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Analysis of Axial CT-Scan image of COVID-19 patients based in gender using the Otsu Thresholding method

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Abstracts

At the beginning of 2020, the world was shocked by the emergence of the COVID-19 virus. This virus has spread to all corners of the world, not only in Indonesia. Therefore, the government needs to make efforts to break the chain of transmission of this virus. One of these efforts is to detect COVID-19 as early as possible. Using CT images can be one of the early detection efforts of early-phase lung infections in COVID-19 patients. The stage in detecting COVID-19 is by segmenting the image. In this study, segmentation was carried out using the Otsu Thresholding method on 8 axial CT images of the lungs of COVID-19 patients, consisting of 4 images of male patients and 4 images of female patients. Then the image segmentation results of male and female patients were compared and evaluated using ROC measurements, Threshold (T) values and analyzed for GGO (grand-glass opacity). The result can be seen that judging from the value of the ROC measurement results, the measurement of image segmentation evaluation of male patients is more accurate than female patients. The number of false negatives for male patients and female patients is the same, while the number of false positives for male patients is less than female patients. Threshold value of the image segmentation results of male and female patients is the same so that the density of image segmentation is the same. GGO (grand-glass opacity) for male COVID-19 patients aged between 45-55 years is fuller than female COVID-19 patients aged 45-55 years. This shows that men are more at risk of dying from COVID-19 than female.

Keywords: lung; CT-Scan; COVID-19; Otsu Thresholding

1. Introduction

At the beginning of 2020, the world was shocked by the emergence of an infectious disease caused by a virus. Since its discovery, this new virus has been given the name Coronavirus (SARS-CoV-2) or people are more familiar with the name of the disease, namely Corona Disease 2019 (COVID-19) by the World Health Organization (WHO). This virus originated from Wuhan, China and was discovered on December 31, 2019. This virus continues to spread and to date 216 countries around the world including Indonesia have been infected by this COVID-19 virus [1].

According to WHO data [2] as of June 17, 2020, more than 8,061,550 positive patients for COVID-19 have died and more than 440,290 people have died. In Indonesia alone, according to data from the Task Force for the Acceleration of Handling COVID-19 [3], the number of positive COVID-19 patients reached 41,431 people and 2,276 people died. This number is expected to continue to grow considering that the chain of transmission of COVID-19 still exists in the community [3].

The spread of this virus is very easy. Transmission of COVID-19 virus transmission occurs between humans and humans through droplets with an incubation period of about 3-7 days [1]. After the Coronavirus is successfully transmitted, this virus reproduces through host cells [4] and then infects the respiratory tract [1], so the common symptoms caused by this virus patient will usually be fever, cough, and difficulty breathing [5].

Similar to other countries in the world, in Indonesia, patients under monitoring (PDP) and people under surveillance (ODP) are increasing. PSBB (Large-Scale Social Restrictions) is being implemented and health protocols must be heeded. The government's next step is to detect COVID-19 as early as possible.

In the study of Ng, et al [6] on CT images of the lungs of COVID-19 patients, it showed the presence of GGO (grand-glass opacity). In the study of Salehi, et al [7] also found the presence of GGO (grand-glass opacity) as much as 88% on chest CT-Scan.

In addition, in the study of Susilo, et al [8] stated that the results of CT-Scan imaging of COVID-19 patients also obtained GGO (grand-glass opacity). In addition to GGO (grand-glass opacity), infiltrates, peribronchial thickening, focal consolidation, pleural effusion, and atelectasis on chest radiographs were also found, so that radiological examination using CT images can be an early detection of early-phase lung infections [9].

COVID-19 is more common in male (0.31/100,000) than female (0.27/100,000). The dynamics of COVID-19 transmission as indicated by the basic reproductive number (R0) with a median value of 3.28. This means that from 1 person with COVID-19 will infect 3.28 people in a period so that it can cause an epidemic or outbreak [10].

