Histogram Equalization and Gaussian Filtering Combination Method for Face Image optimization

Conference Paper · October 2018

DOI: 10.1109/iCAST1.2018.8751523

Histogram Equalization and Gaussian Filtering Combination Method for Face Image Optimization

I Nyoman Gede Arya Astawa
Electrical Engineering
Politeknik Negeri Bali
Badung Indonesia
arya_kmg@pnb.ac.id

Ni Gusti Ayu Putu Harry Saptarini
Electrical Engineering
Politeknik Negeri Bali
Badung Indonesia
4yu.h4rry@gmail.com

Sri Andriati Asri
Electrical Engineering
Politeknik Negeri Bali
Badung Indonesia
sriandriati@pnb.ac.id

Putu Gde Sukarata
Electrical Engineering
Politeknik Negeri Bali
Badung Indonesia
sukarata@pnb.ac.id

I Made Ari Dwi Suta Atmaja
Electrical Engineering
Politeknik Negeri Bali
Badung Indonesia
arisuta@pnb.ac.id

***Abstract*—Good image plays an important role in the delivery of information, where the image quality is often influenced by the process of image retrieval or storage. As a result, there is a decrease in the intensity of image quality as the image will contain defects or noise, the color will be contrast or blur. Histogram Equalization and Gaussian Filtering Combination Method can be used to improve the image quality. The test result that we used is the comparison between the original image and filtered image. In the initial process, the system used facial images that have the RGB format converted to grayscale format. Furthermore, there was an equalization of the light intensity value in the grayscale image. The next process was image filtering using Gaussian Filtering method to reduce noise. The noise measurement in the image was calculated using the Peak Signal-to-Noise Ratio (PSNR). Meanwhile, the measurement of signal quality used Signal-to-Ratio (SNR). The test was performed on a standard deviation of 0.5 to 1 and obtained the highest value of the 3x3 Gaussian filter at a standard deviation of 0.5 where the values of SNR = 45.7757 and PSNR = 32.948. The greater the value of PSNR image, the image will be closer to the original image as well as the larger the SNR value, the better the signal quality generated.**

Keywords— *Face Image, Gaussian Filtering, Peak Signal-to-Noise Ratio, Signal-to-Ratio*

I. INTRODUCTION

An image has characteristics that are rich in information. Good image plays an important role in the delivery of information, where the image quality is often influenced by the process of capture or image storage process. This often leads to a decrease in image quality intensity as the image will contain defects or noise, the color will be contrasted or blurred. In the process of sending digital images via cable or via satellite also has the opportunity to make the image received often damaged (noise) which resulted in the existing information to be reduced.

Researchers (1) stated that increased intensity is a significant processing technique for image and video, thereby effectively improving the visual quality of images for perception and recognition. Researchers (2) stated that a very important part in low-level image processing is enhanced image contrast, which aims to improve image quality with low-contrast values, to increase the intensity difference between objects and background images and increase the perception of the information contained on the picture.

The contrast enhancement is usually done by spreading the histogram from the gray-level on the spatial image pixel so that it is evenly distributed (3). Histogram Equalization leveled the gray-level of an image by using information from the histogram form. Furthermore, we started to do the equalization function in a grayscale image Histogram Equalization is an efficient technique. This technique can reduce the mismatch between the original results and the results of the test data (4, 5). Likewise in the study (3) which says that the Histogram Equalization method is very effectively used not only in improving the whole image but also in improving the texture detail. It also makes changes to the order of gray level original image is completely under control, making it more effective in improving the image quality. Researchers (2) mentioned the use of the Histogram Equalization method is considered easy because of its simplicity and relatively better performance on almost any type of image and increased contrast in the image.

In this research, facial image optimization used image processing method, that is equalization of light intensity in a digital image using Histogram Equalization and noise reduction process using Gaussian filtering method. Image processing used Matlab 2010a software (version 7.10.0.499).

II. RESEARCH METHOD

The image used in this research was a kind of digital image data because it is very commonly used and has a relatively small size for a data type and can provide a lot of information. Digital image processing was done using approach through image matrix to compare the original image and image of filtering result which was then processed by using Matlab software.

