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DISCERN BRAIN TUMOR

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ABSTRACT

In the recent years, death rates have been increased due to the yearly and improper diagnose of brain tumor in India. Nearly 70,000 new cases of primary brain tumors are diagnosed every year. More than 4,600 children between the ages 0-19 are diagnosed with brain tumor. Brain and central nervous system tumors are the most common cancers among children ages 0-19. There are more than 120 types of brain tumors. They are the leading cause of cancer related deaths in children under age 20, deaths in males and females aging 20-39. In India alone there has been a tremendous increase in the death rates. Nearly 23,130 people were been detected with brain tumor and there were 14,080 deaths due to brain tumor in the year 2013. Our proposed study is to detect the early stage of brain tumor in order to decrease the death rate. This study implements inputs as MRI brain images and thereby applying high pass filters to reduce the noise and enhance the image by applying contrast stretching, histogram equalization and the edge is detected using first order derivatives, segmented using threshold segmentation and the tumor is separated from the segmented image using Watershed algorithm. The output of the segmented region is classified using Radial Basis Function (RBF) for training and testing. This in turn helps the practitioner to diagnose the tumor shape and size since it plays a vital role in the treatment to the tumor.

Keywords: Segmentation, Enhancement, Magnetic Resonance Imaging (MRI), Watershed, Histogram, RBF.

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1. Introduction

A brain tumor is a malignant growth in the brain. Primary brain tumors initially form in brain tissue. Secondary brain tumors are cancers that have spread to the brain tissue from tissue elsewhere in the body.Brain tumor detection is very challenging problem due to complex structure of brain [1]. Image processing techniques are been widely used in medical imaging research. These techniques are useful for visualization, enhancements, segmentation and many more operations which are useful for processing medical images which maybe MRI, CT or any other images obtained through one of the imaging modality. Some of these abnormalities include tumor, blocked vessels or sometimes broken joints. This paper focuses on the detection of tumor from Magnetic Resonance Imaging (MRI) of brain using Image segmentation techniques. The segmentation of brain tumors helps in knowing the exact size and shape of the tumor and the location. Some image enhancement techniques is been used to enhance the contrast and normalize the pixel values in the image. Detection and extraction of tumor from MRI scan

images of the brain is done by using MATLAB software and future developments and trends are addressed for brain tumor segmentation methods.

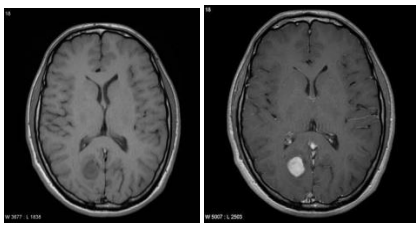


Fig 1: (a) MRI of Human Brain.(b) MRI of human brain with tumor

Treatments such as the chemotherapy, radiotherapy and also surgery are carried out against brain tumor. When a brain tumor is diagnosed a medical team is formed to assess the condition and treatments to the patients. Before a final decision is been taken on the brain tumor the surgeons look carefully at the evolution of the neoplasm and the various treatments which may depend on the neoplasm type and location. In these cases imaging plays a crucial role in the treatment of brain tumor. Imaging gives an extraordinary view of the presences of the brain tumor to the physicians or the surgeons.

In this paper we have developed an algorithm which is able to detect the tumor within the brain in images which are obtained through magnetic imaging resonance (MRI) or computed tomography (CT). Therefore by using the watershed algorithm we are able to segment the tumors and also we are able to clearly observe the shape of the tumors.

