Segmentation Stroke Objects based on CT Scan Image using Thresholding Method

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Abstract — Brain image segmentation is one of the most important parts from a clinical diagnostic tool to determine the characteristics of a particular stroke type. Find anatomical contours and the location of the stroke to characterize the type of stroke perfectly in segmentation is very difficult this research proposes an approach to Image segmentation by the process of separating objects from other objects in CT Scan images. CT scan image segmentation uses the thresholding method with the Binarization process. Implementation of the Threshold method is Global binary thresholding, and Otsu thresholding. Preprocessing images to make repairs before segmentation. The dataset is used from Surabaya Hajj General Hospital and public data. The results of this experiment is improved image evaluated using peak signal-to-noise ratio (PSNR) and mean-square error (MSE), the best results were seen in bilateral filtering with a PSNR value of 69% MSE which was the lowest 0.008%. The best stroke object segmentation results using Otsu Thresholding by determining the lower threshold with a High Value of ≤170.

Keywords – Stroke, Segmentation, Thresholding, Noise removal

I. INTRODUCTION

Type of stroke is divided into two types of ischemic stroke when the blood supply to part of the brain is suddenly interrupted, the Stroke Hemorrhagic when the brain blood vessels rupture. Computed Tomography Scanning / CT Scan is one of the diagnostic tests performed to find out how the brain is seen when a stroke occurs. CT scan images that have a thick size will produce a picture with low detail, on the contrary a thin size will produce high detail. If the thickness rises, artifacts will arise and if too thin there will be noise [1][2].

Brain image segmentation is one of the most important parts of a clinical diagnostic tool. Finding the anatomic contour and location of the stroke to characterize the type of stroke perfectly in segmentation is very difficult. this research proposed an approach to image segmentation with the process of separating the object from the location of the stroke with other objects from the CT Scan image. CT scan image segmentation is performed using the Thresholding method with the binary process. The threshold method that will be implemented to be compared is adaptive thresholding, Global binary thresholding, Otsu thresholding.

Before doing segmentation, image repairs will be done, because the CT scan of the brain contains mostly noise, artifacts. It is important to remove noise before image segmentation start. the most common noise seen in CT images are Salt and Pepper noise, Speckle noise, Gaussian noise [3][4]. Image repair will be done by applying Noise Removal to CT scan images. Filters that will be implemented are median Filtering, Gaussian Filtering and Bilateral Filtering, from the three filters the Best filter will be taken for Image repair Performance is evaluated using Peak Signal-to-Noise Ratio (PSNR) and Mean Squared Error (MSE). The best results will be implemented in Stroke Object Segmentation.

II. RELATED WORK

Jodiaman et al. conducted a study of stroke classification which was classified as three ischemic stroke classes, hemorrhagic stroke and normal through CT Scan image images as a dataset. The steps taken are preprocessing digital images consisting of gray scaling to convert images to gray, scaling to reduce image pixels so that time is efficient. Process the Contrast Limited Adaptive Histogram Equalization (CLAHE) to increase image contrast[5].

Siddique et al. In this study the implementation of segmentation using the Thresholding Otsu method on digital images by setting the threshold for the image in Otsu applied. The Otsu method is carried out to study thresholds that can maximize the variance between classes or the equivalent of making light in the class variance of the entire image. The result of this paper is to compare three types, namely original image, Otsu thresholding level 2 image and Otsu Thresholding level 3 image[6].

Pannirselvam et al. in this paper analyzed various filters and proposed a new methodology for fingerprint pre-processing. In this paper use Bilateral Filters, High boost filters and Gaussian filters for efficient fingerprint image quality. In the proposed methodology, the original is filtered using a High Pass and Gaussian filter to remove noise[7].

Shima et al. this study detected kidney lesions using abdominal CT scans. This paper was conducted for the pre-processing of abdominal CT scan images so that the kidneys were grouped for further analysis of lesion detection. Various noise filters and segmentation techniques have been tried to select the best filters and segmentation techniques for CT image pre-processing. Experimental studies found that the Median filter combination followed by Wiener filter was more effective for removing the different noise present in CT images. Different segmentation techniques have been carried out on CT image test data sets and it was observed that Edge-based active contours yield better results than Graph Cut and region-based active contours[8].

