Segmentation of Liver using Abdominal CT Scan to Detection Liver Desease Area

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***Abstract*— Liver disease is a disease that can reduce liver function and affect the production process of protein, hormone and nutrients in the human body. One way of knowing liver disease by doing abdominal CT scan. CT Scan (Computerized Axial Tomography scan) can produce images of organs that cannot be seen by the standard x-ray photo equipment and the resulting image has good and accurate resolution. However, the problems found in Abdominal CT Scan are not able to ensure the image of the heart properly. This is because Abdominal CT Scan has a weakness that there are images that should not participate recorded, so the results cannot be used as a reference. From the problem, an idea came up to detect liver disease using Abdominal CT Scan automatically. Watershed transform algorithm used in the segmentation process to produces liver locations that can distinguish objects by background. Then the image will be segmented again using binary threshold method to separate the liver image as the observed object. The final step is done by doing a calculation to determine the affected area percentage. The output of this paper is a wide percentage of the area of liver disease that can be useful as a radiology doctor's analysis. From the result, the wide segmentation of the liver has an average accuracy of 81.15% and segmentation of disease has an average accuracy of 98.28%. So it can be concluded that the watershed method can be used for segmentation process on CT scan abdominal image.**

Keywords— ***CT-Scan, Abdominal CT-Scan, watershed, Liver, Segmentation, Binary Tresholding***

I. INTRODUCTION

Liver diseases are among the leading causes of death worldwide. To be able to know the severity of the condition on the growth of the disease (i.e. performed diagnostic procedure approach that has high accuracy and dependability) [1].

In the medical field medical imaging technology has been widely used to obtain information about the human body called CT Scan as used on Abdominal CT Scan. CT Scan is a non-invasive diagnostic imaging procedure that uses a combination of Xray and computer technology to produce clearer medical imaging. Abdominal CT Scan can provide information about the Liver through the standard CT Scan on the abdomen. In general, CT Abdominal examination is performed to look at gastric, Liver, gallbladder, pancreas, small intestine, kidney lesions and to see the vascular system in more detail. Finding out the liver object in the abdominal image can be done in two ways. The first is ultrasound scan imaging and computed tomography (CT), then the second is magnetic resonance imaging (MRI) which can separate the liver parenchyma area of liver and non-parenchyma areas of liver [2]. Liver CT-Scan image input will be processed to obtain desease image with percentage calculation of liver.

The author uses the watershed transformation algorithm to take the liver area to get the disease on the liver object. In another study, using watershed transformation algorithms has also been performed to obtain objects in lung images that have an accuracy of 87.25% [3] as well as in other studies using the watershed transformation algorithm on tooth image [4]. Based on some previous research the author added some new methods to increase the accuracy of liver disease detection system by using abdominal CT scan that have an accuracy 98.28%. In this new methods the process will be done by using median filtering to keep the edge of object. Then the image will be segmented again using binary treshold to separate areas of the liver and disease. And the last method is to calculate the percentage of disease areas in the liver. In this study, calculate the areas of the liver and the disease is obtained automatically

II. METHODOLOGY

In this section, the procedure for liver segmentation using erosion and dilation for preprocessing. And the image will be segmented by watershed to crop liver area. Image result will be calculated by binary treshold. The procedure used will be described clearly in the schematic diagram as shown below in Fig. 1.

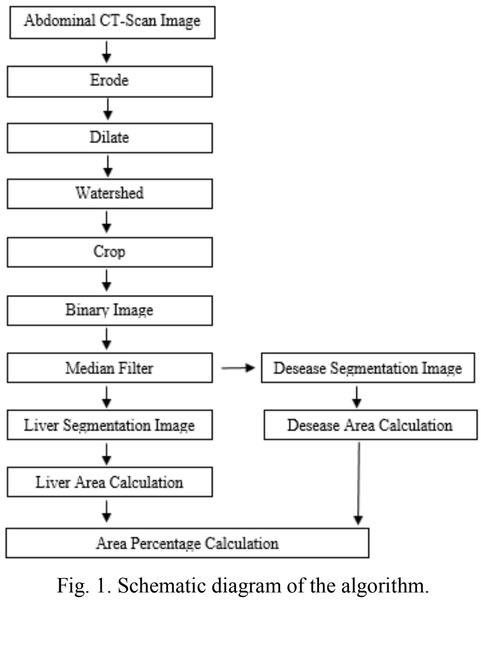


Fig. 1. Schematic diagram of the algorithm.

