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BRAIN TUMOR DETECTION, SEGMENTATION USING WATERSHED SEGMENTATION AND MORPHOLOGICAL OPERATION

[1]Pooja Thakur, [2]Dr. Kuldip Pahwa and [3]Dr. Rajat Gupta
[1]Mtech (E.C.E.) Maharishi Markandeshwar Engineering Collage, Mullana, India
[2]Proff. (E.C.E.) Maharishi Markandeshwar Engineering Collage, Mullana, India
[3]Proff. (E.C.E.) Maharishi Markandeshwar Engineering Collage, Mullana, India

Abstract:
In the field of medical image processing, detection of brain tumor from magnetic resonance image (MRI) brain scan has become one of the most active researches. Brain tumor is an abnormal mass of tissue in which some cells grow and multiply uncontrollably, apparently unregulated by the mechanisms that control normal cells. This Paper Present the detection and segmentation of brain tumor using watershed and thresholding algorithm. This technique will help physicians to diagnose brain tumor effectively shape, size and area of the tumor is also calculated.

Keywords: MRI, Brain tumor, Watershed segmentation, thresholding segmentation, morphological operation.

Introduction

Brain, heart and lung and so on are the most critical parts of the human body. And after that, all parts of the body are controlled by the brain cells. Subsequently, brain is a crucial organ of the body. These days, brain tumor is an intense ailment among youngsters and grown-ups. Brain tumor are the most fatal and recalcitrant diseases. Brain tumor's location and rapidly spreading makes a basic issue in treatment of tumor. In this manner, image segmentation and identification are crucial technique to tackle the medical problem of the various diseases.

I. Operations & types of tumors

With time when most typical cells get old or get damaged, they die, and new cells take their place. Sometime, this procedure turns out badly. New cells are formed when body doesn't need them, and old or damaged cells don't die as they ought to. The development of additional cells frequently shapes a mass of tissue called a growth or tumor [1].

B. Type of tumor: Primary brain tumors can be benign or malignant:

Benign brain tumors don't contain cancer cells:

- Usually, benign tumors can be removed, and rarely grow back.
- Benign brain tumors more often than not have an undeniable outskirt or edge. Cells from benign tumors infrequently attack tissues around them. They don't spread to different parts of the body. However, benign tumors can press on sensitive areas of the brain and cause serious health problems.

- Unlike benign tumors in most different parts of the body, benign brain tumors are here and there life threatening.
- Benign brain tumors may become malignant with time.

Malignant brain tumors (also called brain cancer) contain cancer cells:

- Malignant brain tumors are normally more severe and frequently are a risk to life.
- They are likely to grow quickly and crowd or attack the adjacent healthy brain tissue.
- Cancer cells may split far from malignant brain tumors and spread to different parts of the brain or to the spinal cord. They seldom spread to other parts of the body.

Tumor grade

Specialists group brain tumors by grade. The evaluation of a tumor alludes to the way the cells look under a microscope:

- **Grade I**: The tissue is benign. The cells look almost like ordinary brain cells, and they grow gradually.
- **Grade II**: The tissue is malignant. The cells look less like typical cells than do the cells in a Grade I tumor.
- **Grade III**: The malignant tissue has cells that look altogether different from typical cells. The anomalous cells are actively growing (anaplastic).
- **Grade IV**: The malignant tissue has cells that look most irregular and have a tendency to grow rapidly. Cells from low grade tumors (grades I and II) look more typical and by and normally grow more slowly than cells from high-grade tumors (grades III and IV).

Over time, a low-grade tumor may tumor may turn into a high-grade tumor. In any case, the change to a high-grade tumor happens more frequently among adults than children

How is brain tumor analyzed?

MRI: MRI is essentially utilized as a part of the biomedical to distinguish and envision better points of interest in the inside structure of the body. This system is fundamentally used to distinguish the distinctions in the tissues which have a much better method when contrasted with computed tomography. So this makes this procedure an exceptionally extraordinary one for the brain tumor identification and growth imaging. In the medical field, magnetic resonance image (MRI) is broadly utilized as a part of numerous examinations. MRI methods is a noninvasive technique and uses powerful magnet and radio waves to make the image of the body. It is suited for probing soft tissues of the human body, for example, Ligament and tendon damage, spinal cord injury and brain tumors, and so on.

