Automated Brain Tumor Detection And Quantification

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Abstract— **Few techniques to obtain Human anatomy are Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Position Emission Tomography (PET) etc. Brain tumor diagnosis is easy by using these medical equipments. The correct measurement of the tumor area for the further treatment, needs to extract the abnormal part from the 2D MRI scan accurately and measure the region of interest and Human-Computer interaction is helpful for this procedure. In this paper, we have presented a semiautomatic segmentation method to extract the tumor from MRI scan and measure the exact area, centroids, perimeter, equidiameter, bounding box of the brain tumor by using quantitative analysis. Here we propose a fully automatic algorithm to detect brain tumors by using symmetry analysis . Key indicators of disease progression is obtained by quantitative analysis of MRI brain tumor .Here we consider modular and multi-step approaches mimicking the human visual inspection process. The experiments showed good results also in complex situations. Segmentation of images covers a major position in the region of image processing. Magnetic resonance (MR) imaging provide more perfect information than that of other medical images such as ultrasonic , CT images and X-ray. Tumor segmentation and area calculation from MRI data is an essential but fatigue, boring and time unbearable task when it completed manually by medical professional when evaluate with present day's high speed computing machines which facilitate us to visual study the area and position of unnecessary tissues.**

Keywords— *MRI image, Segmentation, Brain Tumor detection, Morphological analysis, Symmetry analysis, Brain tumor quantification.*

I. INTRODUCTION

Our task is to recognize a tumor and quantifications of the same from a particular MRI scan using digital image processing techniques. Later we compute the area of the tumor using fully automated process and performing symmetry analysis. New technique of automatic segmentation has great capability in clinical medicine by allowing physicians to be free from the burden of manual labelling. Unlike the undisputed usefulness of automatic tumor segmentation, this is not yet a widespread clinical practice, therefore the automatic brain tumor segmentation is still a widely studied research topic. Brain tumors are very heterogeneous in terms of shape, color, texture and position and they can often even deform other nearby anatomical structures. The strong sagittal symmetry of a healthy brain is weakened by the presence of

tumor. The comparison between the healthy and ill hemisphere, considering that tumors are generally not symmetrically placed in both hemispheres, was used to detect the anomaly. One of the motivations to make the substandard segmentation of good organization is the occurrence of artifact in the MR images. Additional cranial tissues (skull) is such an artifact. During segmentation these additional cranial tissues repeatedly hamper with the ordinary tissues which accounts for the substandard segmentation efficiency. A new technique used to produce high resolution images of the parts contained in the human body is MRI. MRI imaging is often used when treating brain tumors. MRI images are used to examine human brain development and discover abnormalities. Out of all medical image processing, image segmentation is initial and most important work, for example, based on accurate segmentation ,quantification of specified region must be done.

A tumor is simply uncontrolled cell growth. Depending on the tumors beginning enlargement prototype and malignancy ,brain tumors are classified into two. Tumors that take place commencing cells in the brain or commencing the wrapper of the brain are called primary tumors. When cancer cells extend to the brain from a primary cancer in a different component of the body they are referred to as metastatic tumors. Studies showed that death due to cancer has increased widely in last 3 decades. Present techniques are faster than current state of the art techniques giving improved results. Our results indicate the benefit of incorporating model aware affinities into the segmentation process for the difficult case of brain tumor. This paper expresses a well-organized technique for automatic brain tumor segmentation for the removal of tumor tissues from MR images. A well occured segmentation trouble within MRI is the task of category voxels according to their tissue type which take account of White Matter (WM), Grey Matter (GM) , Cerebrospinal Fluid (CSF) and rarely pathological tissues like tumor etc. A brain tumor is simply a mass produced by an uncontrolled growth of cells. This is normally found in the brain such as neurons, lymphatic tissue, glial cells, blood vessels, pituitary and pineal gland, skull, or spread from cancers initially located in other organs . Major classifications are based on the type of tissue involved, the location of the tumor, whether it is benign or malignant, and other considerations. Primary (true) brain tumors are named for the cell types from which they

