

Brain Tumor Segmentation and It's Features Extraction by using T2 Weighted Brain MRI

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Abstract: The objective of this paper is to present a method to detect the exact location of brain tumor and its size by using the T2 weighted brain MRI. This objective has been simulated by using the MATLAB R2012 (7.14.0.739). The algorithm has been developed, which skips the areas of brain which do not suits the criteria of high intensity and high entropy; because these are the two main features of brain tumor in T2 weighted MRI. After that the image is rebuilt by using the extended maxima transformation, which helps to detect the brain tumor. The tumor size, major and minor axis length, eccentricity, Perimeter, solidity all this parameter of brain tumor region are extracted by using the region property functions. This method is very simple, fast and versatile; therefore it can be applicable to all types of 2D MRI which represent the tumors.

Keywords: Magnetic Resonance Imaging (MRI), MATLAB Software, Segmentation, Extended maxima transformation, Region property function.

I. INTRODUCTION

A mass of tissue that directly or indirectly damaged by gradual growth of abnormal cells called as tumor. Generally in our body, cells get aged and dies and then they are replaced by new born cells. But in case of tumor cells does not dies, that cells are called abnormal cells which then directly or indirectly damaged the healthy surrounding tissue and tumor form. Tumor can be of two type i.e. primary tumor and secondary tumor. Tumors that start in cells of the brain itself are called primary brain tumors. Primary tumors can spread to other parts of the brain or to the spine, but rarely to other organs of body. And Metastatic or secondary brain tumors begin in another part of the body and then spread to the brain. These tumors are more common than primary brain tumors and are named by the location in which they begin. Brain tumors have been further classified into benign primary tumors which are noncancerous and malignant primary brain tumors that are cancerous. Benign is the least aggressive type of brain tumor which does not have cancer cells. This type of tumor grows slowly, and typically has clear borders that do not spread into other tissue. And malignant brain tumors contain cancer cells and often do not have clear borders. They are considered to be life threatening because they grow rapidly and invade surrounding brain tissue. Diagnosing a brain tumor can be a complicated process. The present existing technology does not give any information about the tumor detection and classification. The evaluation of tumor is still performed manually. The major drawback of manual segmentation is time consuming and based on human decision. Manual assessment of pathological changes is too difficult for everyday clinical use and therefore it is leading to human errors. That's why the development of tools for an automatic detection of tumor is needed today.

This research paper discuss about the detection of tumor in human brain and the extraction of features of tumor such as area, size, eccentricity perimeter, centroid, major and minor axis length, solidity etc. with a more capable technique. Magnetic resonance imaging (MRI) is a high quality medical imaging method therefore now a day it has become a widely used. MRI is a gold standard for brain tumor diagnosis, proposed by A.H. Jacobs, L.W. Kracht, A. Gossmann [1] and H. Carl, Samantha [2].

The advantage of using MRI for brain imaging is that it provides soft tissue contrast and it is non-invasive. The level of detail we can see using the MRI is extraordinary compared with any other imaging modality. Therefore in our paper MR image is used to detect the brain tumor. Detection of tumor is still done manually in many brain tumor diagnosis centres. As per the radiologist the detection of tumor (diagnosis) in one entire MRI report takes almost 10-15 minutes. Therefore the present technology needs the accurate extraction of tumors with less time. So CAD system is useful in this concept. In this research paper, MATLAB R2012a (7.14.0.739) is used to extract the brain tumor with less time. In this paper the time for detection of tumor region is also calculated.

II. LITERATURE SURVEY

Deepthi Murthy T.S. and G.Sadashivappa [3] in their paper has presented thresholding method for automatic brain tumor detection. In this paper, along with the basic morphological commands such as imerode and imdilate, the region of interest is also detected and some of the important features of brain tumor are also extracted. Sandabad Sara, Sayd Tahri Yassine, Benba Achraf,

Hammouch Ahmed [4] proposed a histogram analysis method of MRI image to find the threshold intensity. Then it is used to detect and extract the brain tumor.

