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Image Enhancement Analysis using Various Image Processing Techniques

Ilham Majid Rabbani[1] and Tito Waluyo Purboyo[2]

[1,2] Department of Computer Engineering, Faculty of Electrical Engineering, Telkom University, Jawa, Indonesia.

ORCIDs: [1]0000-0002-6956-8783, [2] 0000-0001-9817-3185

Abstract

Nowadays many software use image enhancement as their best feature such as photo's filter on many apps, . The enhancement used several methods and techniques which is developed to gain best result in image sharpness. This enhancement resulted in line, curves etc. which is easier to analyze for the software developer. Thus, this paper show the result of experimentation of those methods to look for the best method in image processing techniques

Keywords: Image Processing, Image Enhancement, Image Detection

INTRODUCTION

Image processing requires a lot of resources and time to compute. Therefore, a lot of image processing technique developed due to give the best result. The technique used for setting brightness, sharpness, noise removal, image filter and image adjustments [1].

There are many method for image quality measures which is divided into six classes of image assessment, those are: pixel difference-based, edge-based, correlation-based, spectral distance-based, context-based, and HVS (Human Visual System) based [2] .

This paper proposed a comparison of various method in image processing and to determine the best process by using MSE dan PSNR value.

IMAGE PROCESSING

An image is produced by many colors such as RGB image, and some image produced by two color such as black and white image and grayscale.

RGB stands for Red, Green and Blue. which shows that the image has red, green and blue color channel and for each of them has intensity value from 0 to 255. Black-and-White and grayscale image has 1 color channel and both intensity value is 0 to 1.

Image processing could be done using intensity adjustment, histogram equlaization, and Thresholding which is contained in Point Operation, and could be done using Neighborhood averaging, median filtering and high-pass filtering which is contained in spatial operation.

A. Point Operation

Point operation is used by doing modification in input of image's histogram to fit into characteristic based on input. This operation contains intensity adjustment, histogram equalization, and thresholding.

1. Intensity adjustment

   This method works by mapping linearly of intensity value from the origin histogram into the intensity value of new histogram[1].

2. Histogram equalization

   This method created to produce an output value which has equally grey scale histogram's value on image result[3,4].

3. Thresholding

   This method is a process to separate pixels based on their value. The pixel which is smaller than the boundary's value will be 0 and the pixel which is bigger than the boundary's value will be 1[5,6].

B. Spatial Operation

Spatial operation is done by using two dimensions kernel. This operation has Neighborhood averaging method, median filtering method and high-pass filtering method.

1. Neighborhood averaging

Basically, the filter which is used in this method is low-pass filter. The low-pass filter works by changing the value of an origin image with mean value of the pixel and their neighbourhood[7].

2. Median filtering

Median filter is a low-pass filter that works by changing the value of an origin image by their median pixel value and around them. The difference between this method and negihborhood averaging is the median filtering is less sensitive about the differences in pixel[8,9].

3. High-pass filtering

As the process on signal, high-pass filter will miss the high frequence of image component and muffles the low frequence of image component[10].

C. Mean Square Error (MSE)

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

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

If the MSE result is higher, the worse image it is, if the MSE result is lower, the better image it is.

D. Peak Signal-to Noise Ratio (PSNR)

PSNR is a value which used to determine the compressing quality of an image. This value conducted from a mathematical formula that defined in (1)

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

Where S is the value of of bit image, S = 255 if the image is 8 bit image. This formula based on pixel quality. If the PSNR result is higher, the better image it is, if the PSNR result is lower, the worse image it is.

RESULT AND DISCUSSION

Image that used for this experiment is as shown below

Figure 1. Origin Image with 960x540 pixel

The histogram of this image is shown below

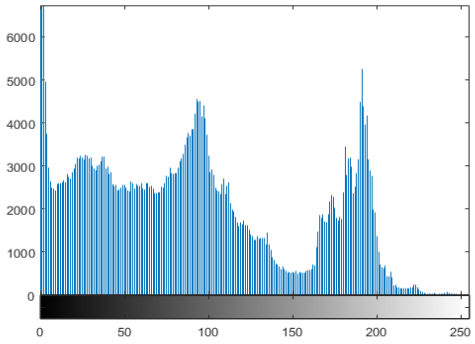

Figure 2. Origin Image's Histogram

1. Intensity Adjusment

To adjust the intensity of the image, this syntax is used

```
I=imread('Telkom1G.jpg');
J=imadjust(I,[0.15 0.9],[0 1]);
figure,imshow(I);
figure,imhist(I);
figure,imshow(J);
figure,imhist(J);
```