Research began by providing face image input. The face image was then converted from the color format (RGB) to grayscale. The converted image was done through the Histogram Equalization process. In this process, we got the histogram value of the converted image then we did the equalization based on histogram. Facial images that had been done through the Histogram Equalization process began to enter the Gaussian noise filtering process. The purpose of this process is to reduce the noise contained in the image. The image results obtained in this process were resized.

The noise reduction process had a big effect on digital image processing. It is necessary to the noise reduction process so that the data obtained more accurate and

978-1-5386-7548-9/18/$31.00 ©2018 IEEE

representative of the real situation. So the results of image processing obtained in the next process to be optimal.

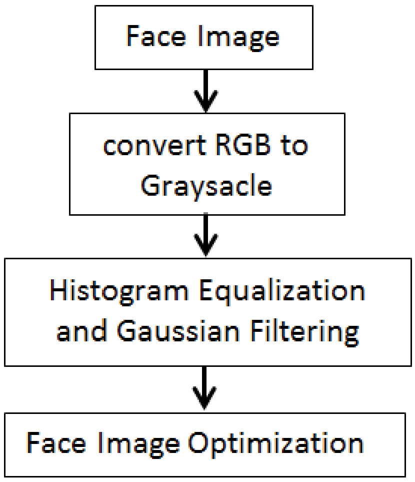

Fig. 1. Research flowchart

Research carried out by (6) obtained results from the application of Wiener filter in the digressed digital image of Speckle noise and Gaussian noise, the output is better when compared to the output with the application of Median filter. The Wiener filter gives better results than the Mean or Median filters to reduce noise in images especially on Speckle noise, Poisson noise or Gaussian noise (6).

Therefore, this research tried to use Gaussian filter in reducing noise in a digital image. For optimization of HE and Gaussian filtering methods, especially to know the amount of noise and signal quality calculated using PSNR and SNR.

A. *Image Enhancement*

Image enhancement is one method that is simple and quite interesting in the field of digital image processing. Basically, the idea behind the image enhancement technique is to improve details that are obscured, or optimize certain features of interest in the image. It is important to remember that image enhancement is a highly subjective area of image processing. Degraded image enhancement is achieved by using the application of image enhancement techniques (7).

To enhance the image contrast, we can use Histogram Equalization (2, 3). The basic concept of Histogram Equalization is to stretch the histogram so that the pixel difference becomes larger or in other words, the information becomes stronger so the eye can capture the information conveyed.

Mathematically, the histogram value can be calculated by the following formula:

$$h_i = \frac{n_i}{n} \text{ ; i = 0,1,...,L-1} \tag{1}$$

Where:

L = gray level

n = the number of pixels

n_i = the number of pixels that have a gray level of i

It is assumed that the Histogram Equalization changes the input value of r_k to s_k and then changes s, the form of the equation is as follows (8) : k becomes vk

$$v_k = T(s_k) = \frac{(L-1)}{n} \sum_{j=0}^{k} n_{rj} = s_k \tag{2}$$

Gaussian filtering is included in the low-pass filter class, which is based on the Gaussian probability distribution function (9) as follows:

$$f(x) = e^{-\frac{x^2}{2\sigma^2}} \tag{3}$$

where σ is the standard deviation. While the Gauss function in dimension 2 is as follows:

$$f(x,y) = e^{-\frac{x^2+y^2}{2\sigma^2}} \tag{4}$$

B. *Noise*

Noise is an image signal damage caused by external interference. Noise in the image is usually a variation in the intensity of a pixel that is not correlated with neighboring pixels.

Gaussian noise shows the ideal form of white noise that causes random fluctuations in a signal (10). Gaussian noise is normally distributed in white noise. If the digital image is represented by I and Gaussian Noise with N, then the shape of the noisy image model is as follows (9) :

$$I + N \tag{5}$$

C. *Root Mean Square Error*

Root Mean Squared Error (RMSE) is best used to measure the error rate of filtered images by comparing it with the original image. The function $f\,'(x, y)$ shows the filtered image pixel; $f\,(x, y)$ indicates the pixel of the original image; m and n are image length and image width respectively; RMSE is calculated as follows:

$$RMSE = \sqrt{\frac{1}{m\,x\,n} \sum_{x=1}^{m} \sum_{y=1}^{n} (f(x,y) - f'(x,y))^2} \tag{6}$$

The greater the RMSE value, the filtering result will have an even greater error rate. Thus, the image produced in the process is increasingly unlike the original image and vice versa.

