Digital Image Restoration using Image Filtering Techniques

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***Abstract*-In modern age, image is useful media used to analyze the information within it. Sometime image which captured get blurred and noise from the environment. This phenomenon can reduce the quality of image. Image restoration technique we can restored degraded image to the nearest real image. Some filters and algorithms can be used to restoring the image, such as Weiner filter, Regularized filter, and Lucy-Richardson filter. This experiment tried to use these three techniques to restore blurry noised image using MATLAB software. Gaussian blur and noise were given to the images. Then, three methods are used to restore degraded images and compared their performance each other based on three parameters, such as Power Signal to Noise Ratio (PSNR) SSID (Structural Similarity Index), and MSE (Mean Squared Error). The experiment result shows that image restoration using Lucy-Richardson algorithm gives best performance on restoring thus degraded image in comparison of all parameter.**

Keywords-Image restoration, Wiener filter, Regularization filter, Lucy-Richardson filter, PSNR, MSE.

I. INTRODUCTION

Image Analysis can be done for different applications for image restoration including digital media restoration, low enforcement, astronomical imaging & medical imaging etc. But, the imperfection during capture and record can cause degraded to the image and reduce the information.[1]. In many images processing task for undergoing for these imperfections are critical. The imperfection or degradation may be due to noise present in the image because of blur image or noise sensors.[2] These imperfections are caused by relative object camera motion, random atmospheric turbulence and camera misfocus. Thus, image restoration concentrates to modelling blurring and noise function and then applying inverse model to de-blurred and de-noise the image. Image restoration process is used to reconstruct or recover degraded image with some degradation techniques. It is used to estimate & reconstruct an uncorrupted image of removing the blurriness & noise from the image [3]. The image restoration process is dependent on the nature of noise and corruption present in the image. The Objectives of the proposed work are, to find out a suitable highly accurate restoration algorithm to filter and remove the degradation on an image using Matlab simulator, to investigate the strength and limitations of each image restoration algorithm, to find a suitable algorithm with high performance of filtering and doing a great job of restoring the image and to generate an estimate of the original image prior to the degradation[4]. This paper is organized as follows- section II describe about the literature review, Section III describes the Matlab implementation of image restoration. Different image restoration techniques have been discussed in Section IV. In Section V, different measuring parameters have been described. Further results have been discussed in Section VI followed by conclusion.

II. LITERATURE REVIEW

In digital image processing concepts, various processing techniques has been used such as image pre-processing, image enhancement, image segmentation, image restoration, etc. Now a days almost in every aspect and everywhere image processing techniques have been used. Among all the techniques, image restoration plays an important technique to save all the un-noised & un-blurred images. Image restoration has been used in various applications and area of digital media, remote sensing, medical imaging, modular spectroscopy, astronomy, low enforcements, etc. There are lots of interferences and different type of noises may be present in the image such as Gaussian noise, impulse noise, and multiplicative noise. The blurriness such as motion blur, gaussian blur, atmospheric blur, uniform blur images may exist because of camera focus or misfocus by able lens, wide lens, long exposure times degradation, wind speed, etc. [7].

To remove noise and blurriness from the image may filtering techniques such as, harmonic mean filters, wiener filter, median filter, inverse filter maximum like hood (MI), max filter etc. have been used. Among all these inverse and wiener filtration method gas been used for image restoration. Stephen works on reconstruction & restoration techniques [8] They worked on user defined data and available data of overlapping images & multiple and even some sense especially for spatial domain process. Michael processes the technique to reduce image blurness for projector and out of focus layer.Yu.et.al. suggested an algorithm for the images degraded by Gaussian and impulse noise. [11] They introduced for restoration process of noisy and distorted images. Multi-resolution texture analysis and image imprinting can be used for digital photographs to restore to its neutral network techniques are used for spatial variation of parameters for training the weight adaptive KNN technique are used to restore the image to minimize the pixel noise.[13] To improve the pixel, intensities adaptive KNN strategy to mean shift has been used to restore the image. To solve the inverse problem such as deblurring CNN methods has been used with model-based optimization, non-local color image de-noising methods. For linear inverse problem iterative method has been used for de-noising as well as to restore the images. Among all filters median filter is the consuming & complex as well. Arithmetic mean filter is used to remove blur from edges, whereas does not work well for sharpened the edges-wiener filter is used to remove minimize the square error between uncorrupted images.

