Brain Tumor Segmentation to Calculate Percentage Tumor Using MRI

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Abstract — **Brain tumor is one of disease type that attacks the brain in the form of clots. There is a way to see brain tumor in detail requires by an MRI image. There is difficulty in distinguishing brain tumor tissue from normal tissue because of the similar color. Brain tumor must be analyzed accurately. The solution for analyze brain tumor is doing segmentation. Brain tumor segmentation is done to separate brain tumor tissue from other tissues such as fat, edema, normal brain tissue and cerebrospinal fluid to overcome this difficulty, The MRI image must be maintained at the edge of the image first with the median filtering. Then the tumor segmentation process requires thresholding method which is then iterated to take the largest area. The brain segmentation is done by giving a mark on the area of the brain and areas outside the brain using watershed method then clearing skull with cropping method. In this study, 14 brain tumor MRI images are used. The segmentation results are compared brain tumors area and brain tissues area. This system obtained the calculation of tumor area has an average error of 10%.**

Keywords— Thresholding, Segmentation, Brain Tumors, MRI Image

I. INTRODUCTION

Cancer cells that grow uncontrolled and attack brain tissue are called brain tumors. Brain tumors consist of benign and malignant tumors. Malignant brain tumors are usually in the form of blood clots accompanied by fat surrounding it. To detect the location and size of brain tumors required MRI images of brain tumors. MRI images can help differentiate brain tissue, brain tumors, edema, and cerebrospinal fluid based on differences in color contrast in each tissue[1]. The problem in radiological is still analyzing the results of MRI brain tumor manually so that it takes a long time to find out the diagnostic from the doctor[2]. Early detection is needed to determine the results of tumor analysis effectively. The MRI scan is more comfortable than CT scan for diagnosis. It is not affect the human body because it does not use any radiation. It is based on the magnetic field and radio waves[3].

Solution to overcome this problem by creating a system that can be integrated automatically and can determine the presence of brain tumors and their extent. The area of the brain tumor that has been detected will help the surgeon to estimate the area of the tumor to be dissected. In future, this system will be developed kiosk for checking brain tumor automatically and effectively[4].

The first step to start performing brain tumors is pre-processing first using the median filtering. Median fitering works by moving the pixel value of the original image to the middle pixel value. The purpose of the median filtering is to maintain the edge of the image. Then thresholding is carried out to identify tumors based on gray level distribution. Thresholding results are used as input to find the largest area. This largest area is useful for separating tumors from other tissues. Then the brain segmentation is carried out using the watershed method which begins by marking the brain region and the outer region of the brain. This marking is useful for distinguishing the brain region and the outer region of the brain. Watershed give different color in the marked area. After that, the removal of skull bones with cropping method.

This paper will discuss brain tumors which are segmented to calculate the area of the tumor and the percentage of area. Supporting theory is discussed in session 2. The proposed method is discussed in session 3. Experimental results are discussed in session 4. Finally, the conclusions are discussed in session 5.

II. THEORY SUPPORT

MRI scanner machine gives effect to MRI images to have a frequency pulse and a strong magnetic field. It can produce detailed images such as images of internal organs, soft tissues, and bones. A detailed MRI image will make it easier for the radiologist to analyze the network to be seen. The MRI image that has been targeted will be saved in the DICOM format. Then if the DICOM image wants to be processed into the system, the DICOM image is converted in jpg format [5].