The treatment for a brain tumor

Individuals with brain tumors have a few treatment alternatives. The choices are surgery, chemotherapy and radio therapy. Many people get a combination of these treatments. The decision of treatment depends primarily on the following:

- The type and grade of brain tumor
- Its location in the brain
- Its size
- Age and general health

Watershed Based Image Segmentation

Watershed transformation additionally called, as watershed method is an effective mathematical morphological tool for the image segmentation. It is more prevalent in the fields like biomedical and medical image processing, and computer vision [2]. In topography, watershed means the edge that partitions area drained by diverse river system. If image is viewed as geological landscape, the watershed lines find out boundaries which separate image regions. The watershed transform figures catchment basins and ridgelines (otherwise called watershed lines), where catchment basins relating to image regions and ridgelines identifying with region boundaries [3]. Segmentation by watershed embodies many of the concepts of the three techniques such as threshold based, edge based and region based segmentation.
Watershed algorithms based on watershed transformation have mainly two classes. The first class contains the flooding based watershed algorithms and it is a traditional approach where as the second class contains rainfalling based watershed algorithms. Many algorithms have been proposed in both classes but connected components based watershed algorithm [4] shows very good performance compared to all others. It comes under the rainfalling based watershed algorithm approach. It gives very good segmentation results, and meets the criteria of less computational complexity.

There are mostly three stages as shown by Figure 1 for watershed based image segmentation approach. First and foremost stage is characterized as preprocessing, second stage as watershed based image segmentation and last stage as post-processing. Input image is initially processed by the preprocessing stage, and afterward given to watershed based segmentation stage. The subsequent image is post prepared by the last stage to get a segmented image. Preprocessing and post-preparing are important to overcome the issue of over-segmentation in watershed based image segmentation.

II Analysis of issue Worldwide, more than 189,000 individuals were assessed to have passed on from brain and CNS cancer in 2012, with death rates changing over the world [13].

- Brain cancer stays a standout amongst the most incurable types of cancer, with a normal survival time of one to two years.
- The chances for surviving of a person with a brain tumor significantly relies upon following:
- type of tumor
- size of tumor
- location of the tumor
- absence or presence of metastasis
- age
- overall wellbeing, and medicinal history

As indicated by Cancer Research UK:

- Around 9,400 individuals were determined to have a brain, different CNS or intracranial tumor in 2011 in the UK that is 26 individuals every day.
- Around 5,200 individuals died from a brain, different CNS or intracranial tumor in 2012 in the UK that is 14 individuals every day.
- Around a fifth of malignant brain tumor patients are presently liable to survive their infection for no less than five years, and more than 1 in 10 survive for no less than ten years.
- Worldwide, more than 256,000 brain and different CNS tumors were assessed to have been analyzed in 2012, with occurrence rates shifting over the world.
- Worldwide, more than 189,000 individuals were evaluated to have passed on from brain and CNS tumor in 2012, with death rates shifting over the world.

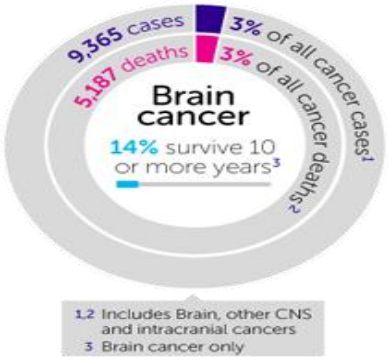

Fig.1 Brain tumor survey

III A. Image Acquisition: Images are acquired utilizing MRI scan and these scanned images are shown in a two dimensional matrices having pixels as its components. These matrices are reliant on matrix size and its field of perspective. Images are stored in Image File and showed as a gray scale image. The entries of a gray scale images are running from 0 to 255, where 0 shows aggregate dark shading and 255 shows pure white shading. Entries between these extents differ in intensity from dark to white.

