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# Comparison of Blood Vessel Detection using Various Image Processing Techniques

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**Abstract**

The reason why every single human need to take care of their vital organs because it has biggest effect for body health. Blood vessel is the most important of vital organs that plays role as a channel to transfer blood from the heart to the others organs in human body. Blood vessel injury can be detected with extraction blood vessel from image. This paper proposed algorithm for injury detection of blood vessel with image processing to make it's image as clear as possible. The proposed algorithm is compared with edge detection algorithm such as sobel, prewitt and canny. The best method will be proposed for blood vessel detection in others research.

**Keywords**: Blood Vessel Extraction, Comparison, Image Processing

## INTRODUCTION

Survey report in America from American Diabetic Association, around 4 million people are affected by diabetic retinopathy and glaucoma [1, 2] . Therefore an accurate of extraction image of blood vessel is necessary [3, 4] .

There are many method for image quality measures that can be divided into six classes of image assessment that is pixel difference based, edge based, correlation based, spectral distance based, context based, HVS (Human Visual System) based [5] .

The proposed algorithm is compared with edge detection algorithm such as sobel, prewitt and canny [6], edge based [7, 8] (Sobel, prewitt and kirsch) and thresholding based [9] and do the comparison with proposed algorithm. Extraction process can be done with image processing. Image processing has a various operation such as point operation, neighborhood operation, noise reduction etc.

## IMAGE PROCESSING

Image can be divided into three mode, that is RGB, Grayscale, and Black&White. RGB has 3 color channel which is Red, Green and Blue, for every channel it has intensity value between 0 to 255. Grayscale has only one color channel and it's intensity between 0 to 255. Same as grayscale, Black and White has only one color channel but it's intensity value only between 0 to 1.

Image processing has three main process, Transform process, Neighborhood process, and Point operation. All of them can be used for image processing such as image restoration, enhancement and image enhancement.

### A. Point Operation

Point operation has five main process on image processing. Process of point operation shown on Table 1 below.

**Table 1:** Main Operations of Point Operation

| Operation | Formula |
|---|---|
| 1. Addition | $Y = x + c$ |
| 2. Substraction | $Y = x - c$ |
| 3. Multipication | $Y = cx$ |
| 4. Division | $Y = x/c$ |
| 5. Complement | $Y = 255- x$ |

From the Table 1 can be seen that every operation has their formula in image processing. Every formulation has a different effect. Effect from all of operation shown on Table 2.

**Table 2:** Effect of Point Operation

| Operation | Effect to image |
|---|---|
| 1. Addition | Increase the brightness |
| 2. Substraction | Decrease the brightness |
| 3. Multiplication | Increase the contrast |
| 4. Division | Decrease the contrast |
| 5. Complement | Invert of intensity value |

### B. Neighborhood Operation

The different contrast between neighbourhood operation with Point operation is pixel process in it. Point operation will process according to the pixels value alone, and Neighborhood operation will do pixel process with it's neighbours [10]. Neighborhood divided into two groups, *Low Pass Filter* (LPF), and *High Pass Filter* (HPF). Low

pass filter will make an image have lower gradation color which is will make iamge more smoother, and High Pass Filter will make an image has higher gradation color and rough image. LPF has three filter, *Average filter*, *Median Filter*, and *Gaussian Filter*. Every filter has different masking in it.

C. Noise Reduction

An image will have a different noise in it. The kind of noise model and what filter that can reduce it's noise shown on table 3.

Every noises model have suitable filter to reduce the noise on image. For example. Gaussian model will fit with Midpoint filter which is from Order-statistics filter and Mean filter is good for Gaussian or salt noise.

D. Peak Signal-to Noise Ratio (PSNR)

PSNR is a parameter that usually used for image compressing to define the quality of image result. PSNR is a mathematical measurement process based on pixel quality and different between two images. PSNR defined in (1)

$$PSNR = 10 \log \frac{S^2}{MSE} \quad (1)$$

The values of S = 255 for 8 bit image. The higher PSNR values it means the more good image is.

