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A Novel Method of Image Restoration by using Different Types of Filtering Techniques

Anamika Maurya, Rajinder Tiwari

Abstract*— Image restoration is an important issue in high level image processing which deals with recovering of an original and sharp image using a degradation and restoration model. During image acquisition process degradation occurs. Image restoration is used to estimate the original image from the degraded data. Aim of this research paper is to provide a concise overview of most useful restoration models .Different types of image restoration techniques like wiener filter, inverse filter, regularized filter, Richardson –Lucy algorithm, neural network approach ,wavelet based approach, blind deconvolution are described and strength and weakness of each approach are identified.

Index Terms— **Blur, Deblurring, Image fusion, Image restoration, Wavelet transforms.**

I. INTRODUCTION

Images are produced to record or display useful information or details .Due to flaws in the imaging and capturing process, however, the recorded image always represents a degraded version of the original scene [1]. The undoing of these imperfections is critical to many of the successive image processing tasks .There exists a huge range of different degradations, which should be taken into account, for example noise, geometrical degradations, illumination and color imperfections (under-exposure/over-exposure, saturation) and blur [2].

The area 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 image. Essentially, it tries to perform an operation on the image which is the inverse of the imperfections in the image formation system [11]. In the use of image restoration methods, the characteristics of the degrading system and the noise are assumed to be known from before. In practical situation, however one may not be able to obtain this information directly from the image formation process. The aim of blur identification is to determine the attributes of imperfect imaging system from the observed degraded image itself prior to the restoration process.

A. What is image restoration?

Image Restoration refers to a group of methods or techniques that aim to remove or reduce the degradations that have occurred while the digital image was being obtained.

All natural images when displayed have gone through some sort of degradation:

- The degradation may occur during display mode
- The degradation may occur when camera is in the acquisition mode, or
- During processing mode degradations may also takes place.

The degradations may be due to

- The degradation may occur due to sensor noise
- The degradations may Blur due to camera misfocus
- The degradation may occur due to relative object-camera motion
- The degradation may occur due to random atmospheric turbulence
- The degradation may occur due to some other reasons also.

In most of the existing image restoration methods we assume that the degradation process can be described using a mathematical model.

B. How much image can be restored?

It depends on how much we know about the original image, information contains in the original image how much the image is degraded, reasons behind the degradations and how accurate our degradation models are and with what accuracy it can be implemented.

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C. Image restoration and image enhancement-differences

- Image restoration differs from image enhancement in that the latter is concerned more with accentuation or extraction of image features rather than restoration of degradations.
- Image restoration problems can be quantified precisely, whereas enhancement criteria are difficult to represent mathematically

D. Degradation model

Distortion is almost always involved in recorded images. Distortion is mainly because of imperfections in the imaging system. This problem can get extremely severe due to random noise involved in the imaging. Degradation operation works on input image f(x, y) to lessen a degraded image g(x, y).

With g(x, y) some information of the degradation function H and information about the noise term also get added, the aim of image restoration is to obtain an estimate f'(x, y) of the original image f(x, y).

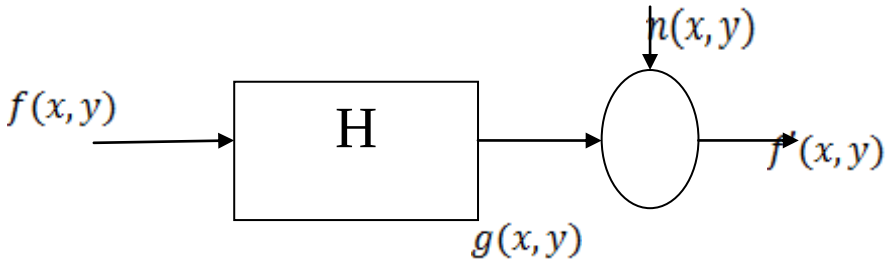

Fig 1: Degradation Model

E. Classification of image restoration techniques

Image restoration techniques are methods which attempt the inversion of some degrading process. Image restoration technique can be broadly classified into two types depending upon the knowledge of degradation. If the prior knowledge about degradation is known then the deterministic method of image restoration can be applied. If it is not known then the stochastic method of image restoration has to be employed. Restoration often exhibits arte facts near the edges, as linear methods are unable to recover missing frequency components which lead to Gibbs effect.