2. Literature Review

Many of the researchers proposed many methods, and algorithms for to find brain tumor, stroke and other kinds of abnormalities in human brain using MR Images. [1] The aim in image processing applications is to extract important attributes from the image data, from which a descriptive, interpretative, or understandable prospect can be obtained by the machine. Several literatures are available in this field of study. [2] paper presents an automatic image segmentation method using thresholding technique. This is based on the assumption that adjacent pixels whose value (grey level, color value, texture, etc) lies within a certain range belong to the same class and thus, goodsegmentation of images that include only two opposite components can be obtained.[3] paper presents thresholding and edge detection being one of the important aspects of image segmentation comes prior to feature extraction and image recognition system for analyzing images. It helps in extracting the basic shape of an image, overlooking the minute unnecessary details. In this paper using image segmentation (thresholding and edge detection) techniques different geo satellite images, medical images and architectural images are analyzed. To quantify the consistency of our results error measure is used. [9] have proposed Brain Tumor MRI Image Segmentation and Detection in Image Processing. In this work, a computer aided system for brain MR image segmentation was proposed for detection of tumor location using K - means clustering algorithm followed by morphological filtering.[35] proposes a fully automated two step segmentation process of brain MRI images. Firstly, the scull is stripped from the MRI images by generating a scull mask from the original MRI image. Finally, an advanced K- means algorithm improvised by two level granularity oriented grid based localization process based on

standard local deviation is used to segment the image into gray matter, white matter and tumor region. Finally, the length and breadth of the tumor is assessed. [4] proposed a method based on histogram thresholding. They follow a concept that there is a uniform background and objects are irregularly placed on it. This makes image histogram the choice for object delineation & finding an appropriate threshold between object and background fulfils the task of object identification. [5] paper is a survey on different clustering techniques to achieve image segmentation. In order to increase the efficiency of the searching process, only a part of the database need to be searched. For this searching process clustering techniques can be recommended. Clustering can be termed here as a grouping of similar images in the database. Clustering is done based on different attributes of an image such as size, color, texture etc. The purpose of clustering is to get meaningful result, effective storage and fast retrieval in various areas. [7] presents an enhanced implementation of brain tumor detection using segmentation based on soft computing.

Several methods in medical image processing and requirements and properties of techniques in brain tumor detection are discussed. Image Segmentation is an important and challenging factor in the medical image segmentation. This paper describes segmentation method consisting of two phases. In the first phase, the MRI brain image is acquired from patients database, in that film artifact and noise are removed. After that Hierarchical Self Organizing Map (HSOM) is applied for image segmentation. The HSOM is the extension of the conventional self organizing map used to classify the image row by row. In this lowest level of weight vector, a higher value of tumor pixels, computation speed is achieved by the HSOM with vector quantization.[32]In this paper, the authors analyzed the segmentation of MRI brain image into different tissue types on brain image using Possibilistic fuzzy c-means (PFCM) clustering. Application of this method to MRI brain image gives the better segmentation result in compare with Fuzzy c-mean (FCM) and fuzzy possibilistic c-means (FPCM). The results are verified quantitatively using similarity metrics, false positive volumes function (FPVF) and false negative volume functions (FNVF).These values are shows that PFCM segments the tumor class effectively. This is achieved by effectively utilizing the membership and possibility (typicality) function in the PFCM.[29]proposed algorithm enables the information of seed region growing and image entropy in its calculation. The algorithm starts by partitioning the image into several levels of intensity using watershed multi-degree immersion process. The levels of intensity are the input to a computationally efficient seed region segmentation process which produces the initial partitioning of the image regions.

These regions are fed to entropy procedure to carry out a suitable merging which produces the final segmentation. The latter process uses a region-based similarity representation of the image regions to decide whether regions can be merged. The proposed algorithm is applied to challenging applications: grey matter-white matter segmentation in magnetic resonance images (MRIs). [28]propose new fuzzy c-means method for improving the magnetic resonance imaging (MRI) segmentation. The proposed method called “possiblistic fuzzy c-means (PFCM)” which hybrids the fuzzy c-means (FCM) and possiblistic c-means (PCM) functions. The proposed algorithm is capable to avoid various problems of fuzzy clustering methods that solve the defect of noise sensitivity and overcomes the coincident clusters problem of PCM. The efficiency of the proposed algorithm is demonstrated by extensive segmentation experiments by applying them to the challenging applications: gray matter/white matter

segmentation in magnetic resonance image (MRI) datasets and by comparison with other state of the art algorithms.[26] paper put forward an unique image segmentation algorithm that make use of a Markov Random Field (MRF) hybrid with biologically inspired technique Bacteria Foraging Optimization Algorithm (BFOA) for Brain Magnetic Resonance Images The proposed new algorithm works on the image pixel data and a region/neighborhood map to form a context in which they can merge. Hence, the MR brain image is segmented using MRF-BFOA and the results are compared to traditional meta heuristic segmentation method Genetic Algorithm.

