Analysis of Image Deblurring Techniques with Variations in Gaussian Noise and Regularization factor

Dr.P.B.Chopade[1]
Modern Education Society's College of Engineering, Pune-01, India
pbchopade@mescoepune.org

Mr. Mukesh Harale[2]
BE student, Modern Education Society's College of Engineering, Pune-01, India
Mukeshharale92@gmail.com

Abstract*—Image blur is integral part of imaging system and it often ruin the resultant image, video signal and photograph. Image Deblurring and Restoration is necessary in digital image processing. Many methods have been proposed in this regard and in this paper we will examine different methods and techniques of Deblurring. The analysis of these methods has been carried out on the basis of subjective and objectives results with varying various factors like regularization and WGN variance. The different methods of deblurring have tested for different spectrum of images. The results have compared with each method and based on comparative results particular method has been suggested for suitable applications. The point spread function has utilized to deblur the blurry images by changing different parameters which help to estimate amount of blur need to remove from blurry image. The performance of various deblurring techniques have evaluated based on MSE and PSNR.[1,2,3].

Keywords*—Blur type, degradation model [1], image Deblurring, motion blur, point spread function (PSf)[1,2], peak signal to noise (PSNR) [3]

I. Introduction

Image blurring is huge problem in many applications. Image blurring is dependent on image degradation model. Image blurring can be caused by many reasons such as motion, some environmental factors, positions of cameras, etc. The bandwidth reduction degrades image quality and it is difficult to avoid in many applications. Due to various types of noises are added into image, information might get lost in these types of degraded images. This happens mainly due to the addition of white Gaussian noise (WGN) [1].

Since the degradation due to a space invariant, linear function can be modeled as convolution therefore degradation process is referred as convolution of image and noise (spread function). Similarly restoration process referred as deconvolution

Image reconstruction or restoration of high resolution image from degraded samples shifted, from multiple low resolutions of true scene is possible by Bose-Boo mathematical model [3]. This method estimates displacement error with high resolution image reconstruction. [2]

Digital images are consisting of picture elements in a grid formation known as pixels, and these pixels holds a quantized esteem which correspond to tone of specific points. Pictures are acquired in zones extending from regular photography to cosmology, remote detecting, restorative imaging, and microscopy.[4]

Tragically all pictures are pretty much hazy. The obscuring or corruption of a picture can be caused by numerous variables, for example, disturbans in capturing procedure that means blur due to camera shake, utilizing long presentation times, utilizing wide point focal point.

Picture Deblurring have wide applications from buyer photography, e.g., evacuate movement obscure because of camera shake; to radar imaging and tomography, e.g., expel the impact of imaging framework reaction. Picture Deblurring is utilized to make pictures sharp and helpful by utilizing scientific model. Picture denoising is additionally a piece of deblurring strategy. [2,4,5]

Three main types of blur in digital images.

1) Average blur: The average blur is one of the few tools useful for reduce noise. It is useful when noise is present over the entire image. Blurring is in vertical and horizontal direction and can be getting by averaging both.

2) Gaussian Blur: Gaussian function is useful for simulation of these type of blur. Impact of Gaussian Blur created through a filter that fallows a bell- shaped curve bringing together number of pixels incrementally. Such kind of blur is invulnerable in the middle.

3) Motion Blur: It happens because of relative movement between the camera and the scene. Motion Blur impacts can be reenacted in a picture utilizing movement channel in a particular heading. The movement can be controlled by point (0 to 360 degrees or -90 to+90) as well as separation or power in pixels (0 to 999), based on product.

4) Out-of-focus Blur: When a camera images a 3-D scene onto a 2-D imaging plane, some parts of the scene are in focus while other parts are not. If the aperture of the camera is circular, the image of any point source is a small disk, known as the circle of confusion (COC). The degree of defocus (diameter of the COC) depends on the focal length and the aperture number of the lens, and the distance between camera and object. An exact model not only describes the diameter of the COC, but also the intensity distribution within the COC [2].