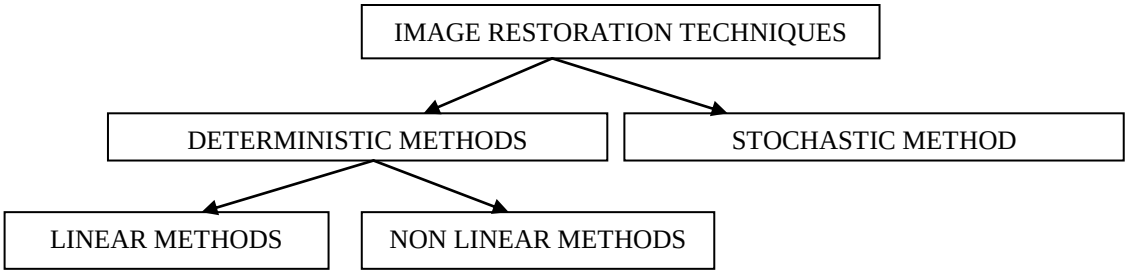

Fig 2: Image Restoration Flow

F. Categories of Image Restoration Techniques

Image Restoration Techniques are divided into two categories on the basis of knowledge about Point Spread Function (PSF).

1. Blind Image Restoration:

This Technique allows the reconstruction of original images from degraded images even when we have very little or no knowledge about PSF. Blind Image Deconvolution (BID) is an algorithm of this type.

2. Non-Blind Restoration:

This Technique helps in the reconstruction of original images from degraded images when we know that how image was degraded i.e. we have knowledge about PSF.

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- Point spread function (PSF):

Point spread function (PSF) is the degree to which an optical system blurs (spreads) a point of light[11]. The PSF is the inverse Fourier transform of optical transform function (OTF) in the frequency domain. The OTF describes the response of a linear, position-invariant system to an impulse.OTF is the Fourier transfer of the point (PSF) [8].

G. Applications of Image Restoration

Applications in the field of image restoration are:

- The first application of digital image restoration in the engineering community was in the area of astronomical imaging. Extraterrestrial observations of the Earth and the planets were degraded by motion blur as a result of slow camera shutter speeds relative to rapid spacecraft motion. The astronomical imaging degradation problem is often characterized by Poisson noise, Gaussian noise etc.
- In the area of medical imaging, image restoration has played a very important role. Restoration has been used for mammograms, filtering of Poisson distributed film-grain noise in chest X-rays and digital angiographic images, and for the removal of additive noise in Magnetic resonance Imaging.
- Another important application of restoration technique is to restore aging and deteriorated films. The motion picture restoration is often associated with digital techniques are used to eliminate scratches and dust from old movies and also to colorize black and white films. There has been significant work in the area of restoration of image sequences and well explained in literature.
- The expanding area of application for digital image restoration is that in the field of image and video coding. As techniques are developed to improve coding efficiency, and reduce the bit rates of coded images. Much has been accomplished to develop ways of restoring coded images as a post-processing step to be performed after decompression.
- Digital image recovery has also been used to restore blurred X-ray images of aircraft wings to improve aeronautical federal control procedures. It is for the recovery of the motion induced in the present frame or composite effects, and is generally used, restoring television images blurred uniformly.

II. BLURRING TECHNIQUES

Blurring is a form of reduction of bandwidth of an ideal image owing to the imperfect image formation process. Blurring can be generating by relative motion between the camera and the original scene, or by an optical network that is out of focus. When aerial photographs are developed for remote sensing purposes, blurs are drive by atmospheric turbulence, aberrations in the optical network, and relative motion between the camera and the ground. Apart from these blurring effects, noise is the main reason behind the corruption of any recorded image. It can also be introduced by the medium through which the image is created (random absorption or scatter effects), by the recording medium (sensor noise), by errors which is caused by the measurements due to the less accuracy of the recording system, and by quantization of the data for digital storage. In digital image various types of blur effects exist:

A. Types of blur

In digital image various types of blur effects exist:

1. Average Blur

The Average blur is one of several tools you can use to remove noise and specks in an image. We can use this tool when noise is present over the entire image. Average blurring can be distributed in horizontal and vertical direction and can be finding by circular averaging of radius R which is evaluated as

$$R = \text{square root of } \sqrt{g^2 + f^2} \qquad (1)$$

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 [4].

2. Gaussian Blur

The Gaussian Blur effect is a filter that blends a specific number of pixels incrementally, following a bell-shaped curve [6]. Blurring is dense in the center and feathers at the edge. Apply Gaussian Blur filter to an image when we want more control over the blur effect [5].