III. MATLAB IMPLEMENTATION FOR DIGITAL IMAGE RESTORATION

The MATLAB is an image processing tool, many algorithms have the facility to modify the source code based on the problem given: Image smoothing, analysis, sharpness, enhancement, deblurring, filter design, contrast enhancement, segmentation, morphological measurement, registration, spatial transformation, image transform may be used for digital image restoration process.

A. *Image Formats in MATLAB*

The most commonly used formats for images are GIF, FPEG, BMP, PGM, PNG, etc. In MATLAB environment many methods are used to import & export the images.

TABLE I. COMMANDS TO CHANGE IMAGE FORMAT

1.	gray2ind()	Intensity to index format
2.	dither()	Index/ intensity/ RGB to binary
3.	ind2gray()	Indexed to Intensity
4.	mat2gray()	convert RGB to intensity
5.	ind2rgb()	Indexed to RGB
6.	rgb2ind()	RGB to indexed
7.	rgb2gray()	Regular matrix to intensity format

B. *Reading files & Work with variables*

In image processing, image is saved as JPEG file or in another file format. This is done by following MATLAB command

TABLE II. COMMAND TO READ & WRITE FILE

1.	imread()	To read file from local storage
2.	imwrite( )	To write file from local storage

C. *Blur Models of Digital Images*

Identification, reconstruction and restoration algorithms are used for blur model. In this paper blur models are presented in continuous form. In this image formation process, imperfection is passive in nature, as no energy absorbed or generated from data.

Different blur models are presented below:

1. *No Blur*

In this model no blur appears in discrete image. The obtained image is considered as perfect image.

2. *Linear motion blur*

Blur can be generated by some disturbance or relative motion between the actual science & recording device. It can be formed as a sudden change of scale, transition or a rotation. In this paper global translation form has been taken.

3. *Uniform Out of focus blur*

If an image capturing device such as camera is circular, the image obtained is in the small dick form and known as circle of confusion (COC). When 3D image change into 2D plane, some portions of image remain unfocus. That creates confusion (COC) in image.

4. *Atmospheric turbulence blur*

In remote sensing process, atmospheric turbulence generates by many factors such as exposure time, speed, wind, temperature, etc.

IV. PROPOSED IMAGE RESTORATION TECHNIQUE

Image restoration process involves following step:

A. *Read the image*- Read the original image using imread() is the first step of the process.

B. *Application of Median Filter method*- Image filtering is the preprocessing step in image processing. It is used to remove the noise and improve the resultant image. Many filtering techniques has been used but among them Median filtering is widely used technique for digital image without disturbing its edges.

C. *Application of Wienerfilter method*– Wiener filter has been used for filtering the observed noisy image. It is used for additive noise, noise spectra and stationary signal from the image wiener filter estimate the error or difference by linear time variant (LTV) of desired or target process of an observed noisy process.

$$f(\mathrm{x,y}) = \left[\frac{1}{\mathrm{H}(x,y)}\,\mathrm{x}\,\frac{|\mathrm{H}(x,y)|2}{|\mathrm{H(x,y)}|2+{}^{\mathrm{S_n}(x,y)}/_{\mathrm{S_f}(x,y)}}\right]\mathrm{G(x,y)} \quad (1)$$

where,

$H_{(x,y)}$ = degradation function

$H_{(x,y)2}$ =complex conjugate of $H_{(x,y)}$

S_n = power spectrum of noise

S_t = power spectrum of original image

$G_{(x,y)}$ = wiener filter

D. *Application of Regularization Filter Method*- When the image has limited information about addictive noise and constrains such as smoothness are applied on recovered image, the regularization deconvolution can be used. Constrained least square restoration algorithm has been used for blur and noisy image to restore the image.

$$\min_u L_\alpha(U) = \min_u\{\alpha R(u) + \left||u_o - Ku|\right|\frac{2}{2}\} \quad (2)$$

where,

‖ ‖2 = Euclidean norm

R(u)=regularization norm.