- Image Degradation Model[1,2]

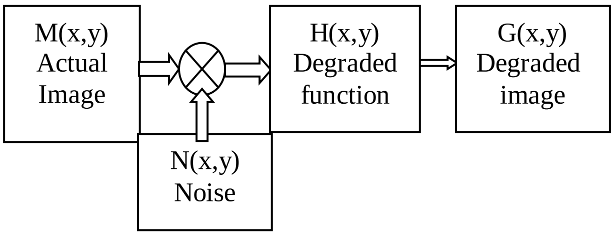

Fig.1 Image Degradation Model[1,2]

G(x,y)=M(x,y)*H(x,y)+N(x,y)

Here g(x,y) is degraded picture, h(x,y) speaks to genuine uncorrupted picture, m(x,y) speaks to blur piece that caused the corruption, n(x,y) represent noise.

Picture or image blurring is view in degradation model. As indicated by degradation model in fig.1, unique picture will convolve with debased capacity i.e. point spread capacity utilizing convolution administrator which work like an increase multiplication operator. At that point we get debased picture or obscured or blurred picture. Noise likewise display into debased picture.

II. Analysis of Deblurring Techniques

There are various Image Deblurring techniques in image processing. These techniques are classified as -

1) Blind deconvolution
2) Non –Blind deconvolution
   A) Deconvolution using Weiner filter.
   B) Deconvolution using Lucy-Richardson method.
   C) Deconvolution using Regularized filter.

1) Blind Deconvolution-

There are essentially two sorts of deconvolution techniques. They are projection based visually impaired deconvolution and greatest probability reclamation (maximum likelihood estimation). In the main approach it all the while reestablishes the genuine picture and point spread capacity. This starts by making introductory evaluations of the genuine picture and PSF. The procedure is cylindrical in nature. Initially we will discover the PSF gauge and it is trailed by picture appraise. This cyclic procedure is rehashed until a predefined joining foundation is met. The value of this strategy is that it seems powerful to mistakes of help measure and furthermore this approach is coldhearted to blur. The issue here is that it isn't one of a kind and this technique can have blunders related with neighborhood minima.
In the second approach the maximum likelihood estimate of parameters like PSF and covariance grids or matrices. As the PSF evaluate isn't novel different presumptions like size, symmetry and so forth of the PSF can be considered. The fundamental favorable position is that it has got low computational many-sided quality and furthermore gets blur, noise and power spectra of the genuine picture. The disadvantage with this approach is of calculation being focalizing to neighborhood minima of the assessed cost work.

[2] Non-Blind Deconvolution

Require the prior knowledge about the parameters of blur kernel (point spread function angle and length) to perform deconvolution.

a. Deconvolution using Weiner filter

This approach requires earlier learning about parameters of point spread function. An estimate of desired random process can produce by weiner filter using linear time –variant filtering of an observed noisy image. Wiener deconvolution can be utilized successfully when the recurrence attributes of the picture and added substance commotion are known, to in any event some degree. Without noise, the Wiener channel lessens to the perfect converse channel. Weiner channel limit the mean square error between the evaluated irregular process and the coveted procedure.

b. Deconvolution using Lucy-Richardson

The LR algorithm can be utilized productively all things considered where the point-spread capacity PSF (blurring operator) is recognized, yet unassuming or no data is accessible for the commotion. It is an iterative technique to reestablish blur picture which is obscured by known PSF. One fundamental issue with essential LR strategy is how frequently process should rehash. Assuming no. of emphasis huge then it will backs off the computational procedure and also intensifies commotion and present ringing impacts.

c. Deconvolution using regularized filter

It is another sort of non-daze deconvolution. It utilizes regularizing channel for deblurring reason. This strategy is helpful where restricted data about commotion is available. In regularized sifting less earlier data is required for deconvolution.

The examination of these distinctive strategies has been completed in light of goal and subjective outcomes with shifting different variables like control factor and WGN fluctuations. The diverse techniques have been tried for various ranges of pictures, for example, low ,medium and high detail pictures.

III. Result and Discussion

The experimental work is carried out on MATLAB (R2013a) for different standard images, while performing analysis of various deblurring methods. The following deblurring methods have been analyzed with reference to objective and subjective results.