B. Preprocessing Stage: In this stage image is improved in the way that better points of interest are enhanced and noise is expelled from the image. Most ordinarily utilized enhancement and noise reduction techniques are executed that can give best conceivable results. Enhancement will bring about more prominent edges and noise will be reduced and so the blurring of image is decreased. Notwithstanding improvement, image segmentation will also be applied. This enhanced and upgraded image will help in recognizing edges and enhancing the nature of the overall image. Edge recognition will

prompt discovering the exact location of tumor [14].

1) RGB to gray scale: MRI scan may have some RGB content in the image, so it has to be converted into 2d or a gray scale image

2) Noise Removal: Many filters are utilized to expel the noise from the images. Linear filters can likewise serve the purpose like Gaussian, averaging filters. For instance average filter are utilized to remove salt and pepper noise from the image because in this filter pixel's value is supplanted with its neighborhood values. Median filter is additionally used to remove the noise like salt and pepper and weighted average filter is the variation of this filter and can be executed effortlessly and give great results. In the median filter estimation of pixel is dictated by the median of the neighboring pixels. In this paper median filter is used to remove the noise from the image.

3) Image Sharpening: Sharpening of the image can be accomplished by utilizing diverse high pass filter. As now noise is removed by utilizing distinctive low pass filters, to sharpen the image as the sharp edges are required in light of the fact that this will help in distinguishing the boundary of the tumor. Gaussian high pass filter is utilized to enhance the boundary of the object in the image. Gaussian filter gives high evaluated results and utilized broadly to enhance the finer details of the object.

C. Processing Stage: Image segmentation is taking into account the division of the image into regions. Segmentation is done on the premise of similar attributes. Similar attributes are isolated out into groups. Essential motivation behind segmentation is the extraction of vital features from the image, from which information can easily be perceived. Brain tumor segmentation from MRI images is an intriguing however difficult task in the field of medical imaging [15].

In processing segmentation is done utilizing after systems.

1) Threshold Segmentation: Threshold segmentation is one of the simplest segmentation systems. The input gray scale image is changed into a binary image. The basic principle of thresholding technique is to choose optimal threshold value to divide pixels in different classes and differentiate the object from background. The pixels are partitioned depending on their intensity value.

- Global thresholding, using an appropriate threshold T:

$$g(x, y) = \begin{cases} 1, \text{if } f(x,y) > T \\ 0, \text{if } f(x,y) \leq \text{T I} \end{cases}$$

- Variable thresholding, if T can change over the image.
- Local or regional thresholding, if T depends on a neighborhood of (x, y).
- Adaptive thresholding, if T is a function of (x, y).
- Multiple thresholding:

$$g(x, y) = \begin{cases} a, \text{if } f(x,y) > T2 \\ b, \text{if } T1 < f(x,y) \leq T2 \\ c, \text{if } f(x,y) \leq T1 \end{cases}$$

2) Watershed Segmentation: It is one of the best routines to gathering pixels of a image on the premise of their intensities. Pixels falling under comparative intensities are assembled together. It is a decent segmentation system for separating a image to partition a tumor from the image. Watershed is a numerical morphological working device. Watershed is regularly utilized for checking yield as opposed to utilizing as an information segmentation method on the grounds that it typically experiences over segmentation and under segmentation [16].

D. Post-Processing Stage:

Morphological Operators: After changing over the image in the binary format, some morphological operations are applied on it. The motivation behind the morphological operator is to discrete the tumor part of the image. Now just the tumor segment of the image is visible, which is shown with white color. Tumor region has the highest intensity than the other regions of the image. Morphological operators are applied after the watershed segmentation. In this paper, erosion which is one of the morphological operators is applied to detect the tumor. The erosion of A by B is given by the expression:

$$A \ominus B = \{(i, j) : B(i, j)\} \quad (1)$$

Where, A= the paired image,

B= the structuring element

(i, j)= the center pixel of structuring element

Some of the morphing commands used in this paper are given below:

Strel: Used for making morphological structuring element.

Imerode: Used to erode (Shrink) an image.

Imdilate: Used for dilating (filling, expanding) an image[17].

