



ANALYSIS OF IMAGE RESTORATION TECHNIQUES

Miss Ankita Sonwani¹, Mr. Yogesh Kumar Rathore²

¹M.Tech. Scholar, CSE Department, RITEE, Raipur

²Asst. Professor, CSE Department, RITEE, Raipur

¹ankita.sonwani1990@gmail.com

Abstract: In high level image processing, Restoration of image plays a key role. It deals with recovering of an original and sharp image using a deterioration and restoration strategy. During image acquisition process degradation occurs as a result of noise, blur etc. Image restoration is applied to acquire the initial image from the degraded data. Aim of this analysis paper is to provide a brief summary of some helpful restoration models. Different types of image restoration techniques like Wiener filter, inverse filter, mean filter, adaptive histogram equalization approach, regular filter, Lucy Richardson formula, neural network approach are described.

Keywords: Image Restoration, Noise, Blur, Degraded Image, Filters

I. INTRODUCTION

An image really worth hundreds of phrases and atmospheric-turbulence impacts the image high-quality so it is essential to restore that degraded pix. Typically, foremost causes of degradation are a blur, noise, and movement. Recovery of the picture is a completely big project in the discipline of picture processing. To repair the photograph there must have expertise of decay. Restoration technique improves the advent of the picture. Reconstruction of the image may be accomplished the usage of 2 forms of model

- (i) Degradation Model
- (ii) Restoration Model.

Image restoration is totally different from Image enhancement as Restoration is a lot of Objective and enhancement is Subjective. Image enhancement couldn't exactly represent by function whereas Image restoration is said to be the feature extraction from the imperfect image. Enhancement is manipulated in the degraded image, will increase the contrast of the image and visual look will be improved.

1.1 Occurrence of Degradation

There are many ways to degrade an image like device noise, camera-misfocus, relative object-camera motion, random part turbulence. Random variation of brightness or color data within the image is named noise it will be made by device and electronic equipment of a scanner or digital camera[7]. whereas object moves to the camera or the other way around, motion blur will be caused [8]. whereas the article is out of focus of the camera throughout exposure, the article region within the image is additionally blurred. This type of blur is named defocus blur imaging system is suffering from part turbulence by virtue of wave propagation through a medium with non uniform index of refraction.

The situation during which degradation happens is image acquisition and transmission of the image. Kinds of distortions are space variant and space invariant. Wherever all pixels are suffered from constant distortion it is said as space variant degradation and the distortion suffered by pixels within the image are known as space invariant.

Space invariant occurred as a result of camera motion or global lack of focus. Space-variant distortion is complicated because it depends on their location with compare to area invariant.

1.2 Image Restoration Techniques

Here we discuss various restoration techniques as well as spatial domain filters used for noise removal.

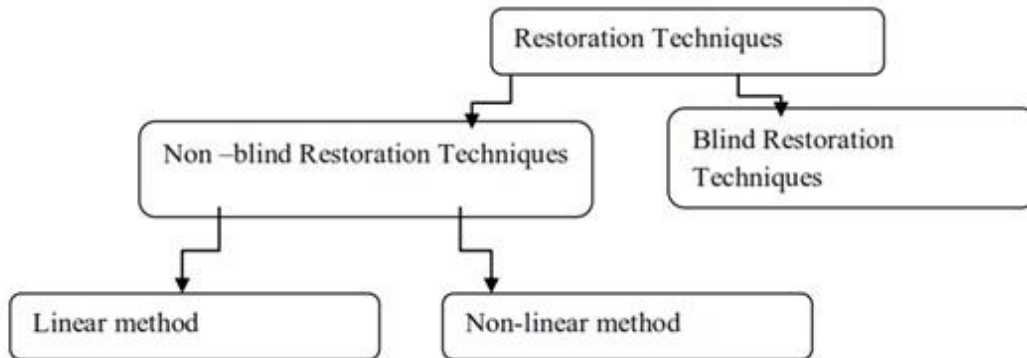


Figure 1. Restoration techniques

Non-blind restoration techniques are further divided into linear and non-linear restoration methods. Linear restoration method includes Wiener filter, inverse filter, and constrained least square filter where as non-linear type of restoration method includes Lucy-Richardson algorithm [1].

