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Calculation of sharpness in lung images of pleural effusion patients and normal lung images using the thresholding segmentation method

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ABSTRACT

Research on the calculation of tapering from lung's images of patients with pleural effusion and normal lungs has been carrying out using the thresholding segmentation method. The tapering calculation was done using the Matlab programming language by applying the thresholding segmentation method's image processing theory. Images sharpness was obtaining from calculating the longest distance from all distances that were searching in the program. The steps taken in this research were image quality improvement, determination of the region of interest (ROI), thresholding segmentation, and calculating the tilt. Taper count was performing on eight lung images identified pleural effusion and eight lung images identified as normal. In 8 images of lungs pleural effusions, each taper was obtained 166; 159; 167; 167; 150; 157; 114; and 149. Whereas in 8 images of normal lungs, it was obtained that the respective curls were 187; 174; 181; 198; 199; 195; 179; and 195. The analysis showed that the lung's images of pleural effusion patients had a tapering of less than 171. In contrast, normal lung images had a tapering of more than 171, so that one characteristic was obtained that could distinguish between normal lungs and pleural effusions. It can facilitate medical personnel in the early detection of pleural effusion patients so that they can be handled quickly and accurately.

Keyword: Pleural effusion, tapering, thresholding segmentation

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INTRODUCTION

The pleura is a thin double layer of tissue consisting of mesothelial cells, connective tissue, capillary blood vessels, and lymph vessels. All of these tissues separate the lungs from the chest wall and mediastinum (Soe et al., 2012). Pleural effusions limit the lungs' ability to expand and collapse and make it difficult for humans to breathe (Godwin et al., 2015). Pleural effusions occur as a result of accumulating excess pleural fluid (Surjanto et al., 2014). Abnormalities can cause excessive fluid build-up in the pleural cavity in the lungs, such as bacterial, viral, fungal, lung tumors, mediastinal tumors, and metastases (Dwianggita, 2016). Other causes come from diseases such as lymph nodes, hypoproteinemia in kidney disease, liver disease, and heart failure (Yovi et al., 2017).

The diagnosis of pleural effusion is based on the chest X-ray results using a chest CT scan (Hasan & Ambarwati, 2018). The images of the examination results are analyzed and diagnosed by a radiologist. Doctors often experience difficulties in diagnosing pleural effusions because the lungs' anatomical boundaries are reasonable, and the effusions are still vague. The characteristics of pleural effusions are not precise, so sometimes, the determination is always subjective (Situmorang et al., 2014).

Several studies have been conducted including: to determine the type of pleural effusion by measuring the pH of the pleural fluid (Pranita, 2020), to determine the increase in the amount of fluid in the pleura (Fatmasari & Fauzar, 2019), to determine the characteristics of patients with suspected TB pleural effusion (*Tubercle Bacillus*) of the results PCR (*Polymerase Chain Reaction*) (Salmah & Culla, 2018), to determine pleural effusion identified TB (*Tubercle Bacillus*) in children (Harjanto et al., 2018), to determine the characteristics of the causes of pleural effusion at the Arifin Achmad Hospital Pekanbaru (Yovi et al., 2017), and to determine the diagnostic value of pleural fluid adenosine deaminase in pleural effusion patients (Amalia & Pradjoko, 2016). Some of these studies only reveal the characteristics of other diseases caused by pleural effusions. Meanwhile, the main point of further treatment of this disease is to know beforehand that the patient's lungs are standard or effusion identified so that treatment is faster. For this reason, it is necessary to know the characteristics of the lungs of patients with pleural effusion and standard lungs.

RESEARCH METHODS

The materials used in this study were eight lung images of pleural effusion patients and eight standard lung images irradiated by conventional X-ray aircraft from the Toshiba Rotanode DRX-1603B brand with a maximum voltage of 150 kV at Roemani Hospital, Semarang.