So, the classical regularization functional is:

$$(u) = \|Su\|2\ /2$$

where,

S = smoothing operator.

Usually, S=I (standard form) or it is chosen as a linear.

E. *Application of Lucy-Richardson Filter Method*- Lucky Richardson algorithm is usedto restore the blurred and noisy image by aculerated & iterative method. To improve the quality, optical system characteristics has been used as input parameters.

$$PSNR = 10log(\frac{MAX_1^2}{MSE}) \quad (3)$$

Which MAXI 2 is the value of maximum possible pixel value squared of the image and MSE. The second criterion is MSE or mean squared deviation to find out the average value of the squares error or deviation or find out the difference between the estimator and what is estimated. MSE formula given by equation below:

$$MSE = \frac{1}{M.N}\sum_{i=0}^{N-1}\sum_{i=0}^{M-1}|f(i,j) - \widehat{f(i,j)}|^2 \quad (4)$$

V. Performance Measuring Parameters

A. PSNR Value

The Peak Signal to Noise Ratio (PSNR) The term peak signal-to-noise ratio (PSNR) is an articulation fortheproportion between the maximum possible value of a signal and the energy of twisting turbulence that influences the nature of its representation.The PSNR is regularly communicated as far as the log decibel scale and given by equation.

$$PSNR = 10\log_{10}\frac{R^2}{MSE} \quad (5)$$

B. SSIM Value

SSIM is utilized for estimating the closeness between two pictures. The SSIM list is a full reference metric; as it were, the estimation or expectation of picture quality depends on an underlying uncompressed or bending free picture as reference.

$$\text{SSIM(X,Y)} = \frac{(2\mu_X\mu_Y+c_1)(2\sigma_{XY}+c_2)}{(\mu_X^2+\mu_Y^2+C_1)(\mu_X^2+\sigma_Y^2+C_2)} \quad (6)$$

where,

μ_x =average value of x
μ_y= average value of y
c_1&$c_2$are variables to stabilize

σ_x = variance of x
σ_y= variance of y,
σ_{xy}=variance of x and y.

C. MSE Value

The mean squared error (MSE) or mean squared deviation (MSD) of an estimator measures the average of the squares of the errors. It is the average squared difference between the estimated values and what is estimated.

$$MSE = \frac{1}{M.N}\sum_{i=0}^{N-1}\sum_{i=0}^{M-1}|f(i,j) - \widehat{f(i,j)}|^2 \quad (7)$$

VI. Result and Discussion

In the proposed work, Weiner, regularization and Lucky-Richardson filter has been used on 03 images of blur and non-blur image. These filters are compared by measuring parameters viz. PSNR, SSIM, MSE. In wiener filter the value of PSNR in blur image are 22.18, 27.45&21.2 and in un-blur images are 20.23, 17.45&15.2.

Fig. 1. (a)-(c) Blur Image Model showing Original image, Wiener filter, Regularization Filter and Lucy-Richardson Filter.

