# A Review Paper On: Different Image Restoration Techniques

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***Abstract - Image restoration is the field of Image processing. In the field of Image Processing restoration of a digital image is challenging. Basically there are different type of image restoration techniques. This review paper is done for image restoration techniques. We compare the result of some image restoration techniques. There are two type of methods for image restoration, they are Deterministic Method and Stochastic Method. Inverse Filter, Wiener filter are the Deterministic Methods. In this article we apply four different techniques on degraded image. This paper discussed some restoration techniques to overcome the problem of blurred and noisy image.***

***Key words: Image Restoration Model, Wiener Filter, Lucy Richardson, Inverse Filter, Regularized Filter, Wavelet based image fusion, Blind Deconvolution, MSE(mean square error), PSNR(peak signal to noise)***

## 1. 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. In this review paper overview has done on the different image restoration techniques. We have implemented different techniques on the blurred image which is degraded by motion blur or noisy image. We apply some image restoration techniques like Wiener Filter, Lucy Richardson, Inverse Filter, Blind Deconvolution etc. on degraded image then we apply Wavelet based image fusion for better result.[6] Result of different restoration techniques have been compared on the basis of performance parameters MSE and PSNR.[3]

The simple equation for expressing image degradation is as follows:-

$$g = f * h + \eta \quad (1)$$

Where f – original image

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

η - random noise

## 2. IMAGE DEGRADATION MODEL

The main purpose of Image Restoration is to recover the original image from a degraded image which is blurred by same degradation functions. On the basis of knowledge about Point Spread Function (PSF) Image Restoration techniques are divided into two categories. 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 he image degradation model can be written as-

$$i(x,y) = o(x,y)*h(x,y) + n(x,y) \quad (2)$$

Here,

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

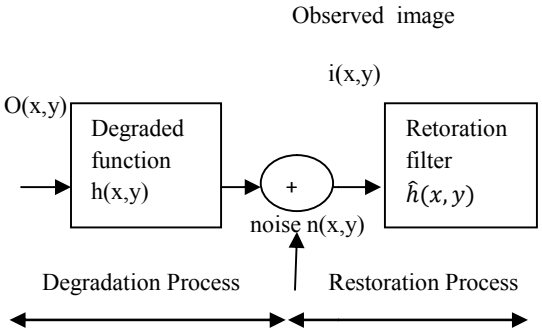



Figure1: Block diagram of Image Degradation and Restoration Process

## 3. PROBLEM

The first step of the whole image processing process is the image restoration. Image restoration is a technique, which increase the quality of an image. Today image restoration technique is used in many fields. These fields have diverse the aim of image restoration, but to all the image restoration problems certain fundamentals are common.[1]

There are many causes of degradation, but mainly two types of degradation which have been often dominant are noise and blurring. In the direction of removal of degradation, the first need is image restoration.

## 4. LITERATURE REVIEW

In the literature many image restoration techniques have been used. Image Restoration is done based on the combination of blur and noise in the image.

Image restoration techniques are basically divided into two categories. They are Deterministic Methods and Stochastic Methods. Deterministic methods are widely used in image processing. Some commonly used methods are following-