1. FFT based deblurring method
2. Wiener deconvolution
3. Blind deconvolution
4. Lucy deconvolution
5. Regularized deconvolution

All mentioned deblurring techniques has been evaluated for different spectrum of images like Lena (low detail image)cameraman(medium detail image) and baboon(high detailed image) in term of objective performance MSE & PSNR with variation in Gaussian noise and regularization factor.

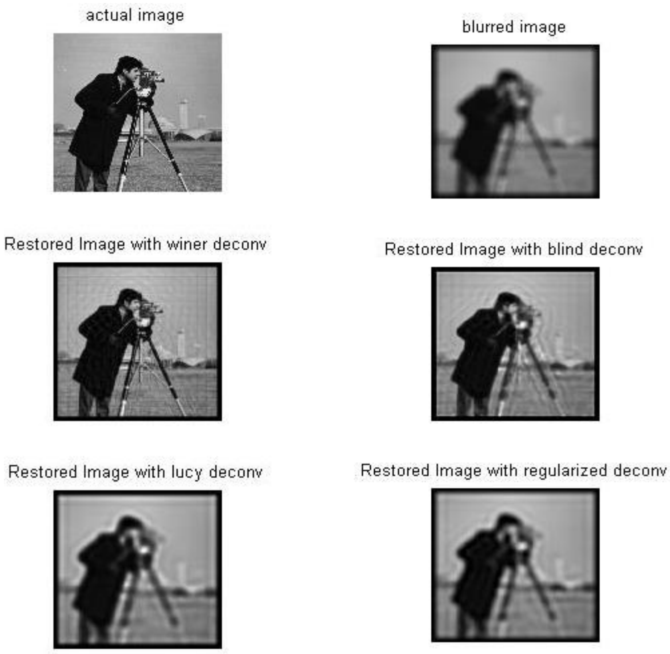

Fig1. Subjective results for varies filter with Regulation factor W=0.0005, L=18, B=5, R=5

Fig1-Fig6 is shown subjective methods results, by varying Regulation factor of each filter. As per the observations the subjective results of blind deconvolution are good as compare to other deblurring technique using different filter. According to Table 1 Weiner filter performance is bad as compared to others, while Blind deconvolution have better performance than others.

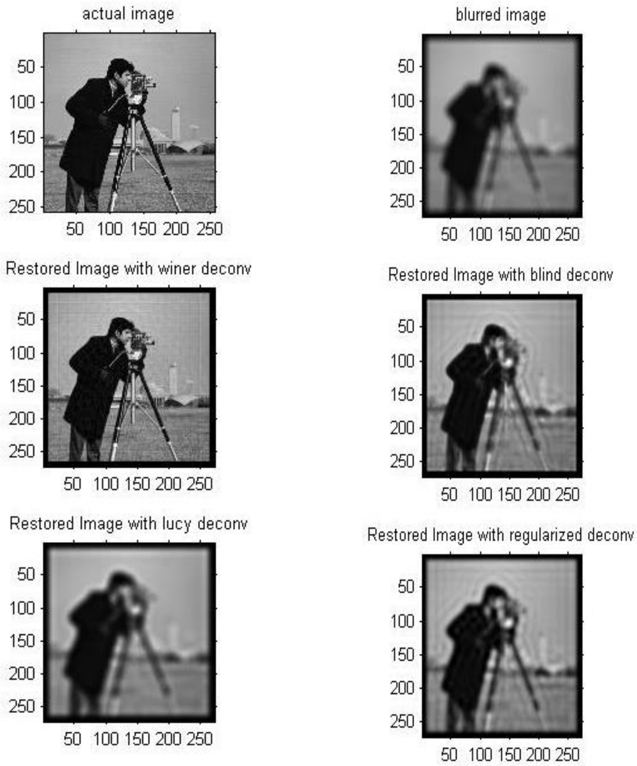

Fig. 2 Subjective results for varies filter with Regulation factor W=0.0001, L=15, B=2.5, R=2.5

