A Novel Approach of Image Enhancement

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***Abstract*—Image enhancement is used to improve the certain features of an image. In this paper, a novel filter of image enhancement has been proposed. The proposed filter is implemented for $n \times n$ masking operation. Authors have convoluted 3×3, 5×5 and 7×7 masks with various poorly contrast images which convert them into good quality images. The performance of proposed filter is analyzed and compared with other existing filters, namely, average filter, Gaussian filter and unsharp filter. The authors evaluated the performance of these filters 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 Matlab 7.4 is used for implementation of proposed filter. The experimental results have carried on more than 1000 images which prove that the proposed filter enhances poor quality images very effectively.**

Keywords: Image Enhancement, Average Filter, Gaussian, Unsharp Filter

I. Introduction

Image enhancement [1, 2, 7, 8, 13] is the processing of image to enhance the certain features of an image. Image enhancement is used in the following cases: (1) removal of noise from image, (2) enhancement of the dark image and (3) highlight the edges of the objects present in an image. The result is more suitable than the original image for certain specific applications. Processing techniques are very much problem oriented. For example, best techniques for enhancement of X-ray image may not be best for enhancement for microscopic images [3, 9, 10, 12].

In this paper, a novel filter of image enhancement has been proposed. The proposed filter is used to remove the noisy pixels and transform them into good one. The proposed filter is based on calculating the distance between image pixels and their neighbors. It is 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, authors have proposed a novel filter which removes the noisy pixels and transforms them into good pixels. In section III, the performance of proposed filter has been evaluated and compared with average filter, Gaussian filter and unsharp filter on the basis of four parameters – eme, mse, rmse and psnr. The graphs and various images that are obtained from these filters have been also displayed. Finally, paper concludes in section IV.

II. proposed filter

In proposed filter, pixels are scanned from center to boundary to calculate the distance between them by using Newton-Raphson method. The Newton-Raphson method is a powerful technique for solving equations numerically. It is based on the equation (1) as given below:

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

Where $f(C_i) = C_i^2 - C_i - 1$ (2)

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

C_i = Central pixel

C_j= Neighboring pixel of C_i

Equation (2) 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 neighboring pixels and apply the Newton Raphson method using above fitness criterion. The distance is calculated between centralized pixel and its neighbors. Then, apply the same process until all the pixels are scanned. Do not scan those pixels which are already scanned. The table 1 has shown for 3×3 proposed filter.

TABLE 1. FILTER OF DIMENSIONS 3 × 3

1.67	2	1.67
2	1	2
1.67	2	1.67

TABLE 2. FILTER OF DIMENSIONS 5 × 5

1.62	1.62	1.67	1.62	1.62
1.62	1.67	2	1.67	1.62
1.62	2	1	2	1.67
1.62	1.67	2	1.67	1.62
1.62	1.62	1.67	1.62	1.62

TABLE 3. PROPOSED FILTER OF DIMENSIONS 7 × 7

1.62	1.62	1.62	1.62	1.62	1.62	1.62
1.62	1.62	1.62	1.67	1.62	1.62	1.62
1.62	1.62	1.67	2	1.67	1.62	1.62
1.62	1.62	2	1	2	1.62	1.62
1.62	1.62	1.67	2	1.67	1.62	1.62
1.62	1.62	1.62	1.67	1.62	1.62	1.62
1.62	1.62	1.62	1.62	1.62	1.62	1.62

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 Method to find out the value of neighboring pixels using the 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

Convolution of 3 × 3 proposed filter with image

The above 3 × 3 proposed filter is convoluted with given image with the formula as given in equation (5).

$$R = \frac{\sum_{i=-1}^{1}\sum_{i=-1}^{1} W_{i,j}\, f(x+i, y+j)}{N} \qquad (5)$$

Where N is the total number of cells in the filter, R is the response of filter at that particular point and $W_{i,j}$ is the mask. In table 4, authors consider the image of dimension 8 ×8. We can take image is of any size. In this paper, all images are of size 256 × 256.

TABLE 4 : ORIGINAL IMAGE OF DIMENSION 8 × 8

23	35	45	89	125	128	37	0
67	98	125	245	23	0	56	123
45	87	67	126	129	34	25	67
49	67	98	56	126	212	0	27
123	178	56	67	37	98	127	1
12	45	126	127	56	57	127	128
25	27	29	126	126	128	98	56
126	126	98	76	56	123	56	65

This 3 × 3 proposed filter is convoluted with above image. The resultant image of same dimension after convolution is shown in table 5

