Image Enhancement using Filtering Techniques

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Abstract— **Image enhancement is used to improve the quality of an image. In this paper, two novel algorithms CB (Center-to-Boundary) and BB (Boundary-to-Boundary) filters have proposed. These algorithms have implemented for $n \times n$ mask, but in this paper, authors have chosen only 3×3 which are convoluted with various poorly contrast images. The performance of these two algorithms are analyzed and compared with the average filter on the basis of four parameters - eme, mse, rmse, and psnr. The experimental results are carried on more than 1000 images that prove that these two algorithms enhance poor quality images very effectively.**

Keywords- Image Processin; Image Enhancement; CB Filter; BB Filter;

I. INTRODUCTION

Image enhancement [1,2,7,8,13] is the processing of image to enhance certain feature of an image. Image enhancement is basically improving the interpretability or perception of information in images for human viewers and providing better input for other automated image processing techniques. The principal objective of image enhancement is to modify attributes of an image to make it more suitable for a given task an\\\\d a specific observer. During this process, one or more attributes of the image are modified. The choice of attributes and the way they are modified are specific to a given task. Moreover, observer-specific factors, such as the human visual system and the observer's experience, will introduce a great deal of subjectivity into the choice of image enhancement methods. Image enhancement is used in the following cases: Removal of noise from image, Enhancement of the dark image and highlight the edges of the objects in an image. The result is more suitable than the original image for certain specific applications. Processing techniques are very much problem oriented [3,9,10,12]. For example, best techniques for enhancement of X-ray image may not be best for enhancement for microscopic images.

In this paper, two novel filters CB (Centre-to-Boundary) and BB (Boundary-to-Boundary) filters have developed. Both these filters are used to remove the noisy pixels and transform them into good one. They are based on calculating the distance between image pixels and their neighbors. They are used to enhance abnormal pixels values to remove noise and enhance the appearance of an image. The distance between the image pixel and its neighbors will be calculated to minimize the effectiveness of noisy pixels. The distance values represent the relation between good pixels and noisy pixels, which satisfy the assumption, that “far noisy pixels have less effect on surrounded good ones”[11,12,15].

In section II and III, authors defined the CB (Centre-to-Boundary) and BB (Boundary-to-Boundary) filter which remove the noisy pixels and transformed them into good pixels. They are implemented for $n \times n$. In section IV, the performance of these two filters for 3×3 mask are evaluated and compared with average filter. The graphs and various images that are obtained from these filters have also displayed. Finally, paper concludes in section V.

II. CB(CENTER-TO-BOUNDARY) FILTER

In CB filter, pixels are scanned from Center to Boundary to calculate the distance between them by using Newton-Raphson's formula. The Newton-Raphson method is a powerful technique for solving equations numerically. The Newton-Raphson formula is based on the equation (1) as given below:

$$C_j = C_i - \frac{f(C_i)}{f'(C_i)} \qquad (1)$$

Where

$$f(C_i) = i^2 - i - 1 \qquad (2)$$

$$f'(C_i) = 2i - 1 \qquad (3)$$

C_i = Central pixel

C_j = Neighboring pixel of C_i

Equation (ii) is chosen experimentally and this is the *fitness criterion*. This formula is applied on 1000 images and results are found very satisfactory. The central pixel is assumed to be 1. Then use 4-connectivity chain code and apply the Newton Raphson's method using fitness criterion $f\ (C_i) = i^2 - i - 1$, The distance is calculated between centralized pixel and its neighbors and then apply the same process until all the pixels are scanned. Do not scan those pixels that are already scanned. The table 1 has shown for 3×3 CB filter.

