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An Efficient Approach of Segmentation and Blind Deconvolution in Image Restoration

Sindhu Jain[1], Mr. Sudhir Goswami[2]
[1](*Computer Science, M.I.E.T, Meerut, India)*
[2](*Asst. Prof. Computer Science, M.I.E.T, Meerut, India)*

Abstract :*This paper introduces the concept of Blind Deconvolution for restoration of a digital image and small segments of a single image that has been degraded due to some noise. Concept of Image Restoration is used in various areas like in Robotics to take decision, Biomedical research for analysis of tissues, cells and cellular constituents etc. Segmentation is used to divide an image into multiple meaningful regions. Concept of segmentation is helpful for restoration of only selected portion of the image hence reduces the complexity of the system by focusing only on those parts of the image that need to be restored. There exist so many techniques for the restoration of a degraded image like Wiener filter, Regularized filter, Lucy Richardson algorithm etc. All these techniques use prior knowledge of blur kernel for restoration process. In Blind Deconvolution technique Blur kernel initially remains unknown. This paper uses Gaussian low pass filter to convolve an image. Gaussian low pass filter minimize the problem of ringing effect. Ringing effect occurs in image when transition between one point to another is not clearly defined. After removing these ringing effects from the restored image, resultant image will be clear in visibility. The aim of this paper is to provide better algorithm that can be helpful in removing unwanted features from the image and the quality of the image can be measured in terms of PSNR(Peak Signal-to-Noise Ratio) and MSE(Mean Square error). Proposed Technique also works well with Motion Blur.*
Keywords *- Blind Deconvolution, Image Restoration, Image Segmentation, MSE ,PSF, PSNR value.*

I. Introduction

An Image is a word that is derived from a Latin word 'imago' which is a representation of visual perception in a 2-D or 3-D picture that has a similar appearance to some objects and a Digital Image is a numeric representation of a 2-D image [1].

1.1. **Image Restoration:**

Image Restoration is a process of undo all the unnecessary effects known as 'blur' or 'noise' that has been added into an image by various reasons like misfocus of the camera, large distance between camera an object, capturing a picture of a moving object known as motion blur, Gaussian blur by using Gaussian filter etc. The process of adding noise into a digital image is known as Convolution and the process of restoring a convoluted image is known as Deconvolution. There are basically 3 types of blur: a) Motion blur, b) Gaussian blur, c) Average blur [2]. The main objective of Image Restoration is to sharpen the features of an image in such a way that it can clearly be seen by a person. However Image Restoration differs from Image Enhancement. In Image Enhancement we do not make use of any degradation model or we do not need to know about the process which is degrading the image while in case of Image Restoration, degradation model is necessary to restore an image. In Image restoration we try to find a degradation model and then by using that model, we apply the inverse process and try to restore the image [3].

Degradation model of Image Restoration:

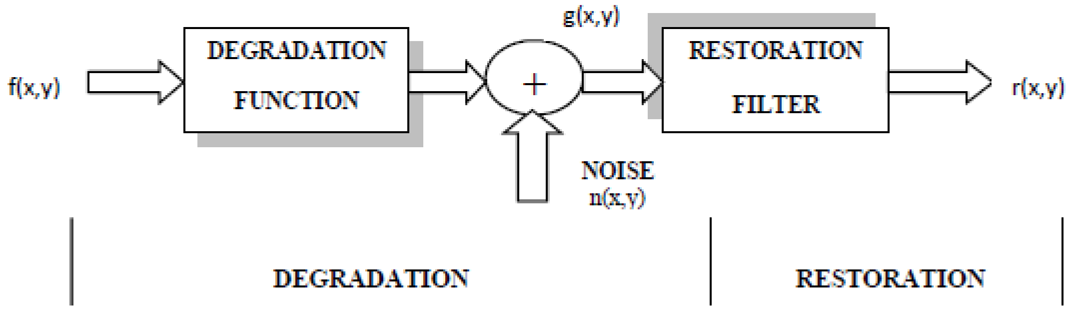


Fig (1): Degradation Model

Some applications of Image Restoration are:
1.1.1. In medical science such as CT, MRI, Ultrasound etc.
1.1.2. Sharpness.
1.1.3. Contrast Enhancement.
1.1.4. Denoising etc.