Table 5: RESULTANT IMAGE AFTER CONVOLUTION

43.3704	76.3333	123.8519	129.5185	112.5926	64.8519	67.7778	45.9259
61.9259	104.1111	163.5185	161.4444	179.1481	112.0741	89.7407	52.4815
66.7778	106.7778	188.0741	193.3333	171.7778	109.4074	104.7037	56.7037
99.2963	138.8889	136.0370	148.6296	167.8519	132.3333	123.9259	46.2593
76.6296	131.0000	151.0741	120.4074	164.9259	161.3333	142.8519	86.2963
75.9630	116.9259	140.7037	132.4815	146.8148	168.9630	157.6296	96.7778
57.1111	105.9259	150.0370	149.4444	152.1481	144.4074	161.5185	104.7778
49.3333	65.7778	76.5556	85.1481	114.5926	102.2593	103.8519	50.2593

By comparing table 4 and table 5, authors concluded that the intensity value of poor pixels in original image has been converted into good one in the resultant image.

III. performance evaluation and comparsion of proposed filter with average , Gaussian and Unsharp filter

The performance of the proposed filter has been evaluated and compared with average, Gaussian and unsharp filter. The four parameters, namely, eme (quality measure of image enhancement), mse (mean square error), rmse (root mean square error) and psnr (peak-to-signal noise ratio) have been chosen to measure the performance of these filters. These algorithms can be applied on n × n dimensions (n is odd). In this paper, 3 × 3, 5 × 5 and 7 × 7 dimensions have been taken and they convolute with various poor quality images. The results are implemented using MATLAB 7.4 using Image Processing Toolbox (IPT) [4, 5, 13].
The following results based on above parameters [14] have been shown in tables given below:

TABLE 6. FILTER OF DIMENSIONS 3 × 3

	Proposed Filter	Average Filter	Gaussian Filter	Unsharp Filter
eme	10.5830	10.1776	12.4495	11.7259
mse	2.3381	34.8754	10.9640	250.0045
rmse	1.5291	5.9055	3.3112	15.8115
psnr	44.4422	32.7056	37.7311	24.1513

TABLE 7. FILTER OF DIMENSIONS 5 × 5

	Proposed Filter	Average Filter	Gaussian Filter	Unsharp Filter
eme	8.6970	8.0220	12.4395	8.5870
mse	8.9660	48.5326	11.0212	250.7480
rmse	2.9943	6.9665	3.3198	15.8350
psnr	38.6048	31.2705	37.7085	24.1384

TABLE 8. FILTER OF DIMENSIONS 7 × 7

	Proposed Filter	Average Filter	Gaussian Filter	Unsharp Filter
eme	7.9809	6.6004	12.4395	8.0803
mse	39.1786	55.8348	11.0212	251.1722
rmse	6.2593	7.4723	3.3198	15.8484
psnr	32.2003	30.6618	37.7085	24.1311

The graphs of proposed filter along with average, Gaussian and unsharp filter on various parameters have shown for 3 × 3, 5 × 5 and 7 × 7 dimensions [4, 13].

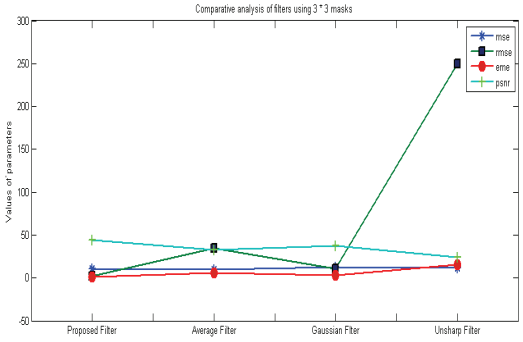

Figure 1. Comparison of filters using various parameters of 3 × 3 dimensions

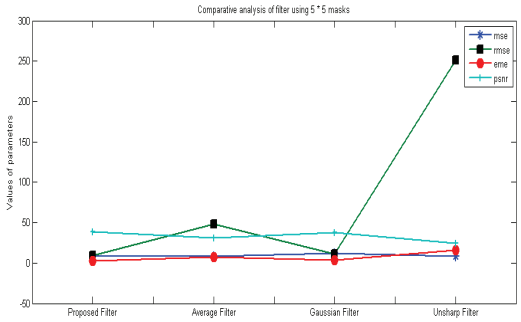

Figure 2. Comparison of filters using various parameters of 5 × 5 dimensions

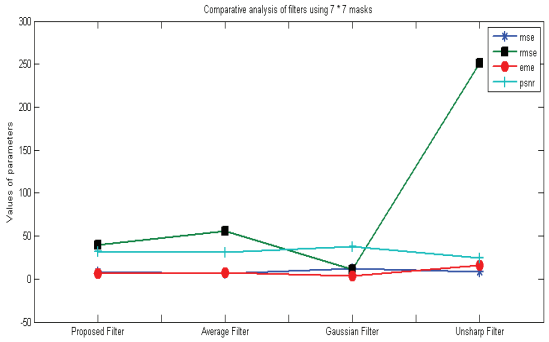

Figure 3. Comparison of filters using various parameters of 7 × 7 dimensions

The image results of proposed, average, Gaussian and unsharp filter have been shown in figure 4.

