Improvements to conventional methods for determining lung cancer areas from CT scan images using ImageJ - software

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Abstract: Early detection of lung cancer will definitely help the patients in treating the illness precisely and as early as possible. One of the methods used to detect lung cancer is through CT scan examination. The images from CT scan will show the cancer area of lung describing the severity of lungs affected by cancer. However, the conventional method is often not accurate. Therefore, this research aims to determine the area of cancer by segmenting the lung organs affected by cancer using Image-J software. The edge detection method was employed to segment an image. The results show that by using the proposed method, the largest cancer area is obtained in the seventh slice with the area of 15.39 cm^2 and the smallest cancer area is obtained in the first slice with the area of 1.52 cm^2. Whereas by using the convetional method, the largest cancer area is obtained in the fourth slice with the area of 20.57 cm^2 and the smallest cancer area is obtained in the teenth slice with the area of 3.52 cm^2. The area of lung cancer in each CT Scan slice determined using ImageJ software is more accurate than the conventional method. For that reason, the proposed technique is potential to improve the accuracy of a medical image analysis.

Keywords: Lung Cancer, CT scan Image, Edge Detection, Segmentation, Image-J

1. Introduction

Cancer occurs due to abnormal genetic changes of a cell. Cancer can occur anywhere in the human body, one of which is in the lungs. This lung cancer if not treated quickly can spread to other tissues which can cause death. To avoid this, a fast and accurate diagnosis is needed. Early detection of lung cancer will greatly help sufferers to get fast and appropriate treatment. One of the methods used to detect lung cancer is through a Computed Tomography (CT Scan) examination (Wibawa, 2018). The image from the CT scan will provide an overview of the difference between normal and abnormal lungs (Desviana et al., 2018; Fadillah, 2019; Sinaga et al., 2017). One of the analyzes carried out is to determine the size of the organ affected by cancer for diagnostic and therapeutic purposes (Mediatrix et al., 2014; Noviana, 2016; Rahmadewi, 2016; Wulan, 2015).

Based on Rodiah and Madenda (2013), medical practitioners usually determine the size of the lungs from CT scan images manually by measuring the diameter of the image. The measurement results are taken from the maximum diameter as a reference to determine the area of the target organ which is assumed to be in the form of a circle. This procedure will give inaccurate results for target organs with irregular geometries. One way that can be done to produce precise and accurate measurements is to use image analysis software. The Computer-Aided Diagnosis (CAD) method using Matlab for CT scan image analysis has been widely reported (Wason, 2019). However, the use of ImageJ for simple and reliable CT image analysis has not been widely reported.

ImageJ is an open source software for java based digital image processing. This software can display, edit, analyze, process, save and print images. This software can also read many image formats including TIFF, GIF, JPEG, BMP, DICOM, ANFITS. The use of ImageJ for image analysis in the biological field has been widely reported (Kurniawan, 2011), but ImageJ is still rarely used for CT Scan image analysis, especially lung images. Therefore, apart from being freeware, ImageJ can certainly be used for medical image analysis such as for determining the target organ area from CT Scan images..

Based on the reasons mentioned above, it is important to do lung image analysis to determine the size of lung cancer area more accurately with the help of ImageJ software. The image analysis method developed in this study will contribute to producing a more accurate diagnosis, so that patients will receive appropriate care and treatment.

2. Experimental

2.1. Data source of lung cancer CT-scan image

The CT Scan image data came from stage IV lung cancer patients in 2019 obtained from a CT Scan machine type CTW 550 at the Radiology Installation of the Zainoel Abidin Regional General Hospital (RSUDZA) Banda Aceh. Original image data obtained in *DICOM format. The image is then converted into *JPG format for analysis using ImageJ software.

2.2. Lung cancer CT-scan image analysis

Data processing to determine the area of the lung affected by cancer using ImageJ software is carried out in several stages, namely inputting the image, calibrating the image scale, converting it to a binary image, performing edge detection and segmentation of lung cancer images, and measuring the area of lung cancer. -lungs. The CT-Scan image analysis procedure of lung cancer is as shown in Figure 1.

