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Coloring of Cervical Cancer's CT Images to Localize Cervical Cancer

Erlinda Ratnasari Putri, Amar Vijai Nasrulloh, Arfan Eko Fahrudin
Physics Study Program, University of Lambung Mangkurat, Banjarmasin, South Kalimantan, Indonesia

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ABSTRACT

Cervical cancer is the most common gynecologic cancer in women. Cervical cancer and the normal cervix usually have similar attenuations on CT images which are obtained. The normal cervix and the tumour cannot be distinguished on normal CT images. CT image of cervical cancer is used by the experts for the analysis of diseases. In this research study, CT image of cervical cancer is done with process of image segmentation and coloring. The process of image segmentation is done after the image sharpening process and the determination of cervical cancer's area. Fuzzy C-Means is used as the algorithm for image segmentation. The colors of image segmentation result are changed by program module. The result is the colors of image segmentation uniform with the other results. The image is overlayed with image result of image sharpening process. Coloring image purposes are to distinguish between cervical cancer's area and normal organ and to localize the existence of cervical cancer. Based on the doctor's observation, the empirical rate of testing 20 samples on the program is 100%.

Corresponding Author:

Erlinda Ratnasari Putri,
Physics Study Program,
University of Lambung Mangkurat,
A. Yani Street km 36.5, Banjarbaru, Indonesia
Email: erlindaputri1703@gmail.com

1. INTRODUCTION

Cervical cancer is the most common gynecologic cancer in women. Worldwide, cervical cancer is common, and ranks second among all malignancies for women [1]. Most of these cancers stem from infection with the human papillomavirus, although other host factors affect neoplastic progression following initial infection. Compared with other gynecologic malignancies, cervical cancer develops in a younger population of women. The most commonly used staging system for cervical cancer was developed by the Féderation Internationale de Gynécologie et d'Obstétrique (FIGO). According to FIGO, only clinical staging fulfills these criteria, and therefore, the staging classification of cervical cancer should be entirely based on the findings obtained from the pretreatment clinical evaluation [1]. The results of CT, MRI, or PET examinations and the surgical-pathologic findings may not be used for staging classification, but they are essential for treatment planning and may provide prognostic information [2].

Computed Tomography (CT) is a non-invasive technique to provide CT images of every part of the human body without superimposition of adjacent structures [3]. CT is useful for detecting this cancer, especially in monitoring patients for recurrence. Assessment of the stage of disease is important in determining whether the patient may benefit from surgery or will receive radiation therapy. The normal uterine cervix is round structure with homogenous soft-tissue attenuation on CT images. Cervical cancer and the normal cervix usually have similar attenuations on CT images which are obtained [8]. The normal cervix and the tumor cannot be distiungished on normal CT images. The detectable finding can be used a clustering segmentation method with Fuzzy C-Means algorithm [4, 5, 6, 7, 8, 9].

As we known, most of researches about medical image segmentation usually use MR images and ultrasound images [4, 5, 6, 9, 10]. In this research, cervical cancer data is taken from the CT-Scan image data. We used CT images because CT-Scan is the main tool which used for physical examination in most of hospitals in this province. Besides that, the use of CT-Scan is a standard analysis for radiologists in some hospitals. To make easier for radiologists to analyze cervical cancer data images, it is important to process CT-Scan data images of cervical cancer and the normal cervix so it can be distinguished.

The clustering segmentation can be successfully used with the intention of discrimation of various tissues on CT images. In particular, borders between tissues are not clearly defined and memberships in the boundary regions are instrinsically fuzzy. The hard clustering methods based on classical set theory, and require that an object either does or does not belong to a cluster. Hard clustering means are partitioning the data into a specified number of mutually exclusive subsets. Fuzzy clustering methods, however, allow the objects to belong to several clusters simultaneously, with different degrees of membership. In many situations, fuzzy clustering is more natural than hard clustering [11]. Therefore, fuzzy clustering methods turn out to be particularly suitable for the segmentation of CT images.

In general, completely autonomous segmentation is one of the most difficult tasks in the design of computer vision systems and remains an active field of image processing and machine vision research. The basic goal of segmentation, then, is to partition the image into mutually exclusive regions to which we can subquently attach meaningful labels [12]. Segmentation can be described as the process related to clusters, in the multimodal feature space, whose points are associated to similar sets of intensity values in the different images [12]. The clustering process is the main step in the segmentation procedure and clustering-based techniques have been shown to be more robust to noise in discrimination of different tissues than techniques based on edge detection [4, 13].

The output image from segmentation process is then colored automatically. Coloring as a purpose to increase the visual interest of output image and shows different details of image, certainly in RGB color model.