originated. They can be benign (non-cancerous), which means that they do not spread to a different place. They can also be malignant and invasive (spreading to neighboring area). Secondary or metastasis brain tumors take their origin from primary tumor from a different position in the body which increase to the brain. Few major parts from where brain tumors are passed are from the lumy, breast, and kidney or from melanomas in the skin. The first aim of our work is to develop a framework for a robust and accurate segmentation of a large class of brain tumors in MR images. Presently existing methods are region-based. The proposed method tries to combine region and edge information which are drawbacks of existing methods, thus taking advantage of both approaches while cancelling their drawbacks. We remove non-brain data through first segmentation of the brain. However, when the tumor is located very close to the brain surface segmentation fails to give out results. Therefore we propose an improved segmentation method, relying on the approximate symmetry plane.

III. MATERIALS AND METHODS

We have used these basic concepts to detect tumor in our paper, the component of the image hold the tumor generally has extra concentration then the other segment and we can guess the area, shape and radius of the tumor in the image. We calculate the area in pixel. We have used MATLAB for MRI image processing. Noise existing in the image can decrease the capability of region growing filter to grow large regions or may result as a fault edges. When faced with noisy images, it is generally convenient to pre-process the image by using median filter. Median filters have the robustness and edge preserving capability of the classical median filter. In pre-processing some fundamental image enhancement and noise lessening procedure are applied. Apart from that dissimilar traditions to identify edges and doing segmentations have also been used. The intention of these steps is fundamentally to recover the image and the image superiority to get more guarantee and ease in identify the tumor. The noise is reducing by the conversion of gray scale image. Then this gray scale image pass in to the filter. We use here a high pass filter imfilter function in matlab to filter an image, replaces each pixel of the image with a weighted average of the surrounding pixels. The weights are determined by the values of the filter, and the number of surrounding pixels is determined by the size of the filter used. Then the gray image and filtered image are merged together to enhanced the image quality. Here we use Median filtering which is a nonlinear operation often used in image processing to reduce "salt and pepper" noise. A median filter is more effective than convolution when the goal is to simultaneously reduce noise and preserve edges. We use here matlab command medfilt2. Then we convert the filtered image into binary image by the thresholding method which computes a global threshold that can be used to convert an intensity image to a binary image with   normalized intensity value between 0 and 1.The uses Otsu's method , which chooses the threshold to minimize the intraclass variance of

the black and white pixels. Then segment the threshold image by watershed segmentation because It is the best method to segment an image to separate a tumor but it suffers from over and under segmentation, due to which we have used it as a check to our output. It not give the better result after that some morphological operations are applied on the image after converting it into binary form. The basic purpose of the operations is to show only that part of the image which has the tumor that is the part of the image having more intensity and more area then that specified in the strel command. The basic commands used in this step are strel, imerode and imdilate, Imerode: It is used to erode an image. Imdilate: It is used to dilate an image. Marge these morphological outputs with grayscale image by the step9 to step19 and we get resultant output in which tumor detect sharply. Then we make the resultant image with sharp location of tumor by morphological output image and gray image from step9 to step18. Traces the exterior boundaries of objects, as well as boundaries of holes inside these image, in the binary image, it also descends into the outermost objects (parents) and traces their children (objects completely enclosed by the parents). It must be a binary image where nonzero pixels belong to an object and 0 pixels constitute the background. Output is shown only in the color portion of the image with tumor. Then tumor area is calculated from 2nd algorithms. From this area we can assume the dangerousness of tumor.
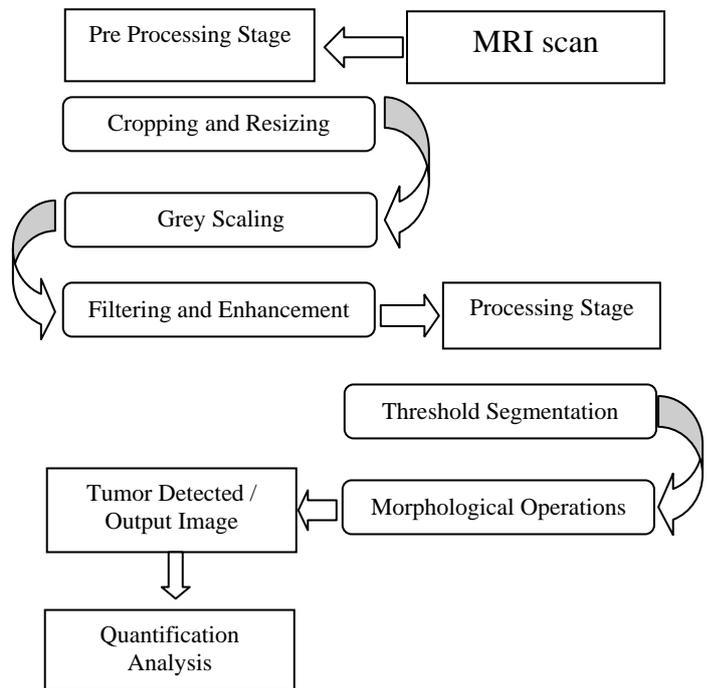
III. OUR APPROACH

