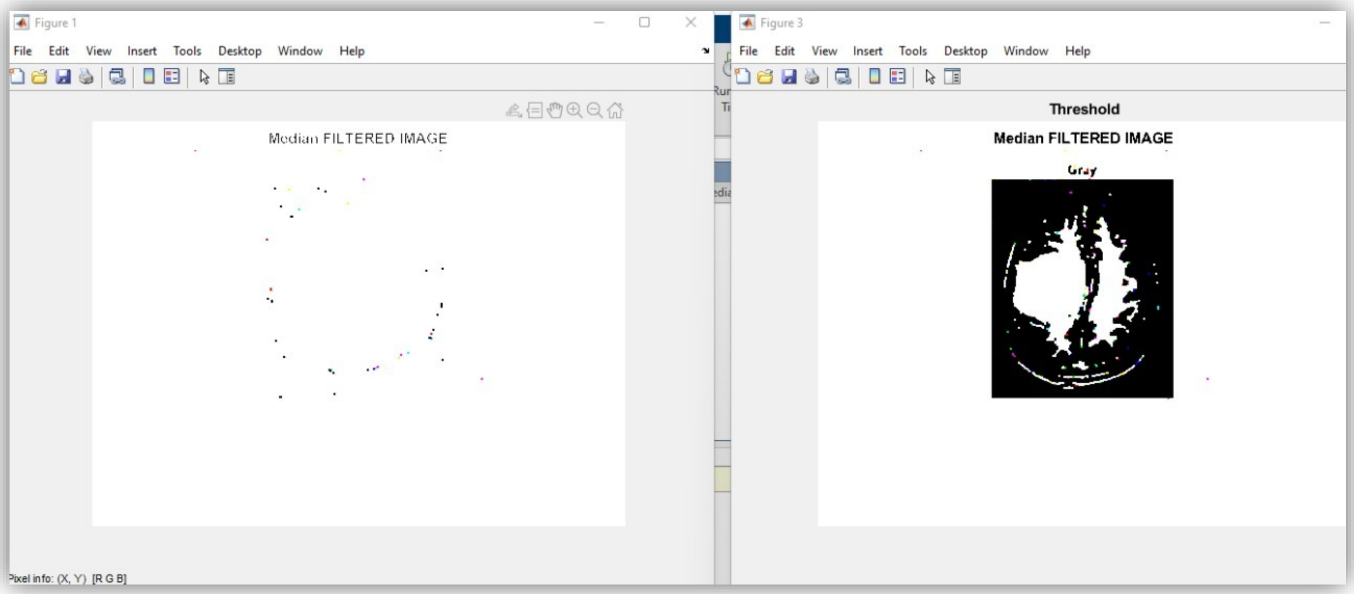
MRI AND GRAY IMAGE



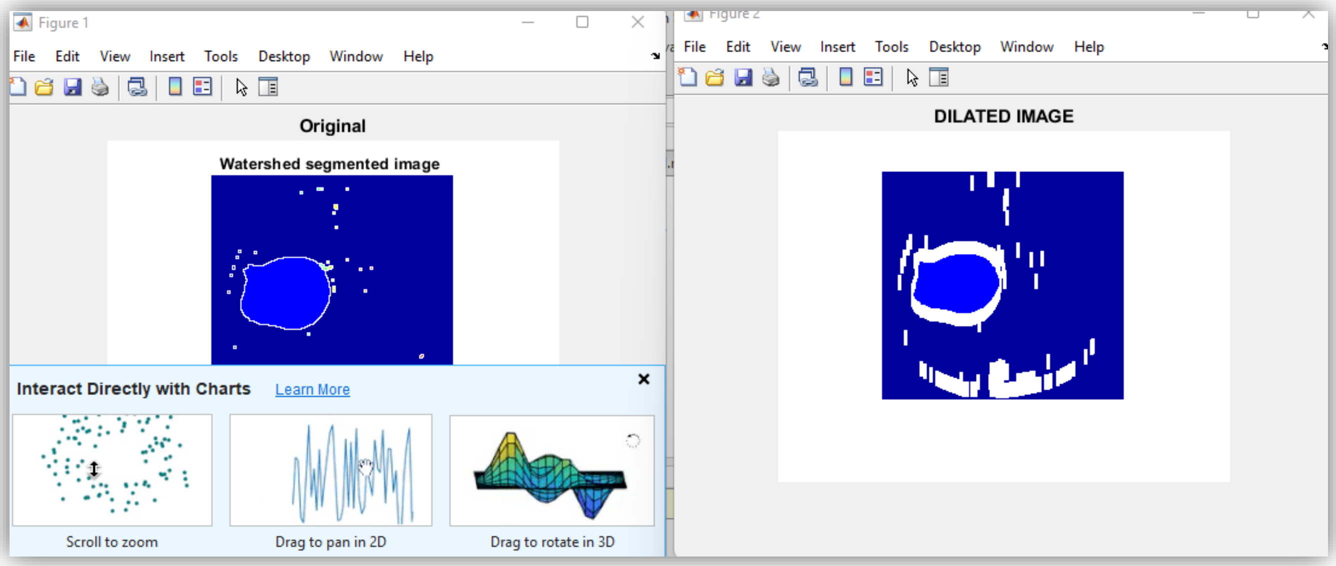
GRAY AND MEDIAN-FILTERED IMAGE



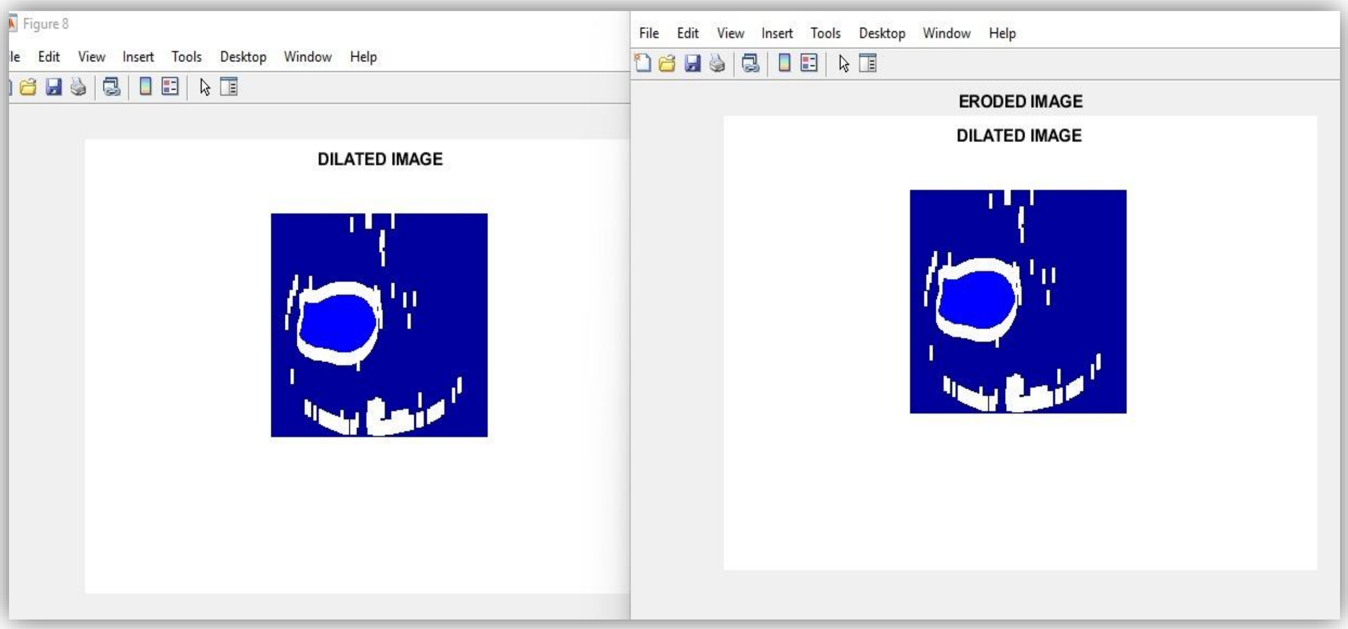
MEDIAN-FILETERED AND THRESOLD



WATERSHED AND DILATED



DILATED AND ERODED IMAGE



THE FINAL OUTPUT

Programming Language Used for Implementation

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and fourth-generation programming language. A proprietary programming language developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages.