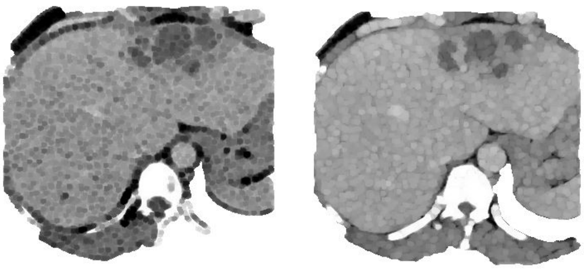
A. Abdominal CT-Scan Image

Generally, an examination of Abdominal CT-Scan performed to see gaster, liver, gall bladder, pancreas, intestine, and kidney lesions on to see vascular system with more detail. Abdominal CT Scan can provide information about the liver through a standard CT Scan of the abdomen. Fig. 2 represent the abdominal CT-Scan.

Fig. 2. The Abdominal CT-Scan

B. Erode and Dilate

In this step, erode and dilate method is used in the preprocessing step. The working principle of erode is to remove the object's point to produce a smaller value based on the kernel used. Then, dilate has a function to isolate each element and connect with different elements by returning the value that has been removed in the previous process. Dilate and erode are generated from the same image. Fig. 3 is the represent of erode and dilate operations.



(a) (b)

Fig. 3. Preprocessing operations (a) erode (b) dilate

C. Watershed

In the process of segmentation using watershed transformation algorithm to segment liver area. First step of watershed transformation algorithm is create a mark particular area that will be segmented. This study using 2 marks on particular areas. First mark area consist of liver area. And the second mark area consist of non-liver area. Non-liver area is marked by a line that surround the positioning of liver Where non-liver area as the waters and liver area as the land. They will be divided into two segments, liver area and non-liver area. Fig. 4 represent the result of watershed operations.

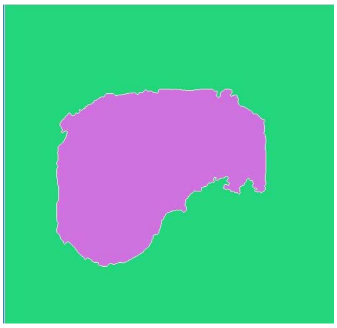


Fig. 4. Watershed Operations

D. Crop

Next step, the result of image segmentation will be crop (land area in watershed). In this step the output is liver area. The procedures will be explained in Fig. 5 and Fig.6 represent the result of cropping operations.

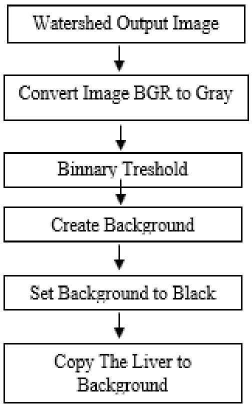


Fig. 5. Croping procedure

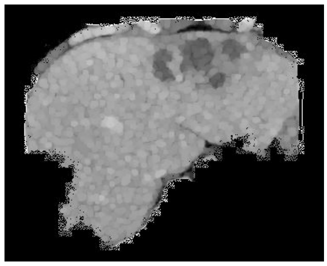


Fig. 6. Croping operations

E. Binnary Image

After cropping image process, the result image will be converted into binary image inverted. To make it easy to calculate the area that has been segmented, calculations based on pixels can be used, so in this step the segmented liver area will have white color (255, 255, 255) and for other objects will have black color (0, 0, 0). In this study, we used threshold binary inverted with minimum value of 150 and maximum value of 255.

F. Median Filtering

Median filter is useful to get smooth texture, reduce noise after segmentation process and keep the edge of image. The output in this step then will be processed using the median filtering to get the liver area using kernel size of 9. Fig.7 represent the result of median filter operations.