2.2.1. Input image

Input and reading of image files in ImageJ software is done by selecting a lung cancer image file in JPG format. The raw image is then opened and displayed on the screen for analysis. The image parameters that appear on the screen include the number of pixels, RGB mode, and image size.
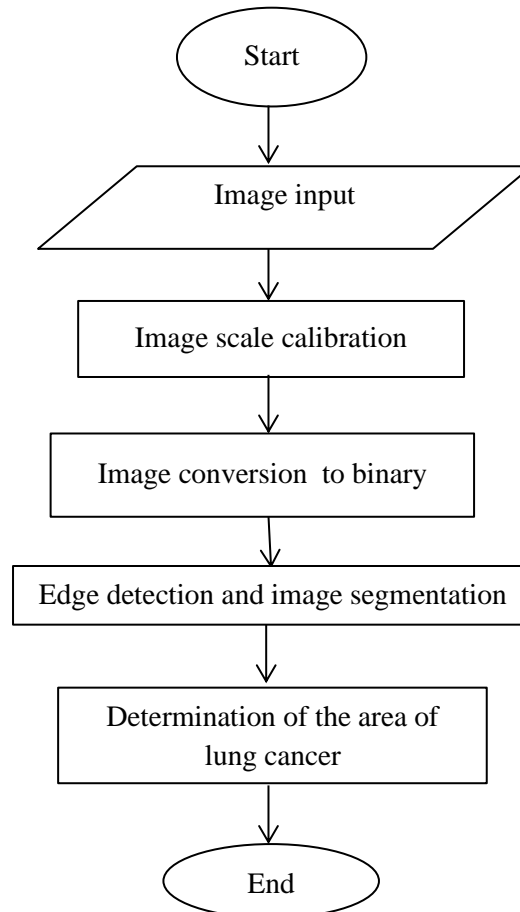
Figure 1. Flowchart of CT-Scan image analysis of lung cancer

2.2.2. Calibrating the image scale

At this stage, the dimension scale (length/width/height) is adjusted with a reference to a scale that is already known from the original image. This calibrated scale will be used as a reference in measuring the dimensions of the image using Image-J software. Calibration will determine the ratio of the number of pixels per unit of the calibrated scale. The unit of scale can also be selected according to the calibrated reference.
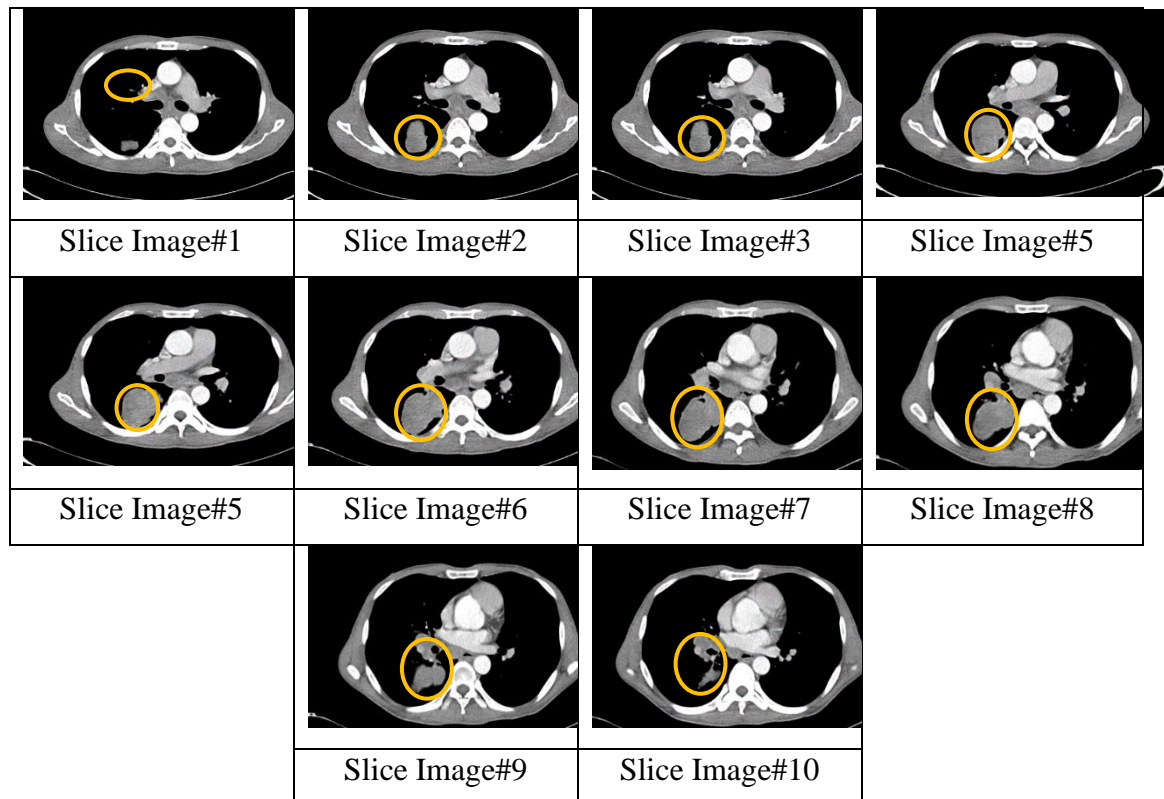
2.2.3. Image segmentation

