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CALCULATION OF AREA, CENTER AND DISTANCE OF CERVICAL CANCER FROM ORGAN AT RISK BY SEGMENTATION OF HISTOGRAM ON CT PELVIC IMAGE

Sitti Normawati*
Magister of Physics, Faculty of Science and Mathematics,
Diponegoro University, Indonesia
noerma@st.fisika.undip.ac.id
Suryono Suryono
Department of Physics, Faculty of Science and Mathematics,
Diponegoro University, Indonesia
Suryono@fisika.undip.ac.id
Catur Edi Widodo
Department of Physics, Faculty of Science and Mathematics,
Diponegoro University, Indonesia
catur.ediwidodo@gmail.com

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Abstract— Radiotherapy becomes one of the options in the treatment of cervical cancer. In the process, radiotherapy requires a radiation dose plan for a target volume, including Gross Tumor Volume (GTV) and Organ at Risk (OAR). The planning is based on the acquisition image of CT scan modalities. In this study, the calculation of area, center and distance of cervical cancer from organ at risk on CT image of pelvis for cervical cancer case through digital image processing method. Stages used include image segmentation with histogram, morphological operation, and the determination of the midpoint (centroid) in the cervical, bladder, and cancerous mass. The calculation of the extent of cervical cancer was performed on seven images which were then compared with the calculations performed radiologist manually. The results of the calculation of the method offered has a percentage error of 0.3% and 39.7% of the value indicates that the image processing techniques offered can be implemented to calculate the extent of cervical cancer and organ distance at risk with cancer centers based on the coordinates of the center point.
Keywords— Cervical cancer; radiotherapy; histogram segmentation; morphological operation; thresholding segmentasi;

I. INTRODUCTION

Cervical cancer is one type of malignant cancer that attacks women in commonly. Cervical cancer occurs in uterine cervix, which is an area of female reproductive organs that is the entrance to uterus located between the uterus and copulational or vaginal lesion [1]. Cervical cancer is caused by human papilloma virus [2]. One of procedures to detect cervical cancer is through examination of the image with various modalities such as Computed Tomography (CT) scans. Abnormal cervix, especially cervical cancer, can be treated with many types of treatment; one of the kinds is radiotherapy. In the process, radiotherapy requires a radiation dose planning.

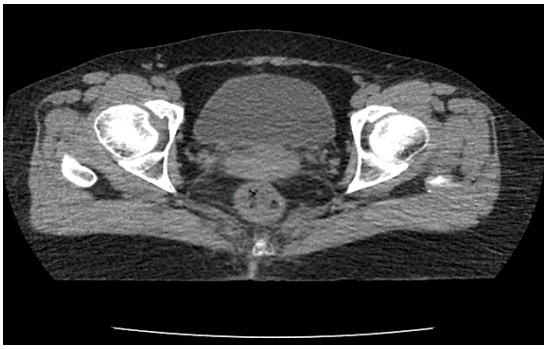
The planning is called Treatment Planning System (TPS). The TPS is part of the sequence of the radiotherapy process. The TPS should be done first before the therapeutic process is carried out. The TPS is usually done manually and takes a long time in this process [3]. This can be done quickly with image processing techniques. One of the alternative methods that can be used in pelvis image processing is by using histogram segmentation. The purpose of histogram segmentation is splitting region of the organs up to obtain a uniform distribution of histogram so that every degree of gray has a relatively equal number of pixels This segmentation has some advantages because the CT image of pelvis can only be analyzed by histogram segmentation that can distinguish the gray scale of the image [4]. This segmentation has not been widely used in cases of cervical cancer.

II. METHOD

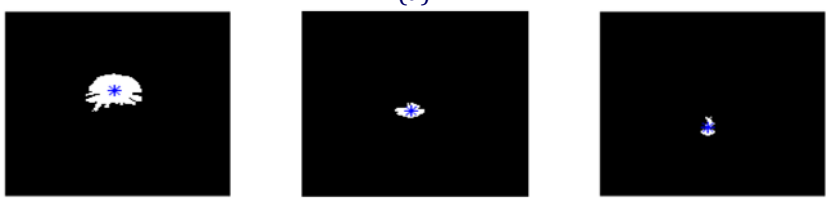
Initial design of this programming research is started from the reading of pelvic CT imagery which has mass saved with DICOM format in MATLAB program. The result of image reading was segmented by using thresholding segmentation method. Image segmentation aims to segmently separate objects (Cancer) with background. After obtained the image of segmentation, morphology operation was performed to the result in the form of binary image to improves tha result of segmentation and eliminates noise. The process of determining the threshold value was conducted through visual analysis of bimodal histogram. The output of the segmentation process is a binary image represented by pixels that are worth 1 (white) while the background is 0 (black). After obtained the image of segmentation results then made the determination of the object center point (cancer), the center point of the rectum, the center point of the bladder and the calculation of cancer area, and the calculation of the distance between cancer and organ at risk. The widespread calculation process was conducted by counting the number of pixels that make up the object in the binary image. The results of the calculation area of cancer were divided by the square of spatial resolution to obtain the area of cancer in units of square centimeters (cm2). The calculation of the distance between cancer and organ at riks was done by determining the coordinates of the cancer centroid (centroid) in units of pixels.