Tools Used

• Neural Network ToolBox.

• Languages: MATLAB.

• Documentation: Microsoft Word, Google docx.

• Software: MATLAB 2021a

• Hardware: Intel Dual Core Dual Processor or advanced version; Minimum 256 MB of RAM; Minimum 1 GB of Hard disk Space.

ALL ABOUT CODES

We have used 3 codes to get the detected tumor and tumor alone part …The first 2 code that we have used are the **single code** which will convert the brain MRI image to detected and tumor alone part, In **second code** we have used two techniques i.e watershed and threshold to get the tumor alone part .

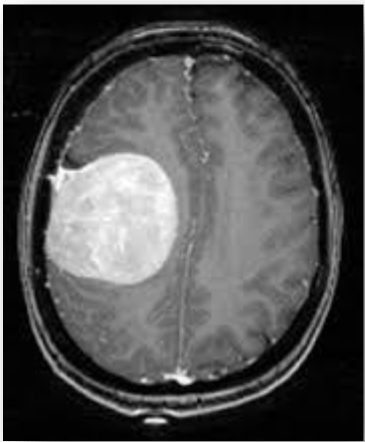
In **Third code** we have used 6 different techniques separately to get the final detected tumor alone part . Firstly we have converted our MRI image to grey scale image and then we have converted our gray scale image to median filtered image …..removing all the noice ….Then in 3rd part of the code we converted median filtered threshold image similarly we then converted them to watershed, dilation and erosion….and then finally we will be getting our final detected tumor part i.e final MRI report using 6 techniques separately …….This was all about implementation now let’s see all the 3 codes one by one …

FIRST CODE

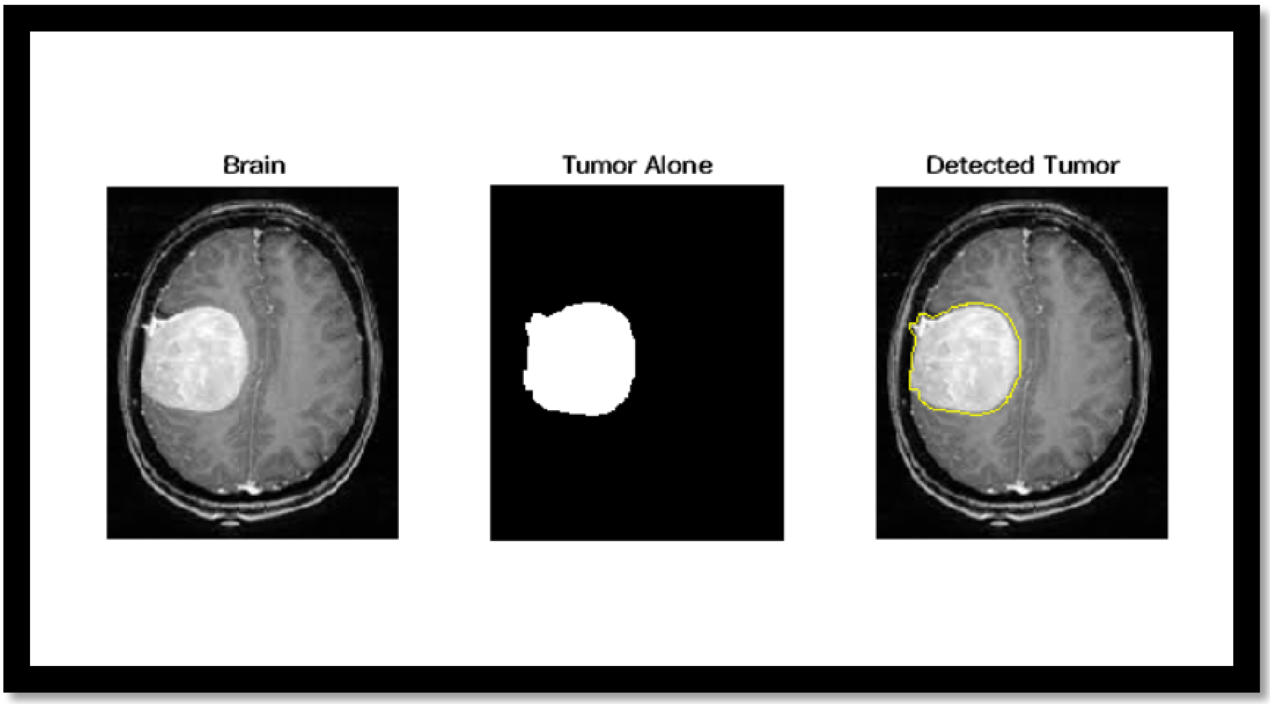
```
close all;

clear all;
clc;
img=imread('m2.jpg');
bw=im2bw(img,0.7);
label=bwlabel(bw);
stats=regionprops(label,'Solidity','Area');
density=[stats.Solidity];
area=[stats.Area];
high_dense_area=density>0.5;
max_area=max(area(high_dense_area));
tumor_label=find(area==max_area);
tumor=ismember(label,tumor_label);
se=strel('square',5);
tumor=imdilate(tumor,se);
figure(2);
subplot(1,3,1);
imshow(img,[]);
title('Brain');

subplot(1,3,2);
imshow(tumor,[]);
title('Tumor Alone');
[B,L]=bwboundaries(tumor,'noholes');
subplot(1,3,3);
```

```
imshow(img,[]);
hold on
for i=1:length(B)
    plot(B{i}(:,2),B{i}(:,1), 'y' ,'linewidth',1.45);
end

title('Detected Tumor');
hold off;
```

INPUT IMAGE:-



OUTPUT:-



MR image pre-processing is very significant to ameliorate the visual effect of the image for further processing. Usually the collected images in the dataset are so poor in quality which requires filtering noise and sharpening the image. In pre-processing step, the acquired image in the dataset is converted into a two dimensional matrix and the image is converted into RGB image to gray scale image. To eliminate the noise in the image, a median filter is used. Then, the enhancement of the image is done by performing adjusted operation, histogram based operation and adaptive histogram based operation. Generally, enhancement of an image means improving the contrast of the image. After that different features are initially extracted implicitly

Experimental results of image

(a) Original image.

(b) Enhanced image.

(c) Skull-stripped image.

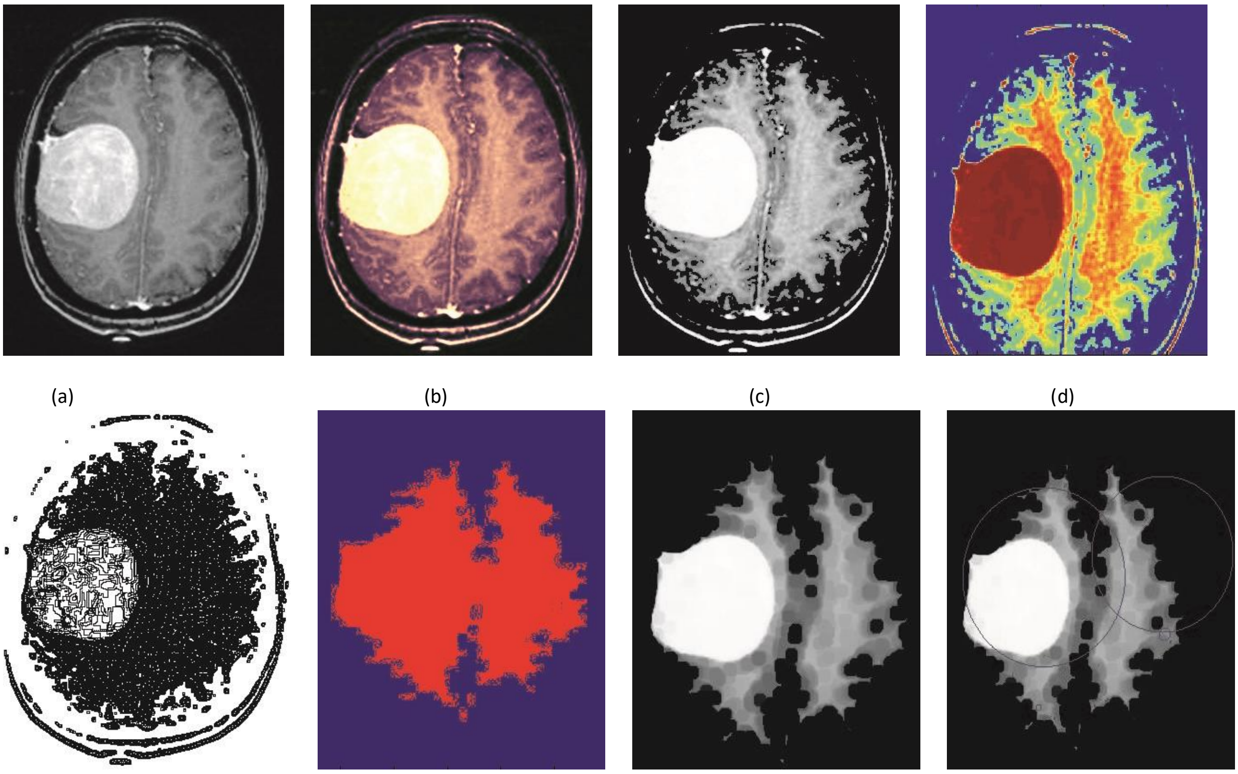
(d) Wavelet decompose image.