Calculation of lung images tapering of pleural effusion patients and standard lungs images is done through several steps, as shown in Figure 1, and the explanation is as follows:

Images quality improvement

Images quality improvement aims to increase the contrast between the object and the background, highlight the images' part to be studied, and remove noise/noise in the images (Mau, 2016). The images repair process is carried out by displaying a grayscale histogram on the images using Matlab. The grayscale histogram depicts the values of the intensity of the image so that dark images and light images can be seen. Dark images have pixels with a concentration close to the value 0, while light images have pixels with an intensity close to the value 255 (Nabuasa, 2019).

The histogram provides knowledge about images with good contrast. It will have an evenly distributed histogram. Dim images have an image histogram collected in a low-intensity area, and bright images have an image histogram obtained in a high-intensity area.

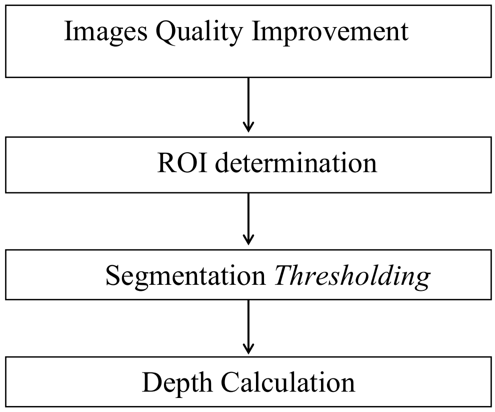


Figure 1. The recalculation process lung images

ROI (*Region of Interest*) determination

The determination of ROI aims to focus on the part of the images that will be processed in determining the cut value. Concentrate of the images is done by limiting the image's area. The method that can be used for restricting the area of the images to be processed using ROI (Region of Interest) (Pratomo et al., 2020). Thus the images of the lungs will be focused on the lower right.

Segmentation *thresholding*

Segmentation aims to separate objects from the background by segment (Senthilkumaran

& Vainthegi, 2016). The threshold technique is one of the essential methods in the image segmentation process. The thresholding process changes the value of the gray degree into two values: 0 (black) and 1 (white). The selection of the threshold value used affects the sharpness of an image (Chaubey, 2016).

The following equation can show this technique:

$$T = T[x, y, p(x, y), f(x, y)] \quad (1)$$

And in general, the grayscale images threshold process to produce binary imagess is as follows:

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

Thresholding is used to partition the images by setting the intensity value of all pixels more significant than the threshold value T as the foreground and smaller than the threshold value T as the background. The threshold value setting is based on the grayscale histogram in the images quality improvement step (Maria et al., 2018).

Calculation of the taper

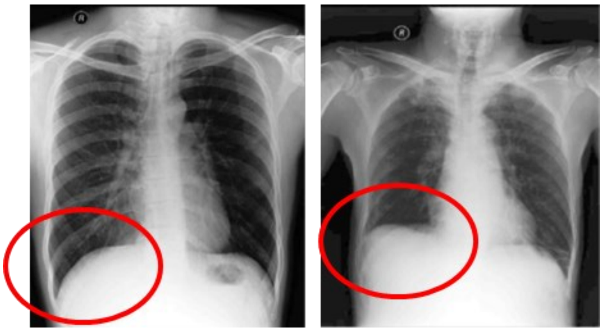
The amount of the longest distance represents the pleural taper's value from the center point of the pleura to the edge of the pleural images. The most extended distance search is done by finding the distance between the center of the pleural images to the side of the pleural images using the center point/centroid method in the MatLab programming. The centroid is the coordinates of the midpoint of an object (Voskoglou, 2013).

The first step is to find center point pleural images then draw a line from the center point to the edge of the pleural images at an angle of 270^0 to 360^0 in quadrant IV with intervals of 0.5^0 to obtain 180 values of the distance from the center point of the pleura to the edge of the pleural images. The angle used is 270^0 to 360^0 because it is a unique feature or differentiator between pleural effusion images and standard pleural images. Of 180 distance values, the largest one is selected, this is what is known as the longest distance, which is used as the value of pleural tapering.