All the experiment results show that MRF-BFOA has better performance than that of standard MRF-GA.[20] states that implementation of a neuro-fuzzy segmentation process of the MRI data is presented in this study to detect various tissues like white matter, gray matter, csf and tumor. The advantage of hierarchical self organizing map and fuzzy c means algorithms are used to classify the image layer by layer.

The lowest level weight vector is achieved by the abstraction level. We have also achieved a higher value of tumor pixels by this neuro-fuzzy approach. The computation speed of the proposed method is also studied. The multilayer segmentation results of the neuro fuzzy are shown to have interesting consequences from the viewpoint of clinical diagnosis. Neuro fuzzy technique shows that MRI brain tumor segmentation using HSOM-FCM also perform more accurate one.[8] have discussed Brain Tumor Detection Using Clustering Method.

This paper focuses on a new and very famous algorithm for brain tumor segmentation of MRI images by k means algorithm to diagnose accurately the region of cancer because of its simplicity and computational efficiency. In this an image is divided into a number of various groups or clusters. By experimental analysis various parameters such as global consistency error ,variation of information, area, elapsed time and rand index have been measured[15] paper deals with the implementation of Simple Cluster Algorithm for detection of range and shape of tumor in brain MR images. This uses computer aided method for segmentation (detection) of brain tumor based on the combination of two algorithms.

At the end of the process the tumor is extracted from the MR image and its exact position and the shape also determined & the tumor's stage is displayed based on the amount of area calculated from the cluster.[24] proposed a new image binarization method that uses a simple standard deviation approach and gives a very good result for MRI of brain images. The problem of binarization of gray MRI images due to the black background and large intensity variation has been overcome by the proposed system. This method is very useful to extract the objects of interest from an image and hence to distinguish the foreground(brain) from the background(black background). The threshold of the image is determined by standard deviation multiplied by a heuristic value. The paper describes the details including the heuristic value used as well as the performance of this method along with some other well known image binarization method.

3. Methodology

The methodology of the proposed system is given below. Here the image of the brain tumor is given as input. Then the filtering of the input image is filtered. The image is enhanced applying contrast stretching. Edge of the image is detected using first order derivatives. Then the image is

segmented using threshold segmentation and the tumor is separated from the segmented image using Watershed algorithm.