1.2. Image segmentation: Image segmentation divides an image into various parts or segments also known 'set of pixels' or 'Super Pixels' in which each pixel or picture element exhibits similar attributes. There are various techniques for image segmentation such as region based segmentation, edge/ boundary based segmentation etc [4]. The segmentation technique used in this paper is based on Pixels known as Pixel Based Segmentation. In this technique a digital image is divided on the basis of the resolution of an image. Resolution is the number of pixels on the horizontal axis and the vertical axis of the image. Segmentation of image depends on the size of the input image. Larger is the size of the Input image and more is the number of segments of that image. This paper considers 9 segments of the input image.

1.3. Blind Deconvolution: Blind Deconvolution is a technique of restoration of a degraded/ blurred image without having any knowledge of blur kernel or PSF(Point Spread Function) of an image. A kernel is a mask in the form of small matrix used to blur an image. This small matrix is known as Convolution Matrix. In this technique of restoration, blur kernel is unknown that is why it is known as 'Blind'. Deconvolution is a technique to sharpen or deblur a blurry image, and collectively it is known as Blind Deconvolution Technique. A kernel is a 2D matrix that is used to blur an image also known as Convolution Matrix. It can be represented as:

$$Y=k*X+n; \qquad (1)$$

Where, X is the input gray image. Y is the degraded image. K is the kernel or convolution matrix that is added with the input image X to transform it into the blurry image called Y. * is the convolution operator.
The goal of Blind Deconvolution is to inverse the above process and to recover both X and k [5]. This technique restores the blurry image by calculating PSF of the degradation by using three techniques and chooses the one that provides better restoration result. Techniques are:
1.3.1. Undersized PSF.
1.3.2. Oversized PSF.
1.3.3. INIT PSF.
The performance of restoration is measured by calculating PSNR (Peak Signal to Noise Ration) value of the restored image. Higher is the value of the PSNR, more will be the quality of restored image.

II. Proposed Methodology

This methodology firstly convert a digital colored image into gray image (if it not a gray image) and then add Gaussian blur into that image. Gaussian blur is added into the image by using following function:

$$H=fspecial (grayimagename, hsize, sigma); \qquad (2)$$

Where, hsize can be a vector or a scalar. This function returns a Gaussian filter of size 'hsize' with standard deviation 'sigma'. fspecial () creates Gaussian 2D filter by using following formula:

$$h_g(n1,n2)=e^{\frac{-(n1^2+n2^2)}{2\sigma^2}} \qquad (3)$$

$$h(n1,n2)=\frac{hg(n1,n2)}{\sum_{n1}\sum_{n2} h_g} \qquad (4)$$

Where h_g is a Gaussian Filter having n1 number of rows and n2 number of columns. σ is a standard deviation.
After adding Gaussian Blur into a Gray image, the technique of segmentation is applied on the image. Number of segments depends upon the size of segments. Larger is the size of image more will be the number of segments.
Architectural model of proposed technique is shown in figure Fig(2):