For the purpose of preliminary treatment using radiotherapy and surgery [14], the Fuzzy C-Means clustering algorithm was introduced for the diagnosis of every patient. Uncertainty is mainly present in medical images, because of the noise in acquisition and of the partial volume effects. Due to this, borders between tissues are not exactly defined and memberships in boundary regions are fuzzy. In this paper we use Fuzzy C-Means segmentation technique is used for tissue differentiation in CT images.

2. RESEARCH METHOD

The medical image data are taken from CT images of the cervical cancer patients. The coloring steps using segmentation with Fuzzy C-Means algorithm can be seen on block diagram in figure 1.

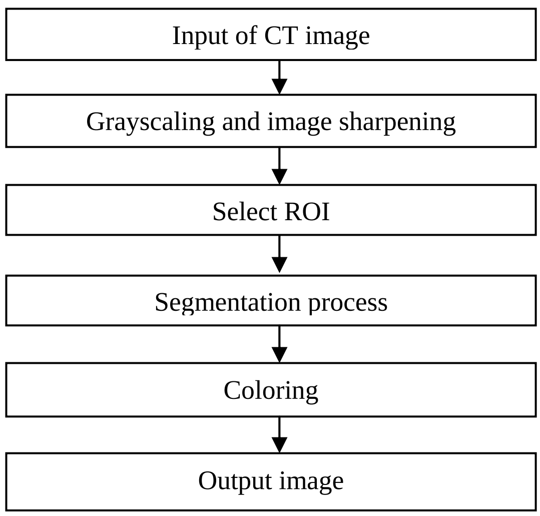

Figure 1. Block diagram of research method

a. Input of CT Image

This research work used cervical cancer's CT images from some patients. Cervical cancer has four

STAGES, i.e., STAGE-1, STAGE-2, STAGE-3, and STAGE 4. Figure 2 shows CT images for each stage [15, 16, 17].

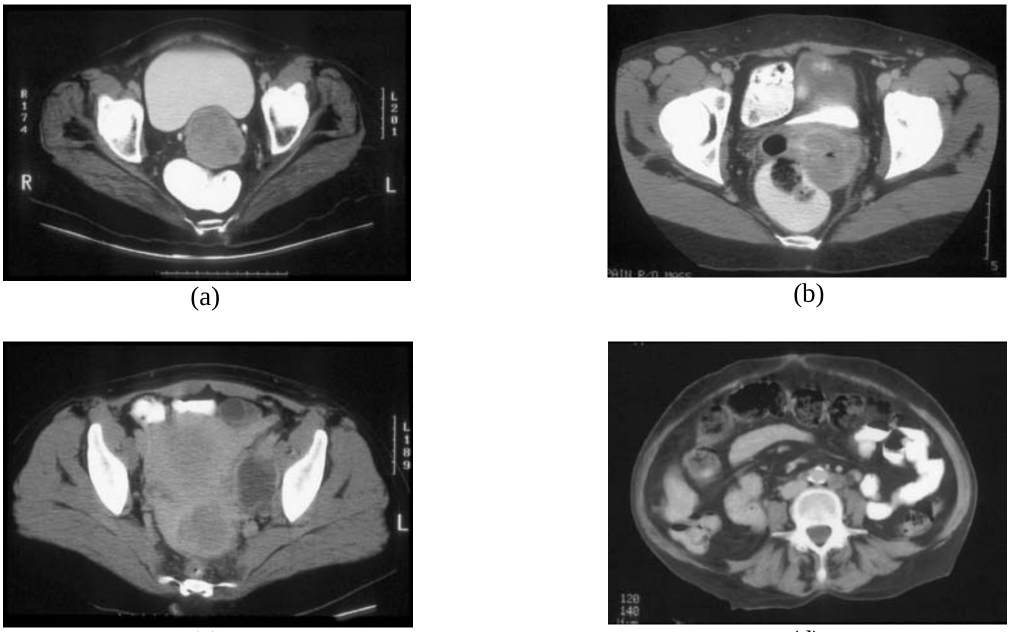
(a) (b) (c) (d)

Figure 2. Cervical cancer’s CT Images (a) STAGE-1, (b) STAGE-2, (c) STAGE-3, (d) STAGE-4

b. Grayscaling and Image Sharpening

The preprocessing of the coloring steps is grayscaling and image sharpening process. Grayscaling is the process to convert the RGB of cervical cancer image into grayscale. Image sharpening is the process to sharpen the edges in image and increase the quality of image.

c. Select ROI

This process locates the area of the cervical organ which is infected suspicion. The ROI (Region of Interest) process proceeds inside the ellipse line that had been chosen. It can be seen in figure 3. The outside had been blackened to make segmentation process easier.

d. Segmentation Process

Segmentation process uses the ROI image to distinguish the normal cells and cervical cancer cells. This process uses Fuzzy C-Means algorithm. The main advantage of fuzzy c – means clustering, it allows gradual memberships of data points to clusters measured as degrees in [0,1]. This gives the flexibility to express that data points can belong to more than one cluster [18]. The Fuzzy C-Means clustering algorithm is presented as follows [18, 19]:

1. Put the data into cluster X, which is a x b matrix.

$$XX = \begin{matrix} x_{11} & \cdots & x_{1b} \\ \cdots & \cdots & \cdots \\ x_{a1} & \cdots & x_{ab} \end{matrix} \quad (1)$$

a = data total
b = variable total
X_{ij} = example data of i (i = 1, 2, 3, …..a) and j (j = 1, 2, 3, ….b)

2. Determine some variables such as:
   - Cluster total = c (≥2)
   - Exponent = w
   - Maximum iteration = *MaxIter*

- Error value = ε
- Earliest objective function P_0 = 0
- Earliest iteration = t = 1

3. Generate random number μ_{ik} which i = 1, 2, ……a; k = 1, 2, 3, …..c; as the elements of the earliest partition matrix U. Calculate the total of attributes (column):

$$Q_j = \sum_{k=1}^{c} \mu_{ik} \quad (2)$$

which j = 1, 2, ……n
Calculate:

$$\mu_{ik} = \frac{\mu_{ik}}{Q_j}$$

4. Calculate the centroid of k: V_{kj}, which k = 1, 2, ….c; and j = 1, 2, ……b.

$$V_{kj} = \frac{\sum_{i=1}^{a} (\mu_{ik})^w X_{ij}}{\sum_{ij}^{a} (\mu_{ik})^w} \quad (3)$$

5. Calculate objective function on t iteration,

$$P_t = \sum_{i=1}^{a} \sum_{k=1}^{c} ([\sum_{j=1}^{b} X_{ik} - V_{kj})^2](\mu_{ik})^w \quad (4)$$

6. Calculate the change of partition matrix:

$$\mu_{ik} = \frac{[\sum_{j=1}^{b} (X_{ik} - V_{kj})^2]^{\frac{-1}{w-1}}}{\sum_{k=1}^{c} [\sum_{j=1}^{b} (X_{ik} - V_{kj})^2]^{\frac{-1}{w-1}}} \quad (5)$$

which i = 1, 2, …a; and k = 1, 2,….c.

7. Compare $P_t - P_{t-1}$. If ($P_t - P_{t-1} < \varepsilon$) or (t > MaxIter), then stop. Else, t = t + 1, return to step 4.
In this research, we determined value for some variables. Cluster total was 3, exponent was 2, error value was 0,000001 and maximum iteration was 100 times.

e. Coloring

This process gives the image some colors to distinguish normal cells and cervical cancer cells. In this research, we use RGB model. RGB model is usually used to represent a static image [20].

3. RESULTS AND ANALYSIS

Figure 3 (a) is an original image in RGB model. Figure 3 (b) is the result of grayscaling and image sharpening process. It is in grayscale model. Figure 3 (c) shows the result of ROI process. Figure 3 (d) is the result of segmentation process using Fuzzy C-Means algorithm. The colors on Figure 3 (d) are changed and the result is Figure 3 (e). Figure 3 (f) is the final result image.

As we can see from the result of ROI process on Figure 3 (c), we use an ellipse form because most of cervical cancer cells which showed on CT images are ellipse. Segmentation process is done in ellipse area to distinguish normal cells and cervical cancer cells like on Figure 3 (d). The main goal of segmentation process is to localize the existence of cervical cancer. We use clustering method with Fuzzy C-Means algorithm. We determine specific values for some variables, i.e., cluster total, exponent value, error value and maximum iteration. Cluster total is 3, exponent value is 2, error value is 0,000001 and maximum iteration is 100 times. These values produce result image such as Figure 3 (d). On Figure 3 (d), The blue is background, the red is cervical cancer's area and the green is an area which not containing a tumor. But, we want change the color. So, we do changing color process and it produces a result image like Figure 3 (e) where the red is background, the green is an area which not containing a tumor and the blue is cervical cancer's area. There is a different color in cervical cancer's area. It caused by a different intensity of grayscale on that area. It shows that cervical cancer cells are growing without forming any patterns. Besides that, the blue on cervical cancer's area is recognized as cervical cancer cells.

