Amputation of Motion Blur From Photograph Using Iterative Approach in Frequency Domain

Ashish Jain [1], Prof. Delkeshwar Pandey [2]

[1] Department of Computer Science & Engineering, U.P. Tech. University, Lucknow, INDIA
[2] Department of Computer Science & Engineering, U.P. Tech. University, Lucknow, INDIA

ABSTRACT

In current years blur removing techniques in the presence of noise have become a great deal of attention in the field of image processing under image restoration [7], [1]. There are several approaches to image denoising, which include linear filters, nonlinear filters and Fourier / Wavelet transforms. Image denoising problem is equivalent to that of image restoration when blurs are not included in the noisy image .Image restoration is the process of recovering the original image from the degraded image and also understand the image without any artifacts errors. Image restoration methods can be considered as direct techniques when their results are produced in a simple one step fashion. Equivalently, indirect techniques can be considered as those in which restoration results are obtained after a number of iterations. Iterative techniques such as iterative Wiener Filtering [5], [3] can be considered as simple indirect restoration techniques. The problem with such methods is that they require knowledge of the blur function that is point -spread function (PSF) and estimation of power spectrum which is, usually not available when dealing with image blurring. In this paper Iterative approach in frequency domain using Blind deconvolution approach, for image restoration is discussed, which is the recovery of a sharp version of a blurred image.

Keywords: Blind Deconvolution, Degradation Model, Frequency Domain, Iterative Approach, Image Restoration, PSF

1. INTRODUCTION

Blurring is a form of bandwidth reduction of the image due to imperfect image formation process. It can be caused by relative motion between camera and original images. Normally, an image can be degraded using low-pass filters and its noise. This low-pass filter is used to blur/smooth the image using certain functions. In digital image there are 3 common types of Blur effects: Average Blur, Gaussian Blur and Motion Blur. Image deblurring can performed for better looking image, improved identification, PSF calibration, higher resolution and better quantitative Analysis.

1.1 Deblurring Model

A blurred or degraded image can be approximately described by this equation:

$$g = PSF*f + N,$$

Where: g the blurred image, h the distortion operator called Point Spread Function (PSF), f the original true image and N Additive noise, introduced during image acquisition, that corrupts the image[8].Image deblurring is an inverse problem which is used to recover an image which has suffered from linear degradation. The blurring degradation can be space-invariant or space-in variant [6]. Image deblurring methods can be divided into two classes: nonblind, in which the blurring operator is known and blind, in which the blurring operator is unknown.

1.2 Iterative Image Deblurring Techniques

i). Iterative Wiener Filter Deblurring Technique-The Wiener filter isolates lines in a noisy image by finding an optimal tradeoff between inverse filtering and noise smoothing. It removes the additive noise and inverts the blurring simultaneously so as to emphasize any lines which are hidden in the image. This filter operates in the Fourier domain [3], making the elimination of noise easier as the high and low frequencies are removed from the noise to leave a sharp image. The Wiener filter in Fourier domain can be expressed as follows:

$$W(f_1,f_2) = \frac{H^*(f_1,f_2)S_{xx}(f_1,f_2)}{|H(f_1,f_2)|^2 S_{xx}(f_1,f_2) + S_{\eta\eta}(f_1,f_2)},$$

Where $S_{xx}(f1,f2)$,$S_{nn}(f1,f2)$ are power spectra of original image and additive noise and $H(f1,f2)$ is blurring filter.

An iterative procedure for wiener filter in spatial domain is listed below:

0. Initialization: R_f (0) =Rg, where Rg is the the autocorrelation matrix of g1. Wiener filter construction: $B(i+1) = R_f(i)H^H[HR_f(i) H^H + Rn]^{-1}$
2. Restoration: $\tilde{f}(i+1) = B(i+1)g$
3. Update: $R_f(i+1) = E\{\tilde{f}(i+1)\, \tilde{f}(i+1)\}$

