A Survey on Image Restoration Techniques

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ABSTRACT: ***During acquisition of images in image analysis various factors occurs which causes degradation of images. To restore the information present in the images certain image restoration techniques are available in research areas. The method of restoring the degraded images is known as image restoration process. The visibility of the images is improved by the use of restoration techniques which is achieved by the removal of added noise and degraded function from the original image. Inverse convolution of the degraded image with that of the restoration method is done to remove the noise and blurs existing in the original image. Various methods are available today for the restoration of the images like wiener filters, inverse filters, and constraint least square filter and blind restoration method. The methods of restoration are either linear or non linear depending on the type of images and the noise present in the original images.***

KEYWORDS: ***Filters, Image Restoration, Image Analysis.***

INTRODUCTION

Images in today's technology plays a significant role in application of all the fields of technology. The image quality must be such that the information can be easily extracted and accessed from the original image. But due to certain reasons the images are degraded in quality while the acquisition of images is performed and thus the degraded images needed to be restored in order to achieve the original image in a better form. There are many reasons for degradation of the images like noise, blurs or motion during acquiring the images by certain tools. Image restoration is a significant task in fields of image analysis as all the further processing of the images depend on the result of the restoration techniques applied on the degraded images. Appearance and visibility of the images are significantly improved with the application of restoration techniques on the images. Reconstructing the original image after degradation depends on two models known as degradation model and the restoration models[1]. The degradation of the images occur while acquiring the images or transferring the images from one place to another The image shown in Figure 1 depicts the clear image retrieved from the degraded original image.

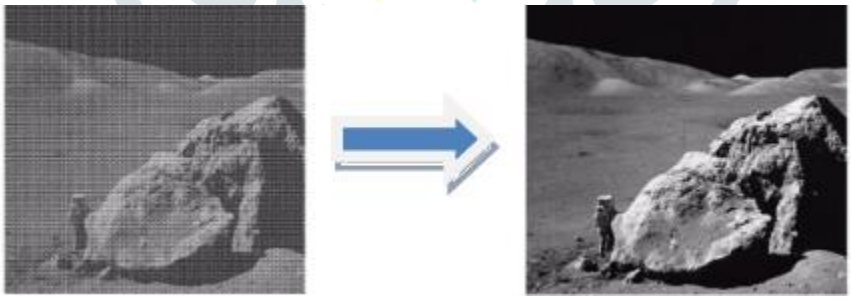

Figure 1: Restored Image

The original image f(x,y) degraded by Point Spread Function[2] is restored with the addition of noises n(x, y) & convoluting the renovation functions. The restored image f(x, y) is obtained and the output is signified as g(x,y) where h(x, y) is distortion.

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

The reconstruction of the degraded images includes two models[3] as shown in Figure 2.

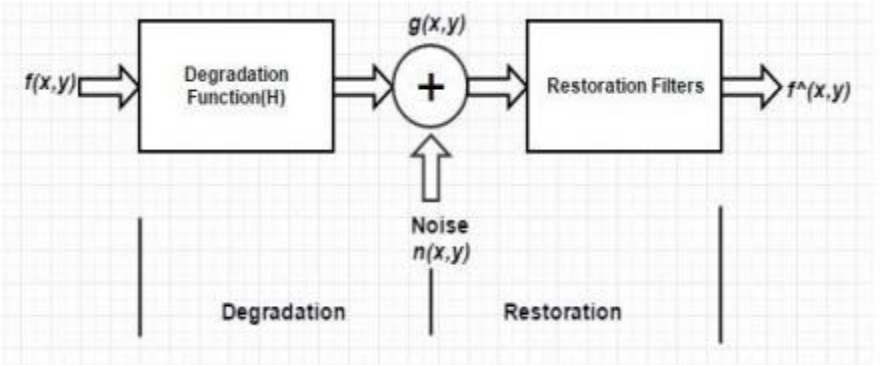

Figure 2: Degradation and Restoration Models

Degradation in form of distortion of the images occurs while the images are captured in motion in the recorded images mainly due to the wrong imaging systems. The degradation of the images increases due to the presence of additional noise to the images. The degradation model as depicted in figure 1 shows the degradation of the original image by blurring the image and adding a noise function to the original image. The restoration model as shown reconstructs the original image back from the degraded image by removing the blur and the noise present in the image.