III. PURPOSE

The purpose of this study was to segment stroke objects based on CT scan images. Finding the contour of anatomical organs and the location of a stroke to characterize the type of stroke perfectly in segmentation is very difficult. This study proposes an approach to image segmentation with the process of separating objects from other objects in CT Scan images. CT scan image segmentation is done using the thresholding method with the binarization process. The threshold method that will be implemented to be compared is adaptive thresholding, binary thresholding, Otsu thresholding and combining between the Binary and Otsu thresholding methods. patients with three types of image dataset classes namely Ct Scan imagery to be implemented are adaptive Thresholding, and Global Binary Thresholding and Otsu thresholding,

IV. THE PROPOSED METHOD

A. Data Collection

The dataset used comes from two sources, the first is the dataset from Surabaya Hajj General Hospital in Indonesia for data on Ischemic Stroke and Hemorrhagic Stroke, because the not Stroke CT Scan dataset is not available in the Hajj Hospital, to complete the non-stroke CT image using data provided on the website https://radiopaedia.org/, the second source is also used in a paper written by Jodiaman et al [3].The image is taken with a thickness or slice thickness of 5.0 mm, retrieval of data with that size is based on the size of the CT scan image has a thickness range between 1.0 - 10.0 mm, where the value is the middle value of the CT scan parameter size generated by each patient. With a thickness of 5.0 mm, 25 images were obtained for each patient. Of the 25 images taken by one patient, a good picture was found where strokes were seen between 1-5 images. Currently the drawing dataset produced by 102 patients is 233 which are divided into two classes of labels namely 226 ischemic strokes and 7 images of hemorrhagic strokes. To homogenize data between the two data sources, it is necessary to process data, then make improvements to CT scan images

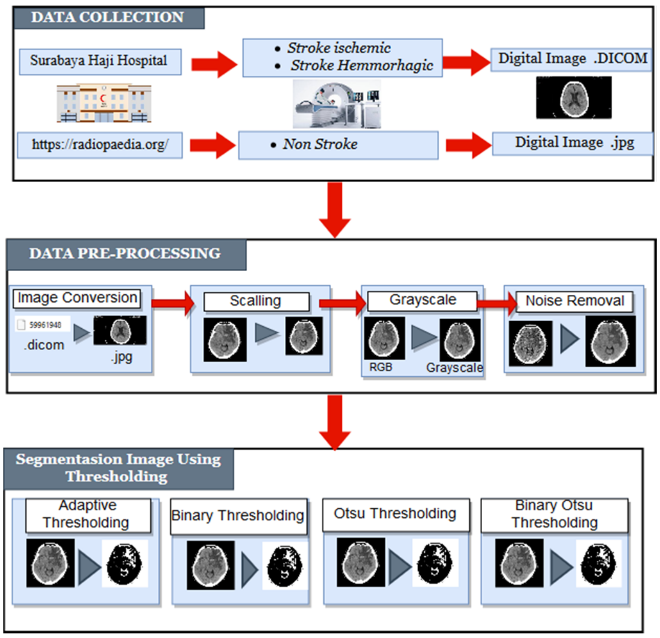


Fig.1 System Design

B. Data Preprocessing

Pre-processing Data is the data processing stage to prepare the Image to be processed and improve the quality of the image data. This process consists of data conversion, from the Dicom extension to jpg. Then apply scaling which functions to adjust the pixel dimensions so that the dimensions of the image have the same size because the data comes from different sources so that the size of the initial dimension is different. The results of the original dataset still represent RGB colors. so that the image that has been processed to scaling will be processed into a Grayscale image that serves to convert the color representation into a gray scale. Then do a Noise Removal, which serves to eliminate noise found on CT scan data. Removal of noise in medical images is an important task in preprocessing images to eliminate noise and improve images better [12]. In this study, the Noise removal method was compared with 3 filters, namely the Median filter, Gaussian Filter and Bilateral Filter. Performance was evaluated using Peak Signal-to-Noise Ratio (PSNR) and Mean Squared Error (MSE)

C. Median Filtering

The median filter method [9]is a nonlinear filter that serves to reduce noise and smooth the image. It is said to be nonlinear because the workings of this filter are not included in the category of convolution operations. Nonlinear operations are calculated by sorting the intensity values of a group of pixels, then replacing the pixel values that are processed with a certain value. The Median Filter output is obtained from:

$$Q^2_{med} = \frac{1}{4n\, f^2\,(n)} \approx \frac{\sigma i^2}{n+\frac{\pi}{2}-1} \cdot \frac{\pi}{2} \qquad (1)$$