TABLE 1. 3×3 MASK FOR CB FILTER

1.67	2	1.67
2	1	2
1.67	2	1.67

A. Algorithm

Step 1: Choose any n×n matrix.
Step 2: Check whether the matrix is odd or even. If even, then exit otherwise proceed to step3.
Step 3: Initialize the central pixel of the matrix equal to 1 i.e $C_i = 1$.
Step 4: Scan from the Central pixel to all neighboring pixels by using 4-connectivity.
Step 5: Apply Newton-Raphson's Method on step 4 to find out the value of neighboring pixels using formula:

$$C_j = C_i - \frac{f(C_i)}{f'(C_i)} \qquad (4)$$

Step 6: Repeat step 4 and 5 until all pixels are scanned (*NOTE: Do not scan those pixels that are already scanned.*
Step 7: Exit

B. Results

The CB filter applied on the original image and results has displayed in Fig.1 [4,5,11]**.**

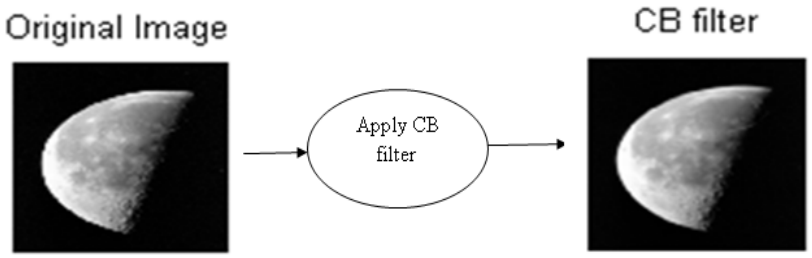

Figure 1. Image enhancement using CB filter

III. BB(BOUNDARY-TO-BOUNDARY) FILTER

In BB filter, pixels are scanned from upper left Boundary to lower right Boundary pixels to calculate distance between them by using Newton-Raphson's formula using equation 1 as described above. The table 2 has shown for 3×3 CB filter.

TABLE 2. 3×3 **M**ASK **F**OR **B**B **F**ILTER

1	2	1.67
2	1.67	1.62
1.67	1.62	1.62

A. Algorithm

Step 1: Choose any n×n matrix.
Step 2: Check whether the matrix is odd or even. If even, then exit otherwise proceed to step3.
Step 3: Initialize the upper left boundary pixel of the matrix equal to 1 i.e $C_i == 1$.
Step 4: Scan from the upper left boundary pixel to all neighboring pixels by using 4-connectivity.
Step 5: Apply Newton-Raphson's Method to find out the value of neighboring pixels using formula:

$$C_j = C_i - \frac{f(C_i)}{f'(C_i)} \qquad (5)$$

Step 6: Repeat step 4 and 5 until all pixels are scanned (NOTE: Do not scan those pixels that are already scanned.
Note: Do not scan those pixels that are already scanned.
Step 7: Exit

B. Results

The BB filter applied on the original image and results has displayed in Fig. 2 [4,5,11]**.**

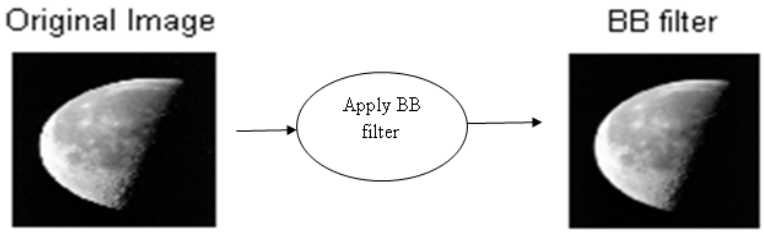

Figure 2. Image enhancement using BB filter

IV. **P**ERFORMANCE **E**VALUATION **A**ND **C**OMPARISION **O**F **C**B **A**ND **B**B **F**ILTER **W**ITH **A**VERAGE **F**ILTER

The performance of the CB and BB filter for 3×3 mask are evaluated and compared with average filter. The four parameters, namely, eme, psnr, mse and rmse have chosen to measure the performance of these filters. These algorithms can be applied on n×n masks. In this paper, only 3×3 mask has taken and it convolute with various poor quality images. The results are implemented using MATLAB 7.4 using Image Processing Toolbox (IPT) [4,5,13]. The results are shown as:

A. eme(Quality Measure Of Image Enhancement)

The following results based on eme parameters [14] have shown in table 3 given below:

TABLE 3. **E**ME **V**ALUES OF **C**B, **B**B AND **A**VERAGE **F**ILTER **F**OR 3×3 MASK

Image	**CB Filter**	**BB Filter**	**AVG Filter**
moon	13.0678	12.3028	12.4036
fish	1.5656	3.1460	2.7913
coin	3.8763	4.1736	4.1546
flower	7.9600	7.9816	7.7674
pout	2.6538	2.7055	2.5805

B. mse(Mean Square Error)

The following results based on mse parameters have shown in table 4 given below:

TABLE 4. **M**SE **V**ALUES OF **C**B, **B**B **A**ND **A**VERAGE **F**ILTER **F**OR 3×3 **M**ASK

Image	CB Filter	BB Filter	AVG Filter
moon	0.1883	0.3361	5.8554
fish	1.0943	2.2286	10.3686
coin	0.7643	1.6088	16.3373
flower	0.4473	1.1854	5.9577
pout	1.2738	2.1309	5.9394

C. rmse(Root Mean Square Error)

The following results based on rmse parameters have shown in table 5 given below:

TABLE 5. **R**MSE **V**ALUES OF **C**B, **B**B **A**ND **A**VERAGE **F**ILTER **F**OR 3×3 **M**ASK

Image	CB FILTER	BB FILTER	AVG FILTER
moon	0.4340	0.5797	2.4198
fish	1.0461	1.4928	3.2200
coin	0.8742	1.2684	4.0419
flower	0.6688	1.0888	2.4408
pout	1.1286	1.4598	2.4371

D. psnr(Peak-to-Signal-Noise Ratio)

The following results based on psnr parameters [6] have shown in table 6 given below:

TABLE 6. **P**SNR **V**ALUES OF **C**B, **B**B **A**ND **A**VERAGE **F**ILTER **F**OR 3×3 **M**ASK

Image	CB Filter	BB Filter	AVG Filter
moon	55.3817	52.8660	40.4552
fish	47.7394	44.6505	37.9736
coin	49.2984	46.0658	35.9990
flower	51.6251	47.3922	40.3800
pout	47.0799	44.8451	40.3934

The graphs of CB, BB and average filters are shown for various images for 3×3 mask [4,13] and they are shown as:

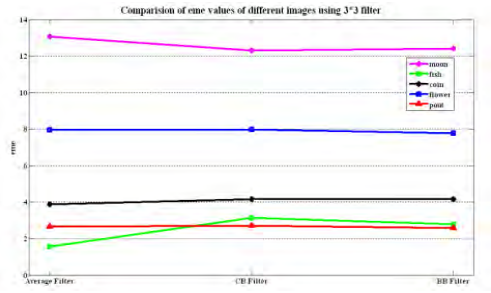

Figure 3. Comparison of eme values of various image using 3×3 filter for table

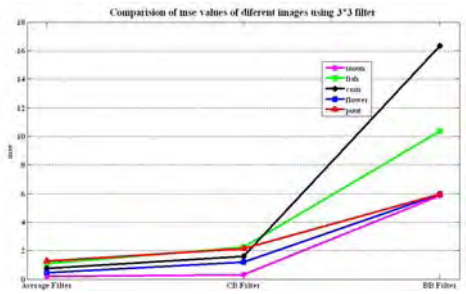

Figure 4. Comparison of mse values of various image using 3×3 filter for table

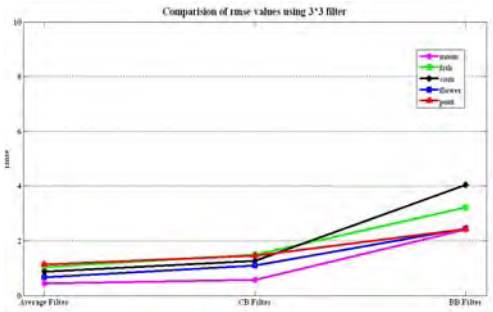

Figure 5. Comparison of rmse values of various image using 3×3 filter for table

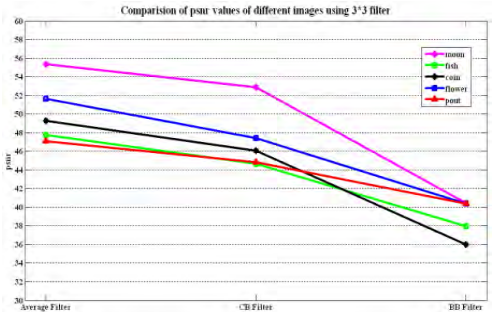

Figure 6. Comparison of psnr values of various image using 3×3 filter for table

The results of various images using CB, BB and average filter are compared and they are shown in figure 7.

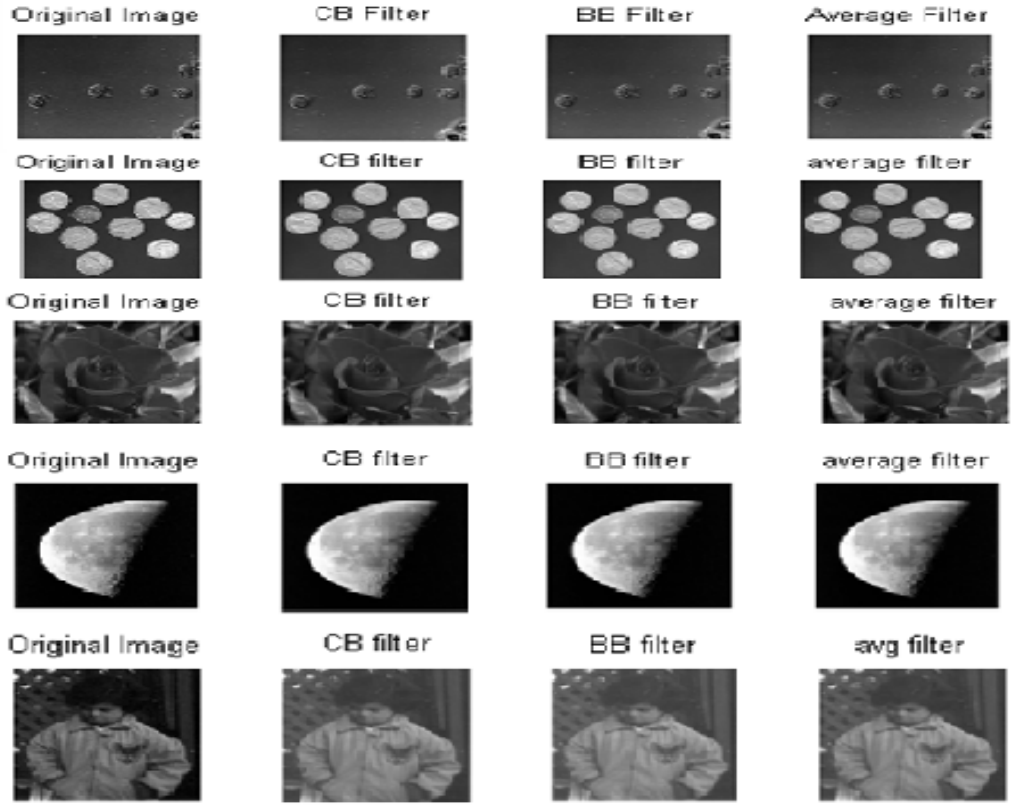

Figure 7. Results of various images using CB, BB and average filter

V. CONCLUSION

In this paper, two novel filters that are Center-to-Boundary (CB) filter and Boundary-to-Boundary (BB) filter using Newton Raphson's methods have developed. These two filters are compared with existing average filter