D. *Peak Signal to Noise Ratio*

Peak Signal to Noise Ratio (PSNR) is a comparison between a maximum value of the measured signal and number of affecting noise to the signal. We calculate the value of image quality using the PSNR. This method compares noise to the peak signal. The greater PSNR value, the closer image to the original. PSNR can be calculated as follows:

$$PSNR = 20 \log\left(\frac{Max_I}{RMSE}\right) \tag{7}$$

Where Max_I is grayscale maximum value; Max_I = 255 and *RMSE* is Root Mean Square Error.

E. *Signal to Noise Ratio*

Noise ratio between the proceed image and the original are used to measure the level of signal quality. This ratio called Signal to noise ratio (SNR). So the greater the SNR value, the better the signal quality is generated. SNR is usually in units of decibels (dB); the equations are as follows:

$$SNR = 10\log_{10}\left[\frac{\sum m,n\, I_{m,n}^{2}}{\sum m,n\, I_{m,n} - \bar{I}_{m.n}}\right] \tag{8}$$

Where $I_{m,n}$ is the original image, $I_{m,n}$ is the proceed image and *m, n are* image dimension.

III. Result and Discussion

Image processing in this research consists of image input process and reading image matrix, image conversion, denoising digital image by applying filter done by using Matlab R2010a software (version 7.10.0.499).

A. Image Input

After inputting the image in Matlab, then the image was displayed in the form of matrix m × n according to the size of the image.

B. RGB Image to Grayscale Conversion

After the matrix reading process, the image produced a digital image matrix with pixel value 0 - 255 in 3-dimensional colors ie Red, Green, and Blue (RGB). So to simplify the following process, it is necessary to process the conversion of RGB digital image into Grayscale.

C. Histogram Equalization

Histogram equalization is a histogram leveling process, in which the distribution of gray degree values of an image is made evenly. Examples of histogram results can be seen in Figure 2.

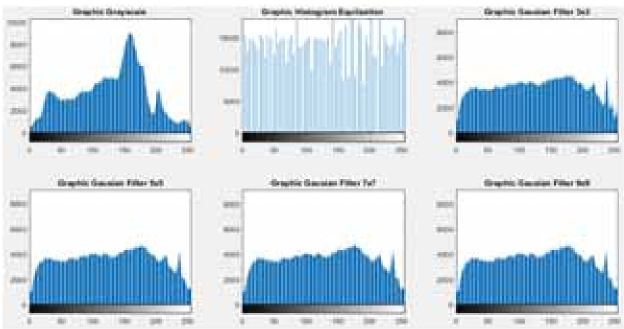

Fig. 2. Histogram using standard deviation = 1

D. Filtering Process

This process is done to reduce the noise obtained from the processing of histogram equalization.

TABLE I. Peak Signal-to-Noise Ratio of Matrix to Standard Deviation

Standard Deviation	Matrix			
	3x3	*5x5*	*7x7*	*9x9*
0.5	25.4616	25.4503	25.4503	25.4503
0.6	22.2824	22.2324	22.2324	22.2324
0.7	20.8031	20.6893	20.6886	20.6886
0.8	20.0217	19.8407	19.8372	19.8372
0.9	19.5638	19.3226	19.3124	19.3122
1	19.2728	18.9808	18.9597	18.959

The used matrix sizes were 3 × 3, 5 × 5, 7 × 7, 9 × 9, with a standard deviation of 0.5; 0.6; 0.7; 0.8; 0.9; 1. The PSNR and SNR values of each matrix can be seen in Tables 1 and 2.

TABLE II. Signal-to-Ratio of Matrix to Standard Deviation

Standard Deviation	Matrix			
	3x3	*5x5*	*7x7*	*9x9*
0.5	54.7101	54.6959	54.6953	54.6955
0.6	52.7389	52.6634	52.6629	52.663
0.7	51.7636	51.4703	51.4654	51.465
0.8	51.192	50.6189	50.6038	50.6035
0.9	50.8308	49.9879	49.9258	49.9243
1	50.5939	49.4917	49.362	49.3609

In Table 1 and Table 2, it can be seen that the greater the value of the standard deviation, the smaller the value of the PSNR and the SNR. That is, the larger the standard deviation value, the more visible the difference between the two images. Examples of image processing results can be seen in Figure 3.