Where:

σi^2 : Input Noise Power (the variance)
n : Size of the Median Filtering mask
f(n) : Function of the noise density

D. Gaussian Filtering

Gaussian Filter [10] is a method commonly used in image processing to smooth, reduce interference, and make derivatives of a computational image, and is a convolution based filter that uses a Gaussian Kernel matrix Gaussian filtering is used to obscure images and eliminate noise and detail. The output of the Gaussian Filtering is obtained from:

$$G_\sigma\,(x) = \frac{1}{2\pi\sigma^2}\exp\left(-\frac{x^2+y^2}{2\sigma^2}\right) \qquad (2)$$

Where:

σ : Standard deviation
x : Distance horizontal axis
y : Distance vertical axis

E. Billateral filtering

Bilateral filter [10] functions to smooth images while maintaining edges, with nonlinear synthesis methods of adjacent pixel values. Bilateral filters take into account variations in intensity to maintain edges. The output of the Bilater filter is obtained from:

$$BF[I]_p = \frac{1}{wp} G_{\sigma_s}(\|p-q\|)\, G_{\sigma_r}(|I_p - I_p|) I_q \qquad (3)$$

Where:

Ip : Filtered Images
I : Original Input Image
X : Pixel Coordinates

Gσs : Gaussian Spatial Kernel
Gσr : The Gaussian range reduces the effect of pixels

F. Peak Signal-to-Noise Ratio (PSNR)

The ability of filters to improve image quality is generally assessed by using PSNR which gives the image quality value in the unit of the two origin images and images. The higher the value of PNSR shows the ability of the filter is good in improving the image quality of the filter [10]. PNSR output is obtained from:

$$PNSR = 10.log_{10}\ (MAX_1) - 10.log_{10}\ .MSE \qquad (4)$$

Where:

MAX_1 : Maximum possible pixel value of the I image
MSE : Difference between each original image pixel and filter image using equations,

G. Mean Squared Error (MSE)

Mean Square Error (MSE)[10]: Mean Square Error (MSE) can be estimated to measure the difference between the value implied by the estimate and the actual quality that has been certified . MSE output is obtained from:

$$MSE = \frac{1}{m.n} \sum_{i-0}^{m-1} \sum_{j-0}^{n-1} [I(i,j) - K(i,j)]^2 \qquad (5)$$

Where:

m : Row size image
n : Columns size image
i : Position point row in the image
j : Position point column in the image

H. Segmentasi image Using Thresholding

Image thresholding is a type of segmentation technique that has a process based on gray scale differences in an image. The results of thresholding will produce binary images 0 and 1.

The threshold that will be compared in the Segmentation Implementation is Adaptive Threshold where each pixel image is Thresholding based on neighboring pixel histograms, both Global Thresholding, global thresholds are based on the assumption that images have a bimodal histogram and, objects can be extracted from the background with simple operations that compare values the image with the predetermined and final threshold value with Otsu thresholding divides the gray level image histogram into two different regions automatically without requiring user assistance to enter the background threshold value with a mean of μ0 and foreground with an average of μ1.

V. Experiment and Analysis

A.Data Conversion

The dataset used comes from two sources, the first is the dataset from Surabaya Haji General Hospital for data on Ischemic Stroke and Hemorrhagic Stroke, because the not Stroke CT Scan dataset is not available in the Hajj Hospital, to complete the not stroke CT image using the data public /. The overall data of the Patients amounted to 102 people, the number of Ischemic data was 226 and Hemorrhagic data were 7 images. From several shots for one patient a good picture between 1-5 images could be used as a dataset

The dataset obtained from the hospital is still in the form of data extension in the form of Dicom CT Scan has dimensions of 512 x 512, Gray scale color representation, and 8 Bit depth, so the Dicom image needs to be converted into jpg format to be processed. Data conversion determines the next stage of the process that must be done because each image has different information results, from the dimensions, number of bits and color representation is different. So that the steps taken must be based on the image conversion information.

B.Scalling Dataset

The scaling stage serves to regulate the dimensions of the image used, this is done to uniform the dimensions of the CT scan image, because the datasets have different image dimensions. The dataset from the Hajj Hospital after conversion has an image dimension of 1105x650, while the second data source obtained from the public has a dimension of 300x300. So that the image will be uniformed according to the lowest dimensions by resizing the data that has a larger dimension.

