www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 4 Issue 7 July 2015, Page No. 13487-13491

Comparative Analysis of Different Technique for Detection of Noise in Restored Image

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Abstract

Image restoration is the process of reconstruction or recovering an image that has been corrupted by some degradation phenomenon. Degradation may occur due to motion blur, Gaussian blur, noise and camera mismatch. In this paper corrupted image have been recovered using Modified Lucy Richardson algorithm in the presence of Gaussian blur and motion blur. The performance of this algorithm has been compared with Wiener filter, Blind deconvolution and Lucy Richardson algorithm. The performance comparison done on the based on peak signal-to-noise ratio (PSNR), Mean Square Error (MSE) and Structural Similarity Index for Measuring Image (SSIM).The result shows that Blind deconvolution Method is better than Wiener filter and Lucy Richardson algorithm.

Key Words:-

MSE (Mean Square Error), Peak Signal to noise Ratio (PSNR), Structural Similarity Index for Measuring Image (SSIM), MCE (Maximum Like hood Estimation), PSF (Point Spread Function)

I. Introduction

Images are produced to record the useful information. Due to imperfections in the Imaging and capturing process, however, the recorded image invariably represents a degraded version of the original scene. The degradation results in image blur, affecting identification and extraction of the useful information in the images. It can be caused by relative motion between the camera and the original scene, by an out of focus of optical system, atmospheric turbulences and aberrations in the optical system [1][2][4].Noise introduced by the medium through which the image is created can also cause degradation. The degradation phenomenon of the acquired images causes serious economic loss. Therefore, restoring the degraded images is an urgent task in order to expand uses of the images. In general there are two types of restoration methods are used. One is non-blind restoration in which we need prior knowledge of h(x,y). In this case three filtering techniques are generally used [4] Wiener filtering, Blind deconvolution and Lucy Richardson algorithm which are discussed in section 2. Other one is Blind Restoration in which we do not need any prior knowledge of h(x,y) [4]. The image restoration model is shown in figure 1. It consist of taking a non-blurred image f(x,y), creating a known blurring function or point spread function h(x,y) and then filtering the image with this function so as to add blur into it. This image is further Corrupted additive Gaussian noise to get the degraded image g(x, y). This degraded Image is passed through a restoration filter R(x,y) to get the restored image $\hat{f}$(x ,y).

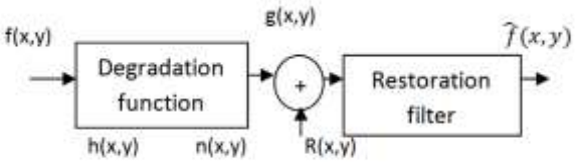


Figure 1: Image restoration process model.

In this paper we are focusing on non-blind restoration methods. We have restored the degraded image by using proposed modified Lucy Richardson Algorithm. Since DWT has excellent spatial localization and multi-resolution characteristics, which are similar to the theoretical models of the human visual system it is widely used in image processing [5][6][7][8]. In the proposed modified LR algorithm we have taken the DWT of degraded image and then apply LR algorithm to it. Further the performance of the proposed algorithm is compared with wiener filter, constraint least square method,
LR method. The rest of the paper is organized as follows. Section 2 consists of different algorithm. In Section 3 we have discussed the proposed parameter. Section 4 consists of simulation set up and the results. Conclusions are drawn in Section 5.

II. Proposed Algorithm

There are basically three algorithm are used in this paper Wiener filter, Blind deconvolution and Lucy Richardson algorithm. These are describe as

1. Weiner Filter:-
Wiener filter is an efficient method for restoration of degraded image because it minimizes the mean square error between the estimated random process and the desired process. With reference to figure 1, the problem statement is For given g(x,y) about h(x,y), obtain the estimate n(x,y) of original image f such that mean square error mse between them is minimum where mse =E $\{(f - \hat{f})2\}$and E is a mean value operator. The solution of this expression in the frequency domain is given by

$$R(u,v) = \frac{|H(u,v)|^2}{H(u,v)\left[|H(u,v)|^2 + \frac{S_n}{S_f}\right]}$$

Clearly, wiener filter requires the knowledge of PSF h(x,y), power spectra of Noise S_n and power spectra of image S_f to be known. When they are not known the ratio is approximated by user and is determined by trial to minimize the error.

2. Lucy Richardson Algorithm:-
The restoration methods which are discussed above are linear. They are also direct in the sense that, once the restoration filter is specified, the solution is obtained in one go. During the past two decades, non-liner iterative methods have been gaining there acceptance as restoration tool that often yield result better than those obtained with linear methods. The Lucy Richardson (LR) algorithm is an iterative nonlinear restoration method. The L-R algorithm arises from maximum likelihood formulation in which image is modelled with poison statistics. Maximizing the likelihood function of the model yield an equation that is satisfied when following iteration converges:

$$\hat{f}_{k+1}(x,y) = \hat{f}_k(x,y)\left[h(-x,-y) * \frac{g(x,y)}{h(x,y) * f_k(x,y)}\right]$$

2. Blind Deconvolution:-

In 1994, [95] proposed a simple method for blind deconvolution based on Lucy's algorithm. The idea is to alternatively perform a Lucy iteration on the object *O* and then on the PSF *P*. However, although attractive because of its simplicity, this process (i) can be highly unstable, and (ii) puts no constraint on the PSF making it difficult to prevent it tending towards the trivial solution$\{I , \delta\}$.
Jefferies and Christou have proposed an iterative blind deconvolution method of multi-frame data based on the minimization of a penalty functional putting physical and "reasonable" loose constraints on the solution (*O*, P*i*). Assuming that one deals with *i* = 1 … frames, this method minimizes the functional:
$J(O , P) = E_{im} + E_{conv} + E_{bl} + E_{Fm}$