1.2.1. Direct Inverse Filtering

The blurring function of an image that is corrupted, is either known or it is developed that proves a quickest and simplest way to restore distorted image. Blurring is said to be low pass filtering during this approach and it uses a high pass filtering action to recover this blurred image without a lot of effort.

1.2.2. Wiener Filter

This technique projected by N.Weiner is a restoration technique which includes both the degradation operate and statistical characteristic of noise into the restoration operate. It has an effective de-blurring approach by which image is reconstructed from degraded one, by using better-known PSF. It works with every high and low pass filter to perform de-convolution to require away noise with compression operation.

$$f = g \times (f + n) \dots\dots\dots(1)$$

The output image is obtained by higher than equation (2) where additive noise and frequency characteristics are known [2].

1.2.3. Lucy – Richardson formula Technique

The Lucy-Richardson de-convolution formula has been popularly utilized in medical imaging and within the field of physical science. It's a non-linear repetitive methodology, here the number of iterations is manually determined for every image as per PSF size. It's used for recovering a picture that has been blurred by well-known PSF. PSF(Point spread function) is that the extent to which an optical supply blurs (spreads some extent of light). It's the inverse Fourier transform of optical transfer function (OTF) within the frequency domain.

1.2.4. Constraint Least-Square Filter

Filtering is employed in a higher manner when some constraints like smoothness are applied on the recovered image at the time once very less data is thought regarding the additive noise. constrained least sq. restoration formula is employed to achieve a blurred and noisy image and uses regular as a filter. This sort provides a similar result as Wiener filtering however

both the techniques conform completely different viewpoints. Spatial domain filters may be categorised as mean filters, order statistic filter and adaptive filter.

1.2.5. Neural Network Approach

Neural network is a digital computer process system with processing components and interconnected node groups [3]. These interconnected node groups are referred to as neurons that sends messages to each other. ANN is employed as a strong tool for approximating a target function by giving a group of input output example and for reconstructing function from a class image. 2 algorithms like Back propagation and also the Perception use gradient-decent techniques are accustomed tune the network parameters so they best suited a training set of input output examples [4].

1.2.6. Mean Filters

Mean filtering may be a easy, intuitive and simple to implement technique of smoothing pictures, i.e. reducing the quantity of intensity variation between one constituent and also the next. It's typically used to reduce noise in pictures. Some mean filters are given below:

Arithmetic Mean Filters

This type of filter is additionally referred to as linear filter that averages all the element values inside the window and helps in smoothing the variations and blurs present in image.

Geometric Mean Filter

This type is same as mean filter that loses less image details whereas process the image.

Harmonic Mean filter

This type of filter is employed in things within which the information values are so high, but it cannot de-noise the pepper noise and is best for gaussian noise and salt noise.

Contra harmonic mean filter

This type of filter is employed for eliminating salt and pepper noise however it cannot take away each of those noises at the same time. If typically wrong values are chosen then it behaves as a dragon. This filter removes pepper noise and for a negative value it destroys salt noise.

Order statistic filter

In order statistic filters, the values of pixels in a picture are ordered stratified and solely those pixels are stratified whose region (area) is boxed inside a filter.

Median Filter

This type of filter calculates the median of the intensity values of the elements that's centre of the pixel values is calculated, once calculating the median it replaces the corrupted element value with a brand new median value. This filter is taken into account as more strong as a result of one element within the neighbor-hood ne'er affects median value.

Max and Min Filter

This type of filter finds the brightest and darkest points within the image. The max filter perpetually replaces the element value with the brightest point and in distinction to the present the min filter replaces the element value with the darkest point.

Midpoint Filter

This type of filter computes centre between max and min values of the image.

Alpha-trimmed Mean Filter

This type of filter trims the $d/2$ highest and $d/2$ lowest intensity values of corrupted image in it's employed in a situation once there exists multiple sorts of noise , gaussian noise and each salt and pepper noise.

Adaptive Mean Filter

This filter is one amongst the kind of spatial domain filters, wherever the dimensions of filter will change. This sort of filter is employed particularly for eliminating high density noise from the corrupted image.