Steps 1 to 3 are repeated until the result converges.
The iterative Wiener filter in discrete Fourier domain is given as:

$$p_f(\mathrm{i}+1) = \frac{\mathrm{p_g p^2}_f(\mathrm{i})|\mathrm{ph}|^2}{[p_f(\mathrm{i})|\mathrm{ph}|^2 + \mathrm{p_n}]^2}$$

The problem with this method is that they require knowledge of the blur function that is point spread function (PSF) and estimation of power spectrum.

ii). Additive iterative algorithm-The questions are whether the estimate of the power spectral density converges, and whether it converges to the true value. It is easy to prove that p_f (i) is sure to converge to some value $\tilde{p}_f$, because p_f (i) as a sequence is both monotonic (The derivative of p_f (i+1) with respect to pf(i) is greater than 0 and bounded. $\tilde{p}_f$ can be derived as follows:

$$\tilde{p}f = \frac{1}{2}[\tilde{p}f - \frac{pn}{|ph|^2} \pm \sqrt{p^2f - \frac{3p^2n}{[p_h]^4}} - \frac{2p_n p_f}{[p_h]^2}$$

The problem is that $\tilde{p}_f$ does not converge to p_f unless p_n is 0. So a correction item is added in every iteration, and an additive iterative method was put forward. p^*_f is used as the update of original image instead of p_f. It can be derived that

$$p^*_f(\mathrm{i}+1) = p^*_f(\mathrm{i}) + \frac{|\mathrm{ph}|^2 {p^*_f}^2(\mathrm{i})[|\mathrm{ph}|^2 {p^*_f}^2(\mathrm{i}) - \mathrm{p_n}]}{[p^*_f(\mathrm{i})|\mathrm{ph}|^2 + \mathrm{p_n}]^2}$$

2. PROPOSED ALGORITHM (ERADICATOR) FOR AMPUTATION OF MOTION BLUR

The method proposed in this paper reduces the noise in the image restored by Iterative approach using the Blind deconvolution with different blur parameters like length and blur angle. Proposed algorithm is to reconstruct frequency components like edges which have been degraded by noise.

Results are evaluated and compared based on Evaluation Metrics Mean Square Error [MSE] and Signal-to-Noise Ratio [SNR]. Fig.1 shows a block diagram of our method.

2.1 Blind Deconvolution approach

Blind Deconvolution is a subset of Iterative Constrained algorithms which produce an estimate of *h(x)* concurrently with *f(x)* [2], [4]. It does not need the PSF h(x) to be measured. Other iterative constrained algorithms require h(x) to be measured by acquiring data from sub resolution fluorescent beads.

$$g(x) = f(x)*h(x)+n(x)$$

Where *g(x):* measurement, *f(x):* unknown object, *h(x):* unknown or poorly known PSF, *n(x):* contamination

2.2 Blurring Parameter

The parameters needed for blurring an image are PSF, Blur length, Blur angle and type of noise. Point Spread Function is a blurring function. When the intensity of the observed point image is spread over several pixels, this is known as PSF. Blur length is the number of pixels by which the image is degraded. It is number of pixel position is shifted from original position. Blur angle is an angle at which the image is degraded. Available types of noise are Gaussian noise, salt and pepper noise, Poisson noise, Speckle noise which is used for blurring. In this paper, we are using Gaussian noise which is also known as white noise. It requires mean and variance as parameters.

2.3 Architecture of image degradation and amputation of motion blur

Fig.1 illustrate that the original image is degraded or blurred using degradation model to produce the blurred image. The blurred image should be an input to the deblurring algorithm. Various algorithms are available for deblurring. In this paper, we are going to use blind deconvolution algorithm. The result of this algorithm produces the deblurring image which can be compared with our original image.