The four processes were carried out on eight lung images of pleural effusion patients and 8 images of standard lungs alternately. A curl value will be obtained from each image, which is then used to distinguish the amount of the lung images of a pleural effusion patient and a normal lung image.

RESULTS AND DISCUSSION

Standard lungs and lungs of pleural effusion patients are shown in Figures 2 (a) and (b).



(a) (b)

Figure 2. Images of lungs (a) Normal lungs (b) Lungs with right pleural effusion (documentation of RS Roemani Semarang, 2016)

From this picture, at a glance, we can see the difference between the lung images of a pleural effusion patient and a standard lung images, namely the lower right corner of the images (red circle). After we observe again, it turns out that the fundamental difference between Standard lung and effusion lung is that the lower right end of the standard lung images is more pointed than the lower right end of the lung images of the pleural effusion patient. This is due to the accumulation of fluid in the lower right corner of the lungs of patients with pleural effusions so that the images appear flatter than usual lungs images. Standard lung images have a higher degree of tapering than the lung images of pleural effusion patients.

Calculating a taper is carried out using the MatLab programming language by applying the image processing theory of the thresholding segmentation method. The first step in the process of calculating the cuttings is images quality improvement. Lungs images of patients with effusion and normal are shown in Figure 5(a). Images quality improvement is performed by displaying the images histogram.

The histogram can remove noise/noise in the images so that the contrast increases, and the image quality is better. As a result, these images of the lungs have a sharper and clearer image quality. The histogram of one pleural effusion images is shown in Figure 3, and the histogram of one of the usual images is shown in Figure 4. The normal images have a more even distribution than the pleural effusion images, which shows that the normal image has better contrast than the pleural effusion images.

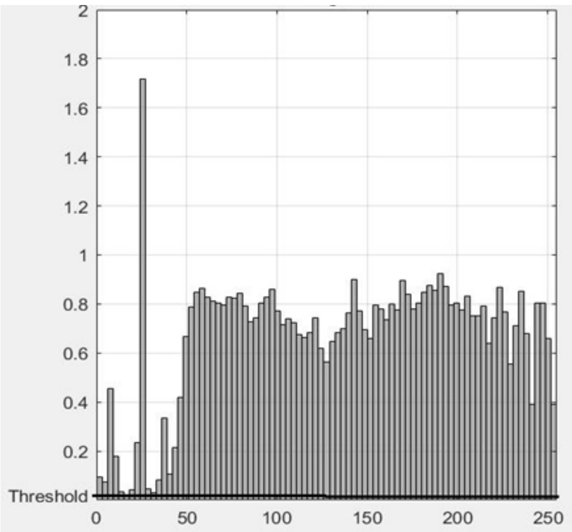


Figure 3. Histogram of pleural effusion

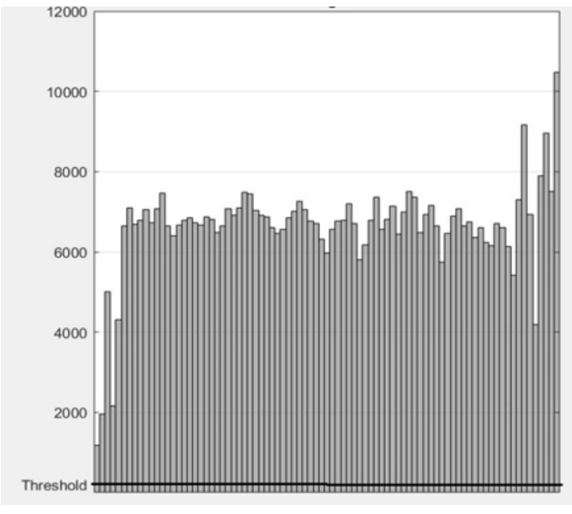


Figure 4. Histogram of normal lung

After images improvement, the next step is to determine the Region of Interest (ROI) / image area boundaries. The purpose of determining ROI is to focus on the part of the pleural images to be studied. The result of the ROI determination process is that only the images of the lower right corner of the lung images are visible for further processing. The image results of the ROI determination process are shown in Figure 5(b). The segmentation thresholding process carries out the images that have focused on the lower right corner of the pleural images. The result of thresholding segmentation is a change in digital images to binary images. The image's results of the thresholding segmentation process are shown in Figure 5(c).

