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GRADIENT CALCULATION on the PLEURAL EFFUSION and NORMAL LUNGS IMAGE

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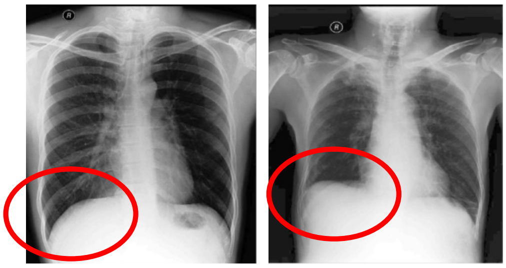
Abstract- A research of gradient calculation for pleural effusion and normal lungs images had been conducted. The gradient calculation was done by using gradient formula on the equation of line. The steps taken in this research were image enhancement, segmentation, and gradient calculation. Gradient calculations were conducted on 8 images of pleural effusion and 8 images of normal lungs. The result of this research showed that the lungs image gradient of the pleural effusion was less than 0.3 whereas the normal lungs gradient was more than 0.3.
Keywords- Gradient, Pleural Effusion, Normal Lungs

I. INTRODUCTION

Pleural are a double layer of thin tissue consisting of mesothelial cells, connective tissue, capillary vessels, and lymphatic vessels. The entire tissue separates the lungs from the chest wall and mediastinum [1]. Pleural effusion limits the ability of the lung to expand and deflate and makes humans difficult to breathe [2]. Pleural effusion results from excessive accumulation of pleural fluid. Pleural fluid is found in the pleural cavity between the lungs and the chest wall inside the human body [3]. Excessive formation of pleural fluid in the *pleural cavity* can be caused by the lung abnormality such as bacterial, viral, fungal, lung tumour, *mediastinum*, and *metastatic* tumour infections. Other causes come from the diseases such as lymph, *hypoproteinemia* in kidney, liver, and heart failure [4]. The pleural effusion check-up used an X-ray engine [5].

The image results from the X-ray engine were analyzed and diagnosed by radiology physicians. The ddifficulties in diagnosing pleural effusions are often faced by doctors because the normal lung anatomical lines and effusion are sometimes vague [6]. The ddifficulty in diagnosing pleural effusion is also due to the unclear characteristics of pleural effusion so that sometimes the determination is still subjective by the physician [7]. Therefore, we need to know the lung characteristics of patients with pleural effusion and normal lung. The normal and pleural effusion lungs are shown in Figure 1.1 (a) and (b).

Figure 1.1 (a) and (b) show that the basic difference between normal and pleural effusion is that the lower end of normal lung is sharper than the pleural effusion image. This happens because there is fluid that accumulates in the lower end of pleural effusion.



(a) (b)
Figure 1.1Lungs images
(a) Normal lungs (b) Pleural effusion of the right-sideof the lung

Thus, the image shows it is flatter compared with the image of normal lung.The image of normal lung has a greater degree of tilt so that the slope of a line or gradient is also greater than the pleural effusion image.

II. MATERIALS AND METHODS

2.1 Materials

Materials used in this study were 8 images of pleural effusion and 8 images of normal lung radiation results from X-ray of Toshiba Rotanode DRX-1603B with a maximum voltage of 150 kV.

2.2 Method

The calculation of the gradient of pleural effusion and normal images was done through several steps as follows:

1. The Enhancement of Image Quality

The aims ofthe image quality enhancementis to increase the contrast between objects with the background and focus the image that will be processed in determining gradient value.

2. Thresholding Segmentation

Segmentation aims to separate objects with the background in each segment [8]. *Threshold* technique is one of the important techniques in the process of image segmentation. The process of *thresholding* is to change the value of gray degree into two values that are 0 (black color) and 1 (white color). The selection of the *threshold* value used in this research affects the sharpness of an image [9] .This technique is shown in the following equation:

$$T = T[x,y,p(x,y),f(x,y)] \quad (2.1)$$

In general, the process of threshold greyscale image to generate binary image is as follows:

$$g(x,y) = \begin{Bmatrix} 0 \ if \ f(x,y) \geq T \\ 1 \ if \ f(x,y) < T \end{Bmatrix} \quad (2.2)$$

Thresholding was used to seperate the image by setting the intensity value of all larger pixels than the Threshold value as the foreground. Besides, the smaller one is used as the background. Usually setting the threshold value is done based on gray scale histogram [10].