III METHODOLOGY

In this section, the procedures segmentation of MRI Scan Brain tumor is represented. The method for MRI Scan Brain tumor segmentation that involves median filtering, threshold, largest contour, watershed segmentation, and crop. The procedure is described in a schematic diagram shown in Fig. 1.
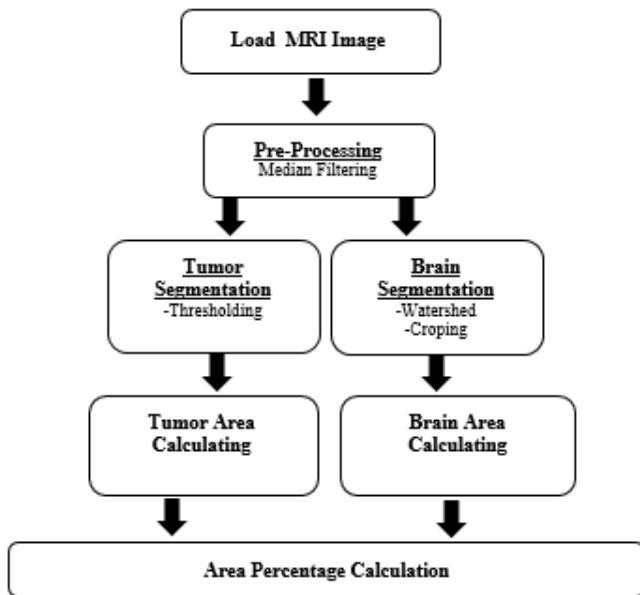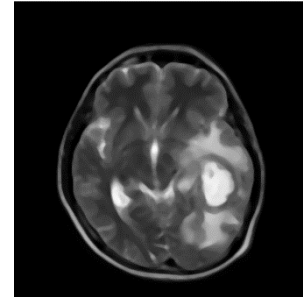
Fig. 1. Schematic diagram of the algorithm

A. MRI Scan Brain Tumor Image

All brain tumor MRI Scans in this research were performed in axial perspective. We just can see the brain from axial perspective . Size of the image is 512 x 512 pixels. Fig. 2 represents the brain images in axial perspective.
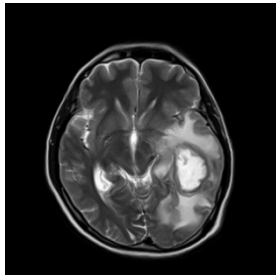

Fig. 2. The brain image in axial perspective

B. Median Filtering

Median filtering is one of methods that can remove noise and retaining edges. The Median filter can move through pixels to pixels in an image then replace each value with the median value of neighboring pixels.

Process to calculate median filtering is to sort all pixel values from window to numerical sequence, and then replacing pixels with pixel middle values. There are steps for finding the above median value. The first step to find the above median value is to read the pixel value to be processed along with its neighbor pixels. The second step to find the above median value is to sort the pixel values from the smallest to the largest. The last step to find the above median value is to select the value in the middle for the new

value for pixels (x, y). The equation of median filtering is shown in [1]

$$y[m, n] = median\ \{x[i,j], (i,j) \in \omega\} \qquad (1)$$

where ω represents a neighborhood defined by the user, centered around location $[m, n]$ in the image.

Using median filtering will give effect to the processed image. It will appear slightly blurred or blurred. Fig. 3 represents the result of median filtering.

Fig 3. Result of Median Filtering

C. Watershed

Watershed transformation is a method used to assign gray images. The basic principle of this method is like a dam that is formed when the water that meets the two cathcment basins will merge into one. The term watershed refers to a ridge that divides areas drained by different river systems. A catchment basin is the geographical area draining into a river or reservoir. The equation of watershed transformation is shown in formula (2) (3) (4) (5).

$$T[n] = \{(s, t)|f(x, y) < n\} \quad (2)$$
$$Cn\ (Mi)\ = C\ (Mi)\ \cap T[n] \quad (3)$$
$$C[n] = \cup_{i=1}^{R} Cn(Mi) \quad (4)$$
$$C\ [max + 1] = \cup C\ (Mi) \quad (5)$$

Min and max notations are used to mark the minimum value and the maximum value of g (x, y). Then make T [n] into a set of coordinates (s, t) where g (s, t) <n so that it can be defined.

Then Cn (Mi) becomes a collection of coordinate points in the filling area that corresponds to the minimum Mi area that is filled in step n. Cn (Mi) can be seen as a binary image and C [n] is a combination of flows in the catchment basin at stage n and C [max + 1] is a combination of all catchment basins.

Water will flow and fill the surface. During the process of filling the water, water will come from two or more different minima. Then the water will reach the desired level and stop flowing when the upper part of the dam is visible.