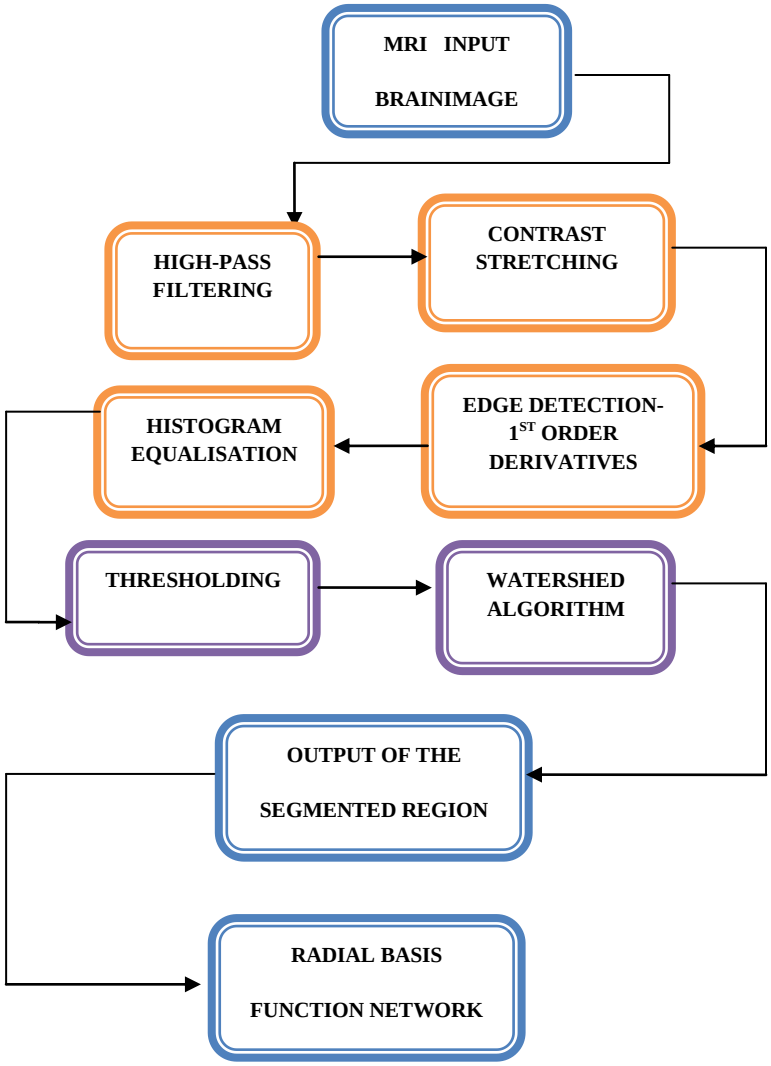


Fig 2. Methodology of the proposed system

Image processing has been one of the useful tools for processing of medical images and its use and benefits are rapidly growing in this advanced technical world. Using some of the image processing techniques we are able to develop an algorithm which is useful for detecting abnormal formation of the cells in the brain. Here we present an approach that detects the tumor within the brain. In this proposed algorithm we have applied a series of operation first some image enhancement techniques and then watershed algorithm to detect the tumor in the brain. Firstly we have taken an image and enhanced its contrast. Most of the medical imaging processing algorithm begin with enhancing the contrast of the image. This helps us to normalize

the pixel values. Here in this paper we have used some contrast stretching techniques. This improves the interpretability of information in images for human viewers.

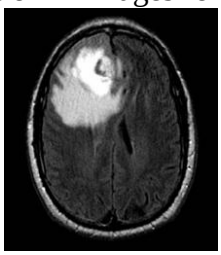


Figure 3 MRI brain image- Input Grayscale Image

3.1 High pass filter

A high-pass filter can be used to make an image appear sharper. These filters emphasize fine details in the image – exactly the opposite of the low-pass filter.

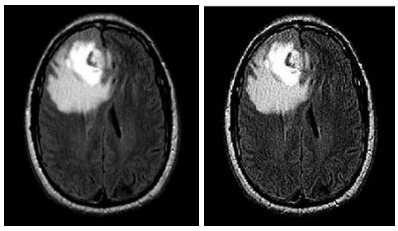
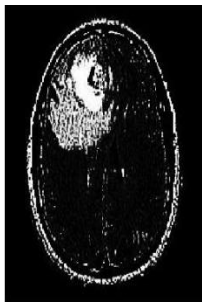


Fig 3.1 (a) Original Image (b) High pass filter

3.2 Contrast stretching

Contrast stretching is a simple image enhancement technique that attempts to improve the contrast in an image by `stretching' the range of intensity values it contains to span a desired range of values.

$$c = (d - e)\left(\frac{x - w}{z - y}\right) + w$$



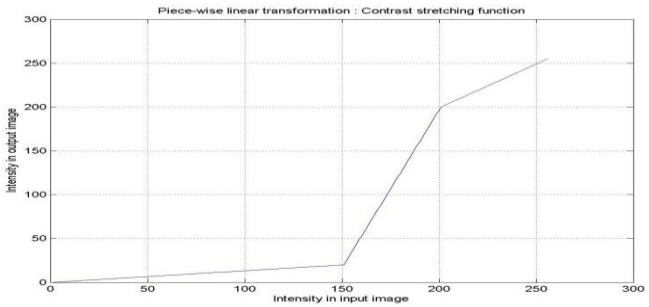


Fig 3.2 (a) Contrast Stretching (b) Contrast Stretching function

3.3 Edge Detection

Edge detection is an image processing technique for finding the boundaries of objects within images. It works by detecting discontinuities in brightness.