Figure 3. Intensity Adjusment Method Result

The histogram of this image is shown below

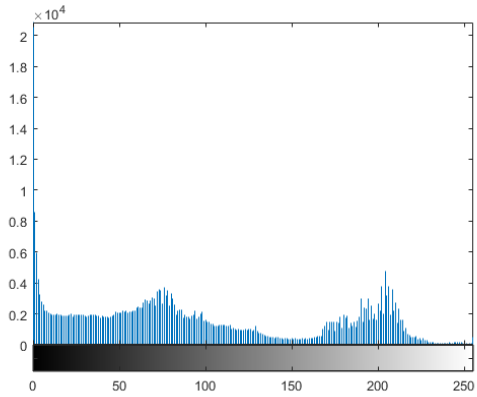

Figure 4. Point Operation Image Result's Histogram

Based on *figure 3*, the image become a little bit darker and has MSE value about 428.2850 and PSNR value about 567.439328238189. As shown on figure 4, the histogram is adjusted based on syntax and it's value become less than original image.

2. Histogram Equalization

To equalize histogram, this syntaxis used:

```
I=imread('Telkom1G.jpg');
J=histeq(I);
```

figure,imshow(I);

figure,imhist(I);

figure,imshow(J);

figure,imhist(J);

Figure 5. Histogram Equalization's Image Result

The histogram of this image is shown below

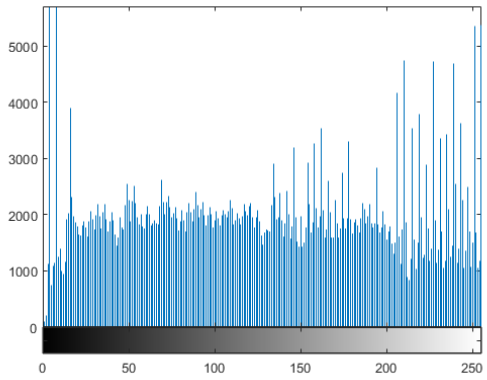

Figure 6. Histogram Equalization Image Result's Histogram

Based on figure 5, the color of flower and leaf became a bit brighter than the origin image. This method has MSE value about 1873.80527391975 and PSNR value about 271.283660163524. As shown on figure 6, the histogram is equally distributed to each grey scale.

3. Thresholding

To do Thresholding this syntax is used :

I=imread('Telkom1G.jpg');

J=im2bw(I,0.4);

K=im2bw(I,0.5);

figure,imshow(I);

figure,imhist(I);

figure,imshow(J);

figure,imshow(K);

Figure 7. Thresholding Image Result

The histogram of this image is shown below

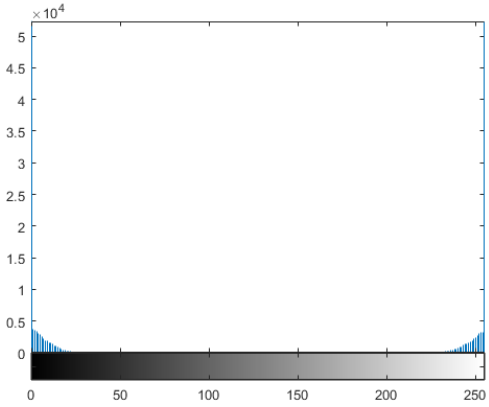

Figure 8. Thresholding Image Result's Histogram

Based on figure 7, as the definition of thresholding, this image use thresholding method and the value is 0.4. Thus, the image become black-and-white since thresholding will set the value becomes 1 and 0 only. This method has MSE value about 5662.25521026235 and PSNR value about 156.059835486505. As shown on figure 8, the value of grey scale just show which is less than 0.4, and if the value is more than 0.4, the value will not be shown.