NOISE MODELS

1. *Gaussian Noises:*

Ordinary noise is a form of noise that has a variable amplitude spread over period and usually occurs. The Figure 3 shows Gaussian noise[4] plot.

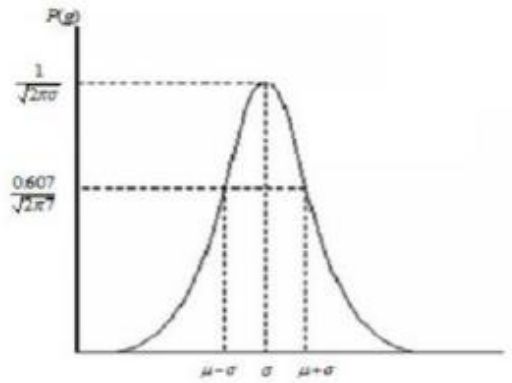

Figure 3: Gaussian Noise

2. *Uniform Noise:*

Uniform Noise as shown in Figure 4 is also known as quantized noise[5] because the pixel of the image are quantized to a quantity of distinct values.

$$p(z) = \begin{cases} \frac{1}{b-a} & if\ a \le z \le b \\ 0 & otherwise \end{cases}$$

Mean and variance of uniform noise can be calculated as:

$$z = a + b/2,$$

$$\sigma^2 = \frac{(b-a)^2}{2}$$

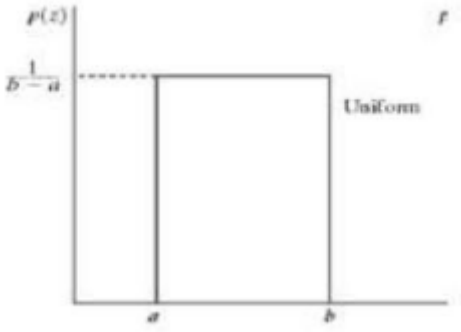

Figure 4: Uniform Noise

3. *Impulse Noise:*

$$p(z) = \begin{cases} Pa, & if\ z = a, \\ Pb & if\ z = b, \\ 0 & otherwise \end{cases}$$

Where strength of 'b' is dot of white color represents salt, where a<b in image and strength of 'a' is dot of black color represents pepper where b<a in image. Thus the impulse noise as shown in Figure 5 is also known as pepper noise and salt [6].

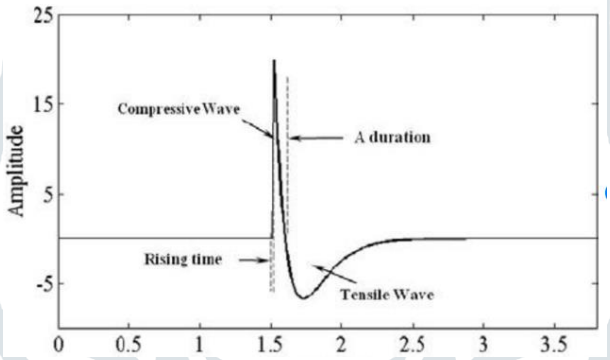

Figure 5: Impulse Noise

RESTORATION TECHNIQUE

For noise reduction, there are a variety of restoration methods and also a spatial domain filter. The methodology works exclusively on the image pixels in spatial domain techniques. Only additional noise is removed using spatial domain models. While blur can often seriously affect picture quality, it can also inadvertently degrade picture quality. The increase in the accuracy of the reconstructed image and over distorted image is calculated by the signal-to-noise ratio of image reconstruction. To restore the damaged image to its original state, contrast enhancement methods are used. Figure 6 illustrates how restoration strategies are divided into two categories: blinded restoration strategies and non-blind restoration strategies. Linear restoration approaches and nonlinear reconstruction approaches are two types of non-blind reconstruction methods[7].