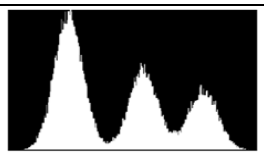
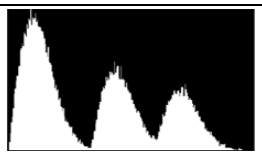
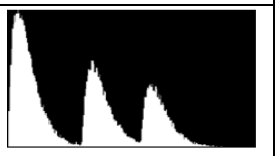
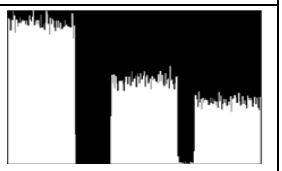
E. Mean Squared Error (MSE)

Mean Squared Error (MSE) used to find the errors between the original or input image and resultan or output image. MSE defined in (2)

$$MSE = \frac{1}{NM} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} e\,(m,n)^2 \quad (2)$$

The value of *m* and *n* are the different error between original (input) image and result (output) image. The lower MSE value of image it means the more good image is.

**Table 3:** Noises and Filters Model

| | | |
|---|---|---|
| NOISES MODEL | Gaussian Noise |  |
| | Rayleigh Noise |  |
| | Gamma Noise |  |
| | Exponential Noise |  |
| | Uniform Noise |  |
| | Impulse Noise |  |
| FILTERS MODEL | Rank-Order Filter | Median filter |
| | | Max filter |
| | | Min filter |
| | Mean Filter | Arithmatic mean filter |
| | | Geomethric mean filter |
| | Order-Statistics Filter | Midpoint filter |
| | | Alpha-trimmed mean filter |

## RESULTS AND DISCUSSION

With a kind methods of image processing, this paper will make a comparison between edge detection method and proposed method which is combination from some method in image processing. Research object in this paper is blood vessel of calve part or the lower part at lower human foot. The original image shown in figure 1.

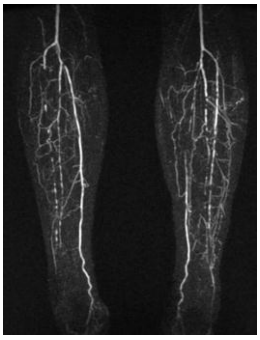


**Figure 1: Blood vessel image**

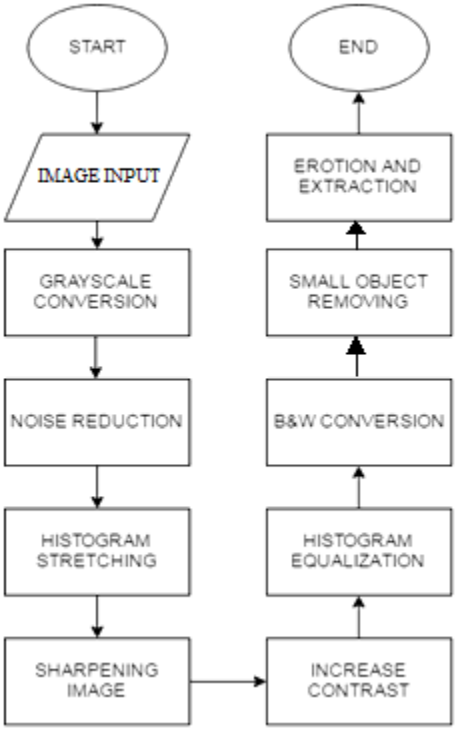



**Figure 2: Proposed Algorithm Process**

Proposed method in this paper used as a comparison with edge detection method is combination from all method in image processing. Algorithm from proposed method shown on Figure 2.

From figure 2, all of process from proposed algorithm will be explained below.