(e) Intense segmented image.

(f) Dice overlap image.

(g) Tumor region.

(h) Area extracted tumor region.



(a) (b) (c) (d)

(e) (f) (g) (h)

SECOND CODE:-

```
I=imread('m2.jpg');
figure, imshow(I); title('Brain MRI Image');
I = imresize(I,[200,200]);
I= rgb2gray(I);
I= im2bw(I,.6);%binarising with thresold .6
figure, imshow(I);title('Thresholded Image');
hy = fspecial('sobel');
hx = hy';
Iy = imfilter(double(I), hy, 'replicate');
Ix = imfilter(double(I), hx, 'replicate');
gradmag = sqrt(Ix.^2 + Iy.^2);
```

```
L = watershed(gradmag);
Lrgb = label2rgb(L);
figure, imshow(Lrgb), title('Watershed segmented image ')
se = strel('disk', 20);
Io = imopen(I, se);
Ie = imerode(I, se);
Iobr = imreconstruct(Ie, I);
Iobrd = imdilate(Iobr, se);
Iobrcbr = imreconstruct(imcomplement(Iobrd), imcomplement(Iobr));
Iobrcbr = imcomplement(Iobrcbr);
I2 = I;
fgm = imregionalmax(Iobrcbr);
I2(fgm) = 255;
se2 = strel(ones(5,5));
fgm2 = imclose(fgm, se2);
fgm3 = imerode(fgm2, se2);
fgm4 = bwareaopen(fgm3, 20);
I3 = I;
bw = im2bw(Iobrcbr);
figure
imshow(bw), title('only tumor')
```

