Project Report

On

IMAGE RESTORATION USING MATLAB: A CASE STUDY ON BLURRED TRAFFIC IMAGES

Submitted

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CERTIFICATE

This is to certify that the dissertation entitled, **IMAGE RESTORATION USING MATLAB: A CASE STUDY ON BLURRED TRAFFIC IMAGES** is a bonafide record of the work done by Ms. **MILA JUDESON** under my guidance as partial fulfillment of the award of the degree of **Bachelor of Science in Mathematics** at St. Teresa's College (Autonomous), Ernakulam affiliated to Mahatma Gandhi University, Kottayam. No part of this work has been submitted for any other degree elsewhere.

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DECLARATION

I hereby declare that the work presented in this project is based on the original work done by me under the guidance of DR. SUSAN MATHEW PANAKKAL, Assistant Professor, Department of Mathematics, St. Teresa's College(Autonomous), Ernakulam and has not been included in any other project submitted previously for the award of any degree.

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Contents

Chapter 1

INTRODUCTION

1.1 INTRODUCTION

Digital image processing is the process by which we use digital computer to modify digital image through various algorithm, it is used to enhance the image. Here in this project we choose image restoration which comes under digital image processing for the restoration of traffic images. Image restoration is one of the fundamental steps in digital image processing. Image restoration is the method of recovering a digital image from a blurred and noisy image. The distortion in image can be referred as noise or blur or a degradation function. Unfortunately, every images are more or less blurry. Due to this reason, there is a lot of intrusion in the camera and also in the environment. Distortion of an image can be caused by many factors including movements during the capture process, using wide angle lens, using long exposure times, etc. We take the case of traffic images and use a software known as MATLAB for this method. MATLAB is a software in which we can easily solve the algorithm. MATLAB is used to enhance the image according to our wish. In this study we use Fourier Transform as an application of mathematics in image processing. Fourier Transform is an important image processing mathematical tool which is used to decompose an image into its sine and cosine components. The output of the transform is a Fourier representation of the image.

1.2 IMAGE PROCESSING

A image may be defined as a two-dimensional function f(x,y), where x and y are plane coordinates and the amplitude of f at any pair of coordinates (x,y) is called the gray level at that point. When x,y and the intensity value of f are all finite, discrete quantities, we call the image a digital image. The field of digital image processing refers to the processing of digital images by digital computers. A digital image consists of a finite number of elements. These elements are called pixels, pixels, pels, and pixels. Images generated by sources such as ultrasound, electron microscopy, and computer-generated images. Digital image processing thus covers a wide variety of applications. The processes of acquiring an image of the area containing the text, pre-processing the image, extracting the individual characters, describing the characters in a form suitable for computer processing and recognizing those individual characters is defined to be digital image processing.

1.3 THE ORIGIN OF DIGITAL IMAGE PROCESSING

Newspaper industry is the first industry to make use of digital image processing. Introduction of the Bartlane cable picture transmission system reduced the time required to transport a picture. Some of the first problems in improving the visual quality of these early digital images concerned the choice of printing method and the distribution of intensity levels. Early Bartlane systems allowed him to encode images in five different shades of gray. This capability was increased to 15 levels in 1929. Thus, the history of the digital image processing is intimately tired to the development of the digital computer. In fact, digital images requires so much storage and computational power that progress in the field of digital image processing has been dependent on the development of digital computers and of supporting technologies that include data storage, display and transmission. The field of image processing has grown vigorously till the present. In addition to applications in medicine and the space program, digital image processing

techniques are now used in broad range of applications. Computer procedure are used to enhance the contrast or code the intensity level into color for easier interpretation of X-rays and other images used in industry, medicine and biological sciences. Image enhancement and restoration techniques are used to process degraded images from irrecoverable objects or experimental results that are too costly to replicate. The birth of digital image processing today can be traced to the availability of these machines to the onset of space program during that period. It took the combination of these two developments to bring into focus the potential of digital image processing concept. The continuing decline in the ratio of computer price to performance and the expansion of networking and communications bandwidth via the World Wide Web and the Internet have created great opportunities for continued growth of digital image processing.

1.4 FUNDAMENTALS STEPS IN DIGITAL IMAGE PROCESSING

1.4.1 Image Acquisition

In image processing and machine vision, image capture is the act of obtaining an image from a source (usually a hardware system such as a camera, sensor, etc.).