Navneet Kaur, Mamta Juneja [5] proposed gradient differential criteria for identification of the brain tumor. The author used the high intensity and high entropy characteristics of tumor area to detect the brain tumor. According to author this method takes only 3.98 seconds to detect the tumor. Sudipta Roy, Samir K. Bandyopadhyay [6] proposed a fully automatic algorithm to detect brain tumors by using symmetry analysis method.

The authors Phooi Yee Lau, Frank C.T.Voon, Shinji Ozawa [7], presents an analytical method to detect tumors in digitized medical images for 3D visualization. In this paper, tumor is detected using three parameters: edge (E), gray (G), and contrast (H) values. In this paper, EGH parameters in a supervised block of input images are studied. These feature blocks is then compared with standardized parameters to detect tumor, e.g. image block which contain tumor cells.

The Author Sudipta Roy, Samir K. Bandyopadhyay [8] used the high intensity characteristics of tumor and other abnormalities to detect the tumor and other abnormalities of brain from MRI. The author calculates centroid of brain tumor for detection of tumor position. Pradeep Singh Yadav, Chandrahas Sahu [9] suggest that in the MRI reports tumor area is of high intensity pixels and normal brain tissue are of low intensity pixels. Segmentation done by using only intensity as a parameter is known as Thresholding. This is a basic type of segmentation based on gray level is used by author to classify the tumor. Watershed segmentation and some basic morphological commands are used to extract the tumor.

In the proposed system brain tumor is extracted using High intensity and high entropy parameters of brain tumor. The pre-processing is carried out using Median filter and enhancement is carried out using imadjust matlab function. Segmentation algorithm is used to segment the brain tumor. Implemented algorithm is very simple, computationally fast and execution time is very less compared to other segmentation techniques and accuracy of tumor segmentation is also high. The detail explanation about the methodology and how segmentation is carried out is given in the following sections.

III.BACKGROUND WORK

MRI is a non-invasive and good soft tissue contrast imaging modality, which provides precious information about shape, size, and localization of brain tumors without exposing the patient to a high ionization radiation [10]. MRI is attracting more and more attentions for the brain tumor diagnosis in the clinical [11]. Therefore we are using the MR image of brain as an input in our project. MRI is a medical diagnostic technique that creates images

of the human body using the principle of nuclear magnetic resonance. The concept of Nuclear Magnetic Resonance (NMR) was first established by Purcell [12] and Bloch [13] in 1946. MRI uses the Magnetic properties of Hydrogen atom, Strong Magnetic Field and Radio Frequency to produce images. MR images are in DICOM format. Signal in MRI image is high or low i.e. bright or dark that depends on the pulse sequence used and the type of tissue in the image region of interest.

In T1 weighted image, increased water, as in edema, Tumor, Infarction, infection appears dark. And Fat, Melanin, protein rich fluid appears bright. And opposite to that in T2 weighted image Increased water, as in edema, Tumor, Infarction, infection appears bright. And Fat, Melanin, protein rich fluid appears dark. So that due to the high intensity of tumor area in T2 weighted MRI we used it in our project.

Image preprocessing is the important step in any image processing operations. Segmentation is never performed before the preprocessing step. Preprocessing is used to enhance the quality of the image. Preprocessing step involves noise removing and image enhancement techniques. Filter is use to remove the noise present in input image. The aim of image enhancement is to improve the sharpness of an image. So that, the further image processing operations automatically gets the 'better' input. If we skipped image prepossessing step then the efficiency, accuracy of segmentation step is reduced because of the presence of noise in the input image.

Segmentation is very important task in image processing. Segmentation is carried out using various techniques such as intensity based, edge detection based, marker controlled watershed based, clustering approach and region growing approach and many more. In Medical applications Segmentation Algorithm is used to segment each and every organ of the human body so that it helps doctors to easily understand the exact location of the problem and therefore they can treat it in better way. The accuracy of the output is completely based on the segmentation technique. Therefore proper selection of segmentation technique is very necessary.