Figure1: Stages of Tumor Detection and quantification

A. Input Data Set:

For the implementation of this method we need to have the images of different patients in our database in order to detect and quantify the tumor. The MRI image is stored along with our main file from various sources. Various class of MRI image is considered.

B. Pre-processing:

1).Size Standardization: The variations in the brain size and shape of persons need to be taken into account before any general technique is applied. To handle this issue, each MRI image is first cropped by detecting the brain boundary and then resized.

2).Gray-Scale Image : The images received from the MRI Scans must be converted to the Gray scale image because though the images are in gray matter the Red Green Blue components are not visible in the image. Thus removing of this RGB component will help to perform the operations easily. This RGB images are converted to grayscale images by eliminating the hue and saturation information while retaining the luminance. For eg: making the property of the image c x r x 3 to cx r

3).Filtering and Enhancement :
The acquired MRI scanned image, stored in database is converted to gray scale image of size c*r. Image is processed to remove any noise represent. Visual quality of noisy image will not be satisfactory the noiseless, high quality image is then operated by a high pass filter for sharpening and edge detection. The obtained sharpened image is then added to original image for further enhancement.

a) *Noise Removal:* Many filters are used to remove the noise from the images. Linear filters can also serve the purpose like Gaussian, averaging filters. For example average filters are used to remove salt and pepper noise from the image. Because in this filter pixel's value are replaced with its neighborhood values.Median filter is also used to remove the noise like salt and pepper and weighted average filter is the variation of this filter and can be implemented easily and give good results. In the median filter value of pixel is determined by the median of the neighboring pixels. This filter is less sensitive than the outliers.

b) *Image Sharpening:* Sharpening of the image can be achieved by using different high pass filters. As now noise is been removed by using different low pass filters, we need to sharpens the image as we need the sharp edges because this will help us to detect the boundary of the tumor
Gaussian high pass filter is used to enhance the boundaries of the objects in the image. Gaussian filter gives very high rated results and used very widely to enhance the finer details of the objects.

C. Processing:

In this phase Segmentation of enhanced image and Morphological Operations are performed. Image segmentation is based on the division of the image into regions. Division is done on the basis of similar attributes. Similarities are separated out into groups. Basic purpose of segmentation is the extraction of important features from the image, from which information can easily be perceived. Brain tumor segmentation from MRI images is an interesting but challenging task in the field of medical imaging.

1) Threshold Segmentation: Threshold segmentation is one of the simplest segmentation methods. The input gray scale image is converted into a binary format. The method is based on a threshold value which will convert gray scale image into a binary image format. The main logic is the selection of a threshold value. Some common methods used under this segmentation include maximum entropy method and k- means clustering method for segmentation.