- Grayscale conversión.Grayscale conversión will make the original image has only one channel and simplify the process. Grayscale only has one channel color, which is will make calculating process easier.
- Fix the image using image restoration (Noise reduction ) because the original image has noise in it that causes the blood vessel image seems unclear. As explained in chapter II, noise has variant of model and filter to reduce it's noise. Therefore we need to find the noises model on original image to reduce the noise.
- After the noise of original image has reduced, we need to dissemble noise with image enhancement process which is using histogram stretching method. Because of noise reduction process, image will be blurred and image information are missing.
- The next step is process to get the missing information of image. This process can be done with sharpening image with Unsharp filter. The sharpened image need to be increased it's contrast to clear up blood vessel image.
- Contrast enhancing can be done with multiplication process and histogram equalization with B&W conversión process to make image clearer.
- With morfological operation will remove small object around blood vessel image. From all process happened above, image result has thicker blood vessel.
- The last step is extraction process that will make blood vessel thinner as a original blood vessel.

With such a long process algorithm, image will be more sharp and better. The result from this process shown on figure 3.

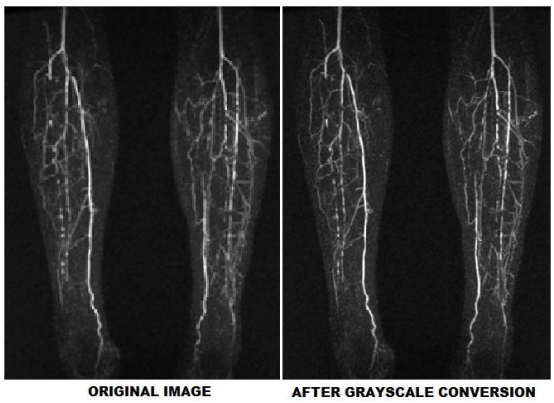



**Figure 3** : The result after Grayscale Conversion Process

After the grayscale conversion, image will only have one color channel to make the next step process easier. The next step is image restoration with noise reduction process. This process result shown on figure 4.

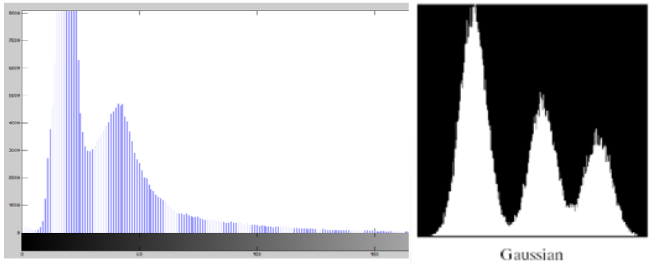



**Figure 4**: Comparison between Histogram of image with Gaussian noise

On figure 4 shown the histogram that produced from original image is matched with Gaussian noise model. So, the image will use some filter that suitable with Gaussian noise. There are many filter which suitable with Gaussian noise. On this process we will use Gaussian filter with masking 3x3 to reduce Gaussian noises .The result of this process shown on figure 5.

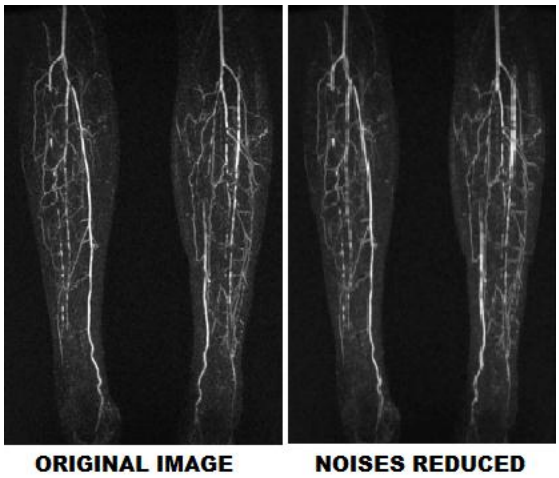



**Figure 5:** The result after Noise reduction with Gaussian filter

From figure 5 shown that noises from original image has been reduced, even with the naked eyes there is no different between two image above. After the noises has been reduced, we need to dissemble the noises on it. With contrast stretching which is with histogram stretching, image will be a little bit clearer than before. This process shown on figure 6.

