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A Survey on Recovering High Resolution images by Using Various Image Restoration Techniques

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***Abstract*—** Now a day's Image Restoration plays an essential task, since it is one of the major components of image processing technique. Image Restoration is used to enrich the appearance of the Image. It is the process of recovering original image from degraded image, which also reduces and removes the degraded image was found using Point Spread Function (PSF).Degradation transpires in many forms namely Motion blur, Noise, Camera Misfocus. There are two types of Image restoration namely degradation model and restoration model. Degradation model includes different types of noise model and restoration model includes different types of Deconvolution algorithm. Deconvolution algorithm is divided into two parts namely Blind Image Deconvolution algorithm and Non-blind Image Deconvolution algorithm. Blind Image Deconvolution algorithm will not have knowledge about how image was degraded. Non-Blind Image Deconvolution algorithm will have knowledge about how image was degraded. In this paper, surveys on various image restoration techniques for recovering high resolution images are analysed.

***Keywords*—** Point Spread Function, Blind Deconvolution, Degradation, Non-Blind Deconvolution

I. INTRODUCTION

Image processing is used to handle an image which gets the high resolution of an image. The aim of Image restoration is to reconstruct the original image from the degraded image. Image restoration having the following issues that are better visual quality, lower computational complexity and robustness against image processing. First issue is Noises related with: The images are affected by various kinds of noises like Gamma Noise, Impulse Noise, Gaussian Noise, Rayleigh Noise and another issue Camera Misfocus or Motion Blur: and another issue is Blurring: Different kinds of Blur affected by an image they are Average Blur, Gaussian Blur, Motion Blur, Atmospheric Blur, Out of Focus. Image Restoration includes a lot of Deconvolution algorithms, they are space-variant and space-invariant techniques and Morphological Operation, etc.,

The Various kinds of filtering techniques are used such as Histogram adaptive fuzzy filter, Weighted Fuzzy Mean filter, Minimum-Maximum Detector Based on Filter, adaptive fuzzy Mean filter, Centre Weighted Mean filter and Min-Max Exclusive Mean filter [1]. Second Deconvolution Technique: A Restoration of images done by different techniques like MAP estimator, image prior, Noise Removal via Bayesian Wavelet Coring, Scale-Space and Edge Detection Using Anisotropic Diffusion, Blind Image Deconvolution, Non-Uniform Deblurring for Shaken Images, Image Deblurring and Denoising Using Colour Preceding. An Anisotropic diffusion mode is the use of hardware such as camera, gyroscopes, and accelerometers are expensive [2], [3]. Richardson Lucy Deconvolution is presents to Noises are found to be excellent to that of other blind Deconvolution algorithm [4] .The goal of image restoration is to reconstruct the original scene from a degraded. A Bayesian estimates that is a natural lean-to the wiener solution. Iterative technique simultaneously identifies and restore noisy blurred image [5], [6]. Combined local-global (CLG) move towards with Total Variation directive the combination of bilateral filtering and anisotropic regulation is used to control propagation [7]. An alternative Deconvolution method called Iterative Distribution Reweighting (IDR) can be implemented which enforces a global constraint on gradients so that a reconstructed image [8].

Image restoration and Image Enhancement technique Adaptive median filter, hu and haan is used for restoring the clear image from a fog degraded image and it is suitable for real-time dehazing for images [9],[10],[11].Mathematical morphology which is a method of nonlinear filters, Morphological operations are erosion, dilation, opening, closing, boundary extraction and region filling, the two basic algorithms (boundary extraction and region filling) are implemented with user interface in which changing the

parameters of SE such as its size or type are simple. Image processing techniques which deal with the shape of features in an image is described by Morphological image processing [12],[13].The camera moves along an arbitrary curve parallel to the image plane, without any rotations. The knowledge of camera trajectory and camera parameters is not necessary [14]. A new image in painting method is Curvature-Driven Diffusion (CDD) model and Total Variation (TV). Image is often statistically corrupted with noise and noise removal is important of this occupation and Input Image allows reducing the computational complications and Performance time is few seconds to several minutes for large images [15],[16],[17].

