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# A Study on Digital Image Restoration Filters

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## ABSTRACT

In this paper, at first a color image is taken Then the image is transformed into a grayscale image. After that, the motion blurring effect is applied to that image according to the image degradation model described in equation 3.the blurring effect can be controlled by a and b components of the model. Then random noise is added in the image via MATLAB programming. Many methods can restore the noisy and motion blurred image: particularly in this paper inverse filtering as well as wiener filtering are implemented for the restoration purpose consequently, both motion blurred and noisy motion blurred image are restored via inverse filtering as well as wiener filtering techniques and the comparison is made among them.

**Keywords :** Color Image, Grayscale Image, Motion Blurring, Random Noise, Inverse Filtering, Wiener Filtering, Restoration of an Image.

## I. INTRODUCTION

In digital image processing, there are a variety of essential steps involved such as image segmentation, image restoration and reconstruction of image etc. Among them, image restoration plays a vital role today's world. It has several fields of applications in the areas of astronomy, long distance surveillance imagery, remote sensing, microcopy, medical imaging satellite imaging, and molecular spectroscopy. low enforcement and digital medical restoration etc, in the process of image restoration there is a lot of interference with noise in the environment such as Gaussian noise, impulse noise, multiplicative noise etc, inclusive of camera disturbances like wide angle lens, wind speed and degradation, temperature, humidity, elevation, blurring is use's such as uniform blur, motion blur, atmospheric blur and Gaussian blur etc., there are various methods of image restoration in the domain of image processing, for an instance, median filter, wiener filtering, inverse filtering, harmonic mean filter arithmetic mean filter, max filter and maximum likelihood(ML) method etc. among these restoration methods, wiener and inverse filtering method is the simplest and advantageous method for overcoming the current restoration challenges mentioned above.

## INVERSE FILTERING

The inverse filtering is a restoration technique for De-convolution, i.e, when the image is blurred by a known low pass filter it is possible to recover the image by inverse filtering or generalized inverse filtering

## WIENER FILTERING

The wiener filtering executes an optimal trade of between inverse filtering and noise smoothing. It removes additive noise and inverts the blurring

It is optimal in terms of the mean square Error In other words, it minimizes the overall mean square error in the process of inverse filtering and noise smoothing. It is a linear estimation of the original image.

The median filter is complex to execute as well as its very time consuming, Maximum filter cannot find the black or dark colored pixel of an Image. When there is a need of sharp edges in the output, the arithmetic mean filter cannot provide the sharp edge rather it blurs the edges.ML method is noise sensitive as the reversal of the imaging equation. Moreover, for pepper noise harmonic mean filter does not work well. After all this drawback of image restoration process mentioned above, wiener and inverse filtering method are prominent and beneficial.

The mean square error between the uncorrupted image is minimized by using the wiener filter also it is not a noise sensitive. Inverse filtering is the prominent and simplest method to restore the image in the existence of noise and blur. In parallel, both wiener and inverse filtering are used to retrieve the noisy and motion blurred images.

## II. FUNDAMENTALS OF IMAGE RESTORATION

Image restoration is a restoring or recovering process of a degraded image by utilizing some prior knowledge of degradation method which has degraded the image. So the image restoration process involves the estimation of the deteriorated model as well as the relevance of the inverse filtering to restore or retrieve the original image. Although the reconstructed image may not be exact form of the original image, It will be the approximation of the original image. Fig(1) below shows a fundamental model of image degradation and restoration procedure.

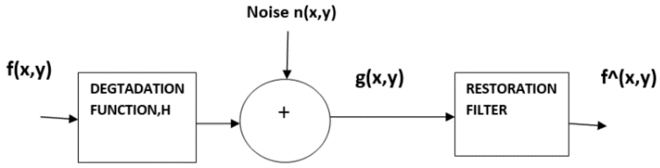



**Fig 1.** The fundamental outline of image degradation and restoration procedure

In spatial domain, The degradation of the original image can be modeled as

$$g(x,y)=h(x,y)*f(x,y)+n(x,y) \quad \ldots(1)$$

Where
(x,y)= Detached pixel coordinates of the image frame
f(x,y)=original image
g(x,y)=degraded image
h(x,y)= image degradation function
n(x,y)= Ad-on noise