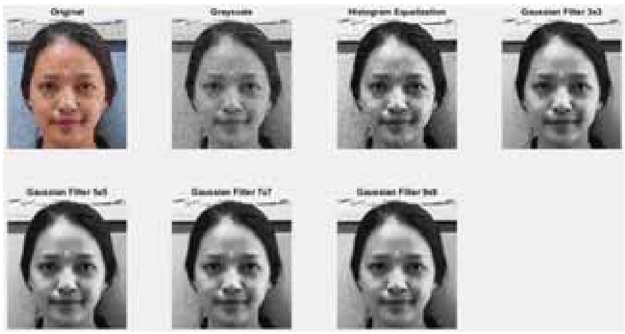

Fig. 3. Examples of image processing results in Standard Deviation = 1

IV. Conclusion

Looking at the results of the research that has been done, obtained the following conclusions:

1. Image processing using Histogram Equalization method can increase the contrast. As shown in Figure 3, where face images that have been proceeded to grayscale still have a low contrast level. Grayscale image processing processed by Histogram Equalization method can increase the contrast in the image. However, there is noise on the image after being processed with Histogram Equalization.
2. To reduce the noise contained in the image, it was done with image filtering using Gaussian Filtering. Judging from the values contained in Table 1 and Table 2, the highest value is in the 3 × 3 filter Gaussian with standard deviation = 0.5 with the value of Peak Signal-to-Noise Ratio (PSNR) = 25.4616 and the Signal-to-Ratio (SNR) = 54.7101. So with both methods, the image becomes more optimal face.

Acknowledgments

The authors would like to express a special thank of gratitude to the department of research and community service center of Politeknik Negeri Bali for financing this research.

REFERENCES

[1] Lidong H, Wei Z, Jun W, Zebin S. Combination of contrast limited adaptive histogram equalisation and discrete wavelet transform for image enhancement. *IET Image Processing*. 2015;9(10):908-15.

[2] Ibrahim H, Kong NSP. Brightness Preserving Dynamic Histogram Equalization for Image Contrast Enhancement. *IEEE Transactions on Consumer Electronics*. 2007;53(4):1752-8.

[3] Li J, Wang J, Li Z, Li B, editors. *A novel algorithm of IC defect images enhancement based on histogram equalization and IHS transform*. 2013 International Conference on Anti-Counterfeiting, Security and Identification (ASID); 2013 25-27 Oct. 2013.

[4] Berlin C, Yao-Ming Y, Shih-Hsiang L. A Comparative Study of Histogram Equalization (HEQ) for Robust Speech Recognition. *Computational Linguistics and Chinese Language Processing*. 2007;12(2):217-38.

[5] Ahirwar V, Yadav H, Jain A, editors. *Hybrid model for preserving brightness over the digital image processing*. 2013 4th International Conference on Computer and Communication Technology (ICCCT); 2013 20-22 Sept. 2013.

[6] Patidar P, Srivastava S, Gupta M, Nagawat AK. Image De-noising by Various Filters for Different Noise. *International Journal of Computer Applications (0975 – 8887)*. 2010;9(4):45-50.

[7] Sheetal G, Bhawna M, Rajesh G. Histogram Equalization Techniques For Image Enhancement. *International Journal of Electronics & Communication Technology (Iject)*. 2011;2(1).

[8] Frank YS. Image Steganography. Image Processing and Pattern Recognition:Fundamentals and Techniques: Wiley-IEEE Press; 2010. p. 474-95.

[9] McAndrew A. An Introduction to Digital Image Processing with Matlab. Boston, MA, United States: Course Technology Press; 2004.

[10] Liu H, Zhang R, Zhou Y, Jing X, Truong TK. Speech Denoising Using Transform Domains in the Presence of Impulsive and Gaussian Noises. *IEEE Access*. 2017;5:21193-203.