E. Calculation the tumor area: The area of the tumor region is computed by the following equation:

Tumor area=A x total number of pixel in the tumor region (2)

A= V x H (3)

Where, A=the range of every pixel

H=horizontal dimension of the image

V=vertical dimension of the image

H=1/ horizontal resolution of the image

IV RESULTS:

STEP I: Load the MRI: load the MRI

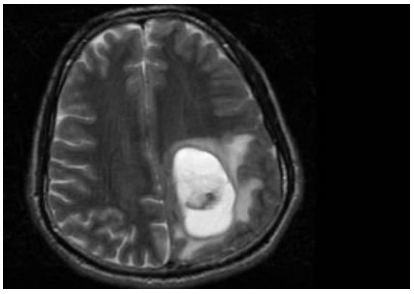

Fig 2: Load the original image

Load the first MRI from the MRI image database. Fig 2 shows the original image from which the tumor has to be detected

STEP II: RGB to gray conversion

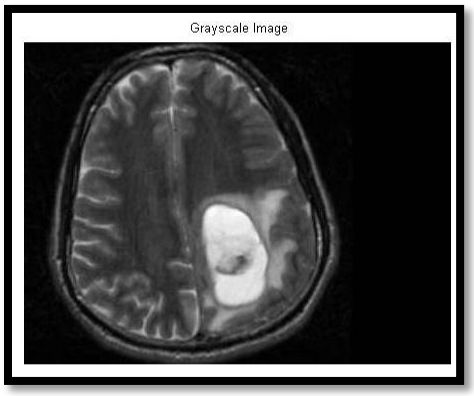

Fig 3: RGB to gray conversion

The original image contains some RGB value; it has to be converted into a gray scale. Fig 3 shows the Gray scale image.

STEP III: Noise removal

The converted image contains some noise which has to be removed. Median filter is used to remove noise if present in the image. Fig 4 shows the image after the noise removal.

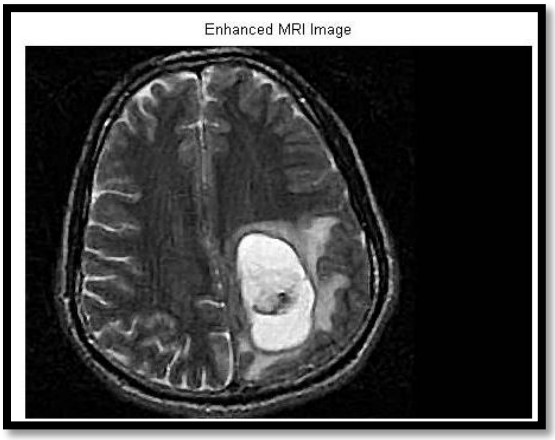

Fig 4.: Median filter output

STEP IV: Enhance image

The noise free image is passed through a high pass filter to enhance the quality of the image. High pass filter is used to make image sharper. High pass filters emphasize fine details in the image. Fig 5 shows the output of high pass filter

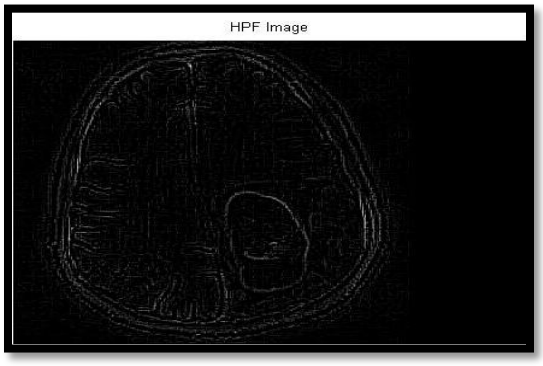

Fig 5: Enhanced MRI image by HPF

STEP V: Segmentation

In this step the segmentation of enhanced image is done. Both thresholding segmentation and watershed segmentation is applied to it. Fig 6 shows the output of the segmentation process.

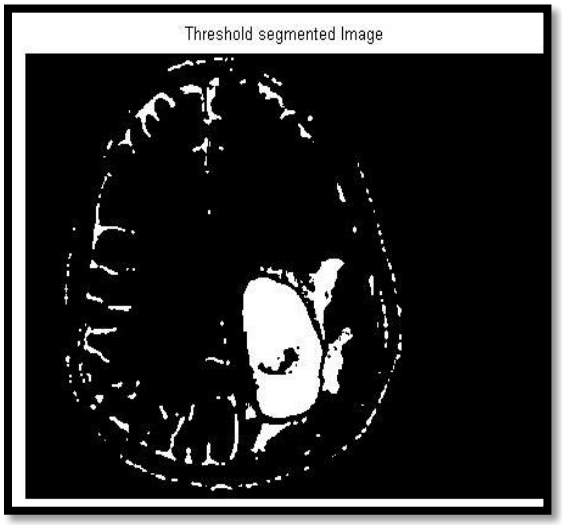

Fig 6: Threshold segmented image

repeating for all pixel coordinates. Imfill is used to fill the small holes in the segmented image.