IV.PROPOSED METHODOLOGY

Flowchart for proposed method is given in the fig 1. The brain tumor MRI images are taken from the radiologist of MGM hospital Aurangabad and some of the images are downloaded from brain tumor MRI database. Each input image is initially preprocessed and then segmented using h thresholding technique and detect the exact location and size of tumor which is explained in brief in the following sections.

A. Brain MRI Image Database

In the proposed system some input images are taken from Radiologists and some images are downloaded from internet. The images taken from the radiologist are firstly

converted into regular RGB format with the help of DICOM converter. The fig. 2a and 2b shows the brain MRI image without tumor and fig. 2c and 2d shows the T2 weighted brain MRI image with tumor.

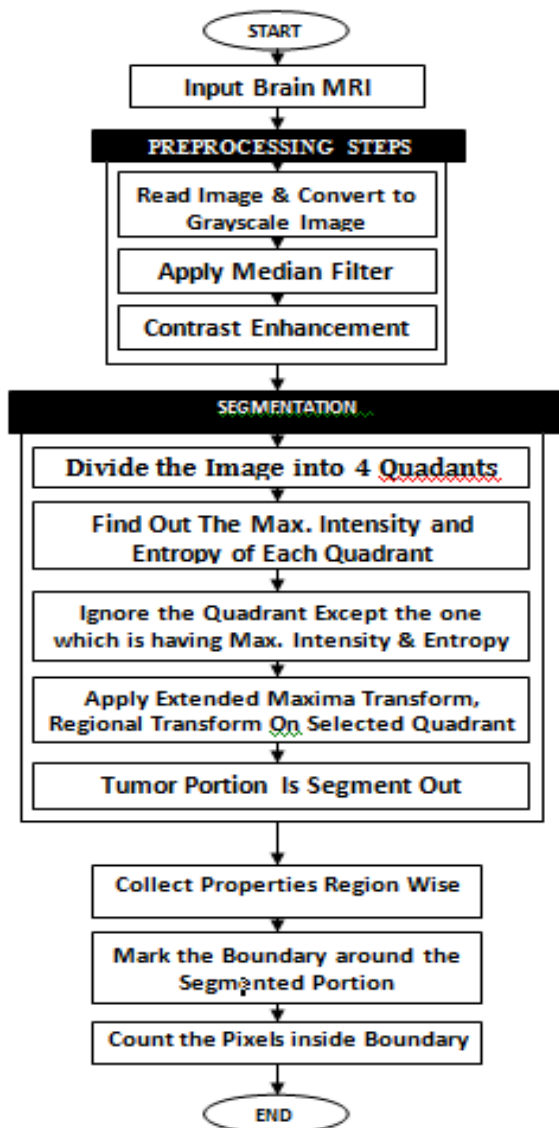


Fig.1. Flowchart of Proposed Method

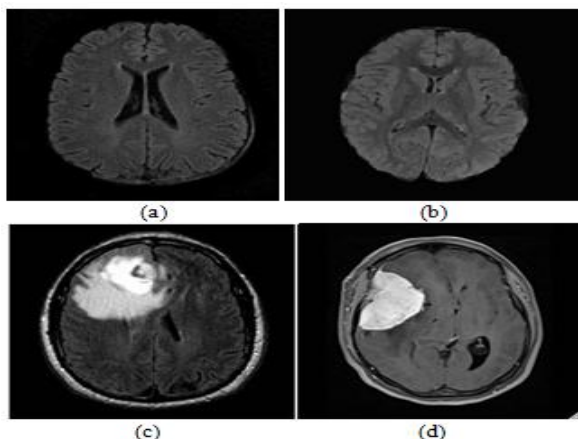


Fig.2. MRI image database with and without tumor

B. Pre-processing Steps

Step 1: Read input image and convert it into Gray scale image:

Digital input image is nothing but a numbers arranged in the form of matrix .we can also say that digital image is collection of pixels and each pixel having some numerical value which shows the intensity value and location value of that particular pixel in the image. Now the initial step of the algorithm is to read the digital input image. imread is the MATLAB command used to read the image from graphics file. After that convert the image into grayscale image. As we know, colour image is the combination of three images i.e. Red, Green, Blue. Therefore it takes more time to work on colour images. So that to reduce the execution time it is necessary to convert the RGB image into gray scale image. There are two methods to convert the image from RGB to gray. One is Average method and other is weighted method.