Blind Deconvolution method and super resolution problem of multiple degraded low resolution frames of the original scene and without any other prior information about the shape of degradation blur. More complex for how image was degraded and continuously frames are generated [18].In this method can restore degraded images and preserves the discontinuities. It presents a new restoration method for noisy images by minimizing the total variation under constraints using a multilayer neural network. Euler-Lagrange functional is resolved by minimizing an error functional[19][20].CNN that is trained on both the spatial and the temporal dimensions of videos to enhance their spatial resolution and consider the problem of video super-resolution image super-resolution (SR) as well as other image restoration tasks.CNN is able to improve the reconstruction quality and reduce the training time. An adaptive motion compensation scheme to deal with motion blurs and fast moving objects.

A. Image Restoration Vs Image Enhancement

Image Restoration Technique is fluctuated from Image Enhancement Technique because Image Enhancement Technique is used to get good Image quality and increase the contrast of image but Image Restoration Technique is narrated to Feature Extraction from the flawed image [1].

II. INTENTION FOR DEGRADATION WORK

There are many reasons for degradation such as Motion Blur, Noise, Camera Misfocus, and Wavelength of light. Degradation is transpires in Image Acquisition and Transmission of image. Types of deformations are Space variant and Space invariant where all pixels are suffered from the same distortion suffered by pixels in the image are depending upon their location called Space invariant and it transpired due to camera motion[7]. Space-variant distortion is complex as it depending on their location.

A. Noise Models

Noises in images are occurred due to Image Acquisition low or high level of lights and atmospheric problem and sensor temperature. In Restoration model, noises are operated in spatial domain, modifications are done pixel directly.

B. Gaussian Noise

It has a random distribution of amplitude over time and it occurs frequently and it is also known as normal noise.

$$P(Z) = \frac{1}{\sqrt{2\Pi\delta^2}}\, e^{\frac{-(z-\mu)^2}{2\delta^2}} \quad (1)$$

C. Uniform Noise

In Uniform Noise the Pixels of sensed image is quantized to a number of discrete levels. That is also called quantization noise.

$$P(Z) = \begin{Bmatrix} \frac{1}{b-a} & if\ a \le z \le b \\ 0 & otherwise \end{Bmatrix} \quad (2)$$

Mean and variance of Uniform Noise,

$$z = \frac{a+b}{2} \quad (3)$$

D. Impulse Noise

It is combination of white and black dots it is also called Salt and Pepper Noise.

$$P(Z) = \begin{Bmatrix} p_a & if\ z = a \\ p_b & if\ z = b \\ 0 & otherwise \end{Bmatrix} \quad (4)$$

When Intensity of _b means salt, where b>a in image and intensity of _a‘ is black dots means pepper where a>b in image.

III. BLURRING TECHNIQUES

Blur will decrease the image quality which is caused by incorrect focus, object motion, hand shaking. Different types of blurs are also responsible for degradation. In Digital image Corrupt in various blur effects these are:

A. Average Blur

The average blur is use to remove noise and specks in an image. Average blurring is can be distributed in vertical and horizontal direction. Averaging of radius R which is evaluated as:

$$R = \sqrt{g^2 + f^2} \quad (5)$$

When g is horizontal blurring, f is vertical blurring.

B. Gaussian Blur

The Gaussian blur outcome is a filter that combines a specific number of pixels incrementally, following a bell-shaped curve.

C. Motion Blur

The motion blur outcome is a filter that creates the image appears to be moving by adding blur in a specific direction.

D. Atmospheric Blur

It transpires due to random variations in the reflective index of the medium between the object and the imaging system and it transpires in the imaging of astronomical objects.

E. Out of Focus Blur

When a camera images a 3-D scene onto a 2-D imaging plane, some parts of the scene are in focus while other parts are not. If the aperture of the camera is circular, the image of any point source is a small disk, known as the Circle of Confusion (COC). The degree of defocus (diameter of the COC) depends on the focal length and the whole number of the lens, and the distance between camera and object. An accurate model not only illustrates the diameter of the COC, but also intensity distribution within the COC.

IV. RESORATION TECHGNIQUES

There are various Restoration techniques as well as spatial domain filter for noise remove spatial domain filters are used for removing additive Noise. Image Restoration techniques are used to make the corrupted image as similar as that of original image [7].

Filters are used to removes unwanted pixels known as noises things or noise. Filters are used to restore the original image from the degraded image the following.