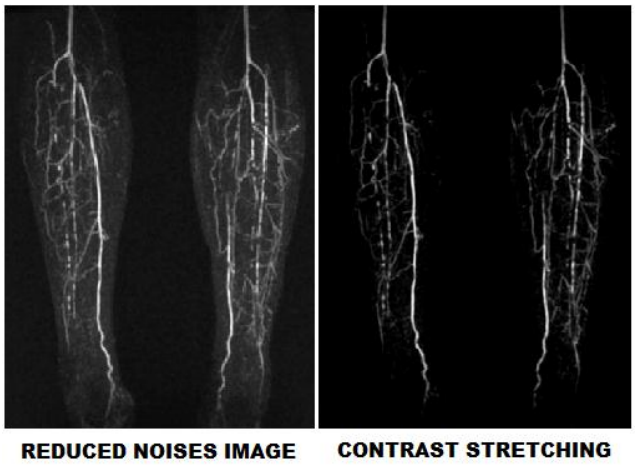



**Figure 6:** The result image after contrast stretching process

From figure 6 shown that after using histogram stretching, blood vessel seen more clearer, but a little bit blurred. Recovering missed information can be done with sharpening the image with Unsharp filter. Sharpening image process result shown on figure 7 .

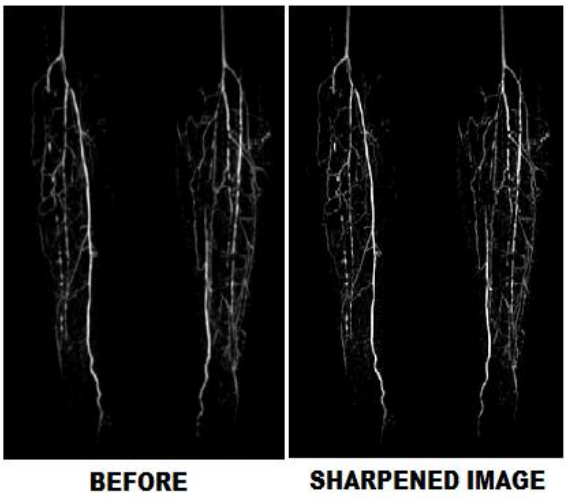



**Figure 7 : I**mage sharpened with unsharp filter

Once again, the result after using Unsharp filter image still a bit blurred. The next step is making image more clearer than before with contrast enhancement point operation with multiplication process to increase it's contrast. The result shown on figure 8.


**Figure 8** : Contrast enhancement result

Blur on the image has gone, the next step is flatten the colors result from multiplication process before. This process will be using histogram equalization with complement process to make a negative result. The result of image shown on figure 9.

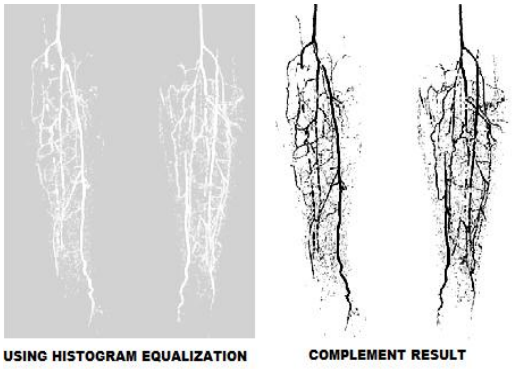



**Figure 9:** Histogram equalization and Complement result

After that negative image will be turned into normal image with black & white conversion and removing small object around blood vessel image with morphological process shown on figure 10.