on the basis of four parameters- eme (Quality measure of image enhancement), mse (mean square error), rmse (root mean square error) and psnr (Peak-to-Signal noise ratio). The performances of these two filters are evaluated on more than 1000 images using MATLAB 7.4 and the results are found very satisfactory as compared to average filter. From table 3, the following results are obtained. eme value of CB, BB and average filter in case of mask are 13.0678, 12.3028 and 12.4036 respectively which shows that CB filter is better than BB and average filter. As we increase the dimension of filters, the quality of image has decreased but still the results of CB and BB filter are much better than average. As it is clear from table 4, the mse values of CB and BB filter are much less than average filters that show that the image is of good quality in case of CB and BB filter. As the dimension of filter has increased, the error between the original images and enhanced image will increase but still the values in CB and BB filter are much lesser than average filter. Similar is the case with rmse value in Table 5.The Table 6 shows that psnr values of CB and BB filter are much higher than average filter that is necessary for good enhanced image. In case of increased filter dimensions, psnr value has decreased but still it is good in case of CB and BB filter. Finally, this paper work is concluded with graph and bar chart that shows the comparison of these three filters over eme, mse, rmse and psnr parameters. The results are implemented on MATLAB 7.4 using Image Processing Toolbox (IPT). In short word, it has been concluded that performance of CB and BB filter are much better than average filter.

REFERENCES

[1] K. Jain, Fundamentals of Digital Image Processing. Englewood Cliffs, NJ: Prentice Hall, 1989.

[2] Aniati Murni [2000], Image Processing, class handouts, Faculty of Computer Science, University of Indonesia, Jakarta.

[3] Ashish Mehta," A Literature Survey On image enhancement", MHTASH002, Research Methods, Date: 07 August 2006.

[4] D-I-Y Matlab Tutorials http://pesona.mmu.edu.my/~johnsee/matlab

[5] E.S. Gopi, Digital Image Processing using Matlab, Senior Lecturer, Department of Electronics and Communication Engineering, Sri. Venkateswara College of Engineering Pennalur, Sriperumbudur, Tamilnadu, SciTech Publication (India) Pvt. Ltd., 2007.

[6] "Image Quality Evaluation Based On Image Weighted Separating Block Peak Signal-to-Noise Ratio", IEEE Int.Conf. Neural Networks & Signal Processing, Nanjing, China, December 14-17, 2003.

[7] J.C. Russ, The Image Processing Handbook, CRC Press, Boca Raton, FL., 1992.

[8] K. R. Castleman (1979), Digital Image Processing. Prentice Hall, Englewood Cliffs, NJ

[9] Mr. Salem Saleh Al-amri1, Dr.N.V. Kalyankar2, Dr.S.D.Khamitkar," Linear and Non-linear Contrast Enhancement Image", IJCSNS International Journal of Computer Science and Network Security, VOL.10 No.2, February 2010.

[10] Muhammad Shahzad, Shiraz Latif," Efficient Image Enhancement Techniques", Journal of Information & Communication Technology Vol. 3, No. 1, (Spring 2009) 50-55.

[11] Raghad Jawad AHMED," Image enhancement and noise removal by using new spatial filters", U.P.B. Sci. Bull., Series C, Vol. 73, Iss. 1, 2011 ISSN 1454-234x.

[12] Raman Maini and Himanshu Aggarwal, **"**A comprehensive review of Image Enhancement techniques, journal of computing", volume 2, issue 3, march 2010, issn 2151-9617

[13] R. C. Gonzalez, Richard E. Woods, Digital Image processing, Addision-Wesely, 2003 R. Gonzalez, R. Woods and S. Eddins "Digital Image Processing Using Matlab", 2004, Prentice Hall.

[14] S. S. Agaian, K Panetta, and A. M. Grigorian, "A new measure of image enhancement," presented at the IASTED Int. Conf. Signal Processing Communication, Marbella, Spain, Sep. 19-22, 2000.

[15] T.S. Huang, G.J. Yang, And G.Y. Tang, "A Fast Two Dimensional Median Filtering Algorithm", IEEE Trans. On Accustics, Speech, Signal Processing, Vol. ASSP-27, No.1, Feb 1997.

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