3. The Gradient Ccalculation

The gradient search was done by finding the distance between the pleural image centerline to the pleural edge image every 5 pixels. The distance between the pleural image centerline to the edge of the pleural image wascalled y-axis while the pixel distance is called x-axis. The meeting of x-axis and y-axis will form dots with x and y coordinates. Then, the points were connected to form a line and then it was obtained the line gradient of the image. The gradient was calculated using the following equation:

$$\text{Gradient} = \frac{N.X.Y - \sum X \sum Y}{N.X^2 - (\sum X)^2} \quad (2.3)$$

III. RESULTS AND DISCUSSION

The first step in the gradient calculation process was image enhancement. The images of normal and pleural effusions were processed so that it can be focused on the part where the gradient is determined on the lower right corner of the lungs image. The image result of the enhancement process is shown in Figure 3.1.The section of image enhancement. The next step was *thresholding* segmentation process. The images of normal and pleural effusion were processed to be a binary image. The result of *thresholding* segmentation process image is shown in Figure 3.1 The segmentation section. The last process was the gradient calculation.

The gradient image calculation results are shown in Figure 3.1 The gradient section. From the gradient values, it can be determined whether the lungs were normal or effusion. The gradient data of each image is shown in Table 3.1.

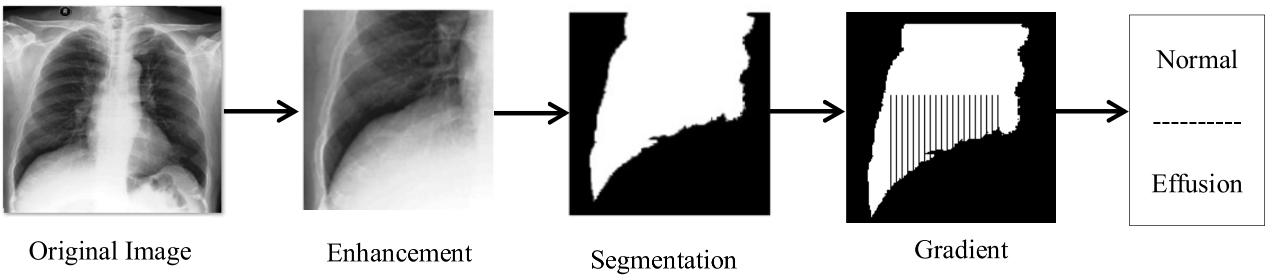


Figure 3.1. The process of calculating the gradient of the lungs image

TABLE 3.1 GRADIENT IMAGE OF PLEURAL EFFUSION AND NORMAL IMAGE

Pleural effusion		Normal	
Name of image	Gradient	Name of image	Gradient
pe1	0,18	pn1	0,48
pe2	0,15	pn2	0,46
pe3	0,27	pn3	0,52
pe4	0,01	pn4	0,41
pe5	0,19	pn5	0,38
pe6	0,09	pn6	0,49
pe7	0,13	pn7	0,60
pe8	0,20	pn8	0,59

From the Table 3.1, it shows that the gradient of pleural effusion ranges from 0.01 to 0.27 while the normal image ranges from 0.38 to 0.60. Normal image has a larger slope of the gradient than pleural effusion. It shows that the level of sharpness of normal image is greater than pleural effusion image.

IV. CONCLUSIONS

The conclusion is that lungs image gradient of the pleural effusion was less than 0.3 whereas the normal lungs gradient was more than 0.3.These results indicate that normal lungs image gradients are greater than the pleural effusion image gradients. Thus, to distinguish the normal lungs with pleural effusion can be determine from the value of the gradient.

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