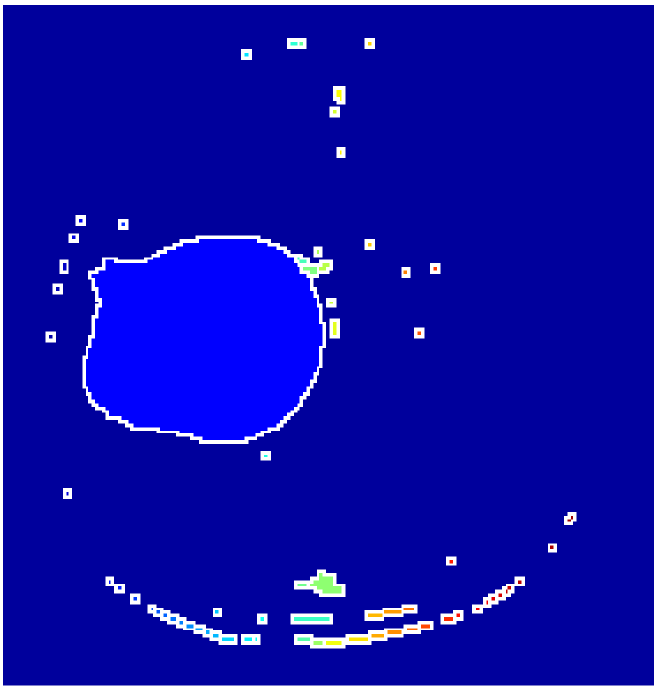
OUTPUT IMAGES

Input THRESOLD

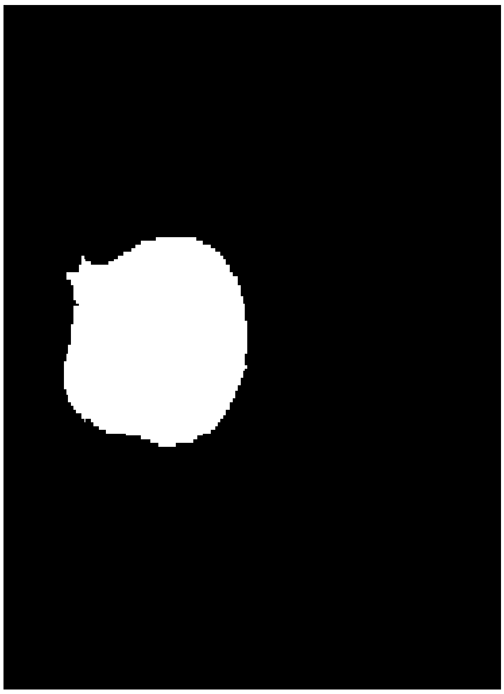
Brain MRI Image

Thresholded Image

Watershed segmented image



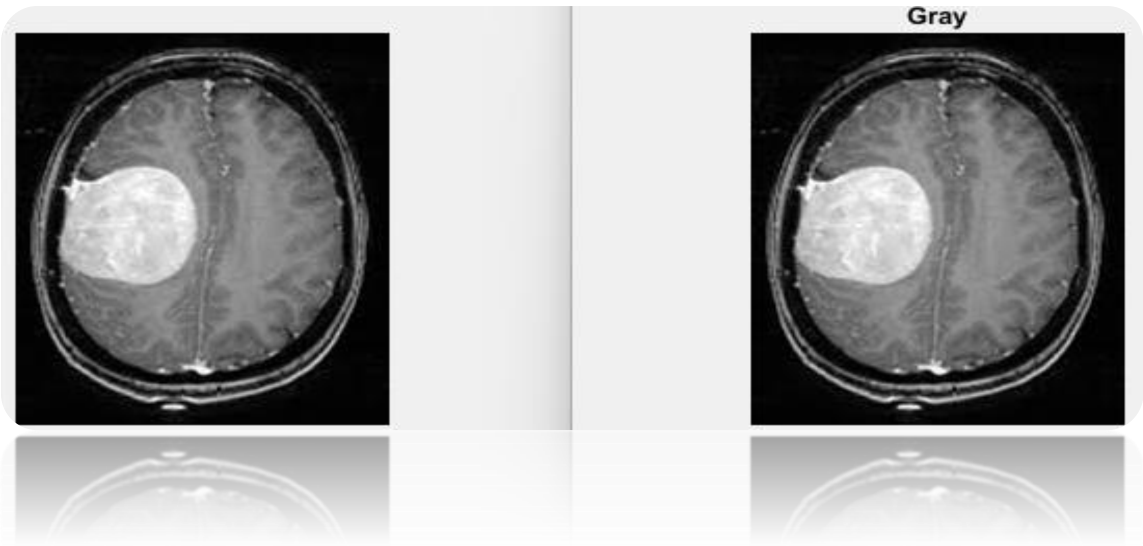
only tumor



THIRD CODE

GREYSCALE-CODE

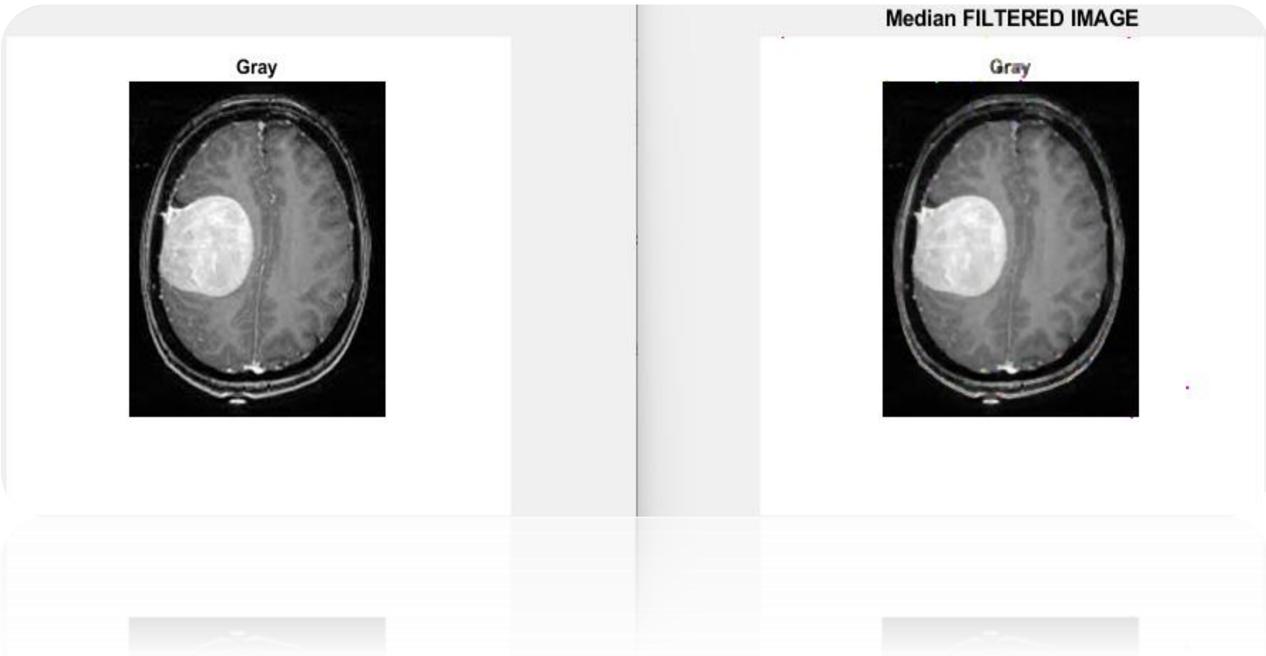
```
close all;
clc;
a=imread('m2.jpg');
figure, imshow(a);

b=im2double(a);
size(b)
gray = 0.2989 * b(:,:,1) + 0.5870 * b(:,:,2)+ 0.1140 * b(:,:,3);
figure,imshow(gray);
title('Gray');

size(gray)
```



MEDIAN-FILTER CODE

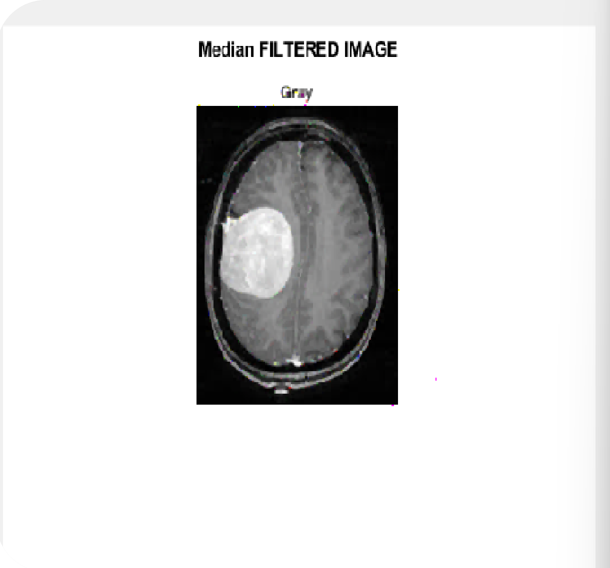
```
clc;

close all;
```

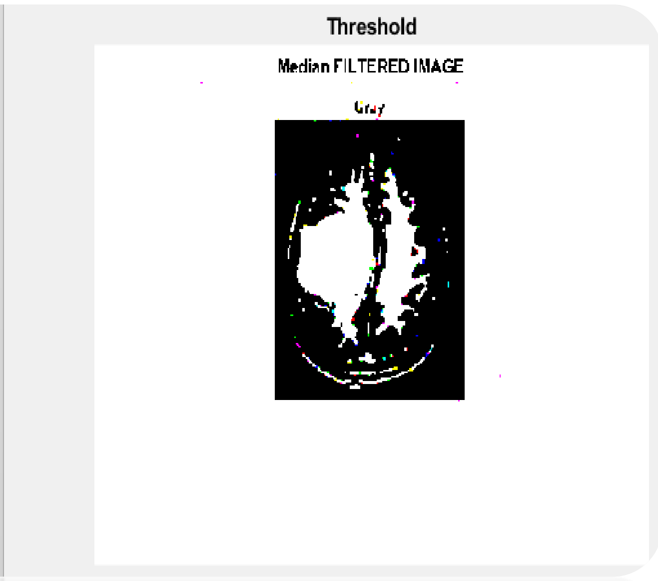
```
A = imread('grayfinal.png');
Y = imnoise(A, 'salt & pepper');

figure,imshow(A);
figure,imshow(Y);
[n, m] = size(A);
for i = 1:n
   for j = 1:m
      mat = zeros(3, 3);
      if ((i - 1) == 0 && (j - 1) ~= 0 && j ~= m)
         mat(2:3, 1:3) = Y(i:i + 1, j - 1:j + 1);
         mat = sort(mat, 1);
         mat = sort(mat, 2);
         Y(i, j) = mat(2, 2);
      elseif (i == n && (j - 1) ~= 0 && j ~= m)
         mat(1:2, :) = Y(i - 1:i, j - 1:j + 1);
         mat = sort(mat, 1);
         mat = sort(mat, 2);
         Y(i, j) = mat(2, 2);
      elseif ((i - 1) ~= 0 && (j - 1) ~= 0 && j ~= m && i ~= n)
         mat(:, :) = Y(i - 1:i + 1, j - 1:j + 1);
         mat = sort(mat, 1);
         mat = sort(mat, 2);
         Y(i, j) = mat(2, 2);
      elseif ((j - 1) == 0 && (i - 1) ~= 0 && i ~= n)
         mat(:, 2:3) = Y(i - 1:i + 1, j:j + 1);
         mat = sort(mat, 1);
         mat = sort(mat, 2);
         Y(i, j) = mat(2, 2);
      elseif (j == m && (i - 1) ~= 0 && i ~= n)
         mat(:, 1:2) = Y(i - 1:i + 1, j - 1:j);
         mat = sort(mat, 1);
         mat = sort(mat, 2);
         Y(i, j) = mat(2, 2);
      end
   end
end

imshow(Y);
title('Median FILTERED IMAGE');
```



THRESHOLD-CODE

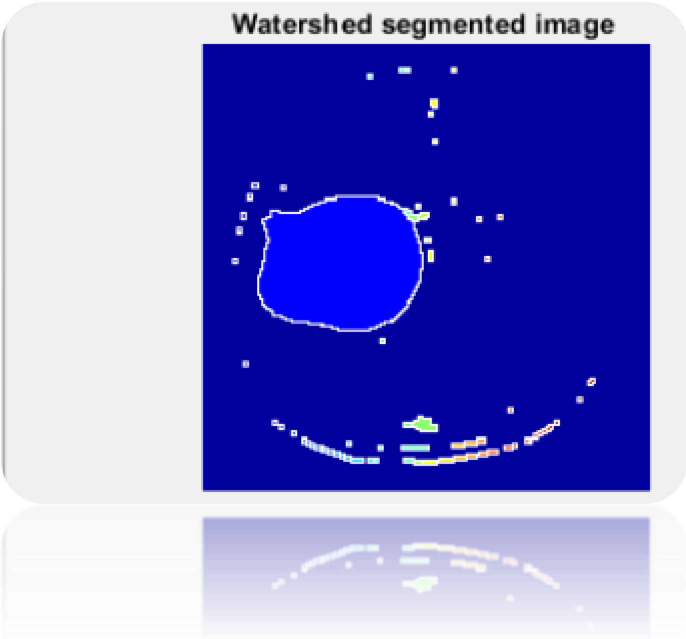
```
close all;
clc;
c = imread('medianfinal.png');
cd = double(c);
figure, imshow(cd);
impixelinfo;

figure, imshow(c);
impixelinfo;

c7 = mod(floor(cd / 128), 2);
figure, imshow(c7),
title('Threshold');
```