C. Gray Scale

Gray scale functions to scale the gray scale of the image, this is done because the converted digital Ct scan image still represents RGB color, while the Ct Scan image only has light intensity level information that describes the number of photos that penetrate the object, so that the image has been scalloped will be processed into the Gray scale image. In addition, in the segmentation process using the original input image thresholding must be changed to Gray scale first

Not Stroke Ischemic Hemorrhagic

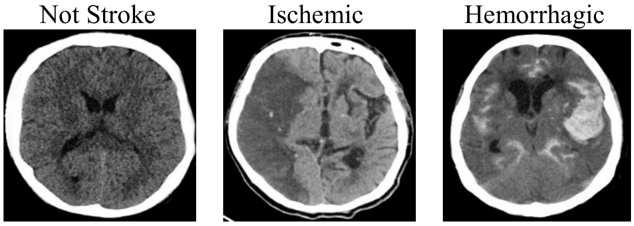


Figure 2. Result Grayscale image

D. Noise Removal Using Median filtering

Median Filtering obtained from the output pixel value is determined by the median of the area mask or specified dimension. Median is searched by sorting the pixel value of the specified mask, then looking for the middle value. The dimensions of the kernel used in this filter are 5 x 5 dimensions.

E. Noise Removal Using Russian Filtering

The Gaussian Filtering functions to ensure that only the closest pixels are considered blurred, while the intensity gaussian function ensures that only pixels with the same intensity as the central pixels are considered blurred. In the implementation the parameters used are the Grayscale image, and the Kernel used is the 5 x 5 dimension, the sigma used is the default parameter with a value of 0.8, the kernel can only be set with an odd value. The standard deviation of a Gaussian distribution will be calculated based on the size of the kernel.

F. Noise Removal Using Bilateral Filtering

Bilateral filtering is defined as a weighted pixel average that takes into account variations in intensity to maintain edges. the parameters used are 8-bit Grayscale image, Pixel diameter initialized with value 9 and Sigma Color sigma filter in color space initialized with 75 and Sigma Space or sigma Filter in the coordinate space initialized value 75. Larger parameter values mean farther pixels will mutually affect as long as the color is close enough.

After the pre-processing with the parameters that have been determined, the filter results can be measured by the accuracy of high image quality, using the value of PSNR & MSE. From Table 1 and Table 2 show the results of filter values that have been done, it can be concluded that the Bilateral Filter gives the highest PSNR value with values and the MSE value is lower when compared with the median and gaussian filters.

Table1 PNSR Value

Filters Name	PNSR VALUE %		
	Non stroke	Ischemic	Hemorrhagic
Median	34.856397	36.170086	36.67901
Gaussian	32.390228	31.842203	30.423184
Bilateral	67.774283	68.975047	68.749674

Table 1 is the result of the assessment of filters that are implemented for Noise removal, the higher the value of PNSR the higher the level of image repair is done. The results of the highest Bilateral assessment of the other 2 filters are Median and Gaussian Filters. Where the stroke ischemic value reaches 69%, and the lowest value is in the gaussian filter with a value of 30%.

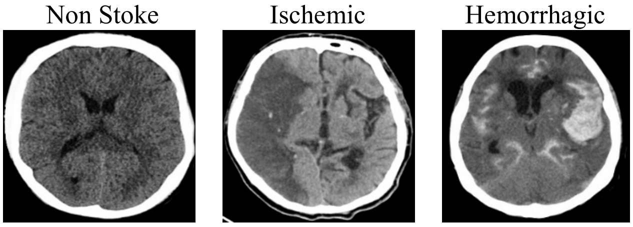
Table 2 Mean Square Error

Filters Name	MSE VALUE %		
	Nonstroke	Ischemic	Hemorrhagic
Median	21.254	3.963108	13.969453
Gaussian	37.50227	42.546133	7.680349
Bilateral	0.010856	0.008233	0.008672

Table 2 show, the MSE assessment can be estimated to measure the difference between the values implied by the estimation and the actual quality, the smaller the MSE value, the better the image produced from image improvement. The smallest MSE value is found in the Bilateral image with a value of 0.008% and the highest is the Gaussian Filtering with a value of 42.5%