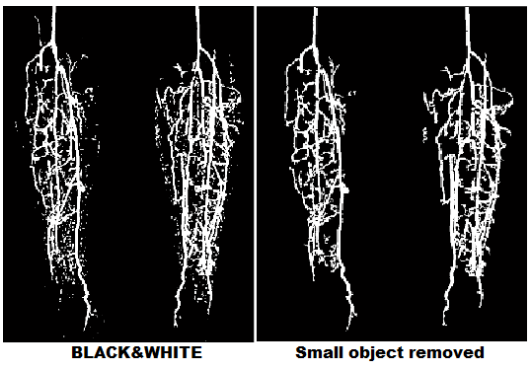



**Figure 10 :** B&W conversion and small object removing

Before doing the last step, we need to make information on image thinner before it's extracted. This process can be done with erotion process with rectangle mask 3x2. Result shown on figure 11.

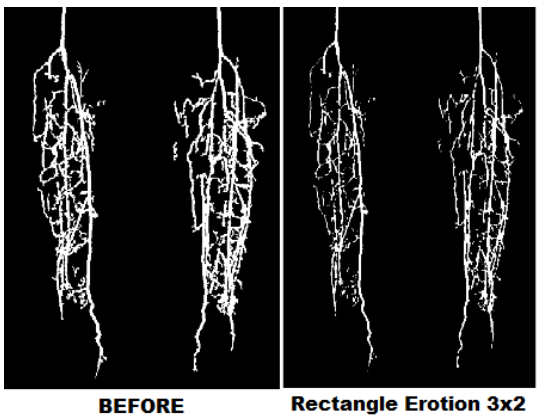



**Figure 11 :** The result after erotion process

The result between original image and after extraction process shown on figure 12.


**Figure 12 :** The result after extraction process

From all processes, the result make blood vessel more clearer and can be seen even with naked eye. For comparison between proposed algorithm with edge detection algorithm shown on figure 13 and 14.

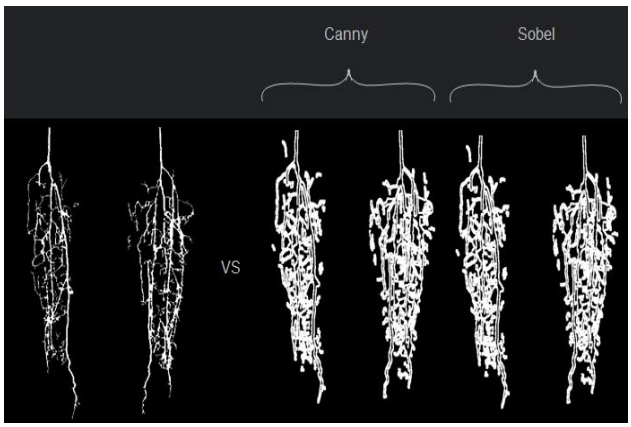



**Figure 13 :** Comparison between Proposed algorithm with Canny& Sobel result

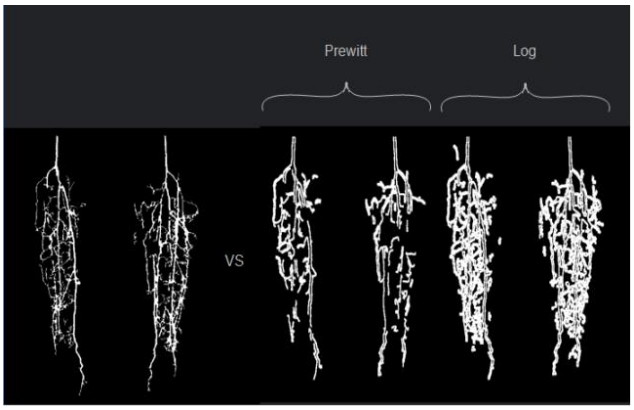



**Figure 14** : Comparison between Proposed algorithm with Prewitt & log result.

As we can see on figure 14, the result from proposed image has a clearer and detailed image without information losses in it.