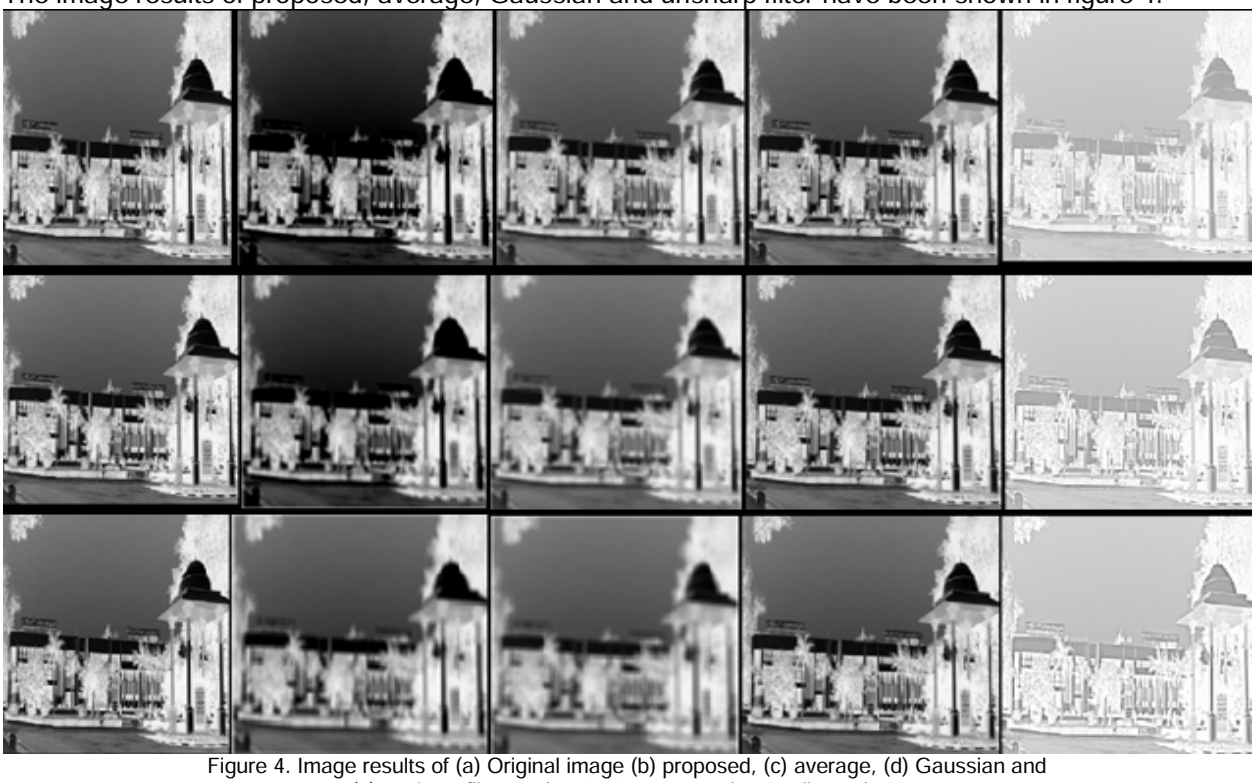

Figure 4. Image results of (a) Original image (b) proposed, (c) average, (d) Gaussian and (e) unsharp filters using 3 × 3, 5 × 5 and 7 × 7 dimensions

IV. CONCLUSION

In this paper, a novel approach of image enhancement has been proposed. The proposed filter is compared with average, Gaussian and unsharp 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 performance of proposed filter has been evaluated on more than 1000 images using MATLAB 7.4 and the results are found very satisfactory. From table 4, it is clear that the quality of proposed filter is higher than average filter but low as compared with Gaussian and unsharp filter. As it is clear from table 5, the error rate of proposed filter is much less than other filters. When the dimension of the filter is increased then the error between the original image and enhanced image of proposed filter is also increased but still it is much less than other filters. Similar is the case with rmse value in table 6. Table 7 shows that psnr values of proposed filter is slightly higher than other filters. In case of increased filter dimensions, psnr value of proposed filter has been decreased but still it is good as compared with other filters. In short, it has been concluded that propagation error between the original image and enhanced image using proposed filter is less than other filters. The quality of proposed filter is much better than average filter but less as compared to Gaussian and unsharp filter.

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