A. Inverse Filter

Inverse filtering is the quickest and easiest way to restore the blurred image .Blurring can be regard as low pass filtering in inverse filtering approach. High pass filtering action is used to reconstruct the blurred image without much effort. Suppose first that the additive noise is negligible. A problem arises if it becomes very small or zero for some point or for a whole region in the plane then in that region inverse filtering cannot be applied.

B. Wiener Filter

Wiener that integrate both the degradation function and statistical characteristic of noise into the restoration function. Weiner Filtering is also a non-blind technique for reconstructing the degraded image in the presence of known PSF (Point Spread Function). It removes or reduces to some amount of additive noise and at the same time inverts the blurring. Wiener filter not only performs the Deconvolution by high pass filtering but also removes the noise with a low pass filtering. It evaluates with an assessment of the noiseless image desired. The input to a wiener filter is a degraded image corrupted by additive noise the output image is calculated by means of a filter using the following expression,

$$\text{i.e. } f = g \times (f + n)\ (2) \qquad (7)$$

Wiener Deconvolution can be used effectively when the frequency (f) characteristics of the image and additive noise (n) are known, to at least some degree. In the absence of noise, the Weiner filter reduces to the ideal inverse filter.

C. Morphological Operation

Image restoration is defined as the processing formed on the image using a priori knowledge of the image degradations to remove the degrading effects. Image restoration techniques are used in a various areas. Their applications are very vast ranging from simple images to complex medical images. Image restoration used to reconstruct damaged regions of an image. Image components for description of region shape, skeletons, and boundaries features are extracted by morphological operations. Morphological operation is best feature extraction for gray scale images.

D. Multilayered Neural Networks

A neural network NN with three layers is used according to the Multi Layer Perceptron MLP. The input layer of the MLP consists of one neuron which is the pixel to be restored. The output layer contains one neuron correspond to the processed pixel. Next Research has been done in evaluating the number of neurons in the hidden layer but no optimal number has been discovered. So the hidden layer consists of a varying number of neurons fixed by the user after several tests in our experimentation case we have used ten neurons. The sigmoid function is applied to each neuron in the hidden layer and output neuron. The output of the MLP is an image corresponding to the desired image u(x, y).So we provided as inputs to the multilayer neural network the degraded image u0(x, y)and at the output of the neural network have,

$$U(x,y)=N(u0(x,y),w) \qquad (8)$$

Where u0(x, y) is the noisy image represented by each intensity of pixel(x, y) and w is the weights vector of the MLP.

E. Convolution Neural Networks

Convolution neural networks (CNN) are a special type of Deep learning Neural Networks (DNN). They have so far been successfully applied to image super-resolution (SR) as well as other image restoration tasks. A CNN that is trained on both the spatial and the temporal dimensions of videos to enhance their spatial resolution. Consecutive frames are motion compensated and used as input to a CNN that provides super-resolved video frames as output. In table 1.1

enclose the restoration techniques and different kinds of input data, Pre-processing, feature extraction, segmentation, strength, weakness.

Table 1.1: Survey Analysis of Restoration Technique

Method		Input	Dataset	Pre-processing	Feature extraction	Segmentation	Strength	Weakness
Novel approach for non-linear filters	[2]	Natural images	Noise and blur images	HAF,WFM,MDB,AFMF,CWM,MMEM filters	Nil	Nil	HAF filter use.	Removes noise only
	[4]	Lena image	Noise and blur images	Inverse and wiener filter	Nil	Nil	High resolution	Nil
Iterative Deconvolution Reweighting (IDR)	[6]	Natural images	Noise and blur images	Nil	Gradient feature, texture	Anisotropic diffusion	Eliminate scratches, better visual quality	Expensive camera
Novel method for medical images	[8]	Medical images	x-ray images	Restoration filter	Nil	BID,LRA	Blind convolution	Complicated to implement
Space variant Technique	[11]	Isomorphic filtering	Natural Images	Isomorphic filtering LSV	Nil	Nil	straight forward Implementation	Computationally expensive
		MAP Estimation	Natural Images	MAP Estimation	Nil	Nil	Visually pleasing Restoration	Iterative technique convergence is not guaranteed
		Coordinate distortion method	Natural images	LSV	Nil	Nil	Fast LSV achieved	Only works for certain Decomposable LSV system
Morphological operation	[13]	Foggy images	Foggy images	Adaptive median filtering	Estimated blur ,contrast, saturated	Nil	Suitable for real time dehazing images	Poor visibility
	[14]	Lena image	Noisy images	Nil	Boundary extraction	Nil	Work with shapes	Work with 2D images
In painting(curvature driven diffusion, total variation)	[15]	Natural images	In Painting images	Nil	Edge, texture, painted region	Region based, threshold	Undertaken Time is Depended on size	Few seconds to several minutes for large images

