

# A Comparative Study for Deblurred Motion Blurred Images

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## Abstract-

*This paper attempts to undertake the study of Restored Motion Blurred Images by using three types of deblurring techniques: Wiener filter, Regularized filter and Lucy Richardson with an information of the Point Spread Function (PSF) corrupted blurred image with  $LEN=21$  and  $THETA = 11$ . The same is applied to the Cameraman image and they are compared with one another so as to choose the base technique for restored or deblurring image. This paper also attempts to undertake the study of PSNR values calculated for the restored images deblurred by above three techniques to justify their comparative results mathematically.*

**Keywords:** Point Spread Function, Blur Types, Deblurring Techniques.

## I. Introduction

Images are produced to record or display 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 undoing of these imperfections is crucial to many of the subsequent image processing tasks. There exists a wide range of different degradations that need to be taken into account, covering for instance noise, geometrical degradations (pin cushion distortion), illumination and color imperfections (under/over-exposure, saturation), and blur. The field of **image restoration** (sometimes referred to as image deblurring or image deconvolution) is concerned with the reconstruction or estimation of the uncorrupted image from a blurred and noisy one. Essentially, it tries to perform an operation on the image that is the inverse of the imperfections in the image formation system.

The recovery process or reconstructing process can be subdivided into two categories as:

1. Classical Restoration
2. Blind Image Restoration

Classical restoration includes the techniques that utilize some prior information regarding the degradation of image during reconstruction. In classical restoration, the blurring function is given and the degradation process is inverted using one of the many known restoration algorithms.

The **blind image** deconvolution (*BID*), refers to the task of separating two convolved signals,  $i$  and  $d$ , when both the signals are either unknown or partially known[2]. In blind image deconvolution, an observed image  $c(x,y)$ , is assumed to be the two dimensional convolution of the true image  $i(x,y)$  with a linear-shift invariant blur, known as **pointspread function (PSF)**  $d(x,y)$  and the additive noise is assumed to be zero[2]. That is,

$$c(x,y) = i(x,y) * d(x,y)$$

The problem of reconstructing the true image  $i(x,y)$  requires the deconvolution of the *PSF*,  $d(x,y)$  from the degraded image,  $i(x,y)$ . A lot of research has been done exploring the various methods for image deconvolution as blind techniques but still, is a critical and challenging problem for the researchers.

The blind deconvolution of images is done by following either of the two approaches:

1. The degradation function, *PSF*, is identified and then using any classical restoration technique[1] such as inverse filtering, wiener filtering, and pseudoinverse filtering the true image is identified. This method is simple and less computation is required. The algorithms in this approach are known as a **priori blur** identification technique.
2. The identification of the *PSF* and the **true image** is done simultaneously in the restoration algorithm. Hence the algorithms in this approach are complex.

The most important technique for removal of blur in images due to linear motion or unfocussed optics blur is the Wiener filter. Wiener filters are far and away the most common deblurring technique used because they mathematically return the best results.

## II. Blurring

Blurring is a form of bandwidth reduction of an ideal image owing to the imperfect image formation process. It can be caused by relative motion between the camera and the original scene, or by an optical system that is out of focus. When aerial photographs are produced for remote sensing purposes, blurs are introduced by atmospheric turbulence, aberrations in the optical system, and relative motion between the camera and the ground. Such blurring is not confined to optical images, for example electron micrographs are corrupted by spherical aberrations of the electron lenses, and CT scans

suffer from X-ray scatter. The blur could be due to a one-dimensional or a two-dimensional point spread function (PSF) and also depends on the density of pixels.

#### Blurring Types

In digital image there are 3 common types of Blur effects:

##### A. Motion Blur

The motion blur occurs if any of the following condition persists:

1. Moving Object captured by static camera,
2. Static Object captured by camera in motion[4],
3. Both Object and camera are in motion,
4. Shutter movement, film is exposed in a camera by the movement of the shutter across the film plane.