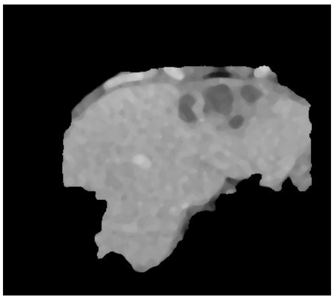


Fig. 7. Median Filter Operations

G. *Area and Percentage Calculation*

In this step will be counted in two areas, liver area and desease area. Both has pixel-based calculation. The calculation of areas will be using count non-zero pixel and this calculation will be converted in millimeter cubic and the result will be counted by sum of pixels then multiplied with constant. In formula (1) can be see formula to calculation areas.

$$Area = \left(\sum_{i=max}^{i=0} pixel \right) x\, 0.264583 \qquad (1)$$

To get the percentages calculation so can comparing two calculated areas by liver area and disease area. Then will be obtained percentage of desease area in liver area. The authors using formulation which is shown in formula (2).

$$\%\ desease = \frac{desease\ area}{liver\ area}\ x\ 100\% \qquad (2)$$

III. Experiment Result

The proposed algorithm was tested using dataset axial liver CT-Scan image from Hospital Haji Surabaya. The experimental steps consist of error value of liver segmentation, error value of liver desease segmentation, percentage area calculation. Segmentation and calculation testing were performed on 150 axial liver CT-Scan images.

A. *Error Value of Liver Segmentation*

Some calculations of error values in 20 layer data images is shown in Table.2. This table shows liver segmentation have average error of 18.85%.

Table 1. Error value calculations of liver segmentation

No.	File Name	Liver Area References (mm2)	Liver area Experimental (mm2)	Error (%)
1	0000.jpg	10128.04	9919,75	2,06
2	0001.jpg	10164.23	9889,45	2,70
3	0002.jpg	10068.93	9958,64	1,09
4	0003.jpg	10365.35	9855,45	4,92
5	0004.jpg	11568.02	10463,99	9,54
6	0005.jpg	13274.13	103222,97	16.78
7	0006.jpg	98562.72	8769,87	9.11
8	0007.jpg	11087.27	10367,95	6,49
9	0008.jpg	13472.06	10621,16	21,16
10	0009.jpg	11064.18	9514,14	14,01
11	0010.jpg	13623.29	10413,72	23,56
12	0011.jpg	12658.29	10592,84	16,32
13	0012.jpg	11893.82	10721,7	9,85
14	0013.jpg	12863.05	10148,88	21,10
15	0014.jpg	12397.45	10973,84	11,48
16	0015.jpg	12108.27	10921,99	9,80
17	0016.jpg	10765.27	9899,11	8,04
18	0017.jpg	12830.18	10865,63	15,31
19	0018.jpg	14241.29	11858,63	16,73
20	0019.jpg	14198.63	12017,89	15,35
		Average		18,85

B. *Error Value of liver desease Segmentation*

Some calculations of error values in 20 layer data images is shown in Table.2. This table shows liver desease segmentation have average error of 1.72%

Table 2. Error value calculations of liver desease segmentation

No.	File Name	Desease Area References (mm2)	Desease Area Experimental (mm2)	Error (%)
1	0000.jpg	7537,79	7603.85	8.76
2	0001.jpg	7487,87	7509.66	2.91
3	0002.jpg	7621,61	7630.04	1.11
4	0003.jpg	7674,54	7526.86	1,92
5	0004.jpg	7918,07	7793.03	1,56
6	0005.jpg	7713,07	7602.79	1,42
7	0006.jpg	6519,46	6497.36	3.39
8	0007.jpg	7567,67	7495.64	1.95
9	0008.jpg	7573,43	7417.58	2.06
10	0009.jpg	6855,19	6723.58	1.91
11	0010.jpg	7512,87	7309.63	2.71
12	0011.jpg	7458,81	7226.82	3.11
13	0012.jpg	7410,06	7219.68	2.57
14	0013.jpg	6914,38	6814.60	1.44
15	0014.jpg	7163,43	6961.68	2.81
16	0015.jpg	7325,35	6924.67	5.47
17	0016.jpg	6958,54	6722.79	3.39
18	0017.jpg	6983,64	6945.83	0.54
19	0018.jpg	8243,02	8103.91	1.69
20	0019.jpg	7156,62	7021.21	1.90
		Average		1.72

C. *Percentage Area Calculation*

The area of desease is obtained by calculating the area of liver and desease area. Then to calculation of the percentage of liver desease area to the liver area as a whole. Table 3. shows percentage area calculations.