Such as result from Prewitt method, some of information from image disappeared and more noises.

The values of MSE is error value between original image and transformed image and the values of PSNR is the different of pixel quality between original image and transformed image which is if the values of MSE are lower it's mean image has a better quality and if the value of PSNR are higher it's mean the pixel quality of transformed image has increased. The result comparison from all methods with different image format shown in figure 15 and 16.

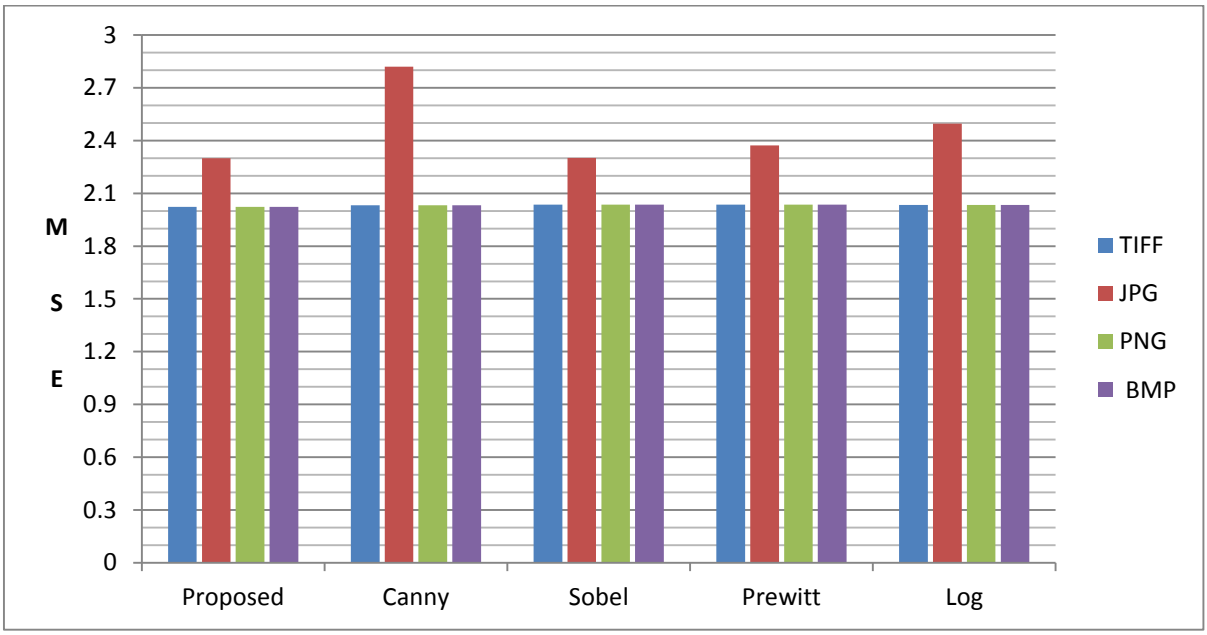



**Figure 15:** Comparison of MSE Values Chart

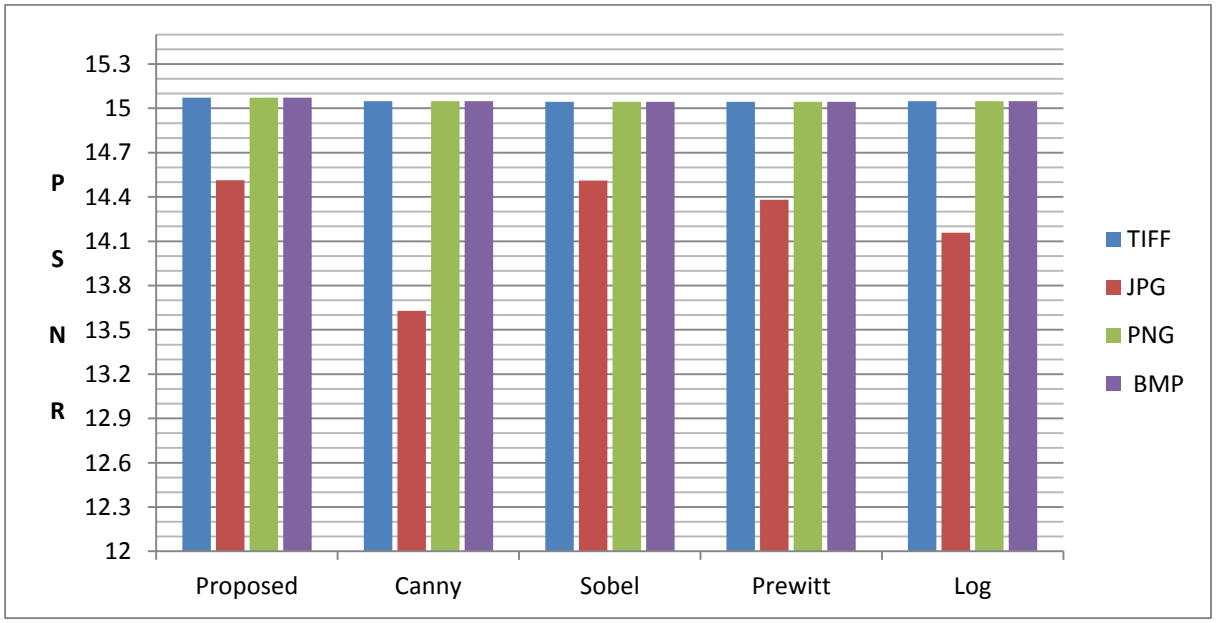



**Figure 16:** Comparison of PSNR Values Chart

Based on the chart, proposed method has a best result than the others methods. The proposed method has lowest of MSE value, it is around 2.0222 and highest value of PSNR it is around 15.0726. All of details for MSE and PSNR values are given in Table 4 .

**Table 4:** Comparison result of MSE and PSNR

| NO | METHOD | IMAGE FORMAT | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **TIFF** | | **JPG** | | **PNG** | | **BMP** | |
| | | **MSE** | **PSNR** | **MSE** | **PSNR** | **MSE** | **PSNR** | **MSE** | **PSNR** |
| 1 | **Proposed Algorithm** | 2.0222 | 15.0726 | 2.2996 | 14.5142 | 2.0222 | 15.0725 | 2.0222 | 15.0725 |