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3. Motion Blur

It occurs when there is relative motion between the object and the camera during exposure. The many type of motion blur can be distinguished all of which are due to relative motion between the recording device and the scene. This can be in the form of translation, a rotation, a sudden change of scale, or some combinations of these. The Motion Blur effect is a filter that makes the image appear to be moving by adding blur in a specific direction. The motion can be controlled by angle or direction (0 to 360 degrees or –90 to +90) and/or by distance or intensity in pixels (0 to 999) based on the software used [7].

4. Atmospheric Blur

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

5. 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 aperture number of the lens, and the distance between camera and object. An accurate model not only describes the diameter of the COC, but also intensity distribution within the COC [8].

III. DEBLURRING TECHNIQUES

A. Direct inverse filtering

Inverse filtering is the quickest and easiest way to restore the blurred image if a good model of the blurring function that corrupted an image is known or can be developed. Blurring can be considered as low pass filtering in inverse filtering approach we use high pass filtering action 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. Weiner Filter deblurring method

Wiener filter is a standard image restoration approach proposed by N. Wiener that incorporates 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. It removes or reduces to some extent the additive noise and inverts the blurring simultaneously. Wiener filter not only performs the deconvolution by inverse filtering (high pass filtering) but also removes the noise with a compression operation (low pass filtering).It compares with an estimation of the noiseless image we want or desired. The input to a wiener filter is a degraded image corrupted by additive noise [9]. The output image is calculated by means of a filter using the following expression i.e.

$$f = g \times (f + n) \qquad (2)$$

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

C. Regularized Filtering

Regularized filtering is used in a better way when constraints like smoothness are applied on the recovered image and very less information is known about the additive noise. The blurred and noisy image is regained by a constrained least square restoration algorithm that uses a regularized filter. Regularized restoration provides almost similar results as the wiener filtering but viewpoint of both the filtering techniques are different. In regularized filtering less previous information is required to apply restoration. The regularization filter is frequently chosen to be a discrete Laplacian. This filter can be understood as an approximation of a Weiner filter.

IV. CONCLUSION

In this paper the objective and definition of image restoration is addressed. We also give a brief introduction about various blurring and deblurring techniques. Each technique has its own advantages and disadvantages. This paper will be helpful for the researchers in understanding the concept of image restoration and deblurring techniques who

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are new in this field .Research work is taking place on image fusion techniques using two algorithms, but there is scope for the improvement, If we can use more than two algorithms and more samples can be used results could have been better. The work will be carried out on MATLAB image processing tool box.

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AUTHOR BIOGRAPHY

Ms Anamika Maurya is presently pursuing M.Tech in Electronics and Communication Engineering from Amity University, Uttar Pradesh, Lucknow. She has done B.Tech degree course in Electronics & Communication Engineering from Shri Ramswaroop Memorial College of Engineering & Management and Technology, Lucknow in 2012 under the affiliation of the UPTU, Lucknow. Presently, she has focused her working area within the various aspects of the image processing using some suitable simulation software in the vicinity of implementation of some highly efficient and accurate algorithms for image restoration. Her research interests also include image fusion.

Mr. Rajinder Tiwari, PhD (P), M.Tech, MIETE is a member of academic staff of Department of Electronics & Electrical Engineering (ASET), Amity University Uttar Pradesh, Lucknow, where he is serving in the capacity of Asstt. Professor in the Department of Electronics Engineering (ASET). He has done M.Tech (I&CE) and M.Sc (Electronics) from NIT, Kurukshetra and University of Jammu, respectively. Presently, he is pursuing Ph.D. (ECE) from Department of Electronics Engineering, Kumaon Engineering College, Dawarahat (Almora) under Uttarakhand Technical University. Mr. Tiwari has given his contribution to the area of Microelectronics (Modeling & Simulation of the Analog CMOS Circuits for ASP Applications), Embedded System Design, Digital System Design and Process Industries Automation and Control System Design (using Graphical Programming Language with dedicated Hardware). He has published several research papers in International/National Journals/Seminar/Conference. He is associated with several technical institutions and bodies as a life member. Before taking the assignment of Amity University, Uttar Pradesh, Lucknow, he had worked in Electronics for Societal Group, CEERI, Pilani, as a Project Scientist and a Multi – National Company as a Sr. Software Engineer (Bridge Instrumentation Division). He is also associated with the successfully implementation of the Hardware and Software for number of projects undertaken by him and in organizing number of International/National Conferences and Seminars.