As convolution operation within the spatial domain corresponds to multiplication in the frequency domain, The equation can be rewritten as

$$g(u,v)=H(u,v)*F(u,v)+N(u,v) \quad \ldots\ldots\ldots(2)$$

Now, motion blur is present when there exists comparative motion in the midst of the recording device and the scene(object) let's pretend the scene to be recorded interprets comparative to the camera at constant velocities a and b along the directions of x and y during the exposure time T. the frequency domain degradation function as

$$H(u,v) = \frac{\sin(\pi(ua+vb)T)}{\pi(uia+vb)} e^{-j\pi(ua+vb)T} \quad \ldots\ldots\ldots(3)$$

However the types of blur may be in the appearance of a translation, rotation and scaling or some combinations of these. Here only the critical case of a global translation will be considered Image restoration process can be subdivided into two classes

1. Deterministic methods are applicable to images with a small amount of noise and familiar degradation function.
2. Stochastic techniques are to restore images according to some stochastic criterion

### A. FILTERING THE BASICS OF INVERSE

**INVERSE FILTERING** :- If we know the degradation function H(u,v) the simplest approach to restore degradation image is direct inverse filtering. The recovery image can be estimated in frequency domain

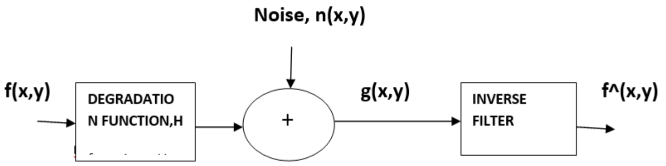



Fig 2. Image restoration model(Inverse filtering)

$$f\^{}(u,v) = \frac{G(u,v)}{H(u,v)} \quad \text{..........(4)}$$

However, the equation does not consider the situation of additive noise

Otherwise, the formula will be

$$F^{\wedge} = F(u,v) + \frac{N(u,v)}{H(u,v)} \quad \text{..........(5)}$$

Where, however, the N(u,v) is usually unknown some times because of the fraction, we have to face the problem that the degradation function as zero or very small values. One way to solve the problem is to limit the filter frequency to values near the origin which is usually non zero. Thus the probability of encountering zero values will be reduced in this experiment we will center the Fourier transform of original image, as well as the degradation function.

### B. THE BASICS OF WIENER FILTERING

The basic image restoration modal for wiener filter is modeled in figure (3)

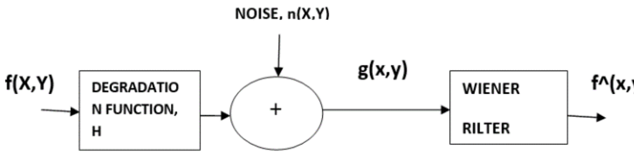



**Fig 3.** Image restoration model (Wiener filtering)

Wiener Filtering, also called minimum mean square error filtering [1-2] is founded on considering images and noise as random variables. The objection function between original clear image f and degraded image and def˜ is

$e^2 = E\{(f - f^{\wedge})^2\}$ or MSE=E[{f(x,y)-$f^{\wedge}$(x,y) }^2 ]

Where e^2= Mean square error

E[ . ]= The expectation operation

f^(x,y)=Restored image

The wiener filter is to locate an approximation $\mu$(x,y)of the original image f(x,y) so as to the mean square error between them is minimized. Wiener filter is represented as

$$L(u,v) = \frac{H^*(u,v)s_f(u,v)}{|H(u,v)|^2 S_f(u,v) + S_n(u,v)}$$

$$= \frac{H(U,V)}{|H(U,V)|^2 + \frac{S_n(u,v)}{S_f(u,v)}} \quad \text{..........(7)}$$

Again

$$L(u,v) = \frac{H^*(u,v)S_f(u,v)}{|H(u,v)|^2 S_f(u,v) + S_n(u,v)}$$

L(u,v)

$$= \frac{1}{H(u,v)} \frac{|H(u,v)|^2}{|H(u,v)|^2 + K} \quad \text{..........(8)}$$

where

$$k = \frac{S_n(u,v)}{S_f(u,v)}$$

$S_f$(u,v)= Power spectrum of the original image

$S_n$(u,v)= Noise power spectrum

Here, k is the inverse of SNR. The image and noise are considered as orbitrary processes. The Wiener filter can Generated optimal estimate only if such stochastic processes are stationary Gaussian. These situations are not typically satisfied for real images. So the restored image can be expressed as