2) Morphological Operators: After converting the image in the binary format, some morphological operations are applied on the converted binary image. The purpose of the morphological operators is to separate the tumor part of the image. Now only the tumor portion of the image is visible, shown as white color. This portion has the highest intensity than other regions of the image.
Some of the commands used in morphing are given below:
 1) Strel: Used for creating morphological structuring element
 2) Imerode():Used to erode (Shrink) an image.
 3) Imdilate():Used for dilating (filling, expanding) an image.

D. Quantification Analysis:

The following quantification parameter are used to quantify and find out exact location of the detected tumor.

1). *Area*: Scalar; the actual number of pixels in the region.

2). *BoundingBox*: The smallest rectangle containing the region

3). *Centroids*: 1-by-Q vector that specifies the center of mass of the region. Note that the first element of Centroid is the horizontal coordinate (or *x*-coordinate) of the center of mass, and the second element is the vertical coordinate (or *y*-coordinate).

4). *EquivDiameter:* Scalar that specifies the diameter of a circle with the same area as the region. Computed as sqrt(4*Area/pi). This property is supported only for 2-D input label matrices.

5). *Perimeter*: Scalar; the distance around the boundary of the region. regionprops computes the perimeter by calculating the distance between each adjoining pair of pixels around the border of the region. If the image contains discontinuous regions, regionprops returns unexpected results. The following figure shows the pixels included in the perimeter calculation for this object.

IV. ALGORITHM FOR DETECTION AND QUANTIFICATION OF BRAIN TUMOR

Step1:- Read the input color or grayscale MRI DATA SHEET image.
Step2:- Crop individual slices from data sheet.

Step3:- Select scaling factor S.
Step4:- calculate size [x y] of image matrix
Step5:- Converts input colour image in to grayscale image.
Step6:- Filters the multidimensional array with the multidimensional filter.
Step7:- Add step2, step4 image and a integer value 25 and pass it in to a median filter to get the resultant enhanced image.
Step8:- Computes a global threshold that can be used to convert an intensity image (Step5) to a binary image with a normalized intensity value which lies in between range 0 and 1.
Step9:- Compute threshold segmentation on step6 image.
Step10:-Compute the morphological operation by two matlab command imerode and imdilate and strel with arbitrary shape.
Step11:- Store the size of the step 8 image into var1 and var2 i.e no. Of rows and column in pixels by [var1 var2]=size(step8 image)
Step12:- Impose identified tumor location on to the input image.

       Step 12.1:-For i=1:1:var1 do
       Step 12.2:-For j=1:1:var2 do
       Step 12.3:-If step8 image (i,j) == 1 do
       Step 12.4:-step2 image (i,j) = 255
       Step 12.5:-Else do
       Step 12.6:-step2 image (i,j) = step2 image (i,j) * 0.3
       Step 12.7:- End If
       Step 12.8:-End For
       Step 12.9:-End For

Step13:-Write step12 image into a memory location for 3D visualization.
Step14:- Convert in to binary image and traces the exterior boundaries of objects, as well as boundaries of holes inside these objects, in the binary image and into an RGB color image for the purpose of visualizing labeled regions.
Step15:- Show only tumor portion of the image by remove the small object area.
Step16:- Show only tumor portion of the RGB color image.
Step17:-Area calculation

    Step17.1:- Compute numbers of rows and column in pixels by [r2 c2] = size (I) of step15 image.
   Step17.2:- Initialize a variable a=0
   Step17.3:- For i=1:1:r2 do
   Step17.4:- For j=1:1:c2 do
   Step17.5:- If I (i,j)==255 do
   Step17.6:- a=a+0
  Step17.7:- Else do
  Step17.8:- a=a+1
  Step17.9:- EndIF
  Step17.10:- EndFor
  Step17.11:- End For
  Step17.12:- Display the area a.

Step18:-If area =0 display 'no tumor has detected' and go to step25, else do.