Prewitt operator

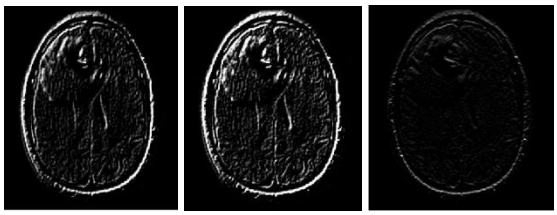
In simple terms, the operator calculates the gradient of the image intensity at each point, giving the direction of the largest possible increase from light to dark and the rate of change in that direction.

Sobel Operator

The Sobel operator, sometimes called the Sobel–Feldman operator or Sobel filter, is used in image processing and computer vision, particularly within edge detection algorithms where it creates an image emphasising edges.

Roberts operator

The Roberts cross operator is used in image processing and computer vision for edge detection. It was one of the first edge detectors. According to Roberts, an edge detector should have the following properties: the produced edges should be well-defined, the background should contribute as little noise as possible, and the intensity of edges should correspond as close as possible to what a human would perceive..



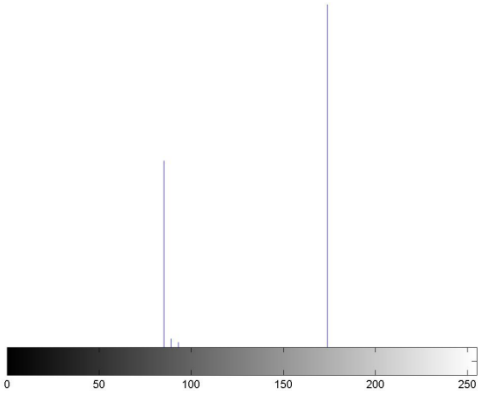
(a) (b) (c)

Fig 3.3 (a) Prewitts edge detection (b) Sobel edge detection (c) Roberts edge detection

3.4 Histogram equalization

Histogram equalization is a method in image processing of contrast adjustment using the image's histogram. Histogram is nothing but the graphical representation of an image.

Fig 3.4 (a) Histogram applied image



(b) Histogram of the equalized image

3.5 Threshold

Image threshold is a simple, effective, way of partitioning an image into a foreground and background

Fig 3.5 (a) Multiple threshold applied image

3.6 Watershed algorithm

It is one of the best methods to group pixels of an image on the basis of their intensities. It is a good segmentation technique for dividing an image to separate a tumor from the image. Watershed is a mathematical morphological operating tool and is normally used for checking output rather than using as an input segmentation technique because it usually suffers from over segmentation and under segmentation.

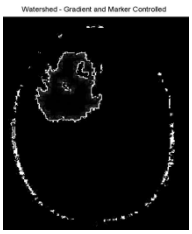


Fig 3.6 (a) Watershed Gradient and marker controlled

3.7 Radial Basis Function Network

RBFN is used for recognizing the patterns of brain tumor. The usage of activation function helps to classify the non-negative values.

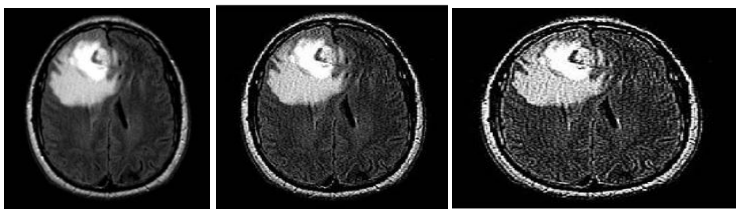
```
clc;

clear all;

xi=[-1 -0.5 1]';

n=length(xi);

d=[0.2 0.5 -0.5]';

x=[-3 0.02 3];

% Construct the M matrix, forst find xi-xj

M0=abs(xi*ones(1,n)-ones(n,1)*xi');

disp('with gaussian radial basis function,...')

M=(1/sqrt(2*pi))*exp(-0.5*M0.*M0)

w=pinv(M)*d

type=1;

f0=zeros(size(x));

f=[];

for i=1:3,

   para=[xi(i) 1];

   f(i,:)=w(i)*kernelld(type,para,x);

end
```