| 2 | **Canny** | 2.0330 | 15.0494 | 2.8193 | 13.6293 | 2.0330 | 15.0494 | 2.0330 | 15.0494 |
| 3 | **Sobel** | 2.0352 | 15.0447 | 2.3013 | 14.5110 | 2.0352 | 15.0447 | 2.0352 | 15.0447 |
| 4 | **Prewitt** | 2.0352 | 15.0447 | 2.3716 | 14.3803 | 2.0352 | 15.0447 | 2.0352 | 15.0447 |
| 5 | **Log** | 2.0332 | 15.0490 | 2.4959 | 14.1585 | 2.0332 | 15.0490 | 2.0332 | 15.0490 |

Based on the results of MSE and PSNR values, it was found that proposed algorithm is better than the others with some of image format. The lowest value ( green label ) of MSE is 2.0222 and highest value of PSNR is 15.0726 for TIFF image format.

## CONCLUSION

Image processing has a lot of methods can be used. Proposed algorithm shown has a better result than edge detection method ( canny, sobel, prewit ). The MSE and PSNR value of proposed algorithm around 2.0221 and 45.0728 which is it has lower value than edge detection method. With a long process from proposed algorithm, the extraction result has a clearer image than original image.proposed algorithm around 2.0221 and 45.0728 which is it has lower value than edge detection method. With a long process from proposed algorithm, the extraction result has a clearer image than original image.

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