    Step18.1:-Calculate Centroid [x,y] of tumor by matlab command
  Centroid =regionprops(step12 image ,'Centroid').

Step18.2:-Display 'tumor has detected' with its location and show step 1 image.
    Step18.2.1:-If x<x1/2 and y<y1/2 display 'Tumor detected at the front-left quarter of brain' else do.
    Step18.2.2:-If x>x1/2 and y<y1/2 display 'Tumor detected at the front-right quarter of brain' else do.
    Step18.2.3:-If x<x1/2 and y>y1/2 display 'Tumor detected at the back-left quarter of brain' else do.
    Step18.2.4:-If x>x1/2 and y>y1/2 display 'Tumor detected at the back-left quarter of brain' .
Step18.3:-end if
Step18.4:-end if.
Step19:- Compute edge detection of step15 image using sobel edge detection technique.
Step20:-Calculate and display 'perimeter of tumor', using matlab command regionprops, and step19 image.
Step21:-Calculate and display 'EquivDiameter' using matlab command regionprops.
Step22:-Calculate and display 'BoundingBox' using matlab command regionprops.
Step22:-Show Step3, Step4, Step12, Step15, Step18 and Step19 images in a single window.
Step23: Convert the quantification parameters to actual dimensions in mm by multiplaying each parameters by s*.36
Step24:Tabulate the quantification parameters.
Step25:-Stop.

V. EXPERIMENTAL OUTCOMES

Results are shown below with coronal brain MRI image slice affected with tumor. Figure 2 is the original MRI scan image; Figure 3 shows grayscale conversion of the image; Figure 4 is the output of the after grayscale image pass into the high pass filtered image and then Figure5 and figure3 image are superpose with a median filter image and get the resultant enhanced image as shown in Figure 6; Figure 5 shows the threshold segmentation with threshold value 0.3 .
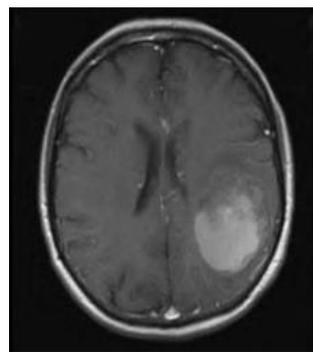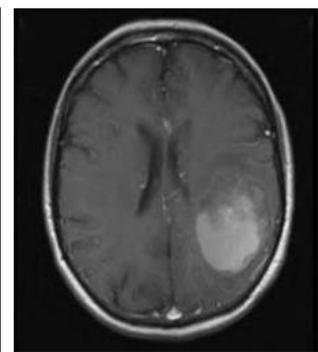

Figure 2: Original Input Image   Figure 3: Grayscale Image
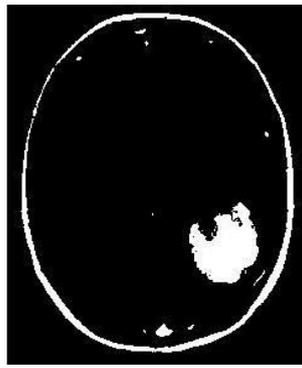
Figure 4: Result of High pass filter

Figure 5: Result of Threshold segmentation
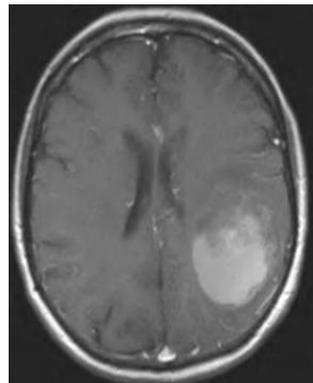