III. Performance Parameter

There are three performance parameter to measure restored image. Image restoration research aims to restored image to from a blurred and noisy image. A widely used measure of reconstructed image fidelity for an N * M size image is the mean square error (MSE) and is given by

$$MSE = \frac{1}{MN}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}\left|f(i,j) - \hat{f}(i,j)\right|^2$$

$$PSNR = 10\log_{10}\left(\frac{255}{MSE}\right)$$

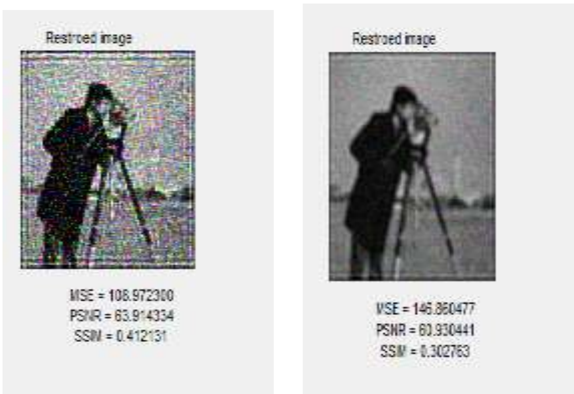
IV. Comparison & Simulation Result

In this paper, we take two images & apply different algorithm both images. Ist one Cameraman & IInd is Leena Image. Comparison of different algorithm is given by Table 1 & Table 2. Table 1. Gives Comparison of different Algorithm for Cameraman Image while Table 2. Comparison of different Algorithm for Lena Image. Images are compared with three algorithms Lucy Richardson algorithm. Wiener filter and Blind deconvolution.

A. Cameraman

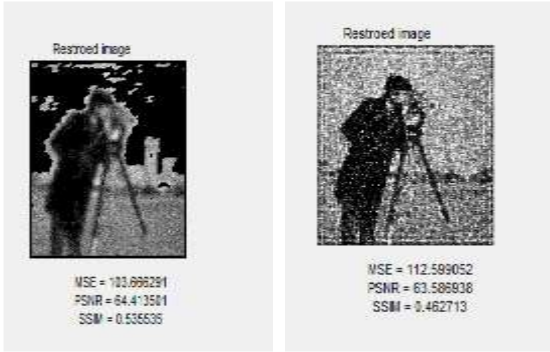
(a) (b)

Fig 2. Cameraman Image a) Original Image b) Degraded Image



(a) (b)

Fig 3. Restored Image (a) Lucy Richardson algorithm (b) Weiner Algorithm



(a) (b)

(c)

Fig 4 Restored Image using Blind Deconvolution Method (a) MLE Algorithm (b)EM Algorithm (c) MAP Algorithm

B. Lena Image

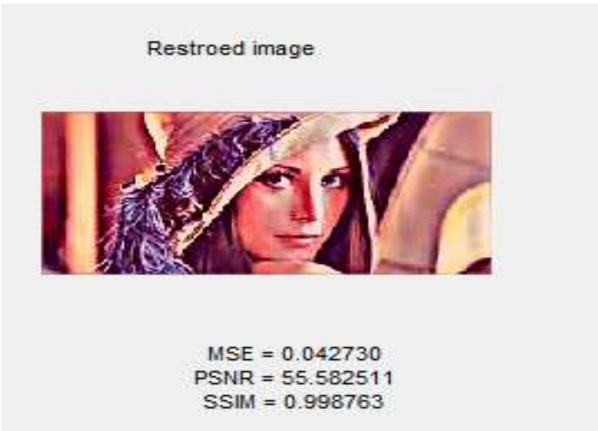
(a) (b)

Fig 5. Lena Image a) Original Image
b) Degraded Image

(a) (b)

Fig 6. Restored Image (a) Lucy Richardson algorithm (b) Weiner Algorithm

(a) (b)



(c)

Fig 4 Restored Image using Blind Deconvolution Method (a) MLE Algorithm
(b)EM Algorithm (c) MAP Algorithm

Sr. No.	Algorithm		MSE	PSNR	SSIM
1.	Degraded Image		108.4438	63.962950	0.081355
2.	Lucy		108.9723	63.914334	0.412131
3.	Weiner		146.8604	60.930441	0.302763
4.	Blind Deconvolution	MLE	103.6629	64.413501	0.535535
5.		EM	112.5991	63.586938	0.462713
6.		MAP	0.033131	56.178855	0.999545

Table 1. Comparison of different Algorithm for Cameraman Image

Sr. No.	Algorithm		MSE	PSNR	SSIM
1.	Degraded Image		115.3089	63.349124	0.114980
2.	Lucy		113.7559	63.484718	0.429797
3.	Weiner		158.9141	60.141627	0.355094
4.	Blind Deconvolution	MLE	158.914	60.141627	0.35094
5.		EM	118.7896	63.051725	0.458092
6.		MAP	0.042730	55.582511	0.998763

Table 2. Comparison of different Algorithm for Lena Image

V. Conclusion

We have seen the requirement and significance of image de-blurring. We have seen the mathematical formulation for the blurred image. We already have the knowledge of point spread function. Weiner filtering provides the better results than the inverse filtering almost in every condition except when the noise having very less variance. The Richardson Lucy provides good estimate for the blurring function and gives better PSNR within the limited iterations. Yet if we use this method with the known point spreading function then it is a time taking method, still it can provides the PSNR even better than Weiner deconvolution. With the help of the basic method of deconvolution, we may try to form some deconvolution method which can provide better PSNR within the very less iterations for the blind deconvolution.

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