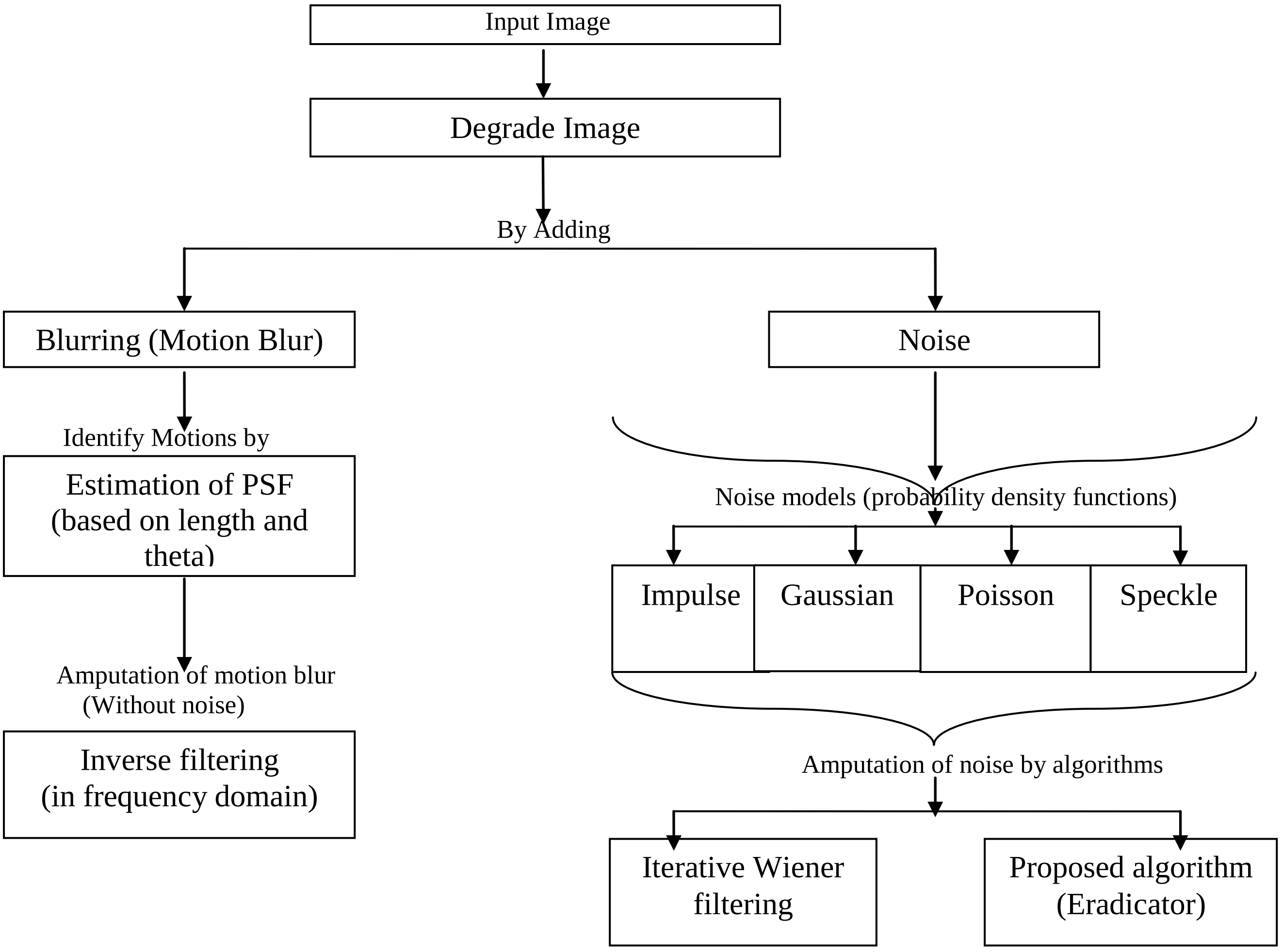

Fig.1 Block diagram of image degradation and amputation of motion blur with and without noise

3. PROPOSED ALGORITHM (ERADICATOR)

Proposed Algorithm (Eradicator) can be used effectively when no information of distortion is known; it restores image and PSF

Step 1: First assume that $\tilde{f}_o$ use a positive constant image with a constant value equal to average of the blurred image.