4. Neighborhood Averaging

This method used this syntax in it's process, which are :

I=imread('Telkom1G.jpg');

kernel=[1 1 1;1 1 1;1 1 1]/9;
J=uint8(conv2(double(I),kernel,'same'));

figure,imshow(I);

figure,imshow(J);

Figure 9. Neighbourhood Averaging Image Result

The histogram of this image is shown below

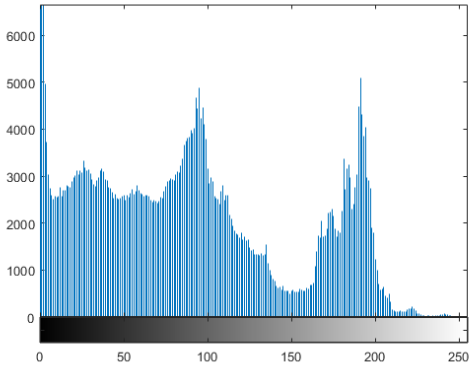

Figure 10. Neighbourhood Averaging Image Result's Histogram

As seen on figure 9, the image become slightly smooth than the origin image. This method has MSE value about 32.0090817901235 and PSNR value about 2075.62673852651. As shown on figure 10, tha value of gray scale is slightly similiar to the original image's histogram as shown on figure 1.

5. Median Filtering

This method used syntax as below :

```
I=imread('Telkom1G.jpg');
IN=imnoise(I,'salt & pepper',0.02);
J=medfilt2(I,[3 3]);
JN=medfilt2(IN,[3 3]);
 figure,imshow(I);
figure,imshow(J);
figure,imshow(IN);
figure,imshow(JN);
```

Figure 11. Median Filtering Image Result

The histogram of this image is shown below

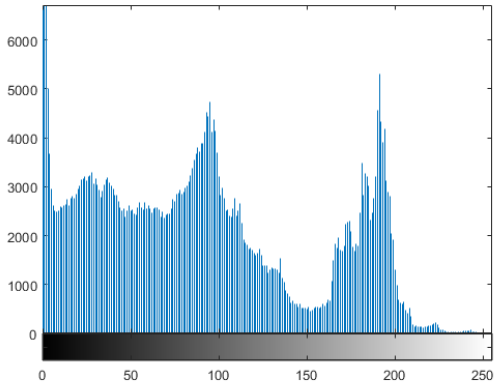

Figure 12. Median Filtering Image Result's Histogram

As seen on figure 11, the image looks like the origin image. This method has MSE value about 13.4300405092593 and PSNR value about 3204.40354468063. as shown on figure 12, the grey scale value is almost as same as shown on figure 1.

6. High-pass Filtering

This method used syntax as below :

```
I=imread('Telkom1G.jpg');
hpf1=[ 1 -2 1;-2 5 -2; 1 -2 1];
hpf2=[ 0 -1 0;-1 5 -1; 0 -1 0];
hpf3=[-1 -1 -1;-1 9 -1;-1 -1 -1];
J1=uint8(conv2(double(I),hpf1,'same'));
J2=uint8(conv2(double(I),hpf2,'same'));
J3=uint8(conv2(double(I),hpf3,'same'));
figure,imshow(I);
figure,imshow(J1);
figure,imshow(J2);
figure,imshow(J3);
```

Figure 13. High-Pass Filtering Image Result

Based on Figure 13, the image become sharper than the origin image and the outline of each picture is shown. This method has MSE value about 759.626757330247 and PSNR value about 426.074691058918. As shown on figure 14, the histogram of this image is filtered using high-pass filter.

The histogram of this image is shown below

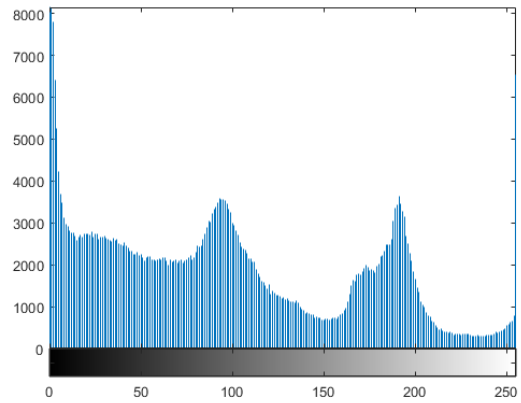

Figure 14. High-Pass Filtering Image Result's Histogram

Based on experiment done above, the result concluded as below :