This stage begins with converting the RGB mode image into a binary image. This step will shape the edges of the image and form only black and white areas. This stage will produce a clear boundary to determine the target area on the CT Scan image to be segmented.

2.2.4. *Measuring the area of lung cancer*

After segmentation, the determination of the area of lung cancer can be done using ImageJ software.

3. Results and Discussion

3.1. *Inputting, calibration, segmentation, and determination of cancer areas on CT-scan images of the lungs*

|			
Slice Image#1	Slice Image#2	Slice Image#3	Slice Image#5
Slice Image#5	Slice Image#6	Slice Image#7	Slice Image#8
Slice Image#9	Slice Image#10		

Figure 2. CT-Scan image display of lung affected by cancer which is inputted in ImageJ software (image source: Radiology Installation, RSUDZA Banda Aceh)

CT Scan image of the lungs with axial cutting into ten slices as shown in Figure 2. The image in *JPG format that is inputted in ImageJ software is displayed in RGB mode. In addition, the pixel size and image file size parameters are also displayed. From the image display in Figure 2, it can be seen that there is a cancer mass formed in each slice of the lung image (circled area). The area of the cancer mass varies in each image slice.
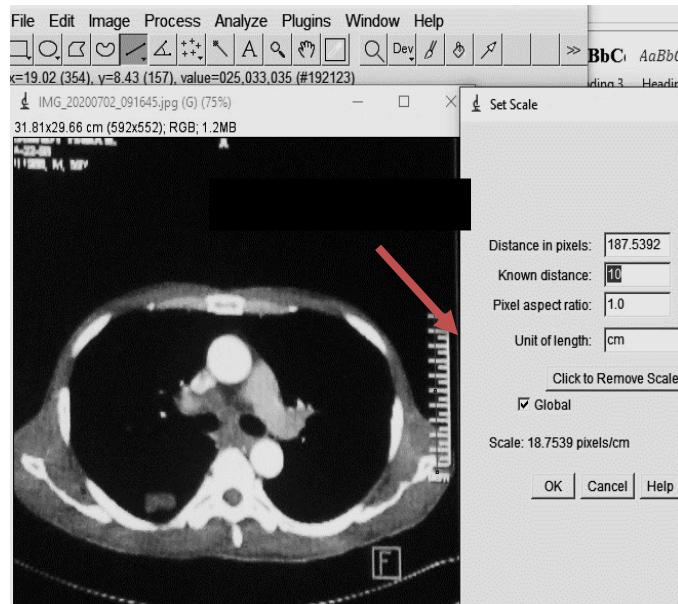
Figure 3. Lung cancer image scale calibration on Image-J software

The calibration of the lung cancer image scale in the Image-J software is done by adjusting the ratio of the reference scale to the number of pixels along the reference line. As in Figure 3, the reference scale for each known slice is 10 cm with a distance in pixels of 187.53. This means that the known distance value is 10 with units of length in cm so that the set scale value obtained is 18.75 pixels/cm, which means 1 cm is equal to 18.75 pixels or 1 pixel is equal to 1/18.75 cm. This set scale value is the basis for measuring the area of lung cancer.