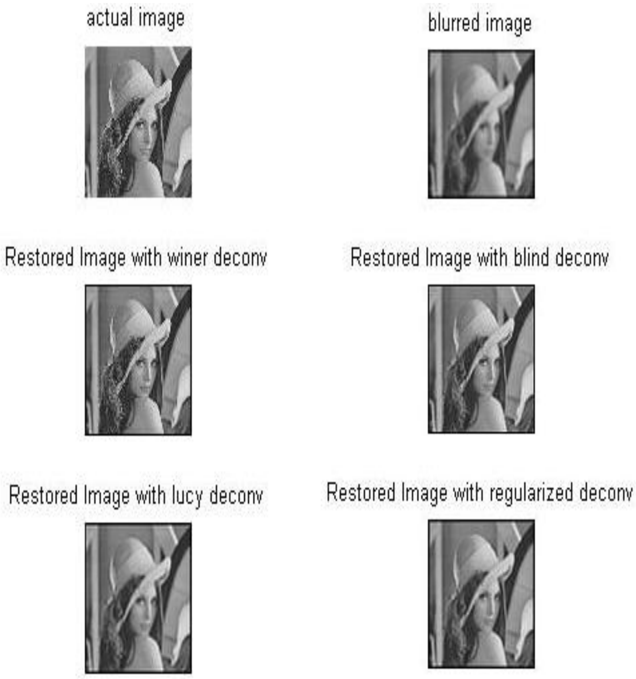

Fig. 3 Subjective results for varies filter with Regulation factor W=0.0005, L=18, B=5, R=5

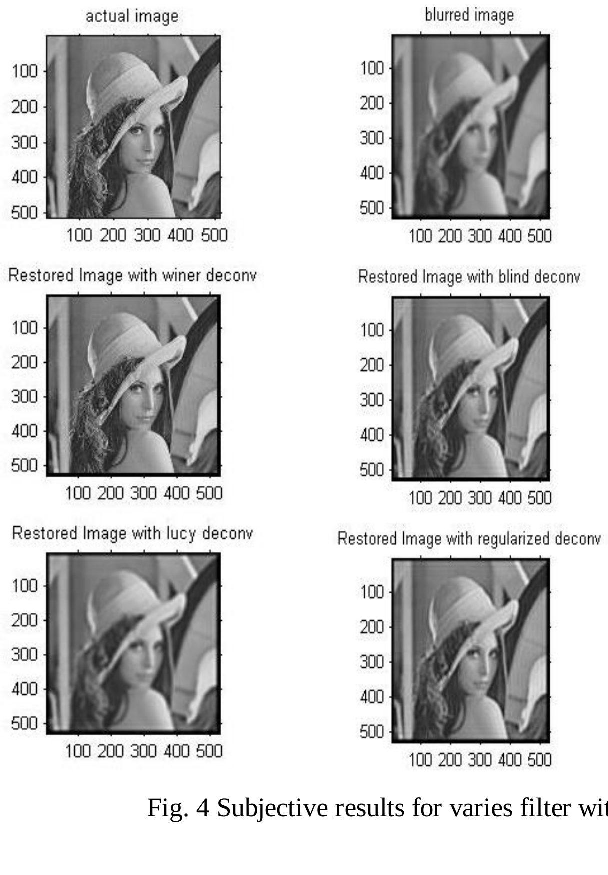

Fig. 4 Subjective results for varies filter with Regulation factor W=0.0001, L=15, B=2.5, R=2.5