In the study of Susilo, et al [8] it was stated that male sex was a risk factor for COVID-19. This is due to an unhealthy lifestyle, such as smoking and alcohol consumption. In addition, age also greatly affects a person in being infected with the COVID-19 virus. Where the elderly over 50 years are more susceptible to various diseases than younger people [11].

According to data from the Task Force for the Acceleration of Handling COVID-19 [3], as many as 40% of deaths due to COVID-19 occurred in people aged 46-55 years where their immune system had weakened. The first case of COVID-19 death was a 61-year-old male who already had a history of intra-abdominal and liver tumors [9]. Although it is possible that younger people are also susceptible to COVID-19, this study used CT data for patients aged between 45-55 years. In addition to knowing how the image segmentation depicts male and female COVID-19 patients, we also know the comparison of GGO (grand-glass opacity) in the lungs of male and female COVID-19 patients at the age of 45-55 years.

Research conducted by Wibawa, S.M and I Made, A.W.P [12] showed that axial lung CT image segmentation using the Otsu method has an average accuracy, TPR, and TNR value of more than 0.98 so that this method is good for

image segmentation. The effectiveness of the Otsu method for image segmentation is that the Otsu method is an image segmentation method using an automatic threshold value [13] and a simple segmentation technique capable of dividing homogeneous areas based on similarity criteria to make it easier to recognize an object [14]. In addition, the use of a grayscale histogram in the area that is the object of segmentation with the Otsu method is quite accurate compared to other methods [8].

This study aims to compare image segmentation between male patients and female patients infected with COVID-19 using the Otsu Thresholding method. The results of this study are expected to be used as an initial diagnosis of COVID-19 patients. The results of image segmentation can be used to determine the image quality and areas of the lungs infected with COVID-19 and help understand and increase knowledge about COVID-19 and the Otsu Thresholding method.

2. Experiments Procedure

The image data studied were taken from the Github site [20]. The CT image data comes from COVID-19 patients in China and Italy. The images used are 8 axial CT images of the lungs. The CT images consist of 4 images of male patients and 4 images of female patients aged between 45-55 years. In this study there are also several stages. Stages first is taking and axial CT image selection. Second stage image segmentation process using Otsu Thresholding method using MATLAB R2013a software. After that, it is evaluated by measuring ROC which includes the values of accuracy, sensitivity and specificity as well as the Threshold (T) value. Then the image is analyzed by looking at its GGO (grand-glass opacity).

Segmentation

Image segmentation is a grouping technique (clustering) for images or a process of dividing images into regions that have similar features, including: color, grayscale, texture, and motion. [15].

There are two main approaches in image segmentation, namely based on the edge (edge-based) and based on the region (region-based). Segmentation based on the edge divides the image based on the discontinuity between sub-regions (sub-region), while segmentation based on the working area is based on the uniformity that exists in the sub-region. The result of image segmentation is a set of areas that surround the image, or a set of contours extracted from the image (on edge detection) [15].

Otsu Thresholding

Thresholding is a technique that is widely used when segmenting images. This technique divides the gray level image into appropriate segments for several classes based on the gray level value [16] or the image segmentation technique used to adjust the gray level. To do thresholding with degrees of gray can use the formula:

$$X = \frac{w}{b} \tag{1}$$

where w is the value of the degree of gray before thresholding, b is the desired number of gray degrees, x is the gray degree value after thresholding [17].

The thresholding process produces a binary image, which is an image that has two gray level values, namely black and white depending on whether the original pixel is larger or smaller than the threshold value (T). Pixels will be changed to white if the gray level value is greater than the T value and will be changed to black if the gray level value is less than or equal to T [18].

Thresholding divides the area into two classes as follows:

$$g(x,y) = \begin{cases} 0 & f(x,y) < T \\ 1 & f(x,y) \geq T \end{cases} \tag{2}$$

While the Otsu method is a method that aims to find a threshold point that automatically divides the histogram of the gray level image into two different areas [16].