WATERSHED-CODE

```
clc;
I = imread('thresoldfinal.png');
I1 = imtophat(I, strel('disk', 10));
figure, imshow(I1);
level = graythresh(I1);
BW = imbinarize(I1, level);
figure,imshow(BW);
C = BW;
figure, imshow(C);
D = bwdist(C);
D(C) = - Inf;
L = watershed(D);
figure, imshow(L);
W1 = label2rgb(L, 'hot', 'w');
figure, imshow(W1);
im = I;
im(L == 0) = 0;
figure, imshow(im),
title('WATERSHED IMAGE');
```



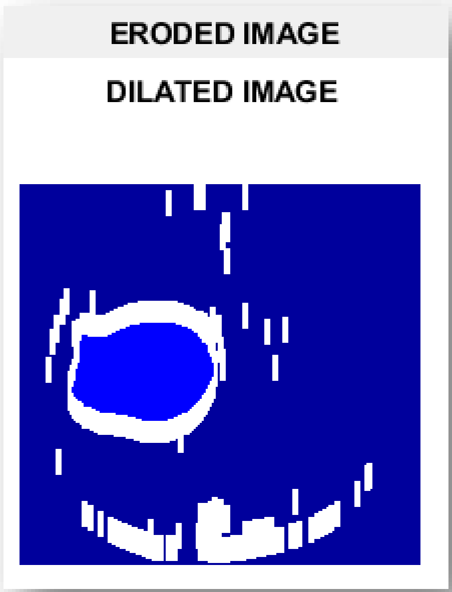
DILATED IMAGE

```
clear all;
clc;
bw = imread('watershedfinall.PNG');
se = strel('line',11,90);
bw2 = imdilate(bw,se);
imshow(bw);title('Original')
figure; imshow(bw2);
title('DILATED IMAGE')
```

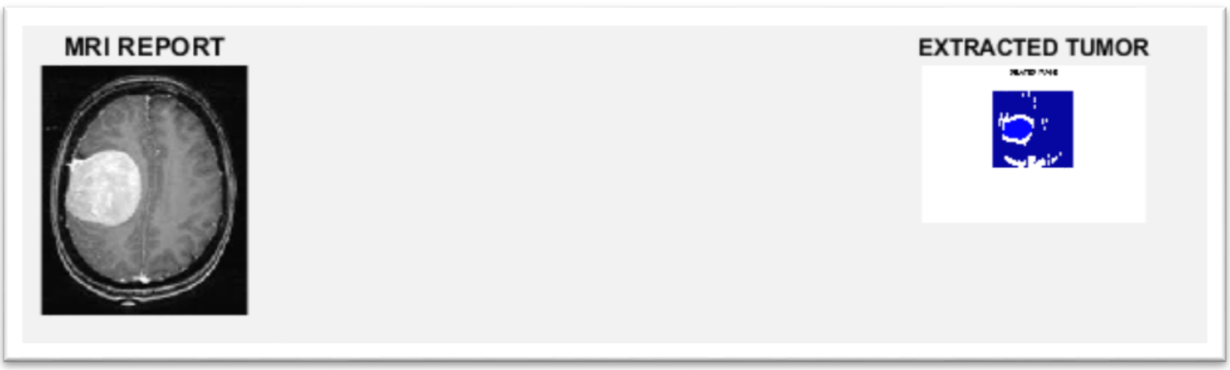
ERODED IMAGE

```
clear all;
clc;
originalI = imread('dilatedfi.PNG');
se = strel('ball',1,1);
erodedI = imerode(originalI,se); figure;
imshow(originalI);
figure,imshow('m2.jpg');
figure, I=imshow(erodedI);
title('ERODED IMAGE');
figure, subplot(2,2,1);
imshow('m2.jpg');
title('MRI REPORT'); subplot(3,3,3);
imshow(erodedI);
title('EXTRACTED TUMOR');
```

OUTPUT



FINAL OUTPUT



IMPLEMENTATION DETAILS:

Noise Removal and Sharpening

As a grayscale or colored image maybe the inputted image, the first step is to convert the given image into a grayscale image [4]. On procuring the grayscale image, the aim then is to filter [4] it so as to sharpen it and remove any noise [4], if present. In the algorithm, unsharp [1] [14] filtering of fspecial [2] [14] filter is applied in order to sharpen the image by removing the low intensity values. For noise-removal 'Gaussian' [1] [9] filters is used from fspecial filters.

Erosion and Dilation

After pre-processing, next step is to estimate the background [14]. In order to do so we make use of the basic morphological operations, erosion and dilation. More erosion [14] and less dilation [14] will result in decrease in skull bones' image size. To accomplish this we will keep the eroding structural element's radius bigger than that of dilating structural elements. The structuring element used is 'diamond'.

Negation

The estimated background, obtained by the previous step, will contain the eroded tumor region as our aim was to remove the skull boundary and radius of structuring element was kept as such. Negative of the image can be calculated by subtracting [11] the image from 255 which the highest value any pixel can have.

Contrast Adjustment

In order to provide a clear and well-defined image to work upon, this operation is further applied to the result of subtracting images in previous step. This operation involves increasing the contrast of the filtered image, which is accomplished by performing contrast adjustment techniques [6]. These contrast images will further be subtracted from dilated image [6] [11] .

Threshold

Next step in this algorithm is to calculate global image threshold using Otsu's method [10], which chooses the threshold to minimize the intra-class variance of the black and white pixels. Thus we will get a clear image of the tumor region [6] . G. Boundary Detection In earlier times without aid of medical imaging tumors were identified manually and boundaries were drawn around it by an expert which always contained issues related to manual-error. Thus, to remove this error, the next step includes producing a clear boundary of the identified tumor using the morphological operation 'remove', which removes all the interior pixels, thus leaving only the boundary pixels on.

OUTPUT:

Canny Algorithm

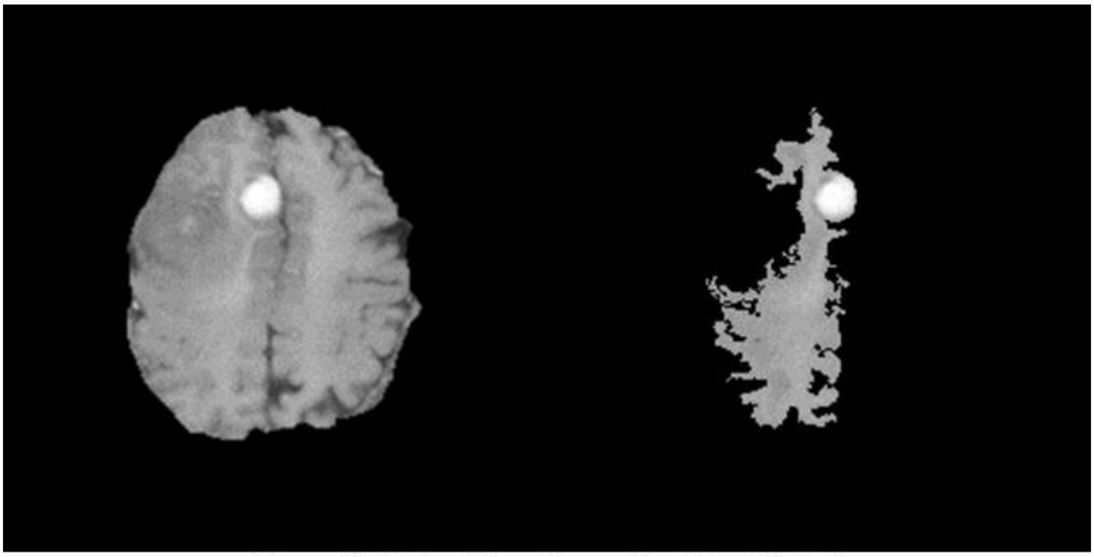


Figure 21: Output from Canny Algorithm (Benign)