Table 3. Percentage area calculations

No.	Name	Liver Area	Desease Area	Percentage (%)

		(mm²)	(mm²)	
1.	0000.jpg	12109.96	1765.83	14.58
2.	0001.jpg	11793.52	1770.06	15.01
3.	0002.jpg	10301.71	1662.11	16.12
4.	0003.jpg	12565.58	2038.35	16.22
5.	0004.jpg	12102.03	1876.42	15.51
6.	0005.jpg	10578.56	1362.07	12.88
7.	0006.jpg	11724.73	1659.99	14.16
8.	0007.jpg	11189.48	1563.69	13.97
9.	0008.jpg	12230.61	1534.85	12.93
10.	0009.jpg	12230.85	1423.99	12.87
11.	0010.jpg	10013.67	1499.66	14.06
12.	0011.jpg	11310.66	1475.31	14.90
13.	0012.jpg	11687.95	1568.98	14.21
14.	0013.jpg	13817.85	1491.72	14.62
15.	0014.jpg	14594.40	1607.34	11.47
16.	0015.jpg	14320.03	1708.68	11.04
17.	0016.jpg	9072.82	1585.38	11.89
18.	0017.jpg	9396.14	1611.31	78.10
19.	0018.jpg	9606.74	1702.33	77.19
20.	0019.jpg	9928.21	7086.06	75.90

IV. Conclusion

This study the liver segmentation and the liver desease segmentation using watershed transformation has some errors if right kidney and gallbladder cover layer is segmented. From the result, the wide segmentation of the liver has an average accuracy of 81.15% and segmentation of disease has an average accuracy of 98.28%. So, the concluded in this paper that the watershed method can be used to process liver segmentation in abdominal CT scan images.

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References

[1] J. Liu, Z. Wang, R. Zhang, "*Liver* Cancer CT Image Segmentation Methods based on Watershed Algorithm", *2009 IEEE Transactions on Medical Imaging.*

[2] M. Lawankar, S. Sangewar, S. Gugulothu, "Segmentation of *Liver* using Marker Watershed Transform Algorithm for CT Scan Images", *2016 International Conference on Communication and Signal Processing, India.*

[3] R. Wulandari, R. Sigit and S. Wardhana, "Automatic lung cancer detection using color histogram calculation," *2017 International Electronics Symposium on Knowledge Creation and Intelligent Computing (IES-KCIC)*, Surabaya, 2017, pp. 120-126.

[4] A. Radhiyah, T. Harsono and R. Sigit, "Comparison study of Gaussian and histogram equalization filter on dental radiograph segmentation for labelling dental radiograph," *2016 International Conference on Knowledge Creation and Intelligent Computing (KCIC)*, Manado, 2016, pp. 253-258.

[5] G. Ismail Sayed, M. Abdelbaset Ali, T. Gaber, A Ella Hassanien and V Snasel4, "A Hybrid Segmentation Approach Based on Neutrosophic Sets and Modified Watershed: A Case of Abdominal CT *Liver* Parenchyma", *2015 IEEE Transactions on Medical Imaging.*

[6] A Mostafa, M Abd Elfattah, A Fouad, A. Ella Hassanien, H. Hefny, T. Kim, "Region Growing Segmentation with Iterative K-means For CT *Liver* Images", *2015 4th International Conference on Advanced Information Technology and Sensor Application.*

[7] A. Zidan, Neveen i. Ghali, A. Ella Hassanien, "level set-baset ct *liver* image segmentation with watershed and artificial neural networks", *2012 IEEE Transactions on Medical Imaging.*

[8] M. Jayanthi, "Comparative Study of Different Techniques Used for medical image Segmentation of *Liver* from Abdominal CT Scan", *2016 IEEE conference.*

[9] R. Foale et al, "Medical Image Segmentation Based on the Watersheds and Regions Merging", *2016 3rd International Conference on Information Science and Control Engineering.*

[10] S. Nassir, "*Image Segmentation Based On Watershed And Edge Detection Techniques", 2006 The International Arab Journal Of International Technology, Vol.3, No.2.*

[11] M. Kamal and R. S. Basuki, "Segmentasi Citra Daun Tembakau Berbasis Deteksi Tepi Menggunakan Algoritma Canny," *2013 Teknik Informatika, p. 3.*