Spatial invariant Technique	[18]	Inverse filter	Natural images	Inverse filter	Nil	Nil	Quickest way to restore	Visual quality is fair
		Wiener filter	Natural images	Wiener filter	Nil	Nil	Visual quality good	Computational Complex
		Geometric Mean Filtering	Natural images	Geometric Mean Filtering	Nil	Nil	Visual quality very good	Assumption is unrealistic
		Constrained deconvolution	Natural images	Deconvolution filter	Nil	Nil	Visual quality good	Sensitive than wiener filter
		Homomorphic deconvolution	Natural images	Homomorphic filter	Nil	Nil	Visual quality very good	computationally complex
		Recursive Filtering	Natural images	Recursive Filtering	Nil	Nil	Visual quality very good	Restrictive and unrealistic assumption
Neural network	[19]	Natural images	Cameraman, Lena images	Nil	Edge, texture	Multilayer neural network	Get more accurate result	Time complexity is high
	[20]	Video data	Video database	Filter	Height, width, depth	CNN Segmentation. Spatially adaptive iterative singular value thresholding	Deep learning network	Time complexity is high

Above table briefly discussed about the different restoration techniques are space variant and invariant techniques, non-linear filtering techniques, morphological operations and finally discussed neural network for accurate result.

V. PERFORMANCE METRICS

A. PEAK SIGNAL NOISE RATIO (PSNR)

Performance Evaluation is mainly used to compare different techniques under image processing. It is commonly used to measure the quality of reconstruction process. Performance evaluation helps us to find the quality of the image.

B. PSNR

Peak Signal to Noise Ratio (PSNR) is used to evaluate new objective perceptual image quality metrics. PSNR is defined as 10*log10 of the ratio of the peak signal energy to the mean square error (MSE) observed between the processed image and the original image.

$$MSE=sum(sum((Oimage-Fimage).^2))/(M*N) \quad (9)$$

$$PSNR=10*log10(256*256/MSE) \quad (10)$$

Oimage-Original Image, Fimage-Filtered Image.

Above table shows the different filtering methods and better visual quality is Histogram Adaptive filter.

VI. CONCLUSION

This paper discussed about the different techniques of Image restoration technology and image Restoration is one of the technical areas of Image Processing. In this section shows various types of degradation models and restoration models technique and results are compared. In many other filtering techniques are compared, finally we told Histogram Adaptive median Filter is better visual quality of an image. Blind Deconvolution algorithm is much better than Non- Blind Image Deconvolution Algorithm. Multilayer Neural Network considers different noise models. Convolution Neural Network trained both

spatial and temporal problem of image and video super resolution task reducing the training time.

Table 5.1.1 Performance Results

Image restoration Technique	Visual quality	Noise perfor mance	Degree of prior knowledg e	computational complexity
Inverse filter	Fair	Poor	Low	Low
Wiener filter	Good	Good	High	Moderate
Geometric mean filter	Very good	Good	High	Moderate
constrained Deconvolu tion	Good	Fair	Moderate	Moderate
Homomorp hic Deconvolu tion	Very good	Good	Low	High
MAP restoration	Very good	Good	High	Very high

Table 5.1.2 Non-Linear filters Performance results

Noise Percen tage%	Filtering Techniques					
	CWM	MME M	AFM F	MBD	WF M	HAF
10	26.58	27.08	28.38	27.72	26.97	37.30
20	24.03	25.63	27.38	26.24	23.87	36.06
30	21.38	24.80	26.00	24.37	21.80	34.98
40	19.56	23.66	24.12	23.72	20.17	33.60
50	16.90	22.54	24.05	21.64	18.70	31.54

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