III. RESULT AND DISCUSSION

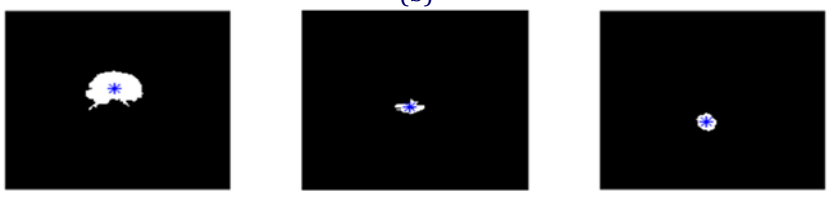
Image segmentation by thresholding method has not been able to produce optimal results and contrast with adjacent objects. Further thresholding techniques are combined with morphological operations to achieve better image results. Morphological operation is able to eliminate noise as well as to process image based on the size and shape of the desired object. It is convincing to make the image more homogeneous on the object that will be the focus of calculation. The results of segmentation of the pelvic image for the calculation of the extent of cervical cancer are shown in figure 1.



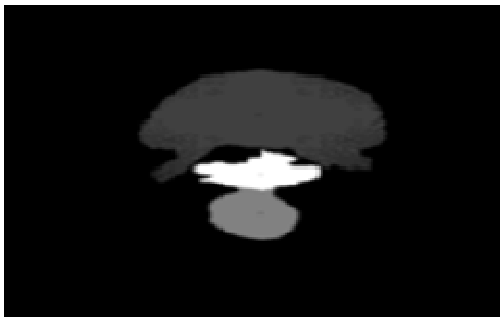
(a)



(b)



(c)



(d)

Fig. 1 Result of segmentation process on the first image; (a) the original image, (b) thresholding method in cancer and OAR, (c) morphological operation, and (d) the result of segmentation

Calculation of the area on the offered method and the calculation of existing methods on each image, results smallest and largest error percentage of each calculation between 3.4% to 32.06%. Thus, the results show that the developed images processing techniques can be implemented to calculate the extent of cervical cancer using the image of the pelvis well. After calculating the extent of cervical cancer image, the next process is the calculation of organ distance at risk on cervical cancer based on the centroid coordinates of each image. The calculation of cancer distance from the organ at risk based on the coordinates of the center point (centroid) for each image is shown in table 1:

Images	Organ at Risk	Distance		Error percentage (%)
		Offered $(cm)^2$	Existing $(cm)^2$	
First	Cancer to bladder	4,51	5,29	14,74
	Cancer to rectum	3,52	4,41	20,18
Second	Cancer to bladder	4,26	5,29	19,47
	Cancer to rectum	5,08	5,29	3,96
Third	Cancer to bladder	4,26	5,29	19,47
	Cancer to rectum	4,59	5,76	20,31
Fourth	Cancer to bladder	3,93	4,41	10,88
	Cancer to rectum	4,26	5,29	19,47
Fifth	Cancer to bladder	4,34	4,84	10,33
	Cancer to rectum	5,00	7,29	31,41
Sixth	Cancer to bladder	4,34	4,41	1,58
	Cancer ke rectum	5,33	7,29	26,88
Seventh	Cancer to bladder	4,57	5,76	20,65
	Cancer to rectum	4,34	3,61	20,22

Table 1 Cancer distance from the organ at risk based on the centroid on the image

The results obtained in the sixth image by estimating the cancer distance to the bladder show the smallest error percentage of 1.58% while in the fifth image shows the largest percentage error of 31.41% with the calculation of cancer distance to the rectum. The distance calculation is due to the different distance of each image in the organ at risk. If the six images were almost at the same distance, then the results would be stable. So the result of cancer distance calculation based on midpoint obtained from image processing is good enough to be implemented.

IV. CONCLUSIONS

In conclusion, calculation of cervical cancer area was conducted for seven images using image processing method compared with radiology officer calculation. The calculation using this method has error percentage at 3,4% and 32,06%. these values indicate that the offered image processing technique can be implemented to calculate the extent of cervical cancer using pelvic image. The calculation of cancer distance from organ at risk based on center point coordinate can be done by image processing method.

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