- Average Method:

This is very simple method in which the average of three colors (Red, Green, and Blue) is taken.

$$\text{Grayscale image} = (R+G+B/3)$$

But in this type of conversion, due to different wavelengths of colors (Red, Green, and Blue) output grayscale image turns into black image. Therefore it is not an effective method to get grayscale image.

- Weighted method:

This method is also called as luminosity method. As we know that wavelength of red color is more than green and blue. And green color has small wavelength compared to red and blue and also green color gives smoothing effect to the eyes. Therefore the significance of red color is decreases and green color increases and the value of blue color is set in between red and green. Therefore the new equation formed is:

$$\text{New grayscale image} = ((0.3 * R) + (0.59 * G) + (0.11 * B))$$

So, the contribution of Red is 33%, Green is 59 % (greater than Red and Blue) and blue is 11%.

Step 2: Apply Median Filters:

Preprocessing is very necessary in every image processing algorithms. This step removes noise present in the input image. This project work uses median filter to remove noise. Median filter is most efficient in removing salt and paper noise present in the image.

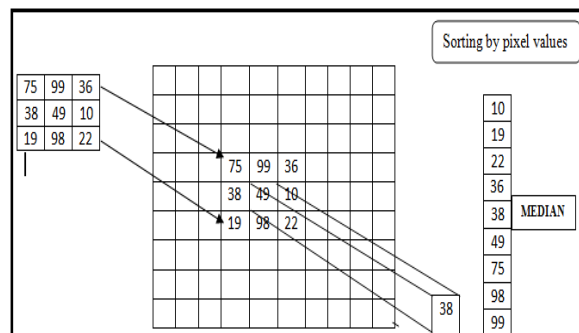


Fig.3. Functionality behind Median Filter

This filter also preserve the edges of input image during smoothing therefore this noise removing method is best in keeping original image information without any change. Median filter is a nonlinear filter in which pixels present in the local window are arranged in order of their intensity values and in result image replace the value of pixel which is present in the middle of window by the median value of this order. And similarly each pixel values are replaced by median of its N×M neighborhood pixels.

Step 3: Grayscale Contrast Enhancement:

Contrast enhancement is the technique which enhances the brightness and contrast of the image. From many previous studies it is proved that contrast enhancement technique is also capable to remove the unwanted noises [14][15][16]. Contrast enhancement plays a very important role in enhancing medical image quality. Thus the resulting improved medical images provide clearer and clean images for better and easier disease screening process by doctor. In this paper imadjust is the MATLAB function which is used for the contrast enhancement.

C. Segmentation

This algorithm is based on three points: (1) The symmetrical structure of the brain, (2) Image intensity, (3) Binary image conversion. It is a well known fact that human brain is symmetrical about its own central axis. In this segmentation algorithm it is considered that the tumor is present in any one of the four quadrants in which brain MRI is divided to reduce the complexity in finding the tumor. Tumor is nothing but a mass of blood cells present in the brain. Brain also contains white matter, Gray matter, CSF, Blood cells. The image of brain in MRI is represented through pixel intensity. As we know MRI is always in grayscale format. Gray scale image having pixel intensity from 0 to 255. Where 0 represents black color and 255 represents white color. In T2 weighted brain MRI image the blood cells appears in white color and 255 pixel value. Now the first step of this method is divide the image into four parts and find out in which part tumor is present. This is achieved just by finding out which part of brain having maximum intensity around 255 [17].

Based on above idea the algorithm is developed which is implemented using MATLAB. The steps included in this segmentation technique are given bellow.

Step 1: First divide the image into 4 equal parts i.e. part 1, part 2, part 3 and part 4.