Watershed Algorithm

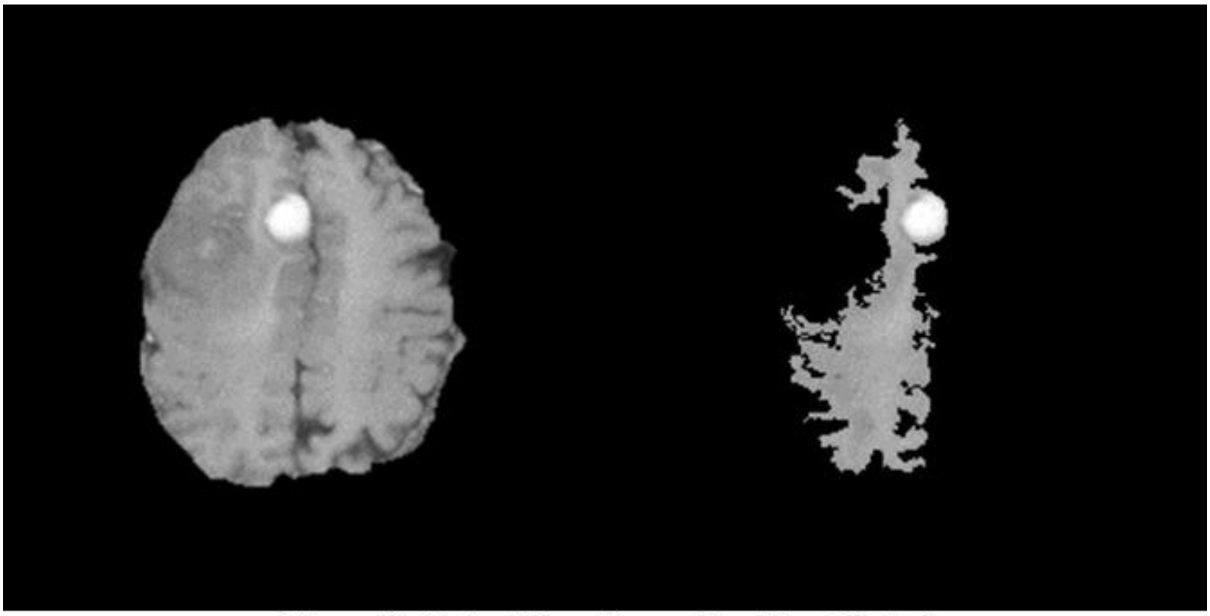
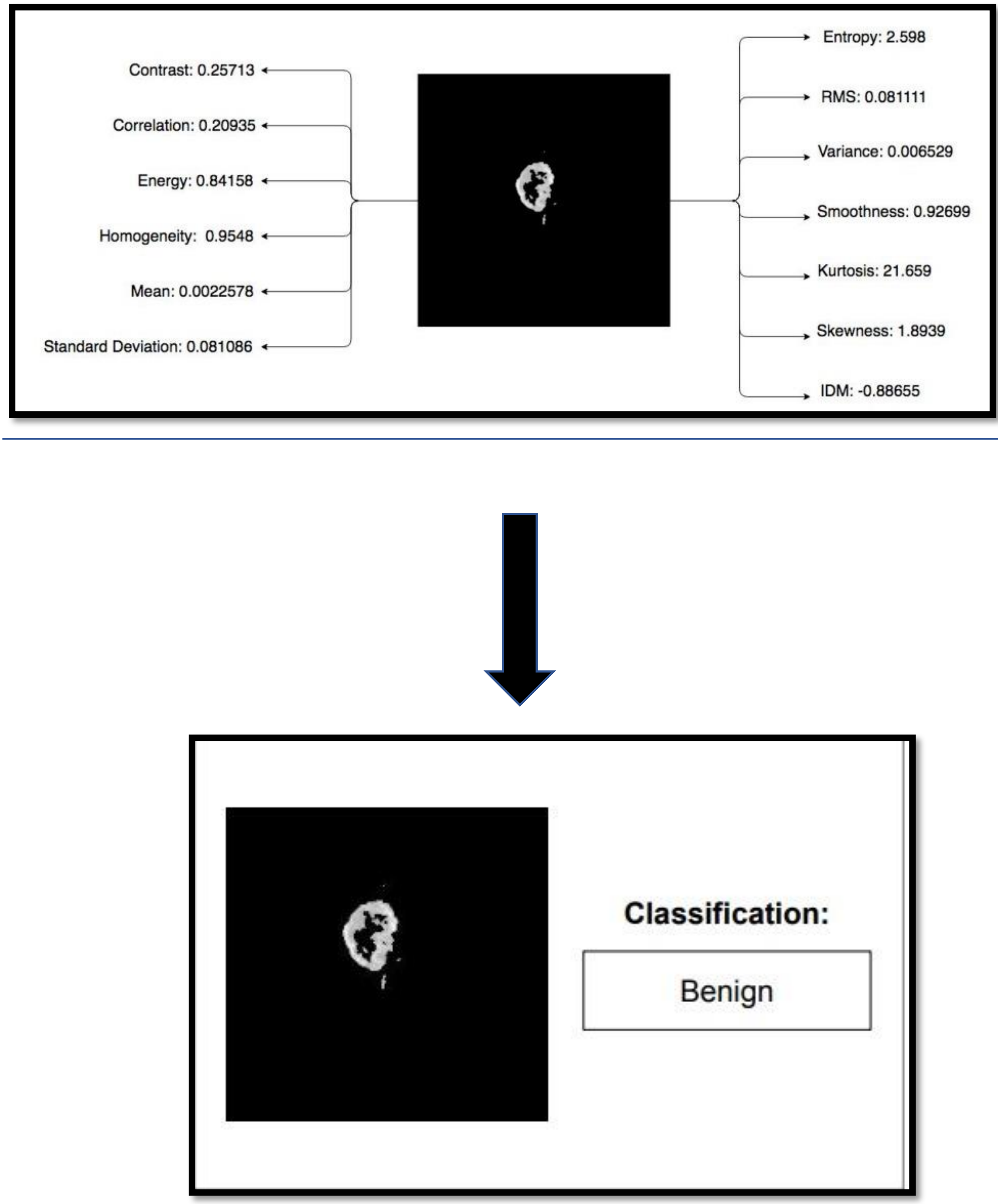
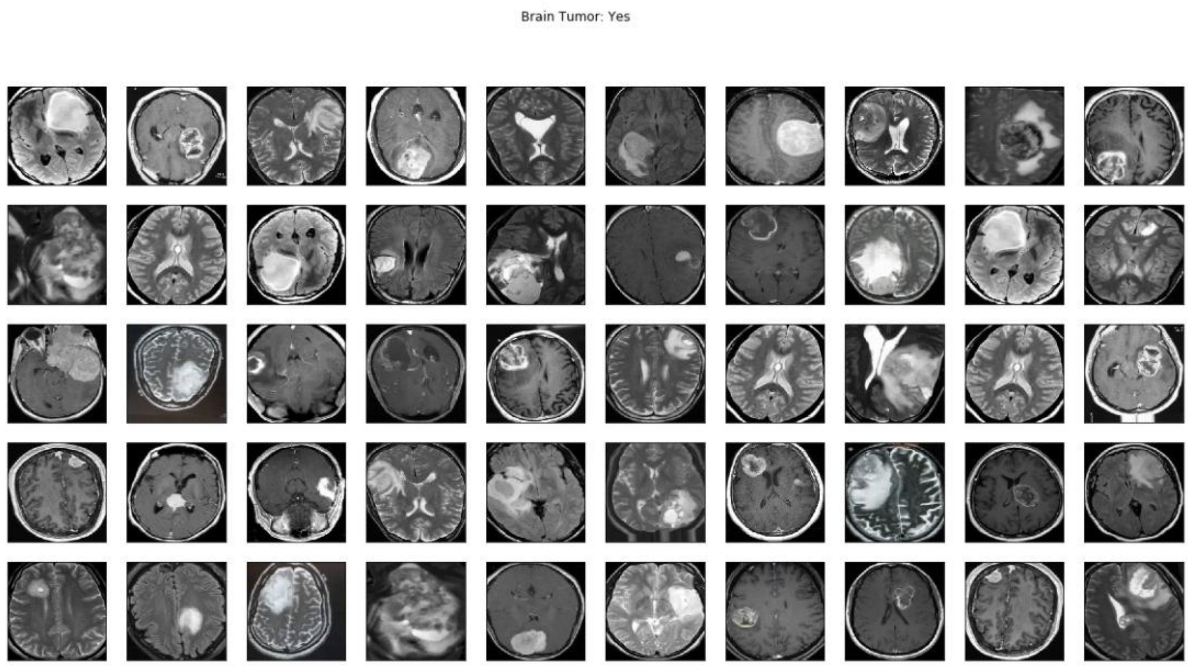