Step 2: This step of the iteration performs a convolution of the current assumption with the PSF:

$$\varphi_n = h \otimes f_n$$

Step 3: In this step compute a correction factor based on the result of the last operation and the original (degraded) image:

simultaneously. Instead of computing the desired (deblurred) image directly, our method computes a sequence of images, which converges to the desired image. Our algorithm is based on the following steps:

$$Øn = \tilde{h} \otimes \frac{g}{\varphi n}$$

Where "$\frac{g}{\varphi n}$" denotes pixel by pixel division. Assume, if some pixel values of $\varphi n = 0$, then we get $g/\varphi n = 0$.

Step 4: At the final step, a new assumption is the product of the current one and the correction factor :

$$\tilde{f}_{n+1} = \tilde{f}_n \,.\, Øn \;,$$

Where " **.** " is the pixel by pixel multiplication.

4. SAMPLE RESULTS

The below images Fig.2 represents the result of proposed algorithm. The sample image after applying the proposed algorithm will be as follows.

Blured image with Noise	Image after 20th iterations	Image after 40th iterations	Image after 60th iterations	Image after 80th iterations

Image after 100th iterations	Image after 120th iterations	Image after 140th iterations	Image after 160th iterations	Image after 180th iterations

Fig.2 Results of the proposed algorithm (Eradicator) for image deblur

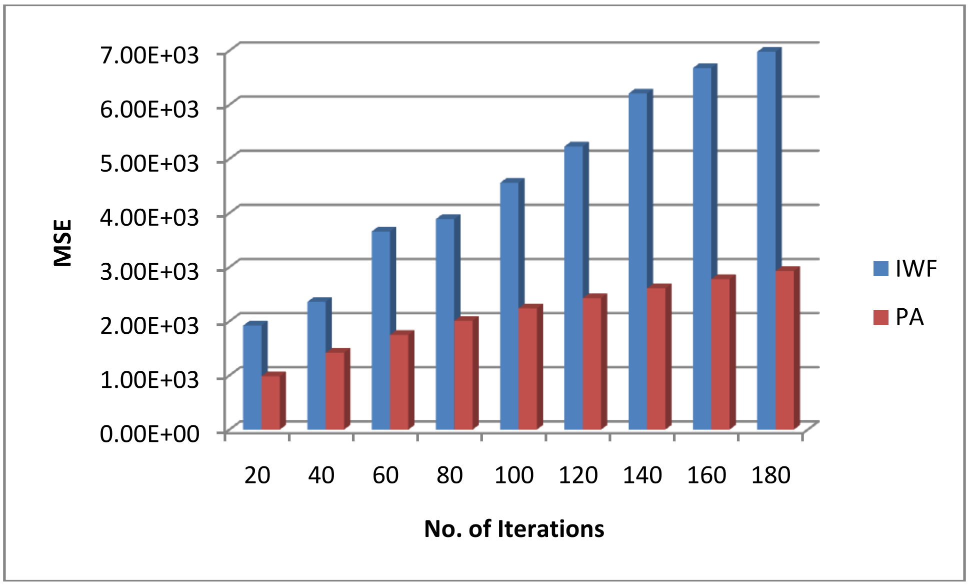

Fig.3 Graph of MSE for comparison of Iterative wiener filter (IWF) and proposed algorithm (PA)