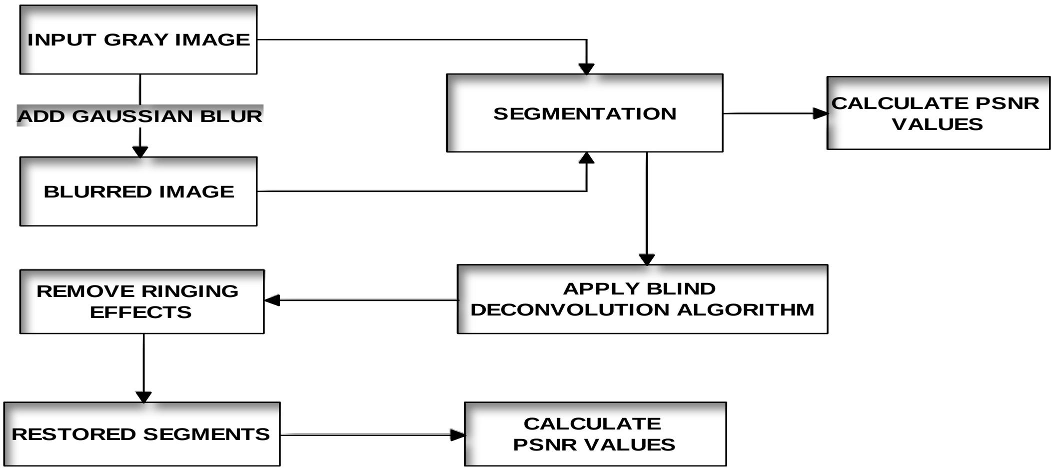


Fig (2): Architectural Model Of Proposed Technique.

Algorithm of Proposed Technique:

Step 1: Read the Original Gray Image I.
Step 2: Add blur into image I say G.
Step 3: Apply pixel based segmentation on image I and corresponding image G. (No. of segments depend upon the size of Input image.
Where Original Gray Image I contains, I=(I1,I2,I3,I4……) segments and Blurred Image G contains, G=(G1,G2,G3,G4…..) segments.
Step 4: Store all segments found in step 3 into a folder.
Step 5: for all G=(G1,G2,G3,G4….) apply Blind Deconvolution Algorithm.
Step 6: Remove ringing effects from the restored segments for accuracy of results.
Step 7: Measure performance of the result by calculating PSNR values.

III. Quality Measurement

Quality of an image in proposed technique is generally measured in terms of PSNR (Peak Signal-to-Noise Ratio) and the MSE(Mean Square Error).

Peak Signal-to-Noise Ratio (PSNR) is a mathematical measure of image quality based on pixel difference between two images [6]. It is generally measured in terms of decibels(db). Higher the PSNR value of the image, better is the quality of that image. PSNR of two images can be calculated as:

$$\text{PSNR}=10\log\frac{MAX^2}{MSE} \qquad (5)$$

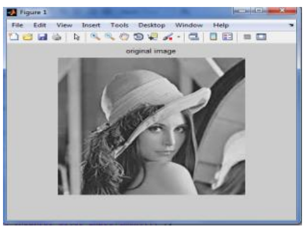
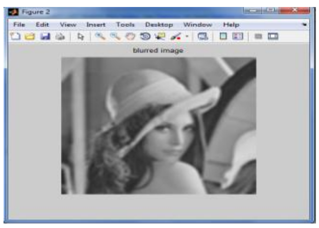
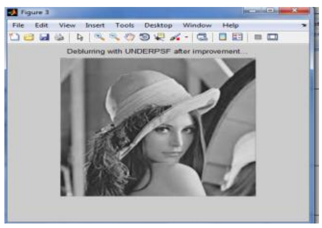
Where, MAX is 255 for 8 bit images. MSE is Mean Square Error

Mean Square Error (MSE) is calculated by averaging the squared intensity of the original image and the output image pixels [7]. It can be calculated as follows:

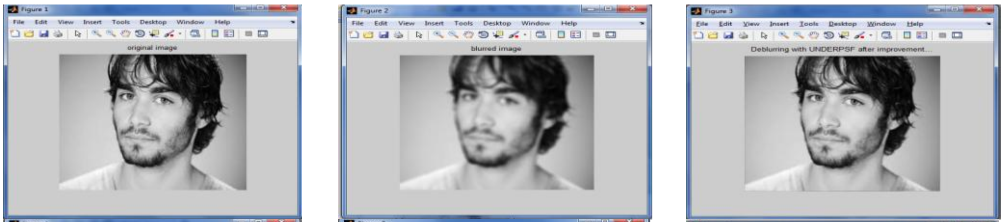
$$\text{MSE}=\frac{1}{MN}\sum_{i=0}^{M=1}\sum_{j=0}^{N-1}[X(i,j)-Y(i,j)]^2 \qquad (6)$$