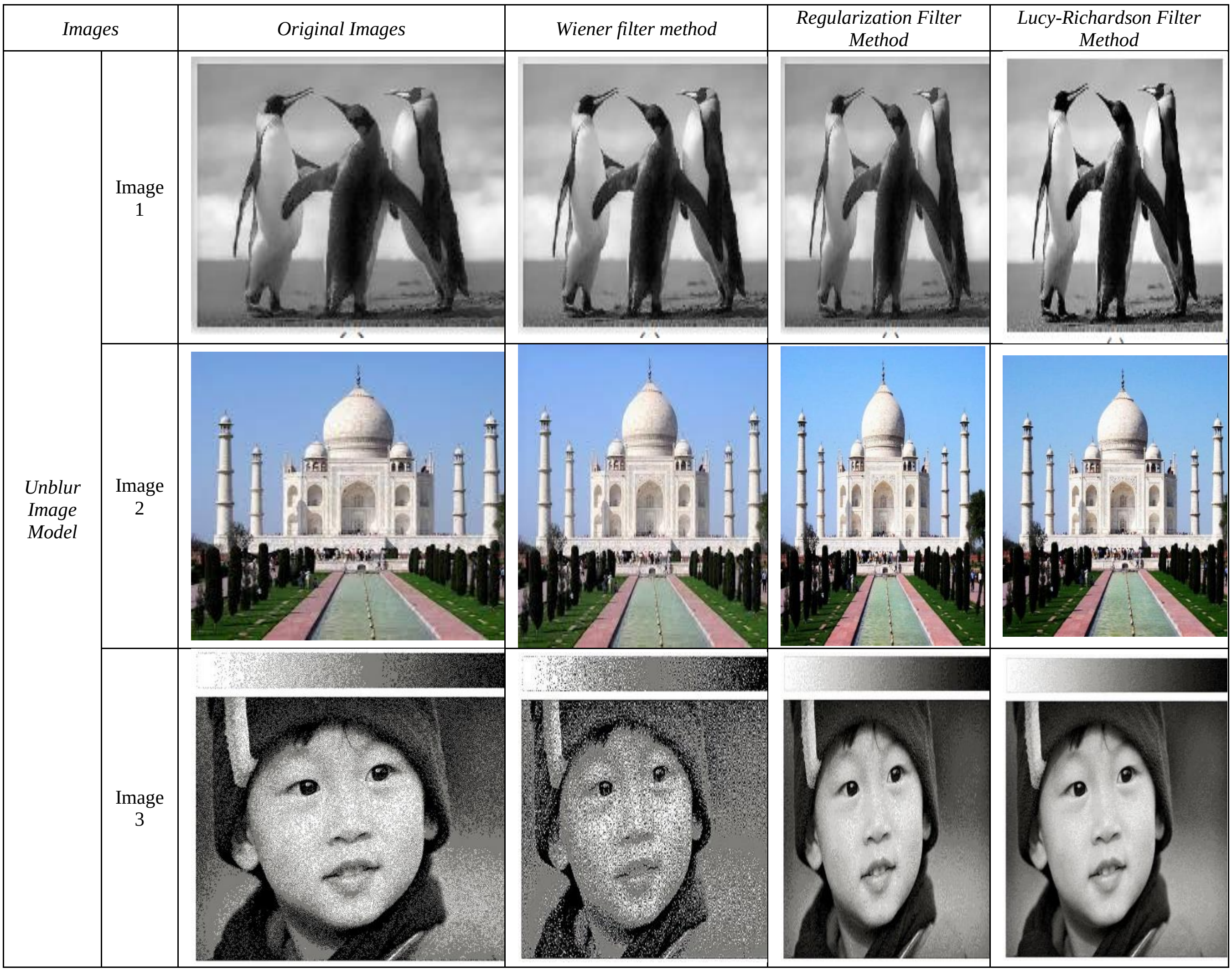

Fig. 2. (a)-(c) Unblur Image model showing Original image, Wiener filter, Regularization Filter and Lucy-Richardson Filter

TABLE III. COMPARISON OF PERFORMANCE PARAMETERS OF BLUR IMAGE AFTER RESTORATION

	Wiener Filter			*Regularization Filter*			*Lucy-Richardson Filter*		
Image	PSNR	SSIM	MSE	PSNR	SSIM	MSE	PSNR	SSIM	MSE
Img1	22.18	0.88	98.67	24.45	0.78	244.17	29.58	0.82	71.58
Img2	27.45	0.77	113.42	22.75	0.78	324.4	30.71	0.91	54.2
Img3	21.2	0.80	87.25	21.23	0.81	239.4	29.70	0.81	66.47

TABLE IV. COMPARISON OF PERFORMANCE PARAMETERS OF UNBLUR IMAGE AFTER RESTORATION

	Wiener Filter			*Regularization Filter*			*Lucy-Richardson Filter*		
Image	PSNR	SSIM	MSE	PSNR	SSIM	MSE	PSNR	SSIM	MSE
Img1	20.23	0.48	616.97	11.45	0.78	144.17	24.58	0.22	41.58
Img2	17.45	0.47	119.42	20.75	0.48	384.4	20.71	0.41	74.2
Img3	15.2	0.40	37.25	45.23	0.11	169.4	20.70	0.31	42.47