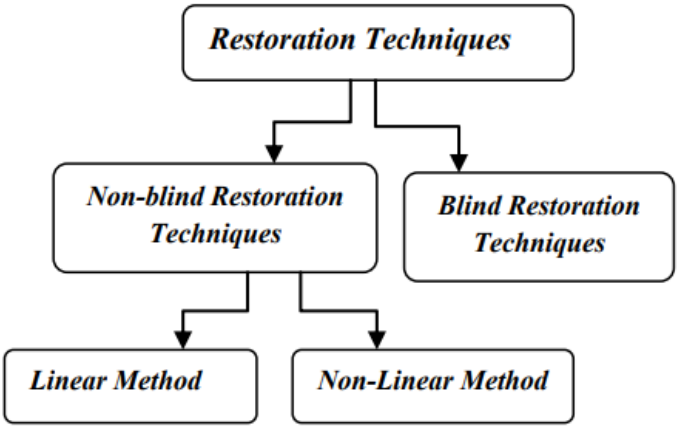

Figure 6: Restoration Technique

1. *Direct Inverse Filtering:*

The removal of blur from the degraded images is the fastest and easiest means to recover the original image back from the degraded image. In the technique of inverse filters[8] the low pass filters are considered as blurring function of the images which can be removed by using high pass filters to reconstruct the original image back from the blurred version as shown.

$$f(n_1, n_2) = g(n_1, n_2) * *h(n_1, n_2)$$

2. *Weiner Filter:*

The Weiner filter[9] is the method which has both the degradation and restoration function applied to the noise. It is one of the best techniques applied for deblurring of the images being a linear method of restoration techniques. It uses high pass filters for inverse convolution along with the low pass filters to remove the noise factor from the images.

$$f = g \times (f + n)$$

The above equation yields the output image, where additional noise and frequencies coefficients are established. A distorted picture contaminated by additive noise is fed into a wiener filter.

3. *Constraint least square filters:*

This filtering technique is applied when limitations like smooth-ness are to be implimented on the improved images and minimum additive noise is present. The blurry and noisy images are reestablished by constraint least square method and give a similar output as that of Weiner filter. The filter is a discrete laplacian approach and is expressed in a form of vector matrix of the degradation model as:

$$g = Hf + n$$

Where f is M*N vector.

4. *Blind Restoration:*

To overcome the problems faced with the restoration techniques using filters and to be applied on the complex images another form of restoration method is available known as blind restoration. Blind restoration[10] follows the inverse convolution approach for restoring the main information from the set of blurred or noise filled images. The point spread function or PSF is calculated for such images and performing the inverse convolution on the same. The blind restoration is as shown in Figure 7.

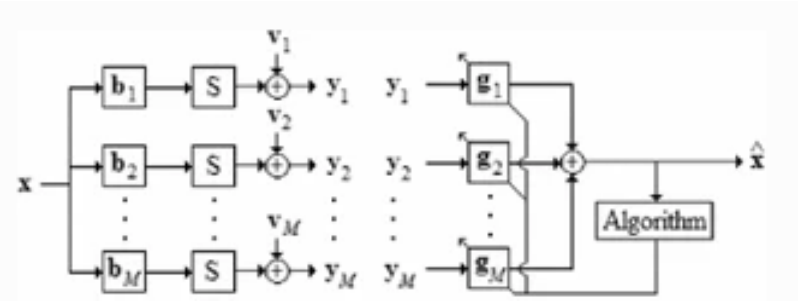

Figure 7: Blind Restoration

CONCLUSION

Images taken by digital tools like camera or phone may get degraded due to certain issues and degrade the quality of the images causing hindrance in further processing of the images. Restoration techniques are used to restore the degraded images back to the original form with better visibility. The methods of restoration improve the quality of the images by removing constraints like noise or blurs from the images. The paper discusses about the noise model that may be present in the images causing the degradation of the images. The paper discusses about the restoration techniques like Weiner filter, constraint least square filter, direct inverse filters and other restoration technique like blind restoration. The restoration techniques discussed in the paper gives the output in form of restored images by removing with blur or noise or both the constraints present in the degraded image. The blind restoration technique is the most useful technique as it overcomes the problems of blur and noise present in the original image easily and gives a better image as output.

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