IV. Experimental Results

4.1.Without Segmentation: Proposed technique is applied on Four Gray Images without segmentation having different image types. Following table shows original gray images, their corresponding degraded images and images obtained after applying Blind Deconvolution Technique:

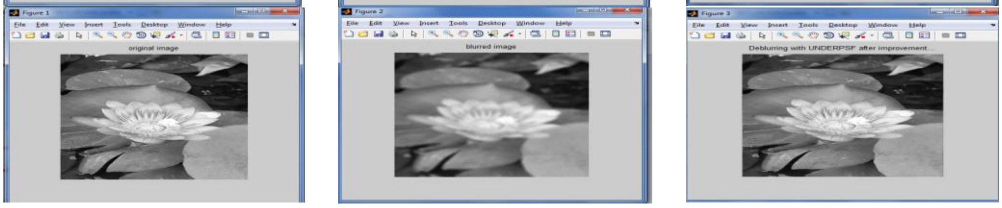
Image Name	Original Image	Degraded Image	Restored Image
Lenna.png (300*300)			

Man.jpg
(300*300)



Cameraman.png
(300*300)

Flower.jpg
(300*300)



PSNR values of images shown in Table(1) using proposed technique:

Table(2)

S.NO.	Name of the Image	Mean Square Error(MSE)	PSNR (With blurred image)	PSNR (With restored image)
1	Lenna.png	18.3528	32.2211	35.4938
2	Man.jpg	25.9320	32.7216	33.9924
3	Cameraman.png	36.7227	28.6653	32.4815
4	Flower.png	34.1088	30.7325	32.8021
5	Flower.jpg	34.1115	34.1115	32.8018

Comparison of Proposed Technique with Existing Method:

Table(3)

S.NO.	Name of the Image	Mean Square Error(MSE)	Peak Signal-to-Noise Ratio(PSNR)	Existing Method	
				MSE	PSNR
1	Cameraman.tif (256*256)	18.3308	35.4990	126.79	27.10
2	Lenna.png (256*256)	28.1503	33.6360	90.74	28.55
3	Cameraman.tiff (128*128)	34.6017	32.7398	167.50	25.89

Graphical Representation Of Comparison Between Proposed Technique And Existing Technique:

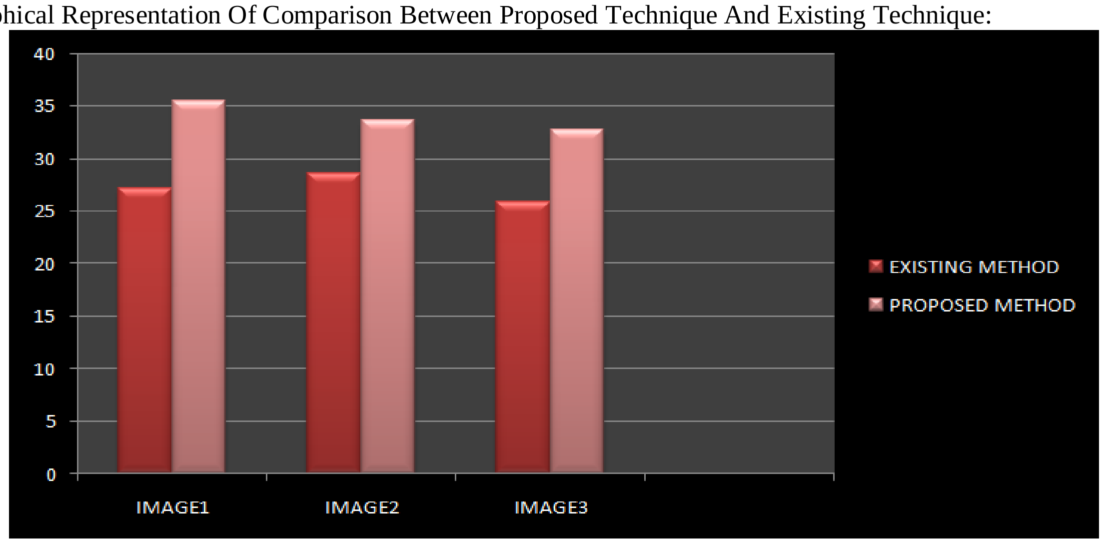


Fig (3): Comparison of PSNR VALUES of Table(3)