II. RELATED WORK

In the year 2003, Edmund Y. Lam, in his paper [5] titled "Image Restoration in Digital Photography", proposed some novel image restoration algorithms for digital photography, which has one of the fastest growing consumer electronics markets in recent years. Many attempts have been made to improve the quality of the digital pictures in comparison with photography taken on films. A lot of these methods have their roots in discrete signal and image processing developed over the last two decades, but the ever-increasing computational power of personal computers has made possible new designs and advanced techniques. The algorithms we are presenting here take advantage of the programmability of the pixels and the availability of a compression codec commonly found inside digital cameras, and work in compliance with either the JPEG or the JPEG-2000 image compression standard.

In the year 2007, Zhang X. F, Ye H, Tian W.F, Chen W.F published a paper [6] titled "Denoising DWI Based on Regularized Filter". In this paper, a regularized anisotropic diffusion filter was once offered and used to revive the DWI. The awarded filtering approach displayed well posedness and wonderful maintenance of edges. To assess its effectiveness in accounting for the Rician noise, the PSNR and MSSIM metrics were used for the first time. The result brought from the unreal and real data evidenced the simpler performance of the offered filters.

In the year 2009, Mateos, J., Bishop, T.E., Molina, R., Katsaggelos, A.K in their paper [7] titled "Local Bayesian image restoration using variational methods and Gamma-Normal distributions," gave a novel bayesian method to restore the blurred and noisy photos. bayesian method depend upon photo priors that encapsulate prior photograph abilities and prevent the in poor health-posedness of image restoring problems. They use a spatially various photo prior employing a gamma-normal hyper prior distribution on the regional preciseness parameters. The projected restoration manner is in comparison with different exposure restoration techniques, demonstrating its expanded performance.

In the year 2010, Wei-Wen Wu, Jin-Hui Zhong, Zhi-Yan Wang, in their paper [8] titled "A new method for restoration of defocused image," initially provide a brief introduction for the optical thought of defocused image, after which stated the items of defocusing and introduce a good approach to calculate the psf (point spread perform) of defocus. The Gaussian model and degradation of defocus in parameter estimation, they suggest a brand new methodology to reconstruct defocused photograph, that is based on Lucy-Richardson algorithmic rule along with Wiener adaptive filtering and removing the noise. The simulation results exhibit that the new system can get wonderful recovery outcome.

In the year 2011, Ramya, S., Mercy Christial, T, published a paper [9] titled "Restoration of blurred images using Blind Deconvolution Algorithm." They told that photo restoration is the approach of recovering the customary image from the degraded photograph. aspire of the enterprise is to revive the blurred/degraded pics utilising Blind Deconvolution algorithmic rule. The principal challenge of image deblurring is to de-convolute the degraded image with the point spread function that precisely describe the distortion. To start with, the common image is degraded creating use of the Degradation model. It is applied via Gaussian filter that is a low-pass filter accustomed to blur a photograph. In the edges of the blurred image, the ringing outcomes also can be detected using canny part Detection approach so it should be removed before restoration method.

In the year 2011, Chongliang Zhong, Jinbao Fu, Yalin Ding published a paper [10] titled "Image motion compensation for a certain aviation camera based on Lucy-Richardson algorithm". On this paper, they use Lucy-Richardson rule to compensate image motion of a chosen aviation digicam as an afterwards compensation. To begin with, they analyze the imaging principle of the camera and therefore the motives that motive image movement.

In the year 2012, Youlian Zhu and Cheng Huang, in their paper [11] titled “An Adaptive Histogram Equalization Algorithm on the Image Gray Level Mapping,” Based on the traditional histogram equalization algorithmic rule, the paper given an adaptive gray level mapping algorithmic rule that takes the entropy and visual effects as the target function. Experiments show that the improved algorithmic program could effectively improve visual effects. It retains details of the image and avoids too bright native areas and false contours. It's a good application prospect in image process, particularly in CT image processing in medication.