(A). Blind Deconvolution

(B). Wiener Filter

(C). Lucy Richardson algorithm

(D). Wavelet based Image Fusion

(E). Inverse Filter

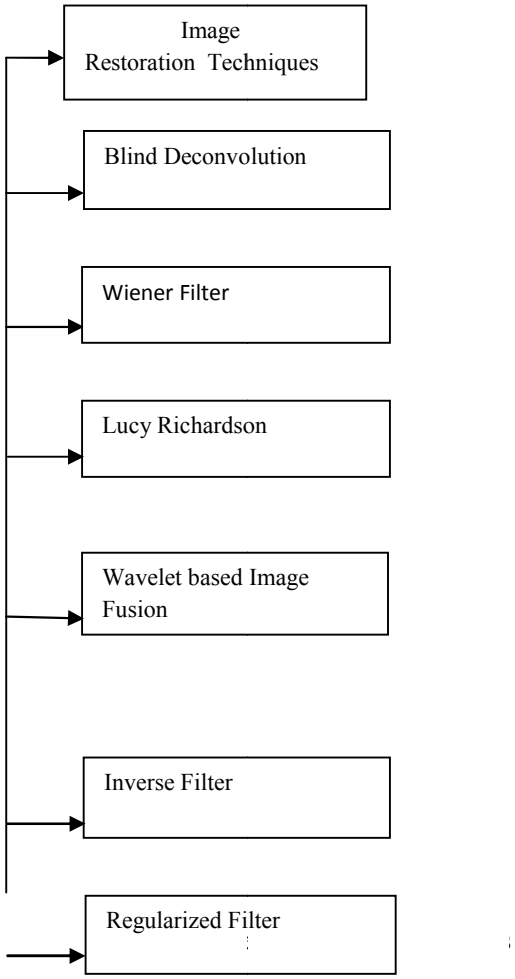
(F). Regularized Filter

### 4.1 Blind Deconvolution

In image processing, blind deconvolution is a deconvolution technique that permits recovery of the target scene from a single or set of blurred image in the presence of unknown PSF. Only the output system is known in blind deonvolution technique. Blind deconvolution can be performed iteratively, where each iteration improves the estimation of the PSF.[4] Blind deonvolution is a lengthy process because it needs higher computation. The blind deconvolution technique is not used only attempt to restore the blurred image, but also estimating the degradation function through MAP.

Blind image deconvolution is an algorithm of blind image restoration.

Block diagram of blind deconvolution technique is as follows-




### 4.2 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] The output image is computed by means of filter using the following expression:-

$$f' = g * (f + n) \qquad (3)$$

In equation (3) 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.

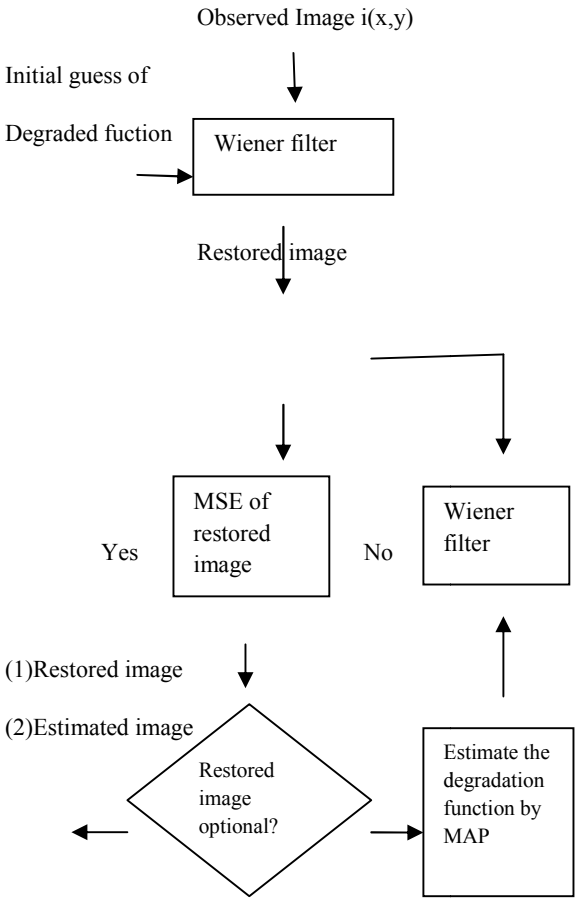



Figure3: Block diagram of Blind Deconvolution Technique

**4.3 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-

$$f'_{k+1}(x,y)=f'_{k}(x,y)[h(-x,-y)*g(x,y)/h(x,y)*f'_{k}(x,y)] \quad (4)$$

Where * is the convolution operation,

f' is the estimated image.[3-5]

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

**4.4 Wavelet based Image Fusion:-**

Image Fusion is the process of combining two or more images into a single image.[6]

In Wavelet based Image Fusion wavelet transform is first perform on source image. 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.[1],[2]

**4.5 Inverse Filter:-**

The simplest approach to restoration is the Inverse Filtering. 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-

$$f'(u,v) = G(u,v) / H(u,v) \quad (5)$$

When the additive noise is not present in the degraded image this method works well.[3] That is, when the degraded image is given by-

$$g(x,y) = f(x,y)*h(x,y) \quad (6)$$

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.