In this project, the image used to input watershed is the original MRI image. Dam formation was carried out to differentiate areas of brain tumors and skull bone regions. The purpose of watershed transformation is to remove the

skull bone region in the brain. Removal of the skull bone area aims to get a brain region without skull. Fig. 6 represents the result of watershed transformation.
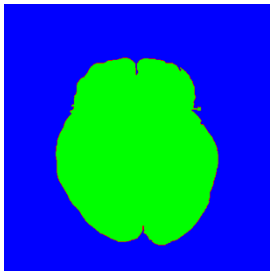

Fig. 6. Result of Watershed Transformstation

D. Crop

One of method to deleting part of an image to cut, retrieve and remove part of the image to obtain the desired result is the cropping method. The cropping method works by cutting the skull bone area to get only the brain region. Find the contours and create a mask is the first step to do cropping. The algorithm of cropping is shown in Fig 7
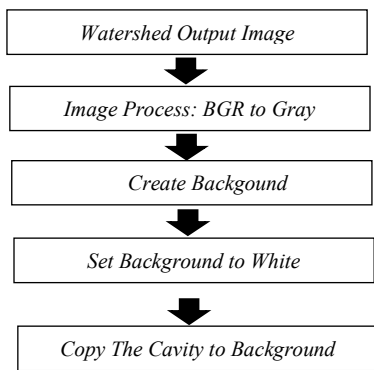

Fig.7. Algorithm of Cropping

Changing the results of watershed images to grayscale is the next step to cropping. Then the results of the grayscale image are processed by the binary threshold method. The the masked original image is copied to the new image, which means only the areas of the contours will be copied. Fig. 8 represents the result of crop operations.
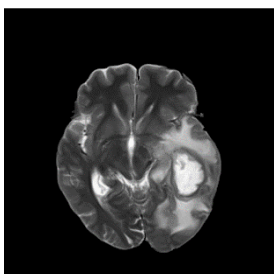

Fig. 8 Result of Crop Operations

F. Threshold Binary

An image produces pixel values that meet the requirements threshold is mapped to a desired value used thresholding method. Thresholding has the aim to change color the background image to be black and make change color the object to be white. The thresholding type used is a binary threshold. The equation of threshold binary is shown in (5).

$$dst(x,y) = \begin{cases} maxVal & if\ src(x,y) > thresh \\ 0 \end{cases} \tag{5}$$

Thresholding works by utilizing the gray level in the image. A threshold that has a pixel value on the image larger than the threshold value then the pixel value will be replaced by maxval value. But if the threshold has a gray pixel value smaller than the threshold then the pixel value will be replaced by 0 or black. Fig. 9 represents the result of threshold binary.

Fig. 9. Result of Threshold Binary

G. Algorithm of Largest Contour

The result of threshold binary produces a series of edge pixels that form region boundary called contour. Therefore the thresholding result is processed again to get the largest contour. The dispersed contours consist of segmented tumors and other segmented organs such as brain tissue, cerebrospinal fluid, and fat present in tumors. The algorithm of largest contour is shown in Fig. 10.
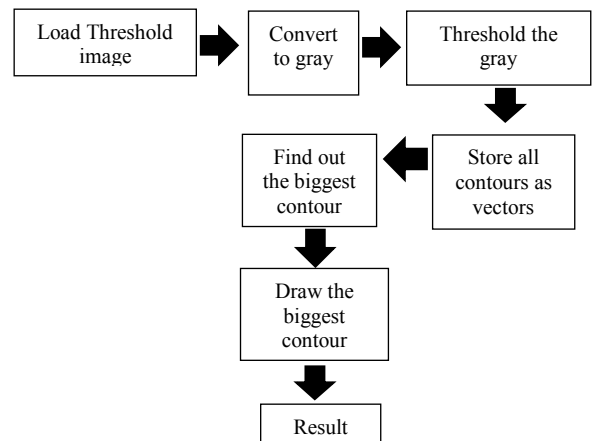

Fig.10. Algorithm of Largst Contour

Thresholding segmentation results produce a series of edge pixels that form a regional boundary or boundary region called a contour. Therefore the results of thresholding are processed again to get the largest contour. The scattered contours consist of segmented tumors and other organs that are segmented such as brain tissue, brain fluid, and fat found in tumors. Fig 11 represents the result of largest contour.