(a)   (b)   (c)

4.
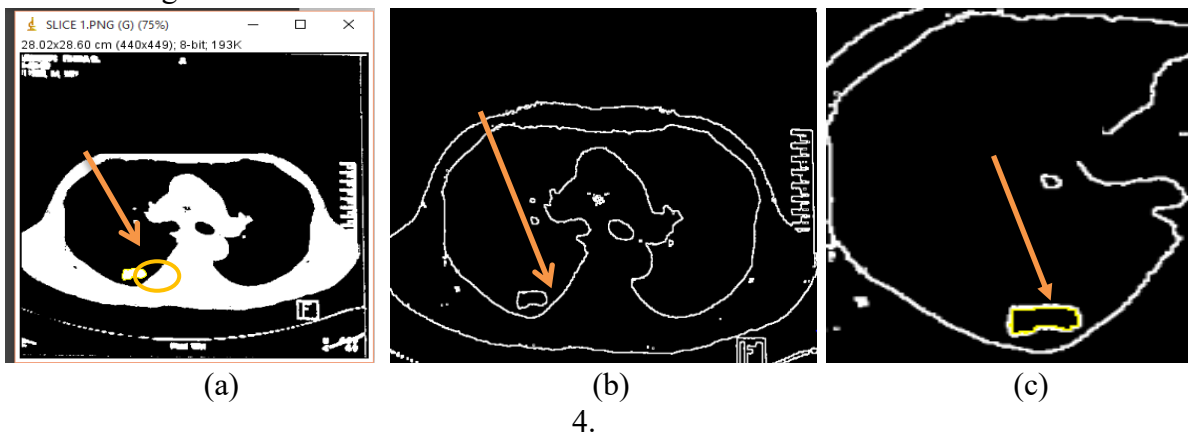
Figure 4. (a) Image conversion from RGB to binary mode, (b) Segmentation results using edge detection method using Image-J software, (c) Area measurement results cancer area on slice #1 by using ImageJ

After the size scale calibration process, then the RGB mode image is converted into a binary image as shown in Figure 4(a). Conversion to a binary image produces a black and white image with strict boundaries. The area of the cancer mass in the axial plane also looks more defined. Next, segmentation is carried out with the edge detection process as shown in Figure 4(b). The segmentation stage aims to separate the lung area from other organs so that the target object is easy to analyze. Then the segmentation that has been

formed can be used to determine the area of the lung affected by cancer. The segmented area can be selected independently to determine its area as shown in Figure 4(c). Then the determination of the area is carried out based on the calculation of the number of pixels that make up the area of lung cancer. The area of lung cancer in slice #1 is 1.52 cm^2.

4.1. Conventional lung cancer area measurement
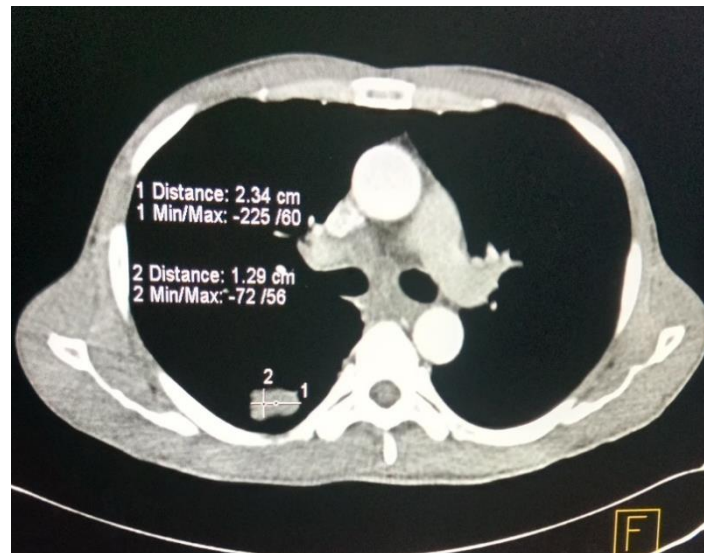
Figure 5. Slices of CT Scan images of lung cancer with the choice of the largest diameter to be determined conventionally