4. Conclusion

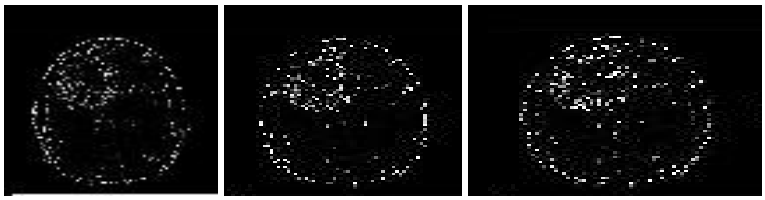
In this proposed work, sample MRI images of the brain is used as the input and pre-processing techniques are used to enhance the quality of the image and also to detect the tumor within the brain while segmenting the image. Watershed algorithm is applied to segment the tumors clearly and are able to outline the shape, it's thickness, size and location of the tumor. The same output is classified using Radial Basis Function (RBF) to perform training and testing and also to detect the accurate stage of brain tumor. This in turn helps the practitioner to diagnose the tumor shape and size since it plays a vital role in the treatment to the tumor. In the

future, the proposed system will be extended using simple algorithms to calculate the area and the thinness of the tumor and also to locate the tumors.

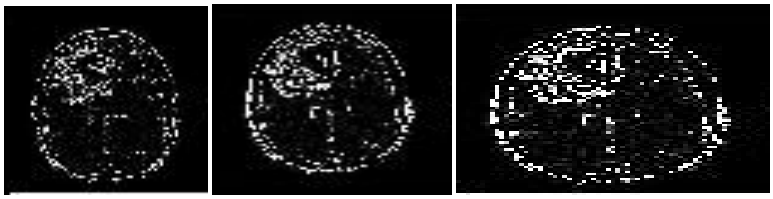
Original image High pass =5 High pass =9



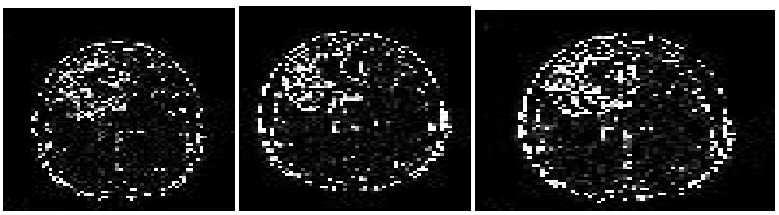
Robert Gx Robert Gy Robert Gx+Gy



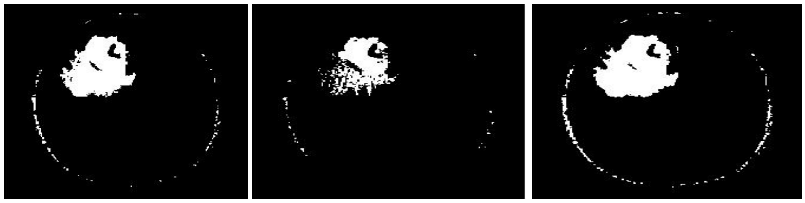
Prewitt Gx Prewitt Gy Prewitt Gx+Gy



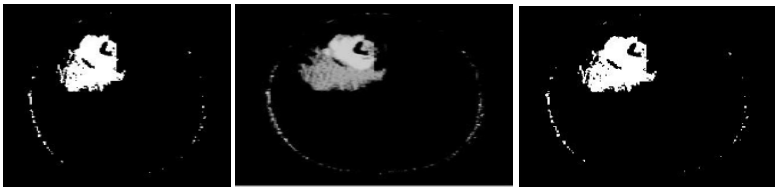
Sobel Gx Sobel Gy Sobel Gx+Gy



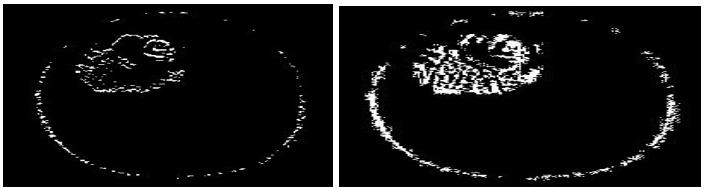
Thresholding = 0.3 Thresholding=0.6 Multiple thresholding



