

Filter technique of medical image on multiple morphological gradient (MMG) method

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Abstract

Filter technique is supportive for reducing image noise. This paper presents a study on filtering medical images, i.e., CT-Scan, Chest X-ray and Panoramic X-ray collected from two of the most prominent public hospitals in Padang City, Indonesia. The aim of this study preserved to facilitate in diagnosing objects in x-ray medical images. This study used filter technique, i.e. Blur, Emboss, Gaussian, Laplacian, Roberts, Sharpen, or Sobel techniques as pre-processing step. The filter process performed before edge detection and edge clarification. MMG method used in this study to clarify the edge detection. Thus, this research showed the hesitation decline (confidence increase) of the diagnosis of objects contained in medical images.

Keywords: edge detection, filter technique, medical image, multiple morphological gradient (MMG), X-ray

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1. Introduction

The medical image is the representation of human organs and their function visually. The medical image in clinical principle aims at diagnosing or revealing the type of disease [1, 2]. In medicine, the medical image is also used for anatomy and physiology education. In addition to clinical services, education and research are also indispensable in improving health services [3]. The types of medical images are as follows [4]:

- Nuclear Medicine Imaging: image using radioactive isotopes in the diagnosis and treatment of disease.
- X-ray Imaging; image to create imagery in helping to diagnose illness.
- Ultrasound Imaging (USG); image for diagnostic investigations that utilize ultrasonic waves with a high frequency in generating imagery without the use of radiation.
- Magnetic Resonance Imaging (MRI); the image of body parts taken by using a strong magnetic force around the limb to detect soft tissue.
- Optical imaging; image using light to get a detailed picture of organs and tissues as well as smaller structures in human organs.

Currently, X-ray is very common because the process is simple, low cost and low radiation. X-ray contains much information. The use of x-rays aims to prove the doctor's perception in diagnosing the disease [5]. The objects in the image must appear more clearly to help the doctor [6]. Medical images filtered using several different filtering techniques as pre-processing to achieve the aim of this study. The next is using Multiple Morphological Gradient (MMG) method to clarify the object edge detection. Furthermore, filter method is better for forming edge detection using MMG. Types of x-ray images used are shown in Table 1. Medical images in Table 1 collected from the Department of Radiology of Central General Hospital (RSUP) Dr. M. Djamil Padang and Semen Padang Hospital (SPH). Both hospitals are categorized as a public hospital.

A raw image is filtered first to produce an image to present the required information [7, 8]. The filter process aims to eliminate noise in the image. Noise is pixel value that interferes with image quality [9, 10]. The value of the noise pixel is lowest or highest value of its randomly distributed and randomly distributed pixel value. Some previous studies used

filtering techniques on x-ray image processing. Image Retrieval (IR) in detecting edges against CT-Scan and Chest X-Ray images using Canny. The filter technique used was Gaussian. The result improved the efficiency and performance of the system [11]. A CT-Scan image in edge detection using Morphology Gradient method. The filter technique used was Salt-and-pepper. The results showed a more practical view [12]. The CT-Scan image also using Gradient Morphology technique for edge detection and Salt and pepper for a filter and the result was more efficient [13].

Table 1. Types of X-Ray Image Processed

Type	Organ	Diagnosis
Computed Tomography Scan (CT-Scan)	Head	Hemorrhage
Panoramic X-ray	Teeth	Caries
Chest X-ray	Chest	Infiltrate

CT-Scan images to diagnose lung cancer cells. The edge detection techniques used the Canny method and the Gabor and watershed filter techniques. The result of the study might reduce errors in early detection of lung cancer [14]. Another study detected edges on Panoramic X-Ray [15]. The technique used selection automatically as a parameter on the conventional edge detection method (Roberts, Prewitt, Sobel, Laplacian, Gaussian, and Canny). Filter techniques used Laplacian of Gradient (LoG), and Gaussian. The result showed the improvement in the accuracy of the diagnosis interpretation [16]. Another study detected lung (filtering) was wavelet [17]. The results of the study increased the sensitivity of the image and could reduce the number of doubts from radiologists to detect nodule [18].

From the description of previous studies, it is noted that filter process can improve the quality of object edge detection in the X-ray image. By using various kinds of filter techniques, the results have better quality. Therefore, this research compared some filter techniques such as Blur, Emboss, Gaussian, Laplacian, Roberts, Sharpen, and Sobel, to support MMG method and found out the best filter in edge detection on a medical image.

2. Research Method

Currently, medical image processing is indispensable in reducing the doctors' perceptions of doubt in diagnosis. Many methods and techniques developed to produce a medical image that illustrates the apparent shape of the observed objects. This research proposes a comparison of some medical image filter techniques before MMG process using the Matlab software. The stages performed in this study are shown in Figure 1.

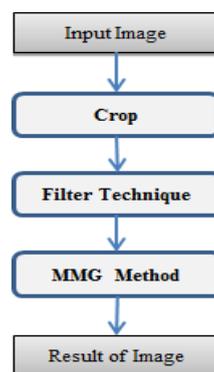


Figure 1. Stages of process

Figure 1 shows the image processing in this study. It consists of three main stages, i.e., Crop, Filter technique, and MMG. Every cropped image was filtered. Filter technique used Blur, Emboss, Gaussian, Laplacian, Roberts, Sharpen, or Sobel. Furthermore, the filtered image was

processed with MMG method to clarify the boundary of the object. The processing stages are presented in the following sub-section.