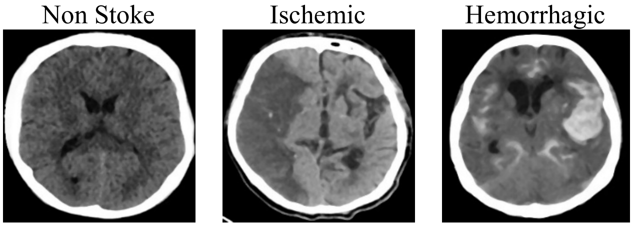
(a)

Non Stoke Ischemic Hemorrhagic



(b)

Non Stoke Ischemic Hemorrhagic



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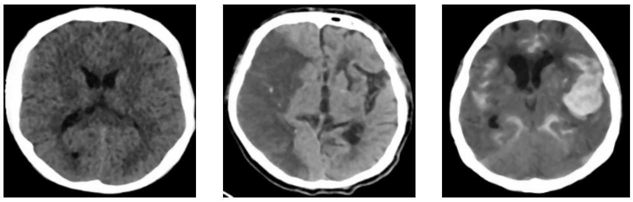
NonStoke Ischemic Hemorrhagic



(d)

NonStoke Ischemic Hemorrhagic

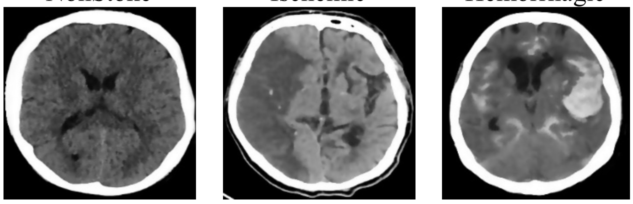


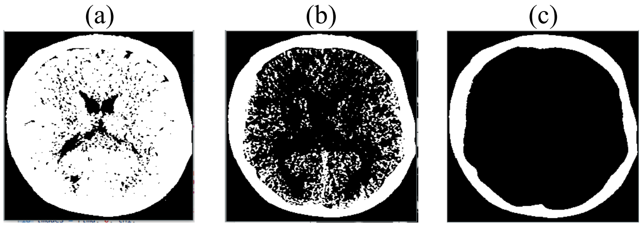
Figure 3. Result Noise removal (a) real data, (b) Median Filtering, (c) Gaussian Filtering, (d) Bilateral Filtering

E. Thresholding

This threshold aims to convert grayscale imagery into binary imagery. The information contained only has two level values namely black and white. Basically, holding has 3 parameters that must be applied, First The source of the image must be Grayscale, second The threshold value used to classify pixel values and last is MaxVal which represents the value to be given if the pixel value is more or less than the threshold value.

Thresholding implementation in segmenting Stroke objects using Global Thresholding and Otsu Thresholding The Threshold Value with a value of 255 and the lower threshold is divided into 3, namely ≤ 50, ≤100 and ≤170. From the results of object stroke segmentation using Threshold can be seen in figure 4.5,6.

(a) (b) (c)



(d) (e) (f)

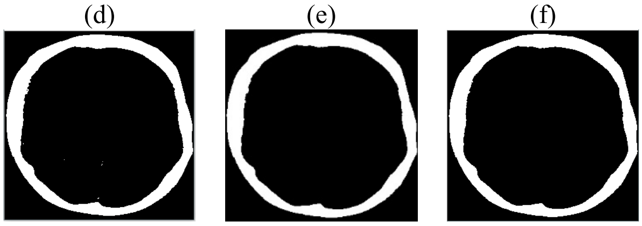


Figure 4 Result Segmentation not Stoke (a) Global Threshold ≤50, (b) Global Threshold ≤100, (c) Global Threshold ≤170, (d) Otsu Threshold ≤50, (e) otsu Threshold ≤100, (f) Otsu Threshold ≤100

In Figure 4 is the result of the Not Stroke Thresholding CT scan, the result of Threshold using the OTSU method produces a consistent image in each of the Lower Threshold parameters which are defined as ≤50, ≤100 and 70170, in the global thresholding method showing maximum results on the lower threshold ≤70.