Table 1. Experiment Result

No	Method	Origin Image (960x540)		Resized Image (576x324)		Resized Image (190x108)	
		MSE Value	PSNR Value	MSE Value	PSNR Value	MSE Value	PSNR Value
1	Intensity Adjustment	428.2850	567.4393	425.3715	569.3793	418.1519	574.2736
2	Histogram Equalization	1873.8053	271.2836	1875.3	271.1755	1898.9	269.4851
3	Thresholding	5662.2552	156.056	5635.7	156.4271	5681.2	155.7994
4	Neighborhood Averaging	32.01	2075.6267	58.9298	1529.7	208.5619	813.1457
5	Median Filtering	13.43	3204.4035	30.2583	2134.8	153.6903	947.2457
6	High-pass Filtering	759.6267	426.0747	198.7642	832.9459	791.5924	417.3833

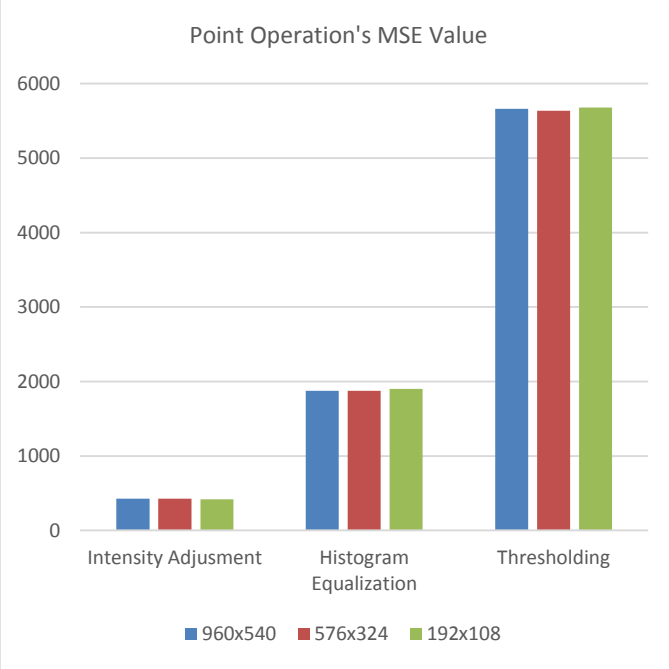

Figure 15. Point Operation's MSE Value Analysis Result

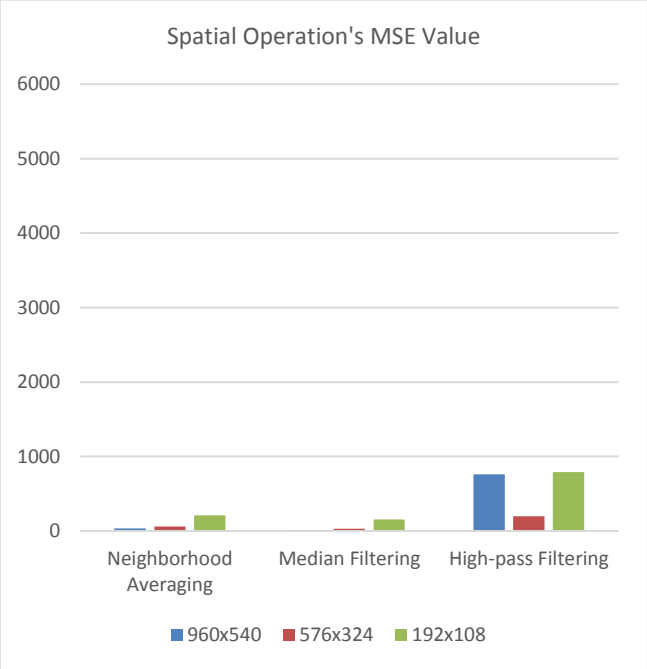

Figure 16. Spatial Operation's MSE Value Analysis Result

Based on figure 15 and 16, **for spatial operation, MSE value on median filtering has the lowest them all, which is 13.4300405092593 for 960x540 image, 30.2583 for 576x324 image and 153.6903 for 192x108 image**. **For point operation, intensity adjustment method has lowest them all, which is 428.2850 for 960x540 image, 425.3715 for 576x324 image and 418.1519 for 192x108 image**. Since MSE counts error, less value shows better value than the more one. Thus, intensity adjustment's method is the best method for image enhancement based on point operation's technique. And median filtering's method is the best method for image enhancement based on spatial operation's technique. Both result are based on MSE value analysis result.