Step 2: Find out Maximum Intensity and Entropy of each part. Entropy is nothing but a number of connected components. The entropy could be explained in following way:

$$etp = - \sum(p * \log_2(p))$$

Step 3: Now find out the part which we need to work on and ignore other part except the one which is having maximum intensity and entropy value.

Step 4: First find out whether tumor is present in MRI or not and for that, by observing Brain tumor MRI database one threshold value is decided.

Threshold =160

If

(Threshold > Max.Intensity)

Tumor not present

Else

Go to step 5

Step 5: Now by using extended maxima transform convert the image into binary image. By this transformation we get maximum value of function i.e. intensity range that represents a tumor.

Step 6: Thus tumor portion is segment out.

D. Collect Region Properties

Proposed system segment out the tumor portion from brain MRI but it is necessary to verify whether the detected portion is tumor or not .So for that we apply regionprops command of matlab over that portion to verify its identity. We extract the Area, Major and Minor axis length, Essentricity, Perimeter and solidity property of segmented tumor region by using regionprops command.

The Features extracted from different brain MRI with tumor is given in the above table.

TABLE I COMPARISON OF PARAMETERS

| Parameter | BT1 | BT2 | BT3 | BT4 | BT5 |
|-------------------|------------------|------------------|------------------|------------------|------------------|
| Area | 1205 | 627 | 1046 | 1063 | 1771 |
| Centroid | 28.622 41.106 | 82.381 57.523 | 65.495 50.374 | 56.759 97.343 | 28.779 31.970 |
| Perimeter | 183.095 | 137.29 | 159.68 | 119.740 | 174.46 |
| Solidity | 0.8242 | 0.8196 | 159.68 | 119.740 | 0.904 |
| Major Axis Length | 49.037 | 34.996 | 47.323 | 37.878 | 68.816 |
| Minor Axis Length | 33.825 | 26.242 | 31.638 | 35.800 | 37.443 |
| Eccentricity | 0.724 | 0.662 | 0.744 | 0.327 | 0.839 |

E. Mark boundary around segmented portion
Mark the boundary around the detected tumor portion so that tumor could be clearly visible and distinguished by the viewer.

F. Count pixels inside boundary
Count the number of pixels lies within the boundary to find out the tumor size.

G. Calculate the time required to find out the tumor location.

Fig.5 shows the histogram segmentation of image i.e. image is divided into 2 parts so that the tumor portion can be easily localize.

Fig.6 is a quadrant with maximum intensity and entropy with its histogram; Binary image is shown in fig.7; Location of the tumor is shown in fig. 8.

Some other results are shown below:

V. EXPERIMENTAL RESULTS

Results are shown below with image name BT1.Fig.4 is original MRI image with its histogram.