(a) (b) (c)

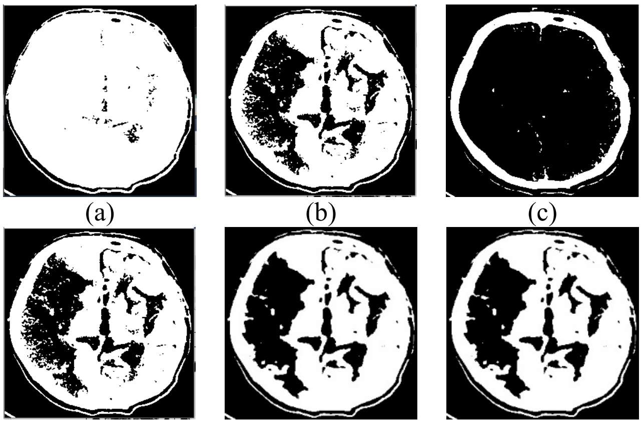


Figure 5. Result Segmentation Stoke Ischemic (a) Global Threshold ≤50, (b) Global Threshold ≤100, (c) Global Threshold ≤170, (d) Otsu Threshold ≤50, (e) otsu Threshold ≤100, (f) Otsu Threshold ≤170

In Figure 5 is the result of the Stroke Ischemic Object Segmentation resulting from the Threshold with the OTSU method still producing the Maximum Image in the Lower Threshold parameter specified is ≤170, in the method.

In Figure 6 is the result of Hemorrhagic Stroke Object Segmentation, the result of Threshold using the OTSU method produces a consistent image in each lower Threshold parameter which is specified as ≤50, ≤100 and ≤170, in the global thresholding method showing maximum results at the lower threshold ≤170

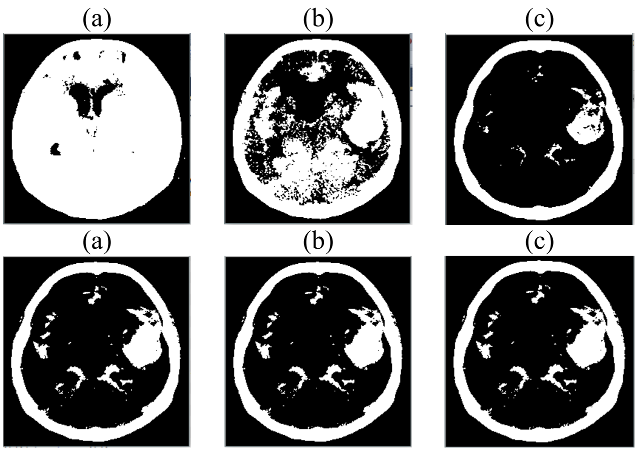


Figure 6. Result Segmentation Stoke Hemorrhagic (a) Global Threshold ≤50, (b) Global Threshold ≤100, (c) Global Threshold ≤170, (d) Otsu Threshold ≤50, (e) Otsu Threshold ≤100, (f) Otsu Threshold ≤170.

Segmentation Ischemic Stroke object produces black while the Hemorrhagic Stroke Object produces a white sting results in the not Stroke CT Image produces a Black block except for the visible part of the Brain Bone. This is based on Parameter which is set by color based on the pixel intensity of the image (x, y) higher than the threshold, then the new pixel intensity is set to Maximal Value. If not, the pixel is set to 0.

VI. CONCLUSION AND FUTURE WORK

In this paper, CT scan image pre-processing techniques are used to support the detection of objects of Ischemic and Hemorrhagic strokes, because the CT scan of the brain contains mostly noise, artifacts. to eliminate noise for better segmentation results. Three types of noise elimination filters are applied to CT Scan images, namely Median filters, Gaussian Filters and Bilateral Filters. This experiment resulted in improved image evaluated using PSNR and MSE, the best results were seen in bilateral filtering with a PSNR value of 69% MSE which was the lowest 0.008%. The best stroke object segmentation results using Otsu Thresholding by determining the lower threshold with a High Value of ≤170. Thresholding segmentation needs to be optimized by repairing other images such as sharpening the edges of removing the brain skull part in the image, so that the cerebral scalp is not visible. In addition, it is necessary to do Morphological Techniques to remove noise and unite objects. The morphological operation function is dilated to develop pixel points according to the dimensions of the kernel used.

Among thresholding segmentation methods, the best result is obtained from a combined method of Binary and Otsu Threshold. However, the drawback to this combined method is that objects that are not ischemic or hemorraghic stroke remain to be detected as an illnes, meaning that corrections on the thresholding segmentation process have to be made. One strategy that can be done is by applying sharpening edges which are sharpening edges that become objects. One way is to erase part of the brain skull line so that the line is not visible when segmented

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