Figure 21: Output from Canny Algorithm (Benign)

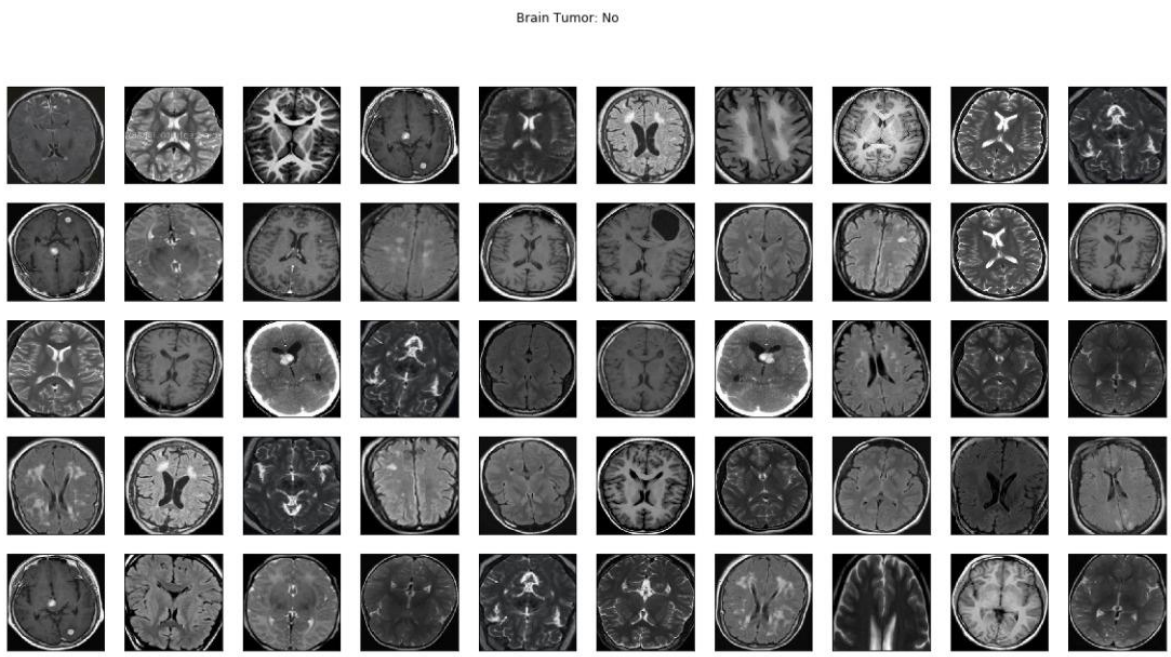
OTHER CLASSIFICATION OUTPUT



Brain Tumor Images



Non Brain Tumor Images



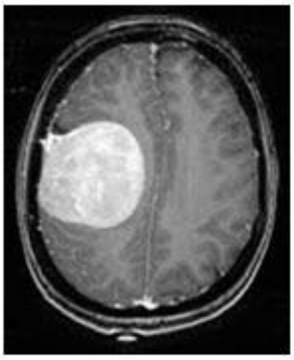
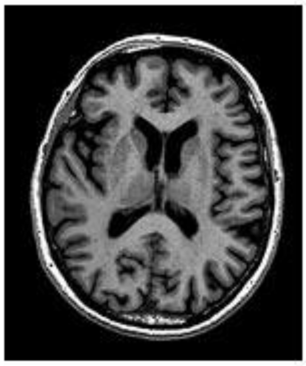
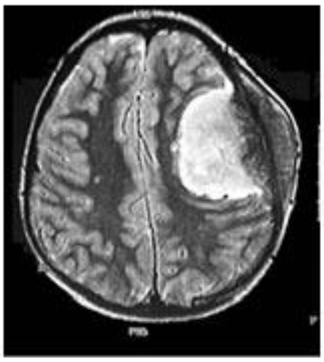
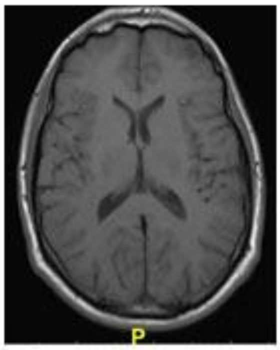
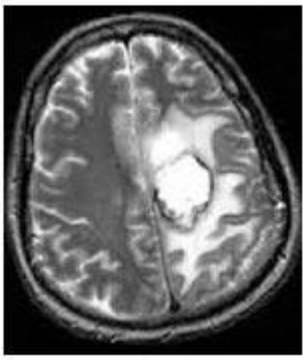
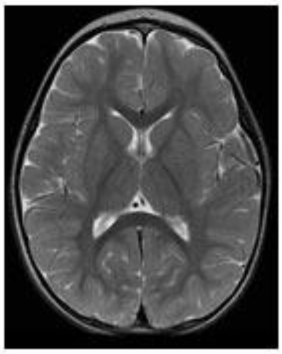
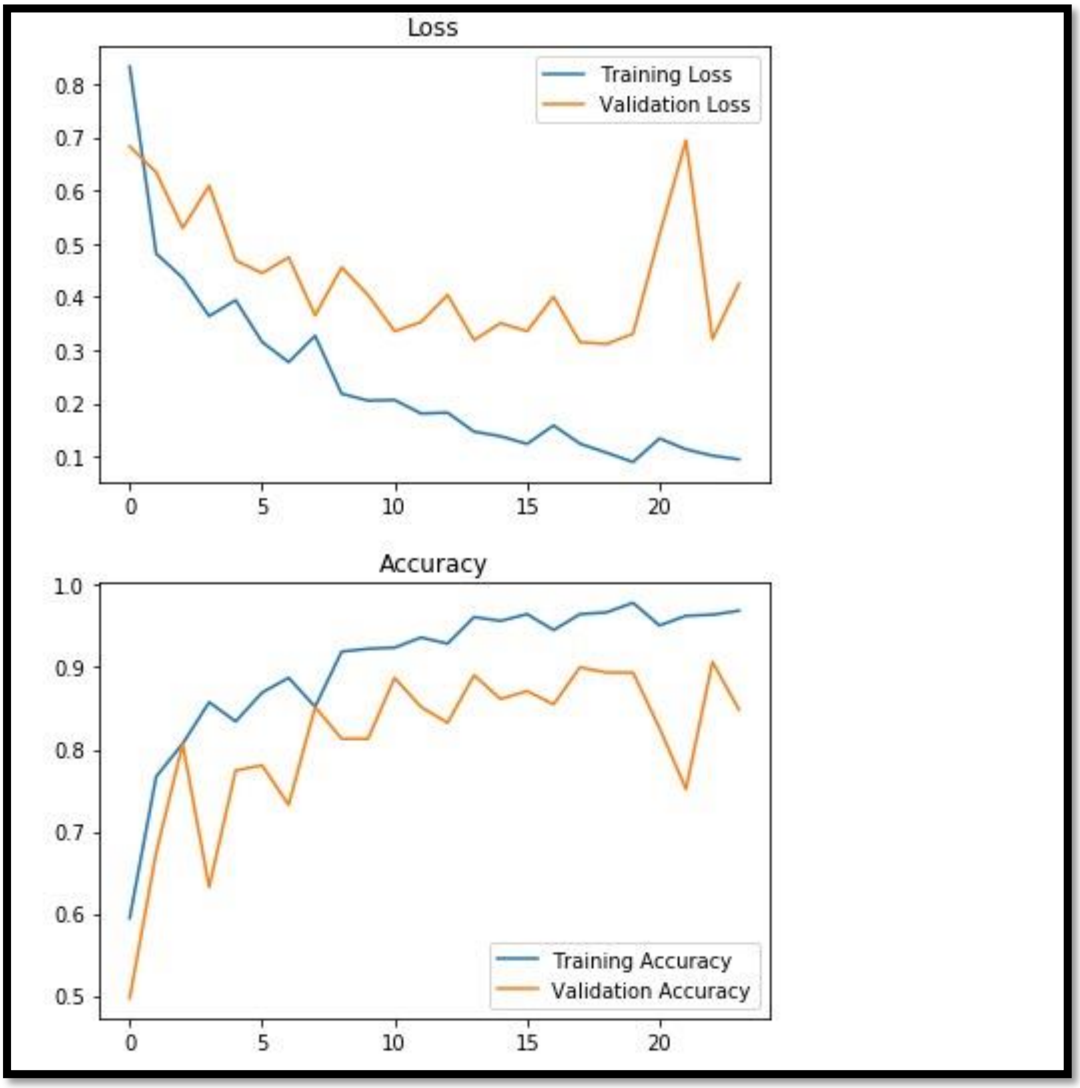
Brain Tumor Image	Brain Non Tumor Image
	