VII. CONCLUSION

From the experiment it is indicated that Lucy-Richardson algorithm was the best image restoration in all parameter measured, such as PSNR, SSIM, and MSE in both blur image and blur-noised image. In image with gaussian blur treatment, all three methods actually have good ability to deconvolute image and make image clear and lost its blur power. On PSNR value result show that each algorithm has an insufficient margin between each other and other parameters too. In other hand, image with Gaussian blur and noise treatment, Lucy-Richardson algorithm was the one best on all parameters assessed. Unlike blur image case, not all algorithms are efficient to reduce Gaussian noise of picture. Here, Lucy-Richardson algorithm proven best in removing image noise. And this method is better than Wiener filter which is usually used in eliminating Gaussian noise. From the graph, indicate the significance enough differences in parameters of PSNR and SSIM. While on MSE, Lucy-Richardson and Wiener method has very small margin, while far apart with regularization method.

REFERENCES

[1] R. L. Algorithm, M. Thakur, and S. Datar, “Image Restoration Based on Deconvolution by,” vol. 14, no. 4, pp. 161–165, 2014.

[2] A. Maurya and R. Tiwari, “A Novel Method of Image Restoration by using Different Types of Filtering Techniques,” Int. J. Eng. Sci. Innov. Technol., vol. 3, no. 4, pp. 124–129, 2014.

[3] Z. Mbarki, H. Seddik, and E. Ben Braiek, “A rapid hybrid algorithm for image restoration combining parametric Wiener filtering and wave atom transform,” J. Vis. Commun. Image Represent., vol. 40, no. Part B, pp. 694–707, 2016.

[4] Suseela, S. A. Basha, and K. P. Babu, “Image Restoration Using Lucy Richardson Algorithm for X-Ray Images,” IJISET - Int. J. Innov.Sci. Eng. Technol., vol. 3, no. 2, pp. 280–285, 2016.

[5] Z. J. Min, “Analysis and Comparison on Image Restoration Algorithms Using MATLAB,” Int. J. Eng.Res. Technol., vol. 2, no. 12, pp. 1350–1360, 2013.

[6] Hong, L. Li, and T. Zhang, “Blind restoration of real turbulence-degraded image with complicated backgrounds using anisotropic regularization,” Opt. Commun., vol. 285, no. 24, pp. 4977–4986, 2012.

[7] R. L. Algorithm, M. Thakur, and S. Datar, “Image Restoration Based on Deconvolution by,” vol. 14, no.4, pp. 161–165, 2014.

[8] A. Maurya and R. Tiwari, “A Novel Method of Image Restoration by using Different Types of Filtering Techniques,” Int. J. Eng. Sci. Innov. Technol., vol. 3, no. 4, pp. 124–129, 2014.

[9] Z. Mbarki, H. Seddik, and E. Ben Braiek, “A rapid hybrid algorithm for image restoration combining parametric Wiener filtering and wave atom transform,” J. Vis. Commun. Image Represent., vol. 40, no. Part B, pp. 694–707, 2016.

[10] Suseela, S. A. Basha, and K. P. Babu, “Image Restoration Using Lucy Richardson Algorithm for X-Ray Images,” IJISET - Int. J. Innov. Sci. Eng. Technol., vol. 3, no. 2, pp. 280–285, 2016.

[11] Z. J. Min, “Analysis and Comparison on Image Restoration Algorithms using MATLAB,” Int. J. Eng. Res. Technol., vol. 2, no. 12, pp. 1350–1360, 2013.

[12] O. Shacham, O. Haik, and Y. Yitzhaky, “Blind restoration of atmospherically degraded images by automatic best step-edge detection,” vol. 28, pp. 2094–2103, 2007.

[13] M. Aoud, “Image restoration based on morphological operations,” vol. 4, no. 3, pp. 9–21, 2014.

[14] Y. Pratama, A. Kusumawardhani, A. M. T. Nasution, and A. Rahmadiansyah, “Distortion Inspection System Development of Rearview Mirror using Radial Line Method Based on Image Processing,” pp. 109–110, 2015.