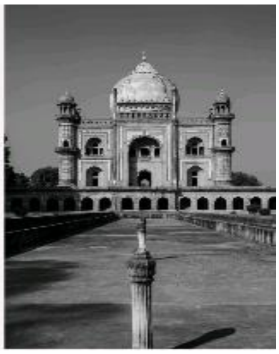
f^(u,v)=L(u,v)G(u,v) ……….(9)

## III. RESULTS

The following work is on executed MATLAB software 2016b version and the images are of size 512 X 512 downloaded from internet

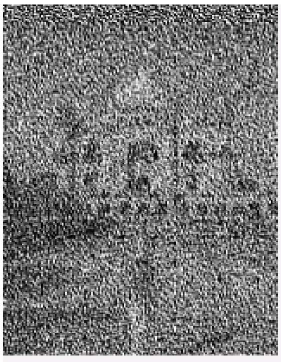
IMAGE A:

ORIGINAL IMAGE

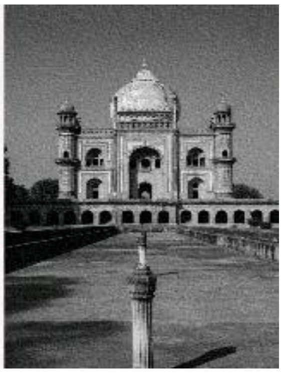


GRAY IMAGE

NOISY



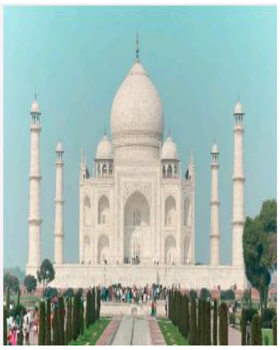
MOTION BLUR IMAGE



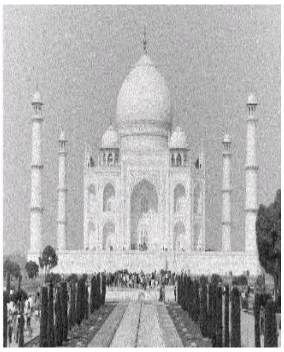
INVERSE FILTERED IMAGE

WIENER FILTERED IMAGE

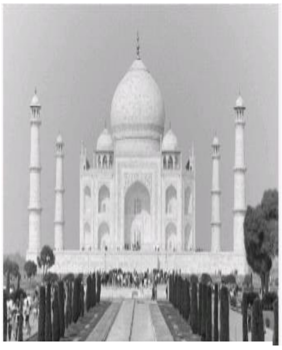
IMAGE B:



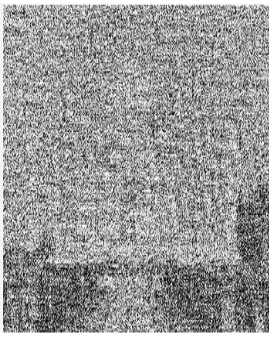
ORIGINAL IMAGE



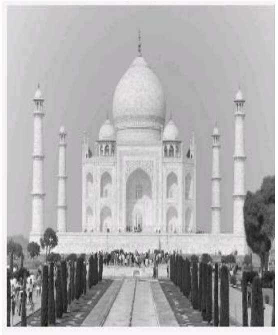
GRAY IMAGE



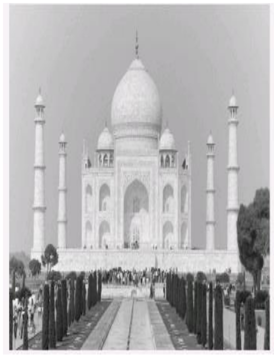
NOISY IMAGE



MOTION BLUR IMAGE



INVERSE FILTERED IMAGE

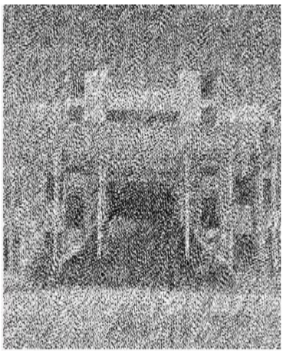


WIENER FILTERED

ORIGINAL IMAGE

GRAY IMAGE

NOISY IMAGE



MOTION BLUR IMAGE

INVERSE FILTERED IMAGE

WIENER FILTERED IMAGE

## IV. CONCLUSION

However, inverse filtering is very sensitive to additive noise, In this paper we present Inverse and wiener filtering practical implementations on different image for image restoration. The approach of reducing one degradation at a time allows us to develop a restoration algorithm for each type of degradation and simply combine them. The wiener filter works better for restoration purpose compared to inverse filtering in case of additive noise

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