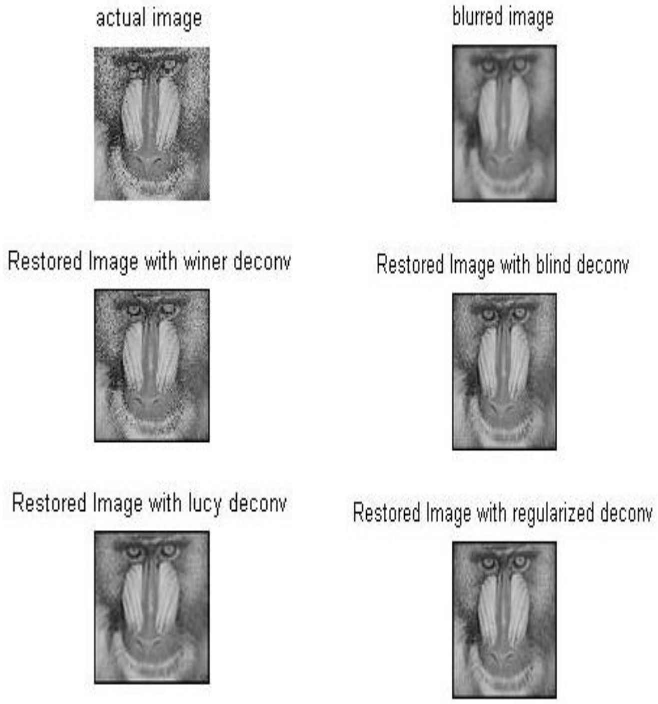

Fig. 5 Subjective results for varies filter with Regulation factor W=0.0005, L=18, B=5, R=5

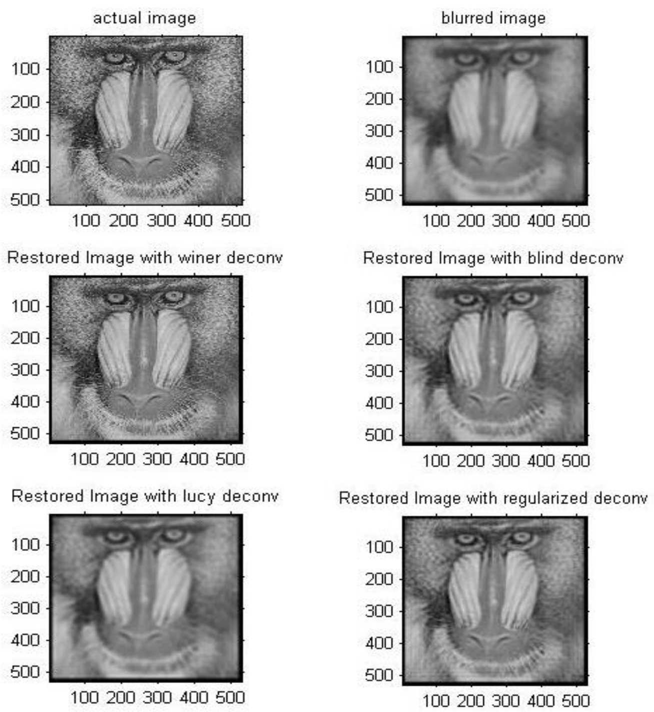

Fig. 6 Subjective results for varies filter with Regulation factor W=0.0001, L=15, B=2.5, R=2.5

Filter	Regulation Factor	PSNR		
		Cameraman	Lena	Baboon
Wiener filter	0.0005	47.0777	54.2040	50.2545
	0.0001	45.3104	52.6669	47.5567
Lucy filter	18	50.9560	56.7853	54.0807
	15	51.9434	57.5246	55.1285
Blind filter	5	57.7359	65.6509	63.2442
	2.5	67.2230	76.1783	75.1528
Regularized filter	5	60.6157	66.4657	62.9342
	2.5	57.2230	62.7426	58.4348

Objective results of varies filter with different regulation factor on cameraman, Lena, Baboon image are shown in table 1. The images are low detail, medium detail and high detail images. Here we analyse PSNR values on each image.