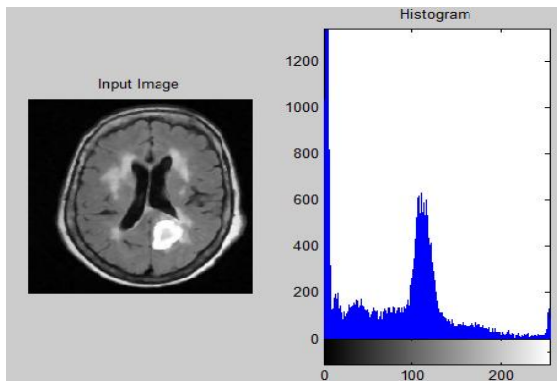


Fig.4. Original input image with its Histogram

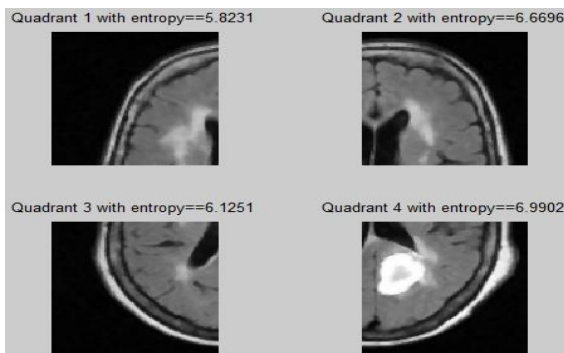


Fig.5. Image divided into two quadrants

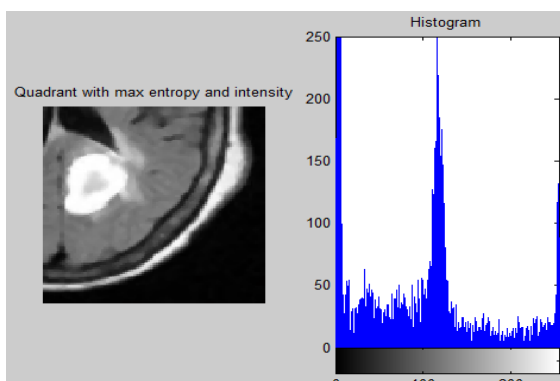


Fig.6. Quadrant with maximum intensity and entropy with its histogram

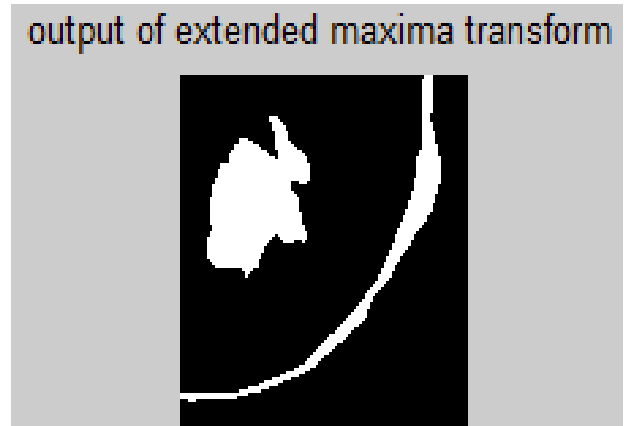


Fig.7. Binary image i.e. output of Extended Maxima Transform

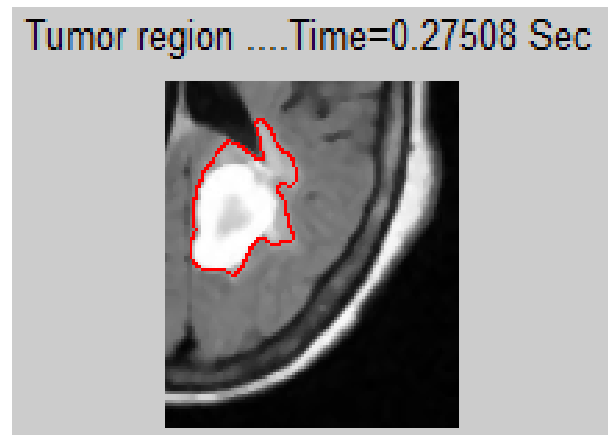


Fig.8. Tumor portion with time required to localize tumor

TABLE II COMPARISON OF PARAMETERS

| Image | Size | Time(sec) Required to Detect Tumor |
|-------|---------|------------------------------------|
| BT1 | 213x226 | 0.27508 |
| BT2 | 200x227 | 0.27591 |
| BT3 | 200x200 | 0.32185 |
| BT4 | 200x228 | 0.27239 |
| BT5 | 200x201 | 0.26445 |

