International Journal of Electrical, Electronics and Computer Engineering **7**(2): 98-101(2018)

ISSN No. (Online): 2277-2626

Image Restoration Model Using Wavelet Based Image Fusion

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(Received 17 September, 2018 Accepted 27 November, 2018)

(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Image restoration is the field of Image processing. This article presence the performance analysis of different basic Image Restoration techniques which is used for restoration of an image. Image restoration is the task of minimizing the degradation in an image that is restoring an image which has been degraded due to presence of noise and blurring. In this work we have implemented four different techniques of Image Restoration and tested our implementation on the noisy and blurred image. First we restore noisy and blurred image by using Inverse filter, Wiener filter and Lucy Richardson method. After that we apply Wavelet based image fusion method for image restoration. Further we have compared the different results on the basis of performance parameter PSNR, SNR and MSE.

Key words: Image Restoration Model, Wiener Filter, Lucy Richardson, Inverse Filter, Wavelet based image fusion, MSE(mean square error), PSNR(peak signal to noise), SNR(signal to noise ratio).

I. INTRDOUCTION

A field of image processing which deals with recovering an original image and sharp image from a degraded image with the use of restoration model is known as Image Restoration. We have implemented different techniques on the blurred image which is degraded by motion blur or noisy image The simple equation for expressing image degradation is as follows:-

$$g = f * h + \eta$$

Where f – original image

η - random noise

g – version that has been degraded through blurring by kemel *h.*

A. Inverse Filter

Inverse filter is the simplest approach for the image restoration. In this method, an estimate of the Fourier transform of the image f‘(u,v) is computed by dividing the Fourier transform of the degraded image by the Fourier transform of the degradation function-

$$f'(u,v) = G(u,v) / H(u,v)$$

When the additive noise is not present in the degraded image this method works well [2]. That is, when the degraded image is given by-

$$g(x,y) = f(x,y)*h(x,y)$$

Theoretically Inverse filter is the inverse of the degradation function. If an inverse operation is performed the inverse filter will have a high pass filter nature, which will cause the blurred image to have a magnified high frequency noise [5].

B. Wiener Filter

Wiener Filter is a method proposed by Norbert Wiener in 1942. It is a non blind method. It compare with an estimation of desired noiseless image. A degraded image corrupted by additive noise is the input to a Wiener Filter [1-3]. The output image is computed by means of filter using the following expression:

$$f' = g * (f + n)$$

In this equation *f* is the original image, n is the noise, f‘ is the estimated image and g is the Wiener filter’s response.

It minimizes the mean square error between the estimated random process and the desired process so Wiener filter is an efficient method for restoration of degraded image.

C. Lucy Richardson Algorithm

An iterative procedure for restoring a blurred image that has been degraded by a known PSF is known as the Lucy Richardson algorithm. This method has become popular in astronomy and medical imaging fields.

The maximum likelihood formulation is given as-

$$f'_{k+1}(x,y)=f'_k(x,y)[h(-x,-y)*g(x,y)/h(x,y)*f'_k(x,y)]$$

Where * is the convolution operation,

f‘ is the estimated image [3-6].

Lucy Richardson algorithm is non-blind technique of image restoration. Non-linear iterative technique is better than the linear technique.

II. IMAGE RESTORATION MODEL

The main purpose of Image Restoration is to recover the original image from a degraded image which is blurred by same degradation functions. Image Restoration techniques are divided into two categories on the basis of knowledge about Point Spread Function (PSF) [4-8]. These are Blind Image Restoration and Non-blind Image Restoration. Relative motion between camera and object, misfocus of lens, opening and closing of shutter are the causes of image degradation. According to the convolution theorem, in frequency domain a convolution of two special functions can be expressed as a product of their respective Fourier Transform. So the image degradation model can be written as-

$i(x,y) = o(x,y)*h(x,y) + n(x,y)$

Here,

o(x,y) – object function
i(x,y) – distorted image
h(x,y) – image degraded function
n(x,y) – additive noise function[4]

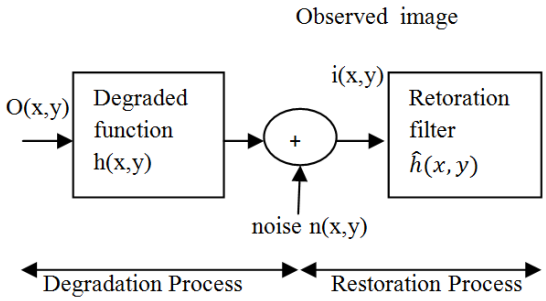

Fig. 1. Block diagram of Image Restoration Model.