Table 1

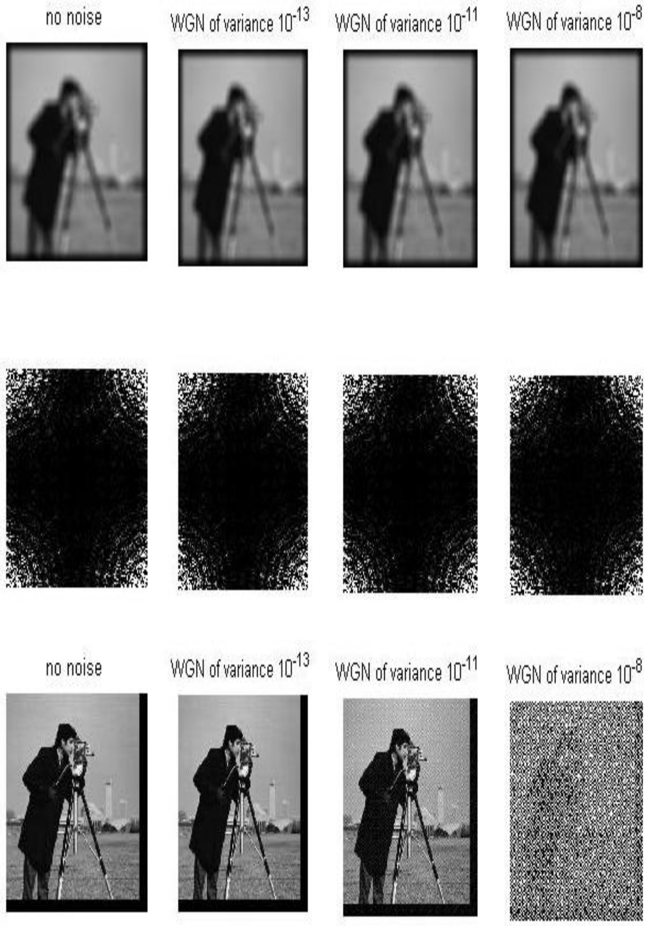

Fig.7 Subjective results of FFT based deblurring technique with varies noises on img Cameraman

Figure 7 to 9 shows implementation of deblurring techniques based on FFT where input images vary with Gaussian noise in the range of 10^{-8} to 10^{-13}, For images Lena Cameraman and Baboon respectively. The same figure shows variation of spectrum of these images as Gaussian noise changes. It is observed that as Gaussian noise variance increases the resultant image of deblurring techniques using FFT becomes more and more blurry where information lost totally while this techniques gives better result for Low Gaussian noise variance. Further it is observed that Low detail images and high detail images are more prone for the changes of Gaussian noise as compared to medium detailed image. These observations are shown in figure to 7 to 9.

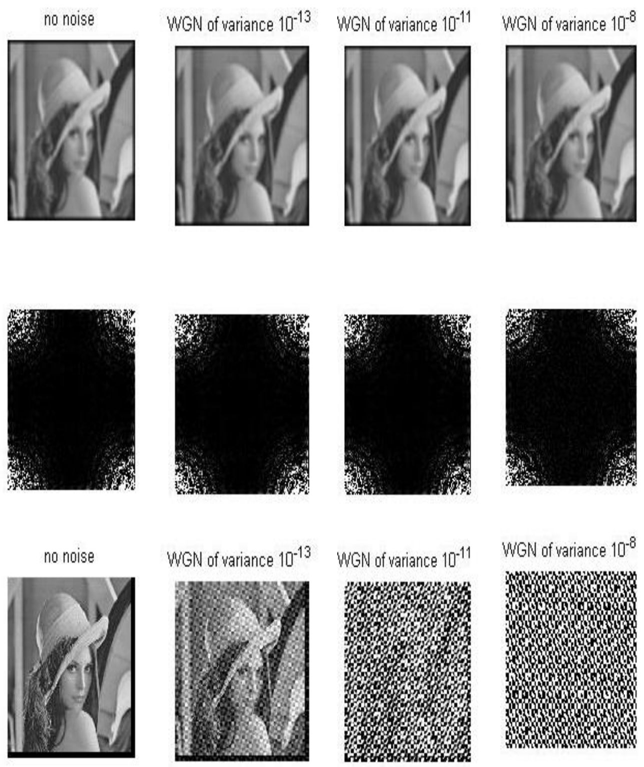

Fig. 8 subjective results of FFT based deblurring technique with varies noises on img Lena