In the year 2016, Rakesh Soni, Dr. Vibha Tiwari in their paper [12] titled “A Review On Digital Image Restoration Process” [10] proposed that the Digital photo process is using laptop algorithms to participate in processing on digital graphics. As a subcategory or subject of digital, digital photograph processing has several benefits over processing. This analysis paper proposes a completely unique and improved restoration technique utilizing blind photo deconvolution and curvelet become. More than a number of blind and non-blind photo restoration procedures are studied to provide a much better answer.

In the year 2017, Y. Dar, A. M. Bruckstein, and M. Elad in their paper [13] titled, “Image restoration via successive compression,” propose a technique for solving various imaging inverse issues via complexity regularization that leverages existing compression techniques. Lossy compression has already been projected within the past for Gaussian denoising – the simplest inverse problem. However, extending this approach to a lot of difficult inverse problems (e.g., deblurring, inpainting, etc.) gave the impression to result in intractable optimization tasks. During this work, they tend to address this issue by decomposing the difficult optimization drawback via the half Quadratic splitting approach, leading to a sequential solution of a simpler regularized inverse problem followed by a rate-distortion optimization, replaced by an efficient compression technique. Additionally, they recommend an improved complexity regularizer that quantifies the average block-complexity within the restored signal, that in turn, extends our algorithmic rule to consider averaging multiple decompressed pictures obtained from compression of shifted pictures. Many compression techniques consider sparsity-seeking procedures and, therefore, sparseness is indirectly enclosed within the regularization of the proposed restoration. They demonstrate the proposed scheme for inpainting of corrupted pictures, using leading compression techniques such as JPEG2000 and HEVC.

In the year 2017, Junping Deng and Zhenling Ma via their paper [14] titled “Multi-beam sonar Image Restoration using Polynomial Interpolation”, proposed that although the oceans cover the most components of the earth's surface, the deepest ones that are known as hadal zones are still terribly mysterious. It's a frontier space to explore the hadal zone using trendy technology. Multi-beam sonar is one among the most common ways to induce the information from the hadal zone. As a result of complicated and volatile environment within the ocean, like water speed, ocean depth, topography and so on, multi-beam measuring device image may have noise and deficiency. During this work, polynomial interpolation that may be a machine learning methodology was used to restore the multi-beam sonar image. Color data is an important element for multi-beam sonar image, particularly for the description of submarine topography, so during this work, a technique for color image restoration was used. The experimental result shows that the planned methodology can recover the most components of multi-beam image

In the year 2017, LI Min and XU chen, in their paper [15] titled “Variational Image Restoration and Decomposition in Shearlet Smoothness Spaces”, proposed that they have a tendency to propose the shearlet-based variational model for image restoration and decomposition. The new model will be seen as generalizations of Daubechies- Teschke's model. By exploitation regularization term in shearlets smoothness areas, and writing the problem in an exceedingly shearlet framework, they get elegant shearlet shrinkage schemes. Moreover, the model permits us to include general finite linear blur operators into the problem. The experiments on denoising, deblurring and decomposition of pictures show that their algorithmic rule is incredibly efficient.

Method	Gaussian noise	Motion blur noise	Gaussian blur	Defocus blur	Uniform noise	Salt-pepper noise
Direct Inverse Filter	No	Yes	Yes	Yes	No	No
Wiener Filter	Yes	Yes	Yes	Yes	Yes	Yes
Constrained Least-Square Filter	-	Yes	Yes	Yes	-	-
Arithmetic Mean Filter	Yes	No	No	No	Yes	No
Geometric Mean Filter	Yes	No	No	No	No	Yes
Harmonic Mean Filter	Yes	No	No	No	No	Salt-Yes, Pepper - No
Conta-harmonic mean filter	No	-	-	-	No	Yes
Median filter	Yes	Yes	No	Yes	No	Yes
Man and Min Filter	No	No	No	No	No	Yes
Midpoint Filter	Yes	No	No	No	Yes	No

Table.1.Comparative Table for Image Restoration Techniques

III. CONCLUSION

The main objective of this work is to hold out a comparative study to judge the performance of various image restoration algorithms using pictures of various sizes and to develop a brand new restoration technique. Based on the performance comparison, an efficient technique will be found then this method will be more improved. As a result, a brand new restoration technique is developed and enforced.

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