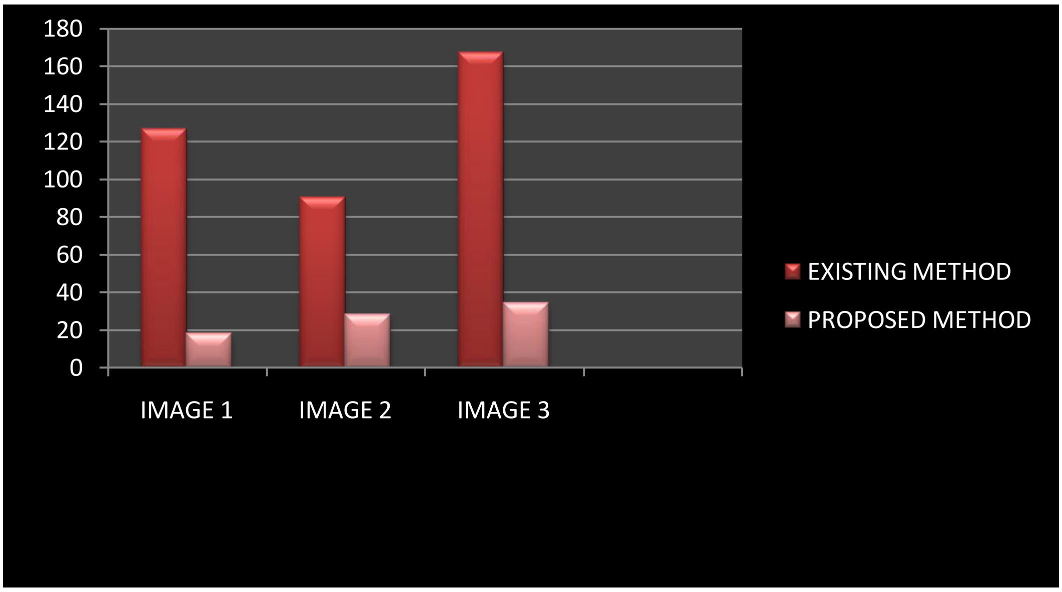
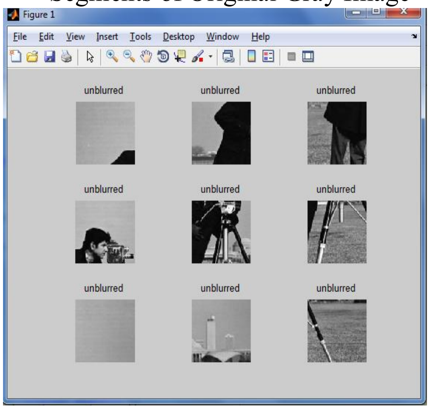


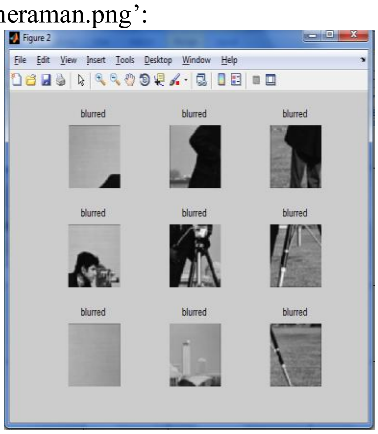
Fig (4): Comparison of MSE of Table(3)

4.2. With Segmentation: Proposed technique is applied on images ‘Cameraman.png‘ and ‘Lenna.jpg’. In this technique an image is divided into nine segments and then each segment is restored separately such that they have their own PSNR value. This method works well when we do not want to restore whole image. We are able to restore only selected portion of the image.