2.1. Input Image

Medical images used by some researchers to examine specific topics section [19]. The medical images were CT scans, Chest X-Ray, and Panoramic X-Ray. The medical image is shown in Table 2. The format of the images in Table 2 was Windows bitmap (bmp), Portable Network Graphics (png) and Joint Photographic Experts Group (jpg). Regarding chest x-ray, the data of this study collected from two groups of patients, namely adults and infant.

Table 2. Description of the Input Image

Type of X-Ray	Source	Total	Format
Brain CT-Scan	RSUP	4	bmp
Chest X-Ray (Infant)	RSUP	17	png
Chest X-Ray (Adult)	RSUP	28	jpg
Panoramic X-Ray	RSUP	28	png
Panoramic X-Ray	SPH	10	bmp

2.2. Crop

The crop is the process of cutting the image. The purpose of the crop is to remove unnecessary areas in the filtering process. The crop technique used in this study is a manual crop. The manual crop is cutting the input image area from the top left coordinate point to the bottom right coordinate point manually [20, 21]. Illustration of the cropping process is shown in Figure 2. The result of crop image contains the necessary area only in the next process. The pixel position starts from (0,0) by the initial position of the crop pixel.

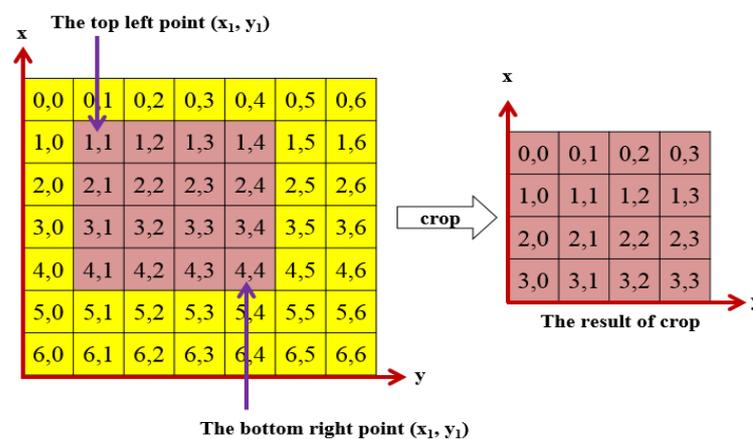


Figure 2. Illustration of crop process

2.3. Filter

The filter is a technique for removing noise in the image. Noise in medical images occurs by electromagnetic wave interference in Computed Radiography (CR) machine. Noise reduces image quality and causes the next processing becomes not optimum. Noise is a pixel that has is too low or too high value from the value of its neighboring pixels. Pixel noise dispersed randomly and unnecessarily. The filter work that it is processing neighbor pixels to get the latest pixel values. Thus, the equalization of pixels and histogram values are evenly distributed. Image filter can enhance (or otherwise modify, warp and mutilate) image and create a new image from pixels of an existing image [22]. A filter uses a convolution process; the sum of all the multiplication results between the filter matrix and the neighbor extension matrix from the (x, y) point in the image. The convolution equation is shown in the following (1):

$$F(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \quad (1)$$

where:

$F(x, y)$: Element of the convolution matrix at position (x, y)

σ : Standard deviation

x, y : The size of mask that runs from $-x$ to $+x$ with the midpoint is $x=0, y=0$.

The following are filter techniques compared in this study:

- Blur Filter is leveling the value of neighboring pixels with a specific mask, where the greater the size of the mask, so the result generated blur effect even greater.
- Emboss Filter is used to increasing the bright pixel value and decrease the dark pixel value.
- Gaussian Filter is eliminating normal spreading noise to create a soft and smooth effect.
- Laplacian Filter is smoothing the image.
- Roberts Filter is elevating the pixel value based on the gradient calculation toward the diagonal.
- Sharpen Filter is sharpening high-frequency pixels and lower pixel values of low frequency.
- Sobel Filter is increasing the pixel value based on the gradient calculation in the horizontal or vertical direction.

2.4. Multiple Morphology Gradient (MMG)

The technique of MMG aims to sharpen the edge of every object in images [23]. The value of edge boundary pixel is required to increase more than other pixels, clarify the edges of the objects contained in the image, and enable easier object identification. It applies morphological method, consisting of a process of dilation, erosion, and gradient. The method reduces the result of deletion morphology from the result of dilation morphology on a recurring basis. The work proposes the use of plain view to observe the border of object and the algorithm to sharpen and smooth the image based on Multiple Morphological Gradient (MMG). The algorithm multiplies the values of the pixel of edge boundary with the minimum multi-threshold (T) value [24, 25] of the MG result image. A multiplier value is considered as a bit depth value. The image enhancement process in each iteration stage displays objects clearly based on (2).

$$MG = F - \{z | (F)_z \subseteq A\} \quad (2)$$

where:

MG is the result of Morphology Gradient

A : element structure

Z : a shift mapping

in (2) is a Gradient morphology for edge detection.

$$mMG_{(x, y)} = \text{bitdepth} * MG_{(x, y)} | MG(x, y) > T \quad (3)$$

where:

bitdepth: bit depth value

T : Minimum multi-threshold value

mMG : Result image of mMG process

In (3) is sharpening edge detection.