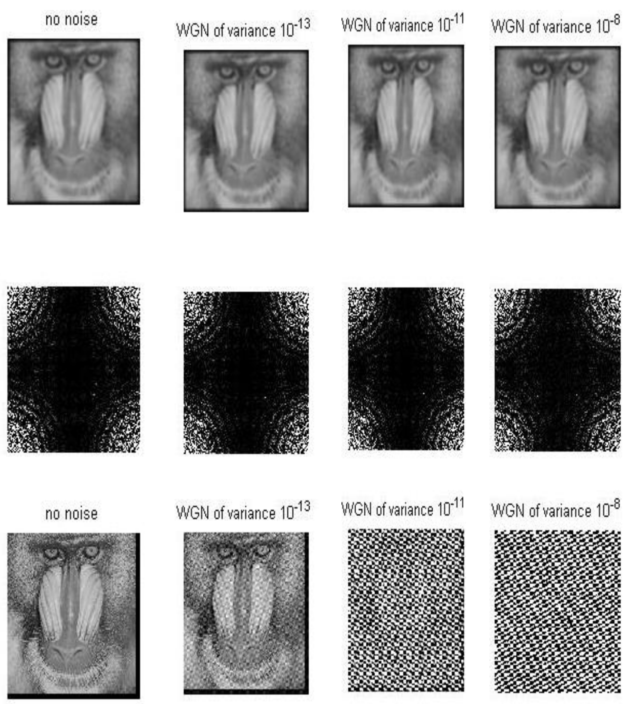

Fig.9 Subjective results of FFT based deblurring technique with varies noises on img Baboon

Table.2

Noise	PSNR for img Cameraman	PSNR for img Lena	PSNR for img Baboon
No noise	29.9809	35.4049	35.0353
WGN of variance 10^{-13}	30.2600	35.4167	35.5408
WGN of variance 10^{-11}	30.9260	24.7611	24.1775
WGN of variance 10^{-8}	25.9672	19.3313	19.2668

The table 2 shows objective results of FFT based deblurring method based on PSNR for different images like Lena Cameraman and Baboon with variance in Gaussian noise in the range of 10^{-8} to 10^{-30}. It is observed that the value of PSNR is better for low variance of Gaussian noise while for high variance of Gaussian noise the PSNR value for Lena image is slightly maintained.

IV. CONCLUSION

The analyses of different deblurring methods have been carried out by varying various factors like regulation factor and WGN variances. Different methods have been tested for different spectrum of images such as low medium and high detailed images. The results have been compared with each method and based on qualitative results particular techniques have been analysed for deblurring and regulation of blurry down sample and noisy images. The performance of various techniques has been evaluated based on MSE and PSNR.

The point spread function of various techniques has utilized to deblur the blurry images. The various parameters like WGN variance and regularization factor had varied and conclusion have made to find suitable techniques for deblur the image.

V. References

[1] Dejee Singh , Mr R. K. Sahu Sudha ," A Survey on Various Image Deblurring Techniques" International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 12, December 2013

[2] N. Bose and K. Boo, "High-resolution image reconstruction with multisensors," Int. J. Imag. Syst. Technol., vol. 9, pp. 294–304, 1998.

[3] Yao Lu, Lixin Shen, and Yuesheng Xu,"Multi-Parameter Regularization Methods for High-Resolution Image Reconstruction With Displacement Errors", ieee transactions on circuits and systems—i: regular papers, vol. 54, no. 8, august 2007

[4] A. Gupta, N. Joshi, C. Lawrence Zitnick, M. Cohen, and B. Curless, "Single image deblurring using motion density functions," in Proc ECCV, 2010, pp. 171–184.

[5] A. Levin, Y. Weiss, F. Durand, and W. Freeman, "Understanding blind deconvolution algorithms," IEEE Trans. Pattern Anal. Mach. Intell., vol. 33, no. 12, pp. 2354–2367, Nov. 2011.

[6] Y. Tai, P. Tan, and M. S. Brown, "Richardson-Lucy deblurring for scenes under projective motion path," IEEE Trans. Pattern Anal. Mach. Intell., vol. 33, no. 8, pp. 1603–1618, Aug. 2011.

[7] D. Kundur and D. Hatzinakos, "A novel blind deconvolution scheme for image restoration using recursive filtering," IEEE Trans. Signal Process., vol. 46, no. 2, pp. 375-390, Feb. 1998.

[8] L. Yuan, J. Sun, L. Quan, and H. Shum, "Image deblurring with blurred/noisy image pairs," ACM Trans. Graph., vol. 26, no. 3, pp. 1– 11,2007

[9]