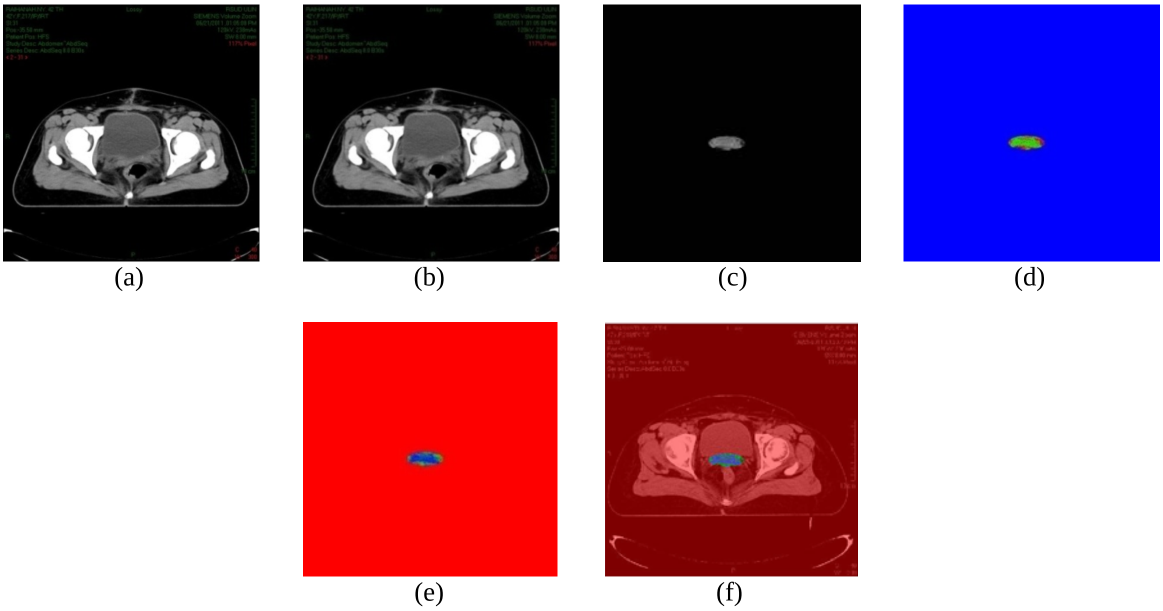

Figure 3. (a) Original image, (b) Result of grayscaling and image sharpening process, (c) Result of ROI process, (d) Result of the segmentation process, (e) Result of the changing color process, (f) Final result image

Figure 3 (f) is the final result image. It is produced by overlay 2 images, i.e., the result of grayscaling and image sharpening process (Figure 3 (b)) and the result of the changing color process (Figure 3 (e)). The overlay image is useful for radiologists to analyze cervical cancer and determine the spread of cervical cancer cells. Moreover, radiologists can also determine the stage of cervical cancer and explain to patients about the growth of cervical cancer in their body.

In this research, we used 20 CT images as objects for the coloring cervical cancer automatically. Results of the overlay images are examined by the doctor. Based on the doctor's observation, the empirical rate of testing 20 samples on the program is 100%. It means that the automatical coloring cervical cancer program can localize the existence of cervical cancer and do coloring of cervical cancer on CT images.

4. CONCLUSION

Image processing steps that are convert the RGB of cervical cancer image into grayscale, determine the ROI of cervical cancer's area, do a segmentation process to the ROI image, do coloring to the result of segmentation process and do image overlaying process to know the location of the existence of cervical cancer on original image. Coloring image purpose is to distinguish between cervical cancer's area and normal organ. Based on the doctor's observation, the empirical rate of testing 20 samples on the program is 100%.

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BIOGRAPHIES OF AUTHORS

Erlinda Ratnasari Putri was born in Banjarmasin, Kalimantan Selatan, in 1993. She received an undergraduate degree in Physics (2015) from University of Lambung Mangkurat (UNLAM), Banjarbaru Indonesia. Her current research interests are Digital Image Processing and Medical Instrumentation.

Amar Vijai Nasrulloh was born in Surabaya, in 1978. He received an undergraduate degree in Physics (2004) from Institut Teknologi Sepuluh Nopember (ITS) and a graduate degree in Electrical Engineering (2010) specialty in Biomedical Engineering Program from Institut Teknologi Bandung (ITB), Indonesia. He received the Academic Achievement Directorate General Higher Education (DIKTI) Scholarship (BPPS) for his graduate degree. In 2005, he joined the Physics Study Program of University of Lambung Mangkurat as a lecturer. Currently he is member of HFI (Indonesian Physical Society/IPS) and IEEE. His current research interests are Electronics and Instrumentation of Physics, Video Processing, Imaging and Image Processing, Biomechanics and Medical Instrumentation.

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Arfan Eko Fahrudin was born in Kediri, in 1979. He received an undergraduate degree in Physics (2004) from Institut Teknologi Sepuluh Nopember (ITS) and a graduate degree in Electrical Engineering (2010) from Universitas Gadjah Mada (UGM), Indonesia. In 2005, he joined the Physics Study Program of Universitas Lambung Mangkurat as a lecturer. He received the Academic Achievement Directorate General Higher Education (DIKTI) Scholarship (BPPS) for his graduate degree. Currently he is member of HFI (Indonesian Physical Society). His current research interests are Image Processing, Pattern Recognition and Medical Instrumentation.