3. Results and Analysis

Brands of recording machines and the size of the neglected imagery processed in this study. The medical images were grayscale and in bmp, png and jpg format. In Figure 3 shows the result of the crop, where one image of each type of x-ray. Noise can be seen in the histogram. The noise was reflected from the uneven pixel gray value between its neighbors. To eliminate the noise, then the image was filtered. The filter mask size used matrix 3x3. The

filter results continued by the Morphology Gradient and MMG process. The result of images can be seen in Table 3 .

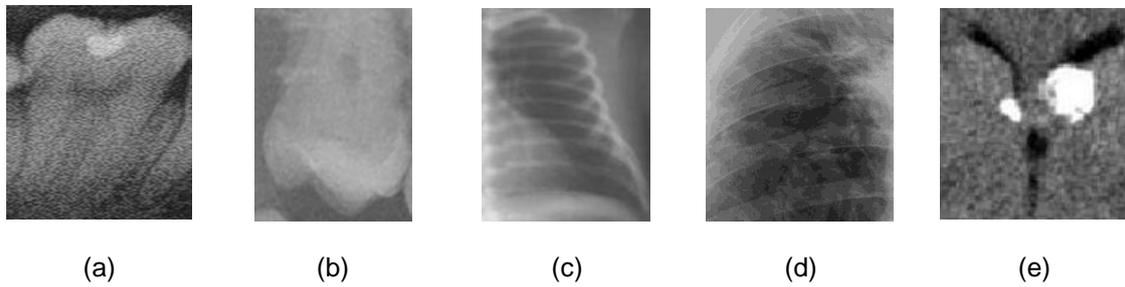


Figure 3. The result of crop, (a) panoramic X-ray (SPH), (b) panoramic X-ray (RSUP), (c) chest X-ray (Infant), (d) chest X-Ray (Adult), (e) brain CT-Scan

Table 3. The Result of Images

Type	Blur	Emboss	Gaussian	Laplacian	Roberts	Sharpen	Sobel
Panora mic X-ray (SPH)							
Panora mic X-ray (RSUP)							
Chest X-Ray (Infan)							
Chest X-Ray (Adult)							
Panora mic X-Ray							

Based on the test results is the Gaussian technique. It is more suitable to support the MMG method in detecting the objects in the medical image. Detection of the object can see clearly that shown in Figure 4.

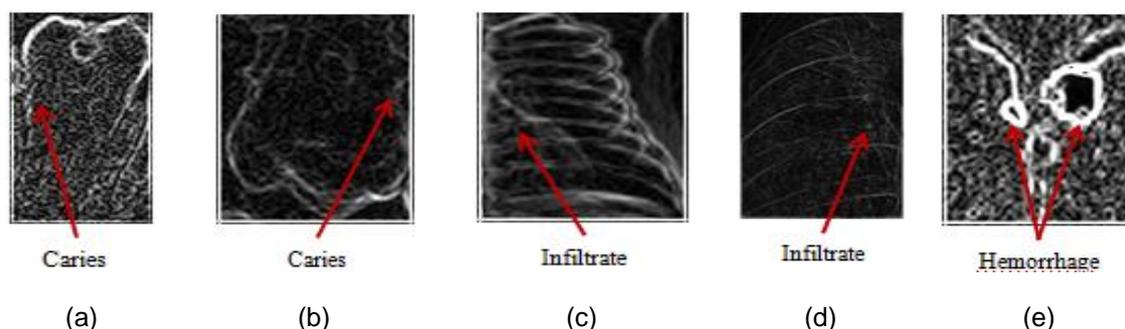


Figure 4. Clarification of object in result of mMG (a) panoramic X-ray (SPH), (b) panoramic X-ray (RSUP), (c) chest X-Ray (Infant), (d) chest X-Ray (Adult), (e) brain CT-Scan

The characteristics of the object on the image processing such as caries are edge detection on the teeth that lie inward and disconnected. Based on the experiment, this study found that Gaussian technique performs the best technique in reducing medical image noise and makes object observation in medical images, such as infiltrates in the lungs, caries in teeth or hemorrhage in the brain. Infiltrate is a point of white between the bones of the chest. The hemorrhage is the thick edge detection connected.

4. Conclusion

In this paper, various filter methods, such as Blur, Emboss, Gaussian, Laplacian, Roberts, Sharpen, and Sobel were used as preprocessing clarify the edge detection. Each filter technique has its superiority and weakness. Based on the observed result images, the Gaussian filter technique was more suitable as preprocessing for the MMG method in clarifying object edge detection. The results of this research showed the hesitation decline (confidence increase) of the diagnosis of objects contained in x-ray medical images.

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