**4.6 Deconvolution using Regularized Filter**

Total variation regularization is a process, which is mostly used in digital image processing. Regularized deconvolution can be used effectively when constraints are applied on the restored image for example smoothness and limited information is known about the additive noise.[2]

The blurred and noisy image is restored by a constrained least square restoration algorithm that uses a regularized filter. The regularized parameter $\lambda$ plays a important role in the denoising process.

When $\lambda = 0$, there is no denoising and the result is identical to input signal.

## 5. PERFORMANCE PARAMETERS

To compare restore image quality two error metrics are used. These are MSE and PSNR. Higher PSNR and lower MSE provide the best image after restoration.[3]

**MSE (Mean Square Error):-**

$$MSE = \frac{1}{M.N}\sum_{Y=1}^{M}\sum_{X=1}^{N}[I(x,y) - I'(x,y)]^2 \quad (7)$$

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):-**

$$PSNR = 10 \cdot log_{10}\left(\frac{MAX_1^2}{MSE}\right) \quad (8)$$

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

## 6. COMPARISON OF RESULT

Comparison of the results of different image restoration techniques based on performance parameters has shown in following tables [1][3]

**Table no. 1**

**Comparison based on MSE**

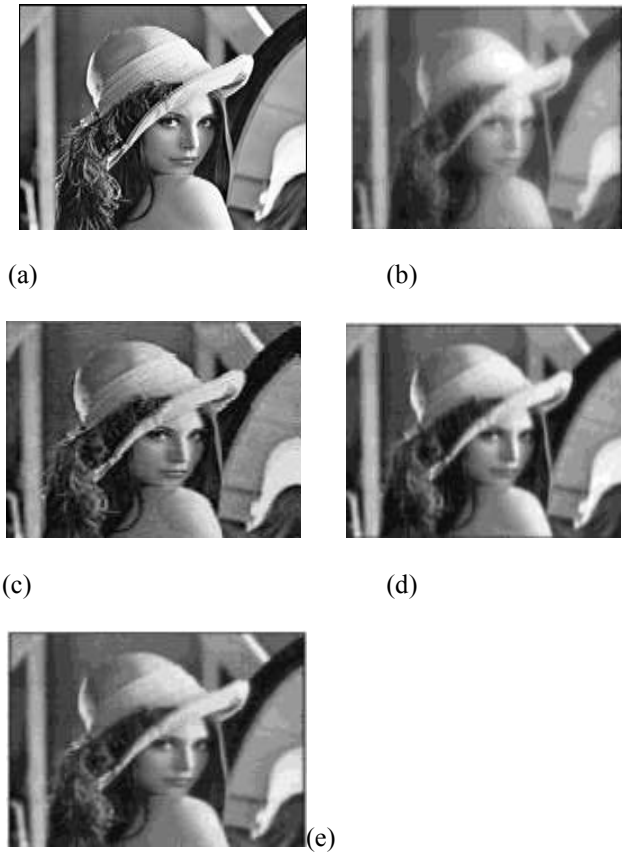
| Image size | Inverse Filter | Wiener filter | Lucy Richardson | Wavelet based image fusion |
|---|---|---|---|---|
| 256x256 | 0.0262 | 0.0259 | 0.0114 | 0.0113 |

**Table no. 2**

**Comparison based on PSNR**

| Image size | Inverse Filter | Wiener Filter | Lucy Richardson | Wavelet based Image Fusion |
|---|---|---|---|---|
| 256x256 | 15.8123 | 15.868 | 19.430 | 19.447 |

**Figure4: TEST IMAGE LENA 256x256**



(a) (b) (c) (d) (e)

Fig.4 (a) Original image (b)Blurred image (c)Image restored by Wiener filter (d)Image restored by Lucy Richardson (e)Image restored by Wavelet based image fusion

## 7. CONCLUSION

In this paper a survey on Image Restoration techniques has been discussed. Each technique of image restoration is different from each other and gives different results. In this work there are so many algorithms that are used to remove so many types of noise and blur from the degraded images. This is conclude that Wavelet based Image Fusion Technique gives good performance and better result from the other image restoration techniques.

## 8. REFERENCES

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