Fig. 11. Result of Largest contour

H. Calculation Pixel of Brain Area & Brain Tumor Area

Search pixels which has a gray value not equal to 0 of the global threshold process is the first step for calculation brain tumor area. The equation of area is represented the result of count pixel that is convert to milimeters in formula (6).

$$Area = (\sum_{i=max}^{i=0} pixsel) \; x \; 0.26 \quad (6)$$

The image will be processed with BGR changes to gray image. Images that have a value of B = G = R will be calculated pixels, where the calculation of pixels will be added up if the gray value is not equal to 0. The number of calculated pixels will be converted to millimeters and multiplied by the scale of the image.
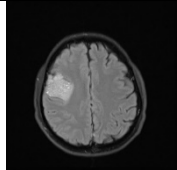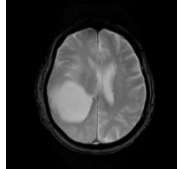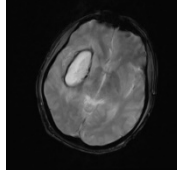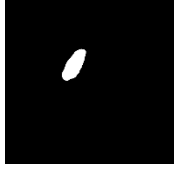
IV EXPERIMENTAL RESULT

This system was tested to show performance of extensive calculations brain tumor area and brain area. The ratio of brain tumors area was calculated using the formula:
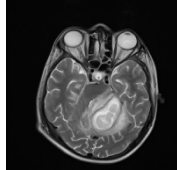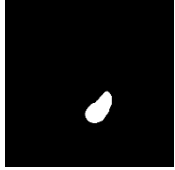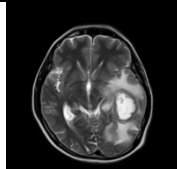
$$Ratio = \frac{Tumor \; Area}{Brain \; Area} \; x \; 100 \; \%$$

The area of brain tumor is obtained by counting the number of tumor pixels. The area of brain tissue is obtained by calculating the number of pixels of the brain. Table 1 shows the calculation ratio of the area of brain tumor and the area of brain tissue that is segmented.

TABLE 1 RATIO OF BRAIN TUMOR AREA

No.	MRI Image	Tumors	Ratio Calculation
1.			3,66%
2.			12,5%
3.			5%
4.			7,45%
5.			3,85%

Then calculation of the average error value of brain tumor s area and brain area. Error values are calculated using the formula:

$$\% \; Eror = \frac{Reference \; Value - Calculated \; Value}{Reference \; Value} \; x \; 100$$

Error testing of tumor extent is used to test how effective segmentation has been done Table 4.9 is the result of the average error of the segmented brain tumor area.

No	Patient	Reference Value (mm^2)	Calculated Value (mm^2)	Error
1	a	2803,68	2584,71	7%
2	b	846,88	682,89	19%
3	c	1445,94	1120,77	22%
4	d	780,55	756,44	3%
5	e	1189,3	1275,25	7%
6	g	901,12	870,47	3%

No	Patient	Reference Value (mm^2)	Calculated Value (mm^2)	Error
7	j	2026,13	2363	16%
8	k	800,32	838,99	4%
9	l	171,19	202,12	17%
10	n	2631,09	2679,6	1%
11	o	1470,7	1409,7	4%
12	u	1083,17	1271,06	17%
Average Error				10%

V. CONCLUSIONS AND FUTURE WORK

The experimental results give conclusion that before do segmentation the brain tumor, the skull shell should be removed first because it has a similarity color with brain tumor object. The process of cutting the skull is done by using Watershed Segmentation method by initializing two lines. In the segmentation of brain tumors performed by thresholding method. After that threholding results were done the largest contour search to separate the object of tumor with other tissues. From the system test obtained the calculation of tumor area has an average error of 10%.

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