Otsu-optimal segmented image | Badly illuminated image | Otsu segmentation for bad illuminated image



Adaptive threshold=18 | Adaptive threshold=2

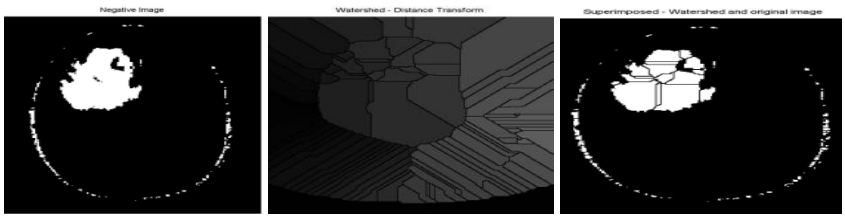


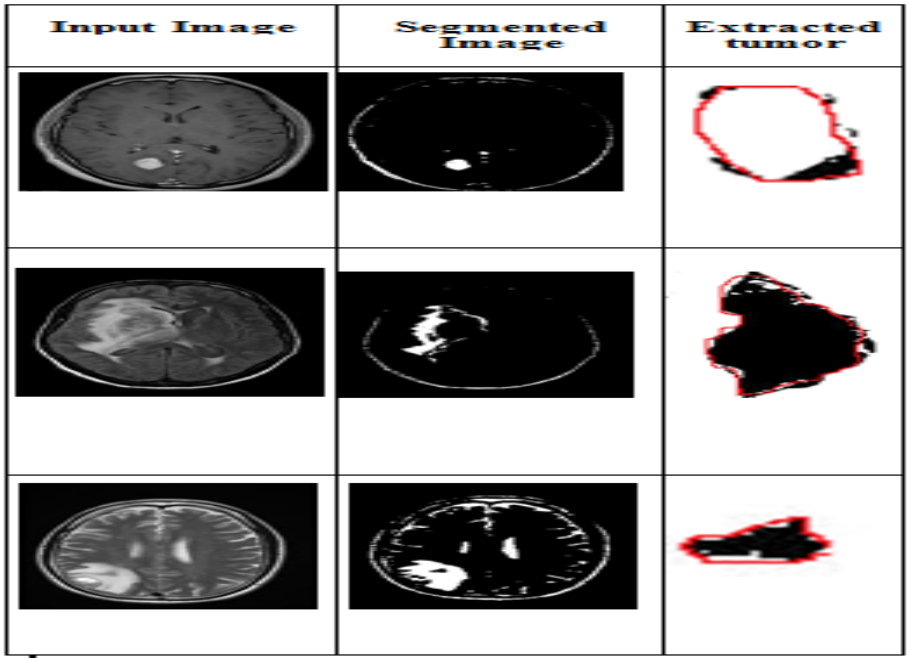
Watershed algorithm

```
figure,imshow(f),title('Original Image');
figure,imshow(bw),title('Negative Image');
figure,imshow(ws),title('Watershed - Distance Transform');
figure,imshow(rf),title('Superimposed - Watershed and original image');
h=fspecial('sobel');
fd=im2double(f);
sq=sqrt(imfilter(fd,h,'replicate').^2+imfilter(fd,h','replicate').^2);
sqoc=imclose(imopen(sq,ones(3,3)),ones(3,3));
wsd=watershed(sqoc);
wg=wsd==0;
```

```
rfg=f;
rfg(wg)=255;
figure,imshow(wsd),title('Watershed - Gradient');
figure,imshow(rf),title('Superimposed - Watershed and original image');
im=imextendedmin(f,20);
Lim=watershed(bwdist(im));
figure,imshow(Lim),title('Watershed - Marker Controlled');
```

Negative image Watershed Distance Transform Superimposed Watershed





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