Based on Madenda and Rodiah (2013), the determination of the area of cancer is conventionally done manually from the CT Scan slice image. The slices that visually show the largest cancer area will be selected to determine the extent. In these slices, the longest diameter of the cancer will be selected and determined manually. This diameter is then used as a reference for calculating the area of the cancer using the circle equation. For example, in slice image #1 (Figure 5), the longest diameter of the cancer area is 2.34 cm, so the area is 4.30 cm^2. Meanwhile, based on the method of determining the area using ImageJ, the area of lung cancer in slice #1 is 1.52 cm^2. There is a significant difference in the results of determining the area of cancer area from the two methods.

4.2. Comparison of lung cancer area measurement results between the proposed method and the conventional method

The procedure performed in Figures 4 and 5 to determine the area of lung cancer nodules was also carried out on other image slices and the results of the calculation of the area of lung cancer as shown in Table 1. The proposed method can work well in determining the area of cancer nodules in each lung image slice. By using the proposed method, the largest cancer area was obtained at the 7th slice which was 15.39 cm^2 and the smallest cancer area was obtained at the 1st slice of 1.52 cm^2. As for the conventional method, the largest cancer area was obtained in the 4th slice, which was 20.57 cm^2 and the smallest cancer area was obtained at the 10th slice, which was 3.52 cm^2.

Table 1. The results of calculating the average area of lung cancer per slice (cm^2) using Image-J and using conventional methods

Name	X and Y values of the conventional method	Area of cancer with conventional methods (cm^2) $Area = \pi r^2$	Area of cancer with Image-J (cm^2)	Difference	
				Δ	%
Slice 1	X= 2.34 Y= 1.29	4.30	1.52	2.78	182
Slice 2	X= 2.76 Y= 3.67	10.64	6.12	4.52	77.8
Slice 3	X= 3.51 Y= 4.51	16.05	7.87	8.18	103.9
Slice 4	X= 4.38 Y= 5.12	20.57	13.40	7.17	53.5
Slice 5	X= 4.71 Y= 4.87	18.68	13.71	4.97	36.3
Slice 6	X= 5.04 Y= 4.92	19.94	12.37	7.57	61.2
Slice 7	X= 5.04 Y= 5.08	20.25	15.39	4.86	31.6
Slice 8	X= 4.83 Y= 4.01	18.40	11.67	6.73	57.7
Slice 9	X= 4.01 Y= 2.49	12.69	5.12	7.57	147.9
Slice 10	X= 2.11 Y= 1.28	3.52	1.63	1.89	116
				Average	86.8

When compared with conventional methods, it can be seen that there are differences in the results of determining the area of cancer nodules which are quite large with an average difference of 86.8%. The magnitude of this difference is due to the conventional method using the method of determining the area of a circle based on the radius or maximum diameter of the cancer nodule. As for the fact that cancer nodules in axial sections can be irregular in shape, so that an approach using the edge detection method for segmenting cancer nodules will give more accurate results. A more accurate size of the area of the cancer nodule will provide more precise information on the severity, so that the treatment steps taken will be more precise.

5. Conclusion

Based on data analysis and discussion, it can be concluded that the determination of the area has been successfully carried out on CT Scan lung cancer images with the help of ImageJ software. By using the proposed method, the largest cancer area was obtained at the 7th slice which was 15.39 cm^2 and the smallest cancer area was obtained at the 1st slice of 1.52 cm^2. As for the conventional method, the largest cancer area was obtained

in the 4th slice, which was 20.57 cm^2 and the smallest cancer area was obtained at the 10th slice of 3.52 cm^2, with an average difference of 86.8%. The area of lung cancer in each CT scan slice determined using ImageJ software is more accurate than conventional methods. Thus, the developed method has the potential to improve the accuracy of conventional methods used in determining the dimensions of a medical image.

6. Suggestion

Further research can be carried out on CT Scan images of other organs to test the accuracy of the proposed method.

Acknowledgments

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