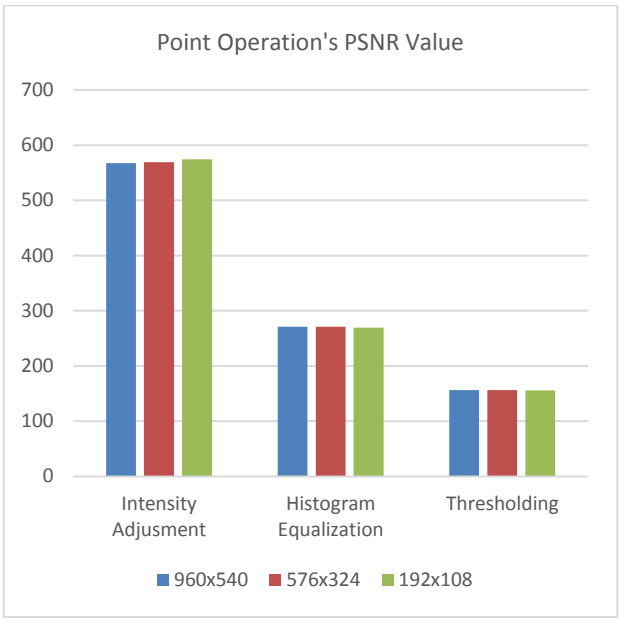

Figure 18. Spatial Operation's PSNR Value Analysis Result

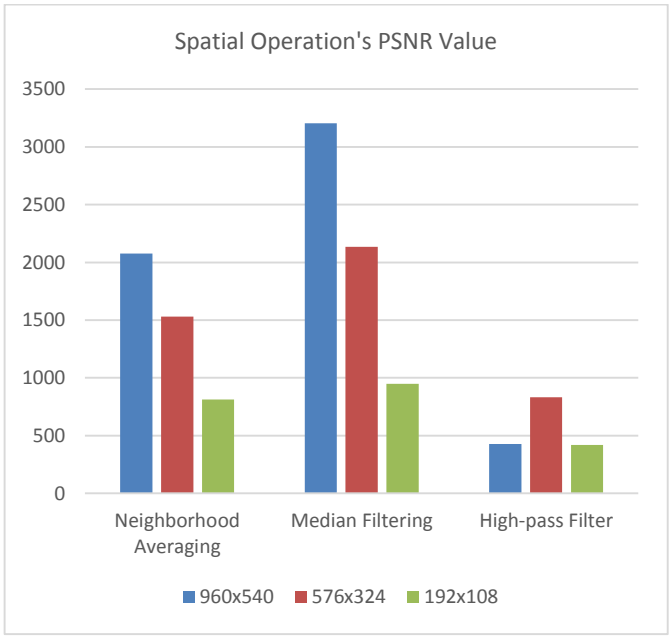

Figure 17. Point Operation's PSNR Value Analysis Result

Based on figure 16**, for spatial operation, PSNR value on median filtering has the most them all, which is 3204.40354468063 for 960x540 image, 2134.8for 576x324 image and 947.2457for 192x108 image**. **And for point operation, PSNR value on intensity adjustment has the most them all, which is 567.4393 for 960x540 image,**

569.3793 for 576x324 image and 574.2736 for 192x108 image. Since PSNR counts image quality, more value shows better value than the less one. Thus, median filtering's method is the best method for image enhancement based on spatial operation's technique and intensity adjustment's method is the best method for point operation's technique. Both result are based on PSNR value analysis result.

CONCLUSION

Thus, the experiment concluded that median filtering's method and intensity adjustment's method for image enhancement are the best one among 6 methods used in this experiment. Which median filtering's method MSE value has 13.4300405092593 for 960x540 image, 30.2583 for 576x324 image and 153.6903 for 192x108 image and PSNR value which is 3204.40354468063 for 960x540 image, 2134.8for 576x324 image and 947.2457for 192x108 image. And intensity adjustment's method MSE value has 428.2850 for 960x540 image, 425.3715 for 576x324 image and 418.1519 for 192x108 image and PSNR value which is 567.4393 for 960x540 image, 569.3793 for 576x324 image and 574.2736 for 192x108.

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