	
	

Figure 2: CNN based classified results

Graph of Loss and Accuracy



ABOUT GETTING ACCURACY PART

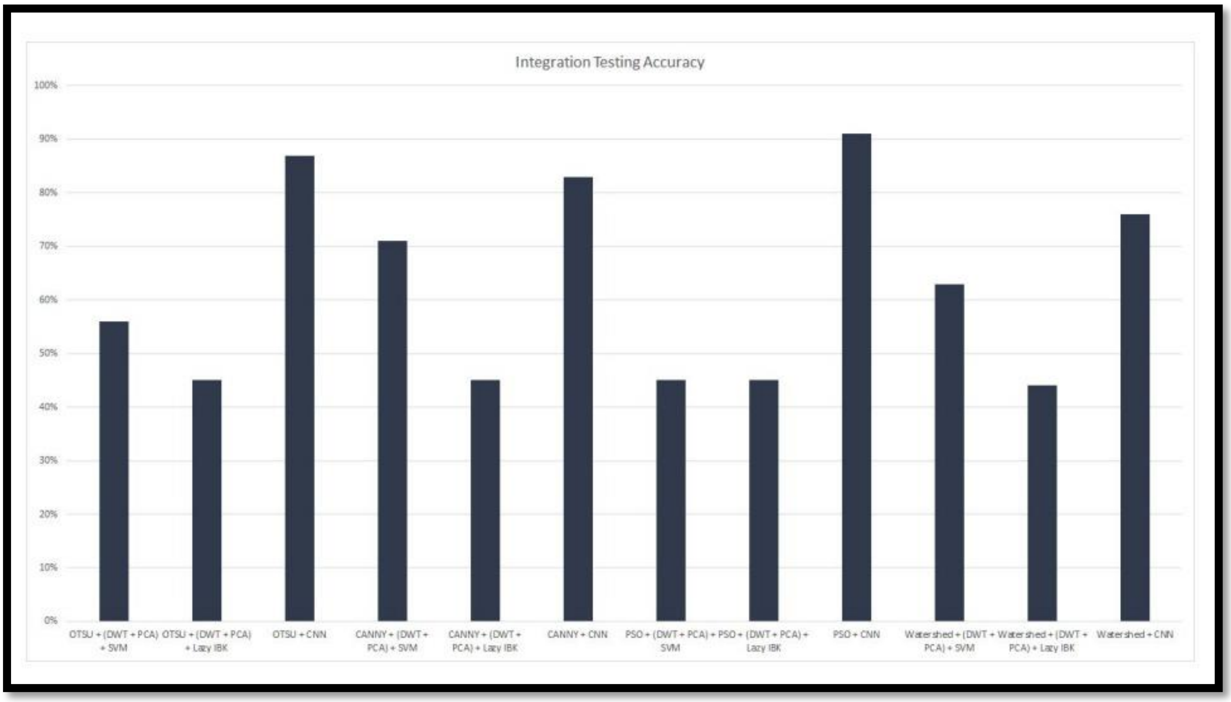
We have used python to get the accuracy percentage ….We have used CNN and different ML algorithms like SVM, Lazzy IBK to finally get the accuracy percentage and the graphs ….

We have actually used 321 MRI images to get the detection of brain tumor as YES and NO. Then we have used CNN techniques on that data set to get the accuracy percentage ….In the next page we can see that accuracy for different segmentation processes like canny, OTSU, PSO and watershed has been found using ML algorithm

Note:- As our project deals with image processing (Matlab) we have not included python code in this report for getting accuracy (Explained in review 2nd and 3rd)

Accuracy Percentage

Test Case:	Accuracy
OTSU + (DWT + PCA) + SVM	56%
OTSU + (DWT + PCA) + Lazy IBK	45%
OTSU + CNN	87%
CANNY + (DWT + PCA) + SVM	71%
CANNY + (DWT + PCA) + Lazy IBK	45%
CANNY + CNN	83%
PSO + (DWT + PCA) + SVM	45%
PSO + (DWT + PCA) + Lazy IBK	45%
PSO + CNN	91%
Watershed + (DWT + PCA) + SVM	63%
Watershed + (DWT + PCA) + Lazy IBK	44%
Watershed + CNN	76%



APPLICATION

Middle channel is the most generally utilized separating procedure among different sifting strategies. Less multifaceted nature and the productivity in disposing of 'Salt and Pepper clamor' are the primary points of interest of middle channel. Unlike Gaussian channel, it is a non-direct channel, Median channel is an edge sparing channel. Moreover, Gaussian channel is a low pass channel from this time forward the edge information will be lost and edges getting removed and clouded. Though, less multifaceted nature and the reasonableness to complete than the Median channel are the major focal points of Gaussian channel. Another piece of space is the Gaussian direct is altogether material in smoothening Gaussian uproar. Thresholding is the best and most clear system among picture. Using this methodology, early stage brain tumour detection is possible. Tumour detection can be done with increased accuracy at high speed. It provides automation in the field of image processing as well as analysis and improves identification of brain structures in medical science.

INFERENCE

Our aim is to develop an automated system for enhancement, segmentation and classification of brain tumors.

The system can be used by neurosurgeons and healthcare specialists.

The system incorporates image processing, pattern analysis, and computer vision techniques and is expected to improve the sensitivity, specificity, and efficiency of brain tumor screening.

The proper combination and parameterization of above phases enables the development of adjunct tools that can help on the early diagnosis or the monitoring of the therapeutic procedures.

CONCLUSION

In this project we have automated the diagnosis procedure for the brain tumor detection by the use of image processing. Apart from several existing brain tumor segmentation and detection methodology are present for MRI of brain image our project has proved to provide an aver all accuracy by upto 97%. All the steps for detecting brain tumor that have been discussed startimg from mri image acquisition ,pre-processing steps to successfully classification of the tumor using the two segmentation techniques is been done. Pre-processing involves operations like wavelet based methods has been discussed. Quality enhancement and filtering are important because edge sharpening, enhancement, noise removal and undesirable background removal are improved the image quality as well as the detection procedure. Among the different filtering technique, Gaussian filter suppressed the noise without blurring the edges and it is better outlier without reducing sharpness of the images. reduces the noise; enhance the image quality and computationally more efficient than other filtering methodology.

The boundary approach and the edge based approach for segmentation are very common but the region growing approach gives better results. It is found that the particle swarm optimization algorithm gives the most accurately segmented tumors. Features extracted by using GLCM method help to increase efficiency as minute details of tumor by using various features can be extracted.

Of the various classification methods studied, it was experimentally found that the convolution neural networks give the best classification accuracy. Accuracy and reliability are of utmost importance in tumor diagnosis, as a patient's life depends on the results predicted by the system. Thus, the proposed methodology helps in increasing the accuracy and obtaining the desired results.

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FINAL PRESENTATION LINK

https://www.canva.com/design/DAEoY0ckubI/RfssS1uEHZYTblna6UcbUg/view?utm_content=DAEoY0ckubI&utm_campaign=designshare&utm_medium=link&utm_source=sharebutton

Note:- Use spacebar to go to next page in presentation.

WORK PLAN

S.NO	NAME	WORK
1.	SAGUTURU KAVYA	• Introduction part • Creating report • Fetching data
2.	LAKSHYA VASWANI	• Code implementation • Collecting images • Creating ppt
3.	SUBHAM JAISWAL	• Literature survey • Creating ppt • Code collection

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