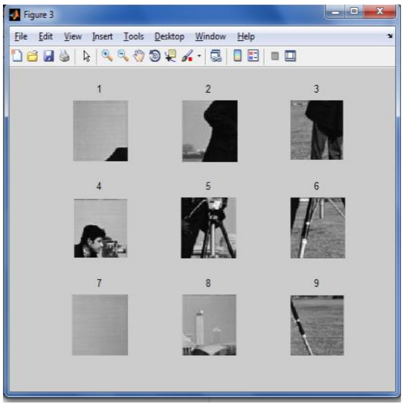
Segments of Original Gray Image ‘Cameraman.png’:



Fig(5): Original segments



Fig(6): Degraded Segments



Fig(7): Restored Segments

PSNR Values of above Segments are shown in Table(3):

Table(3)

Lenna.jpg Segment No.	Mean Square Error(MSE)	PSNR (With blurred image)	PSNR (With restored image)	Cameraman.png Segment No.	Mean Square Error(MSE)	PSNR (With blurred image)	PSNR (With restored image)
1	25.7804	32.3628	34.0179	1	49.6027	30.8297	31.1758
2	32.4765	30.6622	33.0151	2	58.0593	31.6346	30.4921
3	50.2705	28.9009	31.1177	3	56.1695	29.9950	30.6358
4	23.2537	34.1951	34.4659	4	103.0218	27.0308	28.0015
5	46.2948	29.8002	31.4755	5	154.0187	24.7001	26.2551
6	62.2781	31.7089	30.1874	6	112.8070	25.0590	27.6074
7	41.5499	30.9628	31.9451	7	32.0412	31.9243	33.0737
8	36.6626	30.8285	32.4886	8	19.9708	32.5940	35.1269
9	61.8306	30.9862	30.2188	9	72.2476	28.0401	29.5426

V. Conclusion

In this proposed technique we have applied Blind Deconvolution Algorithm on multiple images of different sizes having different format such as .jpg, .png, .tiff. Proposed Technique is compared with the existing method and provides better results in terms of PSNR and MSE. Proposed technique reduces complexity of the system than the existing method because this technique does not use any Edge Detection Method like Canny Edge Detection, Sobel, Prewitt etc. to improve the quality of the image as compared to existing method. This Technique is also applied on multiple segments of a single image and provides good results. But this Technique has some limitations. It does not work for all type of Gaussian Blur added into the image.

VI. Future Work

Many other techniques of image processing can also be applied with Blind Deconvolution Algorithm to provide improved results than the proposed technique. Methods can be developed that can work for all types of blur added into the image. Proposed Technique consists of only nine segments of a single image. It can also be applied on more than nine segments of images in future. Segments that are not restored properly can be further be improved.

References

[1]. Image Segmentation and Various Segmentation Techniques – A Review By Binamrata Baral, Sandeep Gonnade, Toran Verma.

[2]. Study of Region Base Segmentation Method By Ku. Vasundhara H. Lokhande Digital Electronics,Babasaheb Naik College of Engg. Saint Gadage Baba Amravati University, India

[3]. Digital Image Processing By Prof. P.K. Biswas. IIT, Kharagpur.

[4]. Removing Blurring From Degraded Image Using Blind Deconvolution with Canny Edge Detection Technique By Mr. A. S. Mane* Prof. Mrs. M. M. Pawar E&TC Department, Solapur Univesity.

[5]. MRF-based Blind Image Deconvolution By Nikos Komodakis1 and Nikos Paragios Ecole des Ponts ParisTech, nikos.komodakis@enpc.fr Ecole Centrale de Paris, nikos.paragios@ecp.fr

[6]. International Journal of Scientific & Engineering Research, Volume 3, Issue 8, August-2012 ISSN 2229-5518. Comparison of Image Quality Assessment: PSNR, HVS, SSIM, UIQI By Yusra A. Y. Al-Najjar, Dr. Der Chen Soong.

[7]. International Journal of Scientific & Engineering Research, Volume 3, Issue 8, August-2012 ISSN 2229-5518. Comparison of Image Quality Assessment: PSNR, HVS, SSIM, UIQI By Yusra A. Y. Al-Najjar, Dr. Der Chen Soong.