The last process is calculating the tarnish. The binary images resulting from thresholding segmentation are calculated for their curl value by determining the longest distance from the center point of the pleura to the edge of the pleural images using the center point/centroid method with MatLab programming. The part that is looking for the longest point is between an angle of 270^0 to 360^0 because this part is a unique feature or differentiator between pleural effusion images and standard pleural images. From this angle, 180 distance values are obtained, then the most significant amount is chosen. The most substantial cost is known as the longest distance, used as the value of pleural tapering. An image of the tint calculation process is shown in Figure 5(d).

This method of calculating the cuttings was carried out on 16 test images in turn, so that 16 values were obtained. The value data of normal and pleural effusion tapering values are shown in Table 1, and the comparison is shown in Figure 6. The curl values in Table 1 show that eight images identified with pleural effusion, namely pe1, pe2, pe3, pe4, pe5, pe6, pe7, and pe8, have a curl value ranging from 114 to 167. While eight images were identified as normal, namely pn1, pn2, pn3, pn4, pn5, pn6, pn7, and pn8 have a sharpness value ranging from 174 to 199.

(a)

(b)

(c)

(d)

Figure 5. Images of the result of the taper calculation process

Tabel 1. The tapering value of pleural effusion and normal images

Pleural effusion		Normal	
Images name	Sharpness	Images name	Sharpness
pe1	166	pn1	187
pe2	159	pn2	174
pe3	167	pn3	181
pe4	167	pn4	198
pe5	150	pn5	199
pe6	157	pn6	195
pe7	114	pn7	179
pe8	149	pn8	195

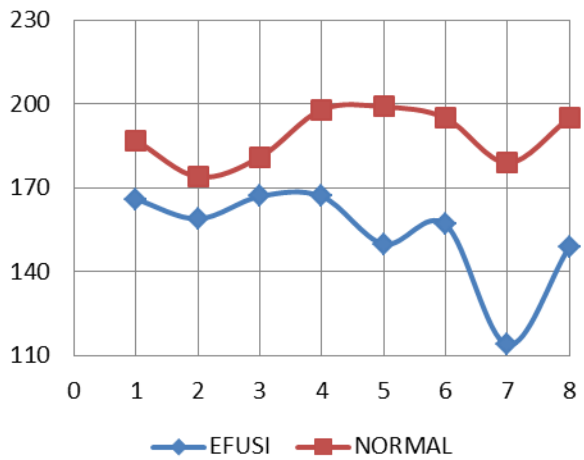


Figure 6. Comparison of pleural effusion tapering and normal images

From Figure 4, the comparison of pleural effusion and normal images tapering can be seen clearly. The blue line's normal lung images have a tapering value that is greater than the lung images of pleural effusion patients, which is shown in the red line. The comparison is that the pleural effusion images have a tilt of less than 171, while the standard images have a tapering value of more than 171. This tapering value is a characteristic that can distinguish between standard lungs and pleural effusion lungs so that it can facilitate medical personnel in early detection—pleural effusion patients so that they can be handled quickly and accurately.

CONCLUSION

In 8 imagess of the lungs of patients with pleural effusion, each taper was obtained 166; 159; 167; 167; 150; 157; 114; and 149.

Whereas in 8 images of normal lungs, it obtained that the respective curls were 187; 174; 181; 198; 199; 195; 179; and 195. It concluded that the lung images of the pleural effusion patient had a curl of less than 171, while the images of the normal lung had a curl of more than 171. These results indicated that the normal lung's curl images were greater than the images of the patient with the pleura effusion. Thus, one of the characteristics distinguishing normal lungs from those with pleural effusion is the image tapering value.

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