III. LITERATURE SURVEY

Many image restoration techniques have been used in the literature survey. During the process of acquisition and transmission digital images are corrupted by different types of noises. In the restoration process detection and removal of noises plays a crucial role. The first step of whole Image Processing is the Image Restoration. It increase the quality of images by getting rid of noisy pixels.

Mohini Sharma *et.al* in Sep 2014 proposed a method for Image Restoration using wavelet based image fusion. They compare Wiener filter, Lucy Richaardson and wavelet based image fusion techniques for image rwstoration for removal of motion blur. The result is compared on the basis of performance parameter MSE and PSNR [1].

Rama Singh and Neelesh Gupta proposed a method in 2013 for image restoration. In this work they used three different image formats viz.jpg, .png and .tif are considered for analyzing the different image restoration techniques like Deconvolution using lucy Richardson (DLR), deconvolution using Weiner Filter (DWF), Deconvolution using Regularized filter (DRF)and Blind image deconvolution algorithm (BID) for removal of Gaussion noise with motion blur [3].

Madri Thakur *et.al* in Aug 2014 proposed a novel approach in which they have implemented three different techniques of image restoration. They used Weiner deconvolution, Inverse deconvolution and Richardson-Lucy algorithm. They compared the result of three methods and find that Richardson-lucy algorithm provide the better results [2].

Firas Ali in Dec 2006 proposed a new scheme for image restoration, which contains two separate steps: Fourier domain Inverse filtering and wavelet domain image denoising. They used Weiner filter a denoising steo to remove the amplified noise. Wavelet based denoising scheme with adaptive threshold is the denoising step in their work [5].

IV. PROPOSED METHOD

Image restoration is the first step of the whole image processing process. Image restoration is a technique, which increase the quality of an image [1]. In proposed method we compare Inverse filter, Weiner filter, Lucy Richardson algorithm and Wavelet based image fusion for removal of motion blur in image restoration. On the basis of performance parameter like PSNR and MSE we compare the restored image.

A. Block Diagram

Fig. 2 shows the block diagram of the proposed method. Noise is added to the original image in the first step.

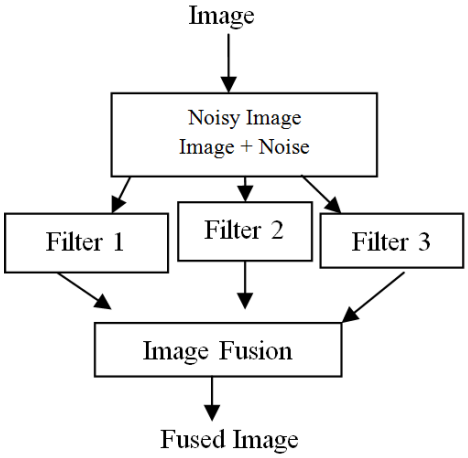

Fig. 2. Block diagram.

In the second step image is restored using restoration techniques that is Inverse filter (filter 1), Wiener filter (filter 2) and Lucy Richardson (filter 3) to remove the motion blur. In the third step all images are fused using wavelet based image fusion method to get the fused image.

B. Wavelet based Image Fusion

Image Fusion is the process of combining two or more images into a single image. The process of image fusion which is based on wavelet transform is known as wavelet based image fusion [1][7][4].

In Wavelet based Image Fusion wavelet transform is first perform on source image [3]. Then a fusion decision map is generated based on a set of fusion rules. Then according to the fusion decision map the fused wavelet coefficient map can be constructed from the wavelet coefficient of source image. Finally by performing the inverse wavelet transform we obtain fused image.