Figure 10: Result of Sobel Edge Detection
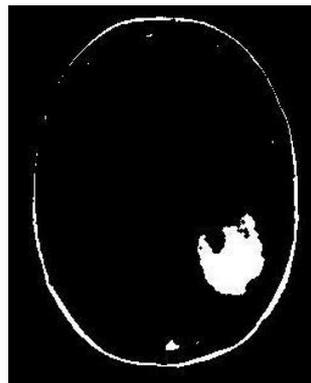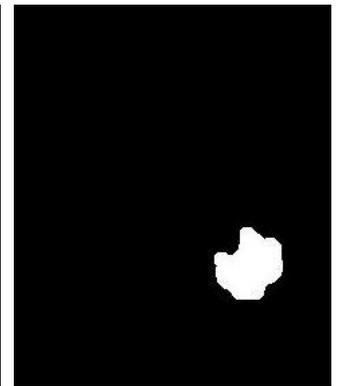

Figure 11: Final Output with Tumor Location only

Figure 6: Enhanced image

Figure 7: Morphological Output-Errosion

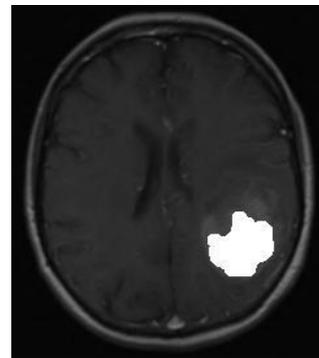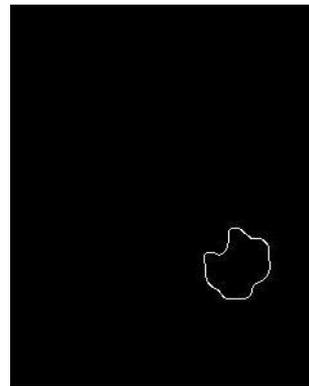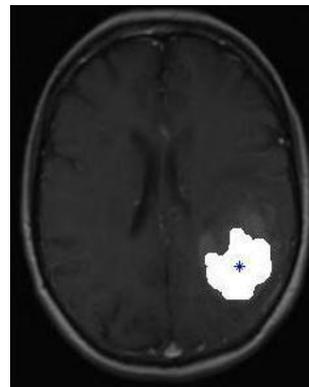Figure 12: Centroid of Detected tumor
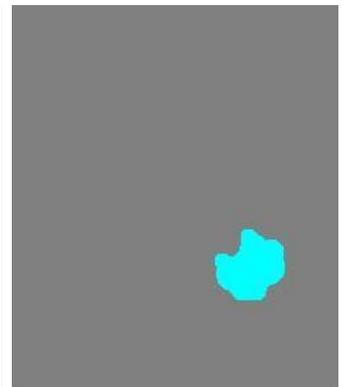
Figure 13: Coloured output with only tumor portion

Figure 8: Morphological Output-Dillation

Figure 9: Output with Tumor Location

Morphological output with disc shape or radius 1 are shown in Figure 7 and Figure 8; Location of the tumor with input image is shown in figure 9; Figure 9 is the edge detection with sobel parameter. Figure 11 shows Final Output with Tumor Location only and Figure 12 shows the centroid of detected tumor , Figure 13 is the coloured image of detected tumor and Table 1 shows the Tumor quantification parameters in pixels.

	Dimensions
Area	1906
Centroids X	178.0331
Centroids Y	204.8893
Perimeter	182.0244
EquivDiameter	49.2625
BoundingBox X0	151.5000
BoundingBox Y0	175.5000
BoundingBox W	51
BoundingBox H	55