1.4.2 Image Enhancement

Image Enhancement is the operation which deals with manipulating an image so that the resultant Image is more useful for a specific application.

1.4.3 Image Restoration

Image restoration is a process which improves the quality and appearance of an image .it is based on mathematical model of image degradation and is objective in nature.

1.4.4 Colour Image Processing

It is an area that is of great prominence because of the increasing use of digital images.it deals with color models and their implementation in image processing application.

1.4.5 Wavelet and Multi resolution Processing

A wavelet is a mathematical function used in compression of images and digital signal processing. Multi resolution analysis is the representation of a signal (eg images) in more than one resolution/scale. Features that may not be detected in one resolution are easily identifiable in another.

1.4.6 Compression

Image compression is a process applied to graphics files to minimize their size in bytes without reducing image quality below an acceptable threshold. Smaller file sizes allow more images to fit in a given amount of disk space or disk space.

1.4.7 Morphology Processing

Morphology is a broad range of image processing operations that process images based on their shape.

1.4.8 Segmentation

Image segmentation is a method of dividing a digital image into different subsets called image segments, which helps reduce the complexity of the image to facilitate further processing and analysis of the image.

1.4.9 Representation and Description

After an image is segmented into regions in the segmentation process, each region is represented and described in a form suitable for further computer processing. Representations deal with image features and regional characteristics. Digital images are represented in image processing and computer systems by numbers in binary form called bits. This section describes the general structure of digital images. First, it

is split into pixel matrices. Then, each pixel is represented a series of bits.

1.4.10 Object Recognition

Image recognition is the process of identifying an object or a feature in an image or video. It can be used in various fields like defect detection, medical imaging, and security surveillance.

Chapter 2

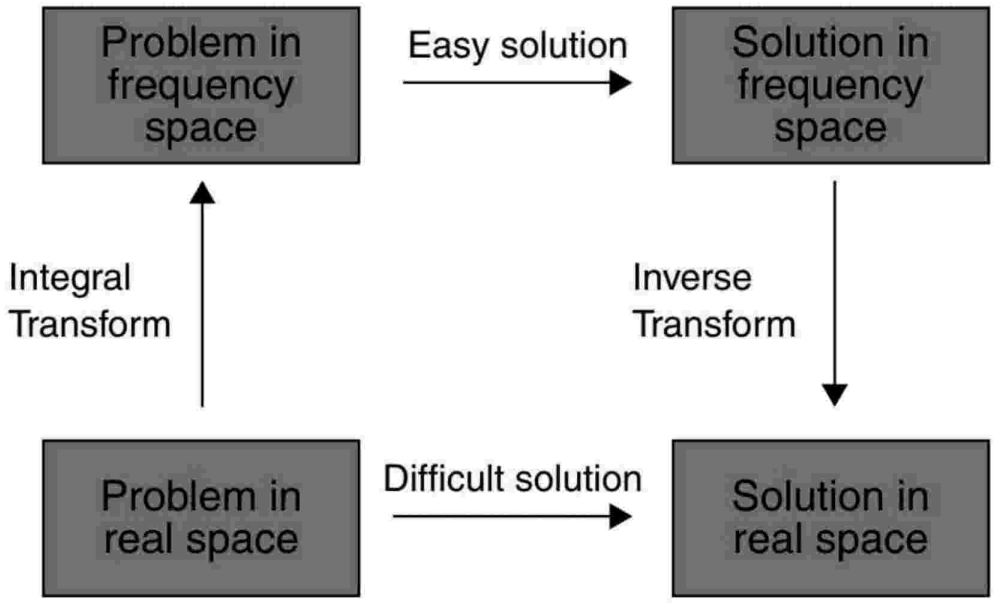
IMAGE RESTORATION

2.1 IMAGE RESTORATION

The aim of image restoration is to improve the quality of images by various techniques and to reduce the distortion by post processing the image. It is an objective process. Thus, restoration techniques are oriented toward modelling the degradation and applying the inverse process in order to recover the original image. This project presents a method for deblurring traffic images. Some sort of degradation happens in every natural image:

- During display mode
- Acquisition mode
- Processing mode
- Sensor mode
- Blur due to camera misfocus
- Relative object-camera motion
- Random atmospheric condition
- others

2.2 MATHEMATICS IN IMAGE RESTORATION



Frequency space : -It refers to the analytic space where mathematical functions or signals are expressed in terms of frequency rather than time. A time domain graph shows how much a signal is present among each frequency band. Eg : Fourier

2.2.1 Fourier Transforms

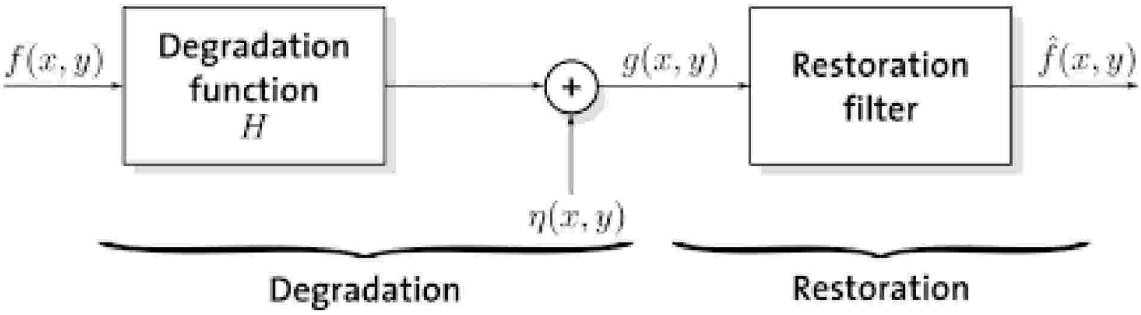
The Fourier Transform is an important image processing mathematical tool which is used to decompose an image into its sine and cosine components that denotes different frequencies. The output of the transform is a Fourier representation of the image. The Fourier contribution to this field shows that any periodic function can be expressed as the sum of sine and/or cosine functions at different frequencies, each multiplied by a different factor. Fourier transforms play an important role in a wide range of image processing applications such as enhancement, analysis, decompression, and compression.

2.3 DEGRADATION MODEL

The degradation process operates on a degradation function acting on the input image using an additive noise term. Given an image f(x,y), convolved with a blurring function h(x,y), with additive noise n(x,y), the task is to reconstruct the original image from the noisy image. The process of degradation mechanism can be expressed as:

G(u,v) = H(u,v)F(u,v) + N(u,v)

where G(u,v) is the Fourier transform of the input image g(x,y), H(u,v) is the Fourier transform of the blur mechanism h, F(u,v) is the Fourier transform of the original image f(x,y) and N(u,v) is the Fourier transform of the noise added to the image.



A model of the image degradation/ restoration process.

2.4 NOISE

Noise in an image is the random dissimilarity of brightness or color information's in the image taken. Generally, noise is a statistical variation of a measurement created by an arbitrary process. It also means a variation of the signal from its original form by a small amount due to external or internal factors. These factors cannot be easily controlled and thus introduce random elements into the image.

2.4.1 Types of Noise in an Image

The noise embedded in an image manifest in diverse varieties. The noise may be correlated or uncorrelated; it may be signal dependent or independent, etc. Some classifications of noises are:

1. **Additive noise: Sometimes the noises generated from sensors are thermal white Gaussian, which is essentially additive and signal independent.**

2. **Multiplicative noise: The graininess noise from photographic plates is essentially multiplicative in nature. The speckle noise from the imaging systems, ultrasound imaging etc. are also multiplicative in nature.**

3. **Impulse noise: Quite often the noisy sensors generate impulse noises. Sometimes the noise generated from digital(or even analog) image transmission system is impulsive noise.**

4. **Quantization noise: The quantization noise is essentially a signal dependent noise. This noise is characterized by the size of signal quantization interval. Such noise produces image-like artifacts and may produce false contours around the objects. The quantization noise also removes the image details which are of low-contrast.**

Chapter 3

ALGORITHM FOR RESTORATION

Image restoration aims to reduce the distortion by post processing the image. Here we carry out image restoration using an approximate distortion with a linear shift invariant system Point Spread Function(PSF). The image which is taken in camera are always a blurred representation of the actual object. So this blurring is described as Point spread Function. The PSF refer to as what a single point in