ROC (Receiver Operating Characteristics)

In the diagnostic test there is one measurement called ROC (Receiver Operating Characteristics). In the medical world, ROC measurement serves as an evaluation of medical test results, for example ROC is used to compare a new device with standard medical devices [19].

The requirement for a proper segmentation application to be used is that it must have sufficient accuracy. To help fulfill these requirements, the researcher uses the ROC measurement method, which is to calculate the value of accuracy, sensitivity, and specificity on the segmented image by comparing the segmentation results trial image on the original image [19].

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \quad (3)$$

$$\text{Sensitivity} = \frac{TP}{TP+FN} \quad (4)$$

$$\text{Spesivicity} = \frac{TN}{TN+FP} \quad (5)$$

Where:

1. TP (True Positive), That is the truth value between the results of the trial image with the lungs.
2. TN (True Negative), That is the truth value between the results of the test image and the background.
3. FP (False Positive), That is the value of the inaccuracy between the results of the test image with the lungs.
4. FN (False Negative), That is the value of the inaccuracy between the results of the test image and the background.

3. Result and Discussion

After selecting the CT-Scan image, then the original image is input for segmentation using the Otsu method. Segmentation with the Otsu method is effective because the image or results of an examination using a CT-scan in diagnosing a COVID-19 patient are less specific and the picture is like a person suffering from pneumonia in general. The results obtained are bilateral grand-glass opacity. So that more analysis is needed to indicate COVID-19 patients [21].

After being segmented, you will get the image of the segmentation result. Image segmentation results need to be evaluated. Evaluation of image segmentation in this study uses ROC which includes values of accuracy, sensitivity, and specificity. To get the three evaluation values, it is necessary to search for the number of TN (True Negative), FN (False Negative), TP (True Positive), and FP (False Positive). Table 1 shows the results of the evaluation of image segmentation in each sample.

Table 1. Evaluation of image segmentation results

Image	Male			
	TN	**FN**	**TP**	**FP**
1	374289	0	229872	229872
2	371371	0	229872	229872
3	372198	0	229872	229872
4	373601	0	229872	229872
Image	**Female**			
	TN	**FN**	**TP**	**FP**
1	388096	0	229872	229872
2	393162	0	229872	229872
3	231963	0	229872	229872
4	271780	0	229872	229872

After looking for the evaluation value of the image segmentation results, the next step is to calculate the values of accuracy, sensitivity, and specificity. Accuracy value is the proportion of true test results (true value) among all those examined. Accuracy indicates the level of accuracy of the measurement. The sensitivity score is the proportion of positive test results among people who are sick. Sensitivity indicates the ability of a test to test positive for sick people. While specificity is the proportion of negative test results among people who are not sick. Specificity indicates the ability of a test to be negative for people who are not sick [22]. The average value of accuracy, sensitivity, and specificity for each patient can be seen in Table 2 and Table 3.

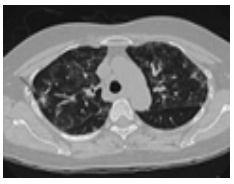
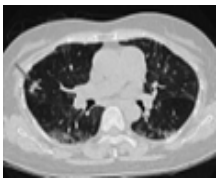
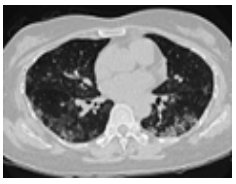
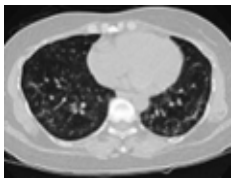
Table 2. Mean values of accuracy, sensitivity, and specificity segmentation of male patients

Image	Accuracy	Sensitivity	Specificity
1	72%	100%	62%
2	72%	100%	62%
3	72%	100%	62%
4	72%	100%	62%
Average	72%	100%	62%