Table 1: Tumor Quantification parameters in pixels
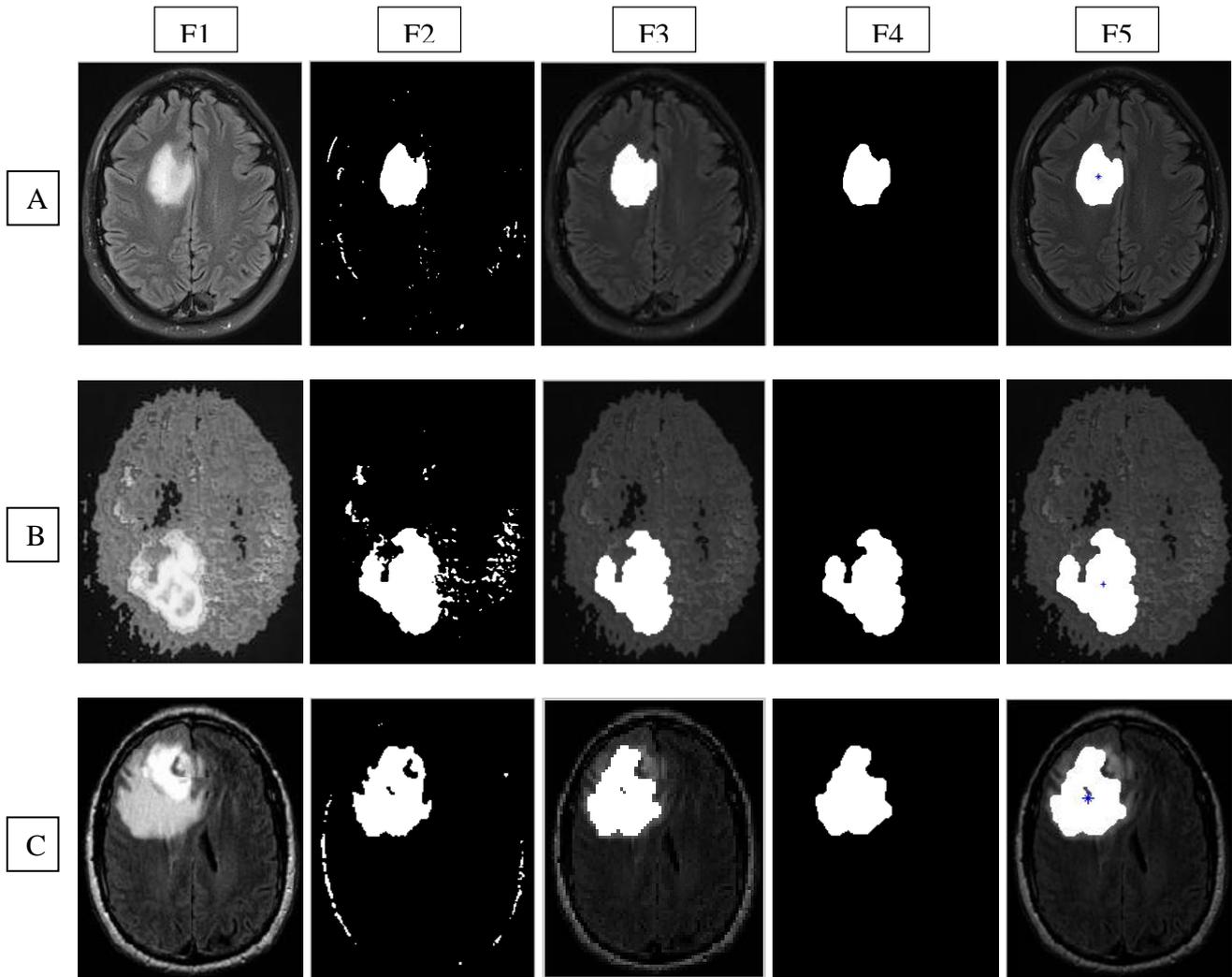
Some other Results are shown below:

Figure 14: Shows the results with different input images namely A,B and C and F1,F2,F3,F4 and F5 are the Input image,Result of segmentation,Tumor location with image,Output with tumor portion only and Centroides of the detected tumor respectively.

VI. CONCLUSION

Brain tumor detection using medical imaging techniques is the aim of this research. Segmentation for quantitative analysis, is done using a method based on threshold segmentation and morphological operators. And this method was experimented with MRI scanned images of human brains: thus locating tumor in the images. MRI images of few samples of brain were taken and then were processed through segmentation methods thus giving efficient end results. The tumors can be found precisely according to the area, perimeter and the exact position of the infected area, these project can help the doctors for the analysis of the tumor and also the damage to the brain in stages i.e in which stage the patient is.

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