The two types of motion blur are:

- 1) **Linear-Horizontal Motion Blur:** Let  $L$  be the blur length. More precisely,  $L$  is the number of additional points in the image resulting from a single point in the original scene. The motion blur arising either to camera moving or the object moving horizontally is given as:

$$d(x) = \begin{cases} \frac{1}{L} & \text{if } -\frac{L}{2} \leq x \leq \frac{L}{2} \\ 0 & \text{otherwise} \end{cases}$$

- 2) **Angular Motion Blur:** When the scene to be recorded translates at a constant velocity,  $V$ , with an angle of  $\theta$  degrees from the horizontal axis during the exposure interval,  $[0 T]$ , then the *PSF* observed is given as:

$$d(x, y) = \begin{cases} \frac{1}{L} & \text{if } 0 \leq |x| \leq L \cos \theta, y = L \sin \theta \\ 0 & \text{otherwise} \end{cases}$$

There are several techniques for preventing motion blur either during image capture or by using any *post processing* techniques. The motion blur can be solved by adopting any of the following measure:-

- Using hardware in the optical system of the camera to stabilise the motion.
- Post-processing technique by estimating the camera's motion from single image (blind deconvolution).

##### B. Gaussian Blur

The Gaussian Blur effect is a filter that blends a specific number of pixels incrementally, following a bell-shaped curve. The blurring is dense in the center and feathers at the edge. It is mostly applied to an image when more control over the Blur effect is needed.

##### C. Average Blur

The Average blur is one of several tools that can be used to remove noise and specks in an image. It is preferred when noise is present over the entire image. This type of blurring can be distributed in horizontal and vertical direction and can be circular averaging by radius  $R$  which is evaluated by the formula:

$$R = \sqrt{g^2 + f^2}$$

where,  $g$  is the horizontal size blurring direction and  $f$  is vertical blurring size direction and  $R$  is the radius size of the circular average blurring.

### III. Deblurring

This paper applies three deblurring techniques:

#### A. Wiener Filter Deblurring Technique

Norbert Wiener proposed optimal filter in a least-squares sense. Wiener filters[6] are often applied in the frequency domain. These filters are comparatively slow to apply, since they require working in the frequency domain. To speed up filtering, one can take the inverse FFT of the Wiener filter to obtain an impulse response. This impulse response can be truncated spatially to produce a convolution mask. The spatially truncated Wiener filter is inferior to the frequency domain version, but may be much faster.

#### B. Regularized Filter Deblurring Technique

Regularized filter deblurs an Image by using deconvolution function deconverge.

#### C. Lucy-Richardson Algorithm Technique

This algorithm[3,5] was introduced by W.H. Richardson (1972) and L.B. Lucy (1974). This is a Bayesian Based Iterative Method of image restoration. The R-L algorithm is the technique most widely used for restoring HST (Hubble Space Telescope) images. The standard R-L method has a number of characteristics that make it well-suited to HST data:

- The R-L iteration converges to the maximum likelihood solution for Poisson statistics in the data (Shepp and Vardi 1982), which is appropriate for optical data with noise from counting statistics.

- The R-L method forces the restored image to be non-negative and conserves flux both globally and locally at each iteration.
- The restored images are robust against small errors in the point-spread function (PSF).
- Typical R-L restorations require a manageable amount of computer time.

#### IV. Result And Experimental Details

The experimentation detailed in this section was carried out with in the MATLAB interactive environment for image processing. This software offers language, tools and built-in math functions that enable us to explore multiple approaches and reach a solution faster.

In this paper, the performance of three filtering techniques - Lucy Richardson, Regularized filter and Weiner filter is evaluated by using the cameraman image. In the first step, the original image was motion blurred by creating a PSF, corresponding to the linear motion across 21 pixels at an angle of 11 degrees. After this, the blurred image was restored by using the filtering techniques. The PSNR value for the blurred image is 17.59 dB.

The original image that has been considered for the experimentation purpose is depicted in figure 1 below:



Figure 1 Original Image

The image blurred by motion blur is shown in figure 2 below:



Figure 2 Image blurred by motion blur

Figures 3, 4 and 5 represent the restored image by Lucy- Richardson algorithm, Regularized filter and Weiner filter respectively.



Figure 3 Image restore by Lucy- Richardson



Figure 4 Image restore by Regularized Filter



Figure 5 Image restore by Weiner Filter

The performance of the three filtering techniques in terms of PSNR values (dB) is shown in table I:

Table I PSNR Values corresponding to different techniques

Filtering Techniques	PSNR Values (dB)
Lucy- Richardson	19.83
Regularized Filter	27.28
Weiner Filter	50.93

#### V. Conclusion

The above experimental results that is snapshots and PSNR values indicates that Weiner filter technique is the best to restore motion blurred image with an information of PSF corrupted blurred image with LEN=21 and THETA=11.

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