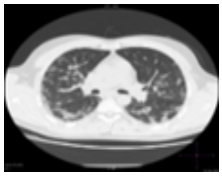
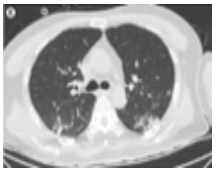
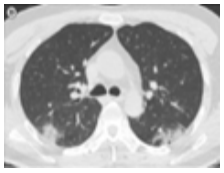
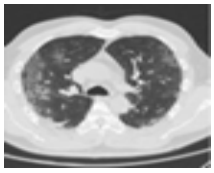
Accuracy, sensitivity and specificity tests were carried out to evaluate the results of medical tests which in this study were in the form of image segmentation using the Otsu Thresholding method. Seen in Table 2, the image segmentation of male patients, the values of accuracy, sensitivity, and specificity are the same, namely 72%, 100%, and 62%. The value of image segmentation evaluation accuracy is 72%, which means, the ability to measure image segmentation evaluation using the Otsu Thresholding method to correctly detect all objects being tested is 72%. The sensitivity value of image segmentation evaluation is 100%, which means, the ability to measure image segmentation evaluation using the Otsu Thresholding method to give positive results for COVID-19 patients is 100%. The specificity value of image segmentation evaluation is 62%, which

Table 4. Comparison of T values of male and female COVID-19 patients

Penderita COVID-19 Laki-Laki Berusia 45-55 Tahun

Pasien 1	**Pasien 2**	**Pasien 3**	**Pasien 4**
Citra Asli	Citra Asli	Citra Asli	Citra Asli
			
Hasil Segmentasi	Hasil Segmentasi	Hasil Segmentasi	Hasil Segmentasi
			
T = 0.498	T = 0.498	T = 0.398	T = 0.498

Penderita COVID-19 Perempuan Berusia 45-55 Tahun

Pasien 1	**Pasien 2**	**Pasien 3**	**Pasien 4**
Citra Asli	Citra Asli	Citra Asli	Citra Asli
			
Hasil Segmentasi	Hasil Segmentasi	Hasil Segmentasi	Hasil Segmentasi
			
T = 0.398	T = 0.398	T = 0.498	T = 0.498

means that the ability of measuring image segmentation evaluation using the Otsu Thresholding method to give negative results for those who do not suffer from COVID-19 is 62%.

Table 3. Mean values of accuracy, sensitivity, and specificity segmentation of female patients

Image	Accuracy	Sensitivity	Specificity
1	73%	100%	63%
2	73%	100%	63%
3	67%	100%	50%
4	69%	100%	54%
Average	71%	100%	58%

Seen in Table 3, the accuracy value in the image segmentation of female patients has the highest value in the 1st and 2nd patient images, namely 73% and the lowest in the 3rd patient image segmentation, which is 67%. The value of the image segmentation sensitivity of male patients is the same at 100%, while the value of the segmentation specificity of the image of male patients is the highest and lowest, respectively, namely in the 1st and 2nd patients by 63% and the 3rd patient by 50%. .

The average value of accuracy of male patients is 72% while the average value of accuracy of female patients is 71%. This means that the measurement of image segmentation evaluation of male patients is more accurate than female patients.

The average value of sensitivity for male and female patients is 100% the same. The higher the sensitivity of a test

Hence the more positive test results in the sick people or the less the number of false negatives [22]. This means that the number of false negatives for male and female patients is the same.

The mean value of specificity for male patients was 62% while female patients was 58%. The higher the specificity of a test, the more negative test results in people who are not sick or the fewer the number of false positives [22]. This means that the number of false positive male patients is less than female patients.

4. Conclusion

The results of the evaluation of the segmentation method using ROC showed that the measurement of image segmentation evaluation of male patients was more accurate than female patients. The number of false negatives for male patients and female patients is the same, while the number of false positives for male patients is less than female patients. The value of the image segmentation density of male COVID-19 patients and female COVID-19 patients is the same. The distribution of GGO (grand-glass opacity) for male COVID-19 patients aged between 45-55 years is fuller than female COVID-19 patients aged 45-55 years, so it is evident that males have a higher risk of death from COVID -19 than female.

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