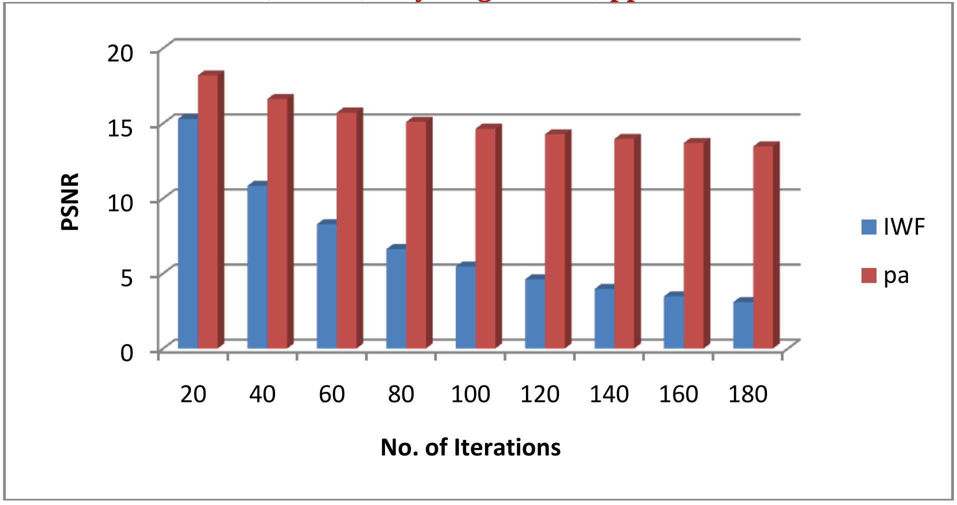

Fig.4 Graph of PSNR for comparison of Iterative wiener filter (IWF) and proposed algorithm (PA)

No. of Iterations	IWF	PA
20	1.92E+03	**986.6066**
40	2.36E+03	**1.42E+03**
60	3.66E+03	**1.75E+03**
80	3.89E+03	**2.01E+03**
100	4.56E+03	**2.24E+03**
120	5.23E+03	**2.43E+03**
140	6.21E+03	**2.61E+03**
160	6.68E+03	**2.78E+03**
180	6.98E+03	**2.93E+03**

Table 1: MSE Performance measure values for values for IWF and proposed algorithm

No. of Iterations	IWF	pa
20	15.2927	**18.1894**
40	1.08E+01	**16.6177**
60	8.28E+00	**15.7116**
80	6.62E+00	**15.0977**
100	5.45E+00	**14.6376**
120	4.60E+00	**14.2671**
140	3.97E+00	**13.958**
160	3.48E+00	**13.692**
180	3.09E+00	**13.4607**

Table 2: PSNR Performance measure valuesfor values for IWF and proposed algorithm

From Fig.3 and Fig.4 it can conclude that the proposed algorithm (pa) gives better results as compare to the iterative wiener filter (IWF). So for deblurring images proposed algorithm (pa) is used and the deblurred images obtained are shown in fig.2.Performance measure values obtained are shown in table 1 and table 2.

5. CONCLUSION

We have presented a method for Iterative blind image deblurring. The method differs from most other existing methods by only imposing weak restrictions on the blurring filter, being able to recover images which have suffered a wide range of degradations. Good estimates of both the image and the blurring operator are reached by initially considering the main image edges. The restoration quality of our method was visually and quantitatively better than those of the other algorithms. The advantage of our proposed algorithm (Eradicator) is used to deblur the degraded image without prior knowledge of PSF and estimation of power spectrum.

REFERENCES

[1] A. Khare and U. S. Tiwary, Symmetric Daubechies Complex Wavelet Transform and Its Application to Denoising and Deblurring, WSEASTrans.SignalProcessing, Issue5, Vol.2, pp.738-745, May2006.

[2] D. Kundur and D. Hatziankos, “Blind image deconvolution, “IEEE sig. process. Mag., pp. 43-64, May 1996.

[3] Furuya, Eda, and T. Shimamura “Image Restoration via Wiener Filtering in the Frequency Domain” wseas transactions on signal processing Issue 2, Volume 5, pp. 63-73 February 2009.

[4] Jain-feng cai, hui ji, Chaoqiang lie, Zuowei Shen., “blind Motion deblurring

using multiple images". Journal of Computation Physics. Pp. 5057-5071, 2009.

[5] Jing Liu, Yan Wu "Image Restoration using Iterative Wiener Filter", ECE533 Digital Image Processing Course project, December 13, 2003

[6] Michal Sorel and Jan Flusser, Senior Member, IEEE., Space-Variant Restoration of Images Degraded by Camera Motion Blur, IEEE Transaction on image processing, Vol 17, pp.105-116, No. 2 Febreary 2008.

[7] P. Bojarczak and S. Osowski, Denoising of Images - A Comparison of Different Filtering Approaches, WSEAS Trans. Computers, Issue 3, Vol.3,pp.738-743,July2004.

[8] Salem Saleh Al-amri et. al. "A Comparative Study for Deblured Average Blurred Images ", journal Vol. 02, No. 03, 2010, 731-733.

..