Fig. 3 shows the block diagram of wavelet based image fusion technique. In which A, B and C are the original images needed to be restored and these are the output of Inverse filter, Wiener filter and Lucy Richardson method and F is the fused image

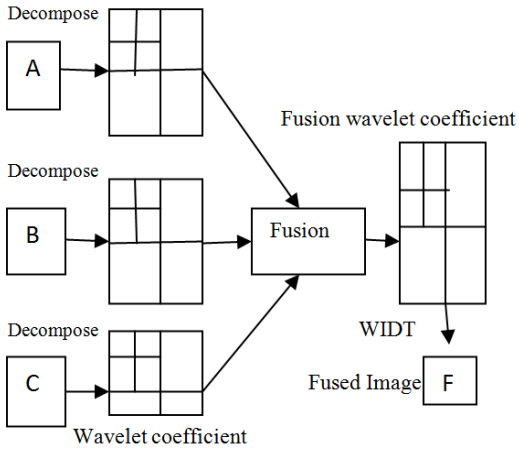

Fig. 3. Wavelet based Image fusion.

V. EXPERIMENTAL RESULTS

The result of restoration methods are compared on the basis of performance parameter MSE, PSNR and SNR.

MSE (Mean Square Error):-

$MSE = \frac{1}{M.N}\sum_{Y=1}^{M}\sum_{X=1}^{N}[I(x,y) - I'(x,y)]^2$

Where,

I(x,y) is the original image, I' is the approximated version (decompressed image) and M,N are the dimension of the image.

PSNR (Peak Signal to Noise Ratio):-

$PSNR = 10 \cdot log_{10}\left(\frac{MAX_1^2}{MSE}\right)$

Where, MAX_1 is the maximum possible value of the image.

SNR (Signal to Noise Ratio):-

$$SNR = 10\log_{10}\left(\frac{Asignal}{Anoise}\right)^2 = 20\log_{10}\left(\frac{Asignal}{Anoise}\right)$$

Where, A is root mean square (RMS) amplitude.

Table 1: Comparison based on MSE.

Image size	Inverse Filter	Wiener filter	Lucy Richardson	Wavelet based image fusion
For variance = 0.0001				
256x256	0.0163	0.0065	0.0060	0.0040
For variance = 0.01				
256x256	0.0172	0.0068	0.0059	0.0040

Table 2: Comparison based on PSNR.

Image size	Inverse Filter	Wiener Filter	Lucy Richardson	Wavelet based Image Fusion
For variance = 0.0001				
256x256	17.8902	21.8658	22.1884	23.9678
For variance = 0.01				
256x256	17.6407	21.6615	22.2686	23.9430

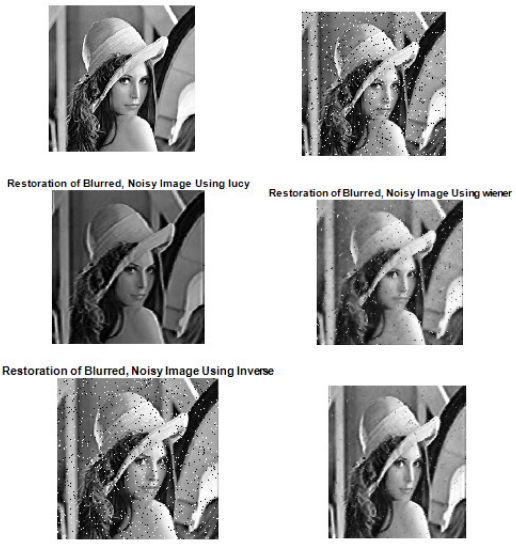

Fig. 1. (a) Original image (b) Blurred and noisy image (c) Image restored by Lucy Richardson (d) Image restored by Wiener filter (e) Image restored by Inverse filter (f) Image restored by wavelet based image fusion.

Table 3: Comparison based on SNR.

Image size	Inverse Filter	Wiener Filter	Lucy Richardson	Wavelet based Image Fusion
For variance = 0.0001				
256x256	12.7573	16.7378	17.0555	18.8349
For variance = 0.01				
256x256	12.8078	16.5286	17.1356	18.8101

VI. CONCLUSION

This paper proposed a scheme for image restoration using Wavelet based image fusion. In this paper we compare four methods of image restoration for removing the motion blur with considering salt and pepper noise from the images. First blurred image is restored using Inverse filter, Wiener filter and Lucy Richardson algorithm. We get that the result based on Lucy Richardsom algorithm is better than the Inverse filter and Wiener filter method. Then we used fourth method of wavelet based image fusion to achieve higher PSNR and SNR and minimum MSE as compared to other three techniques.

VII. FUTURE SCOPES

Image fusion plays a very important role in image processing. The performance of this method can be compared with the other fusion methods like Laplacian pyramid based and Curvelet transform based fusion.

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