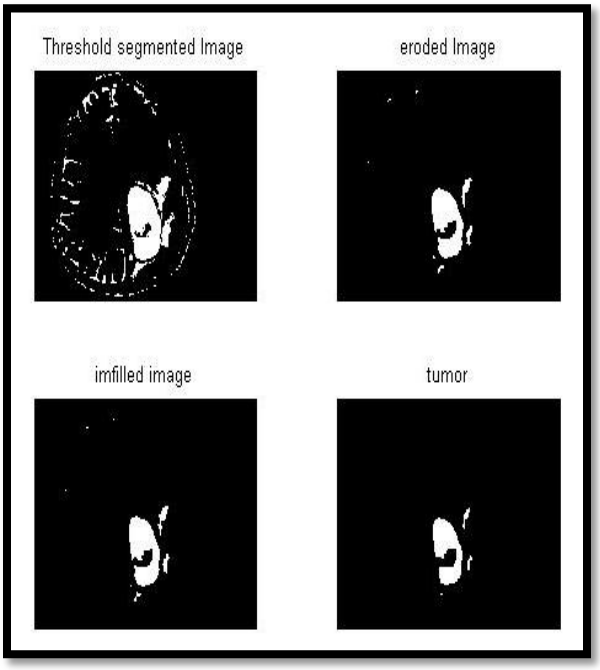

Fig 7: Detection of tumor though different morphological operations

STEP VI: Morphological operations

Here after segmentation varies morphological operations are applied to image. Fig 7 shows the various morphological operation such as erode and imfill. As discussed in above chapter erosion of a binary image by a structuring element produces a new binary image with ones in all locations of a structuring element's origin at which that structuring element fits the input image and 0 otherwise,

STEP VII: Final extracted brain tumor from MRI and calculate the area of tumor

The fig 8 shows the original image and final extracted brain tumor super imposed on original image.

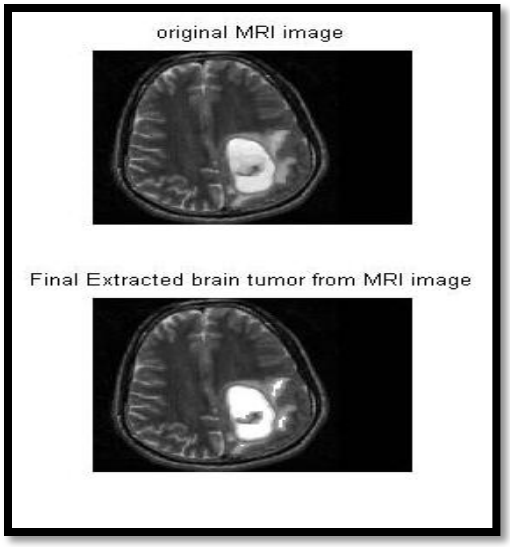

Figure 8: Final extracted brain tumor from MRI

Calculation of tumor area:

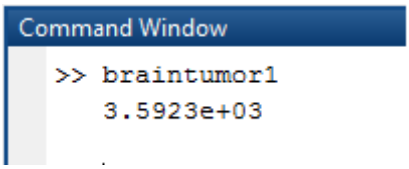

Figure 9: tumor area in pixel

The area of tumor is calculated in pixels. Figure 9 shows the area of the tumor in pixel.

V Conclusion: In this paper, brain tumor is detected by using thresholding segmentation, watershed based segmentation method and with the help of some morphological operators. Watershed segmentation gives very good segmentation results, and meets the criteria of less computational complexity. This paper not only detects tumor, but also calculates the area of the tumor in pixels. This will help the physician in surgery.

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