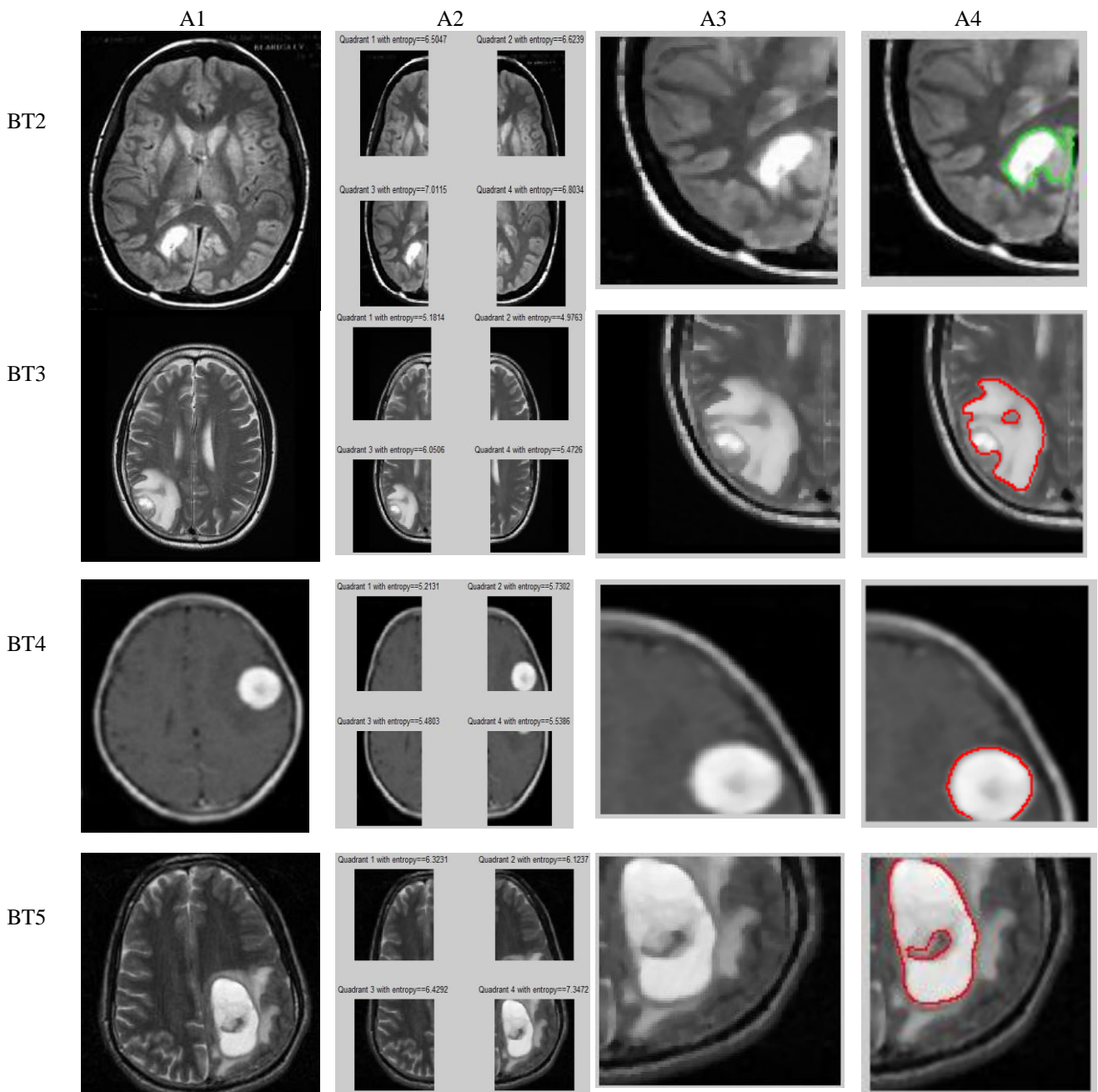


Fig.9. Shows the output image with different input image where BT2, BT3, BT4, BT5 are the different input images. A1 =input image, A2= image segmentation, A3=Quadrant with maximum intensity and entropy, A4=Tumor location.

VI. CONCLUSION

The results shown above shows that the proposed method is best in efficient tumor detection and its features extraction in very less execution time. This method is very less complex as it divides the image into four equal quadrants and find out quadrant having maximum intensity and Entropy as these are the two important parameters of brain tumor and finally transforming the image. Due to this, it becomes easy to locate tumor area and data processing will also be reduced because algorithm has to work on just one quadrant instead of four. The proposed method also finds out the features of tumor

region as shown in table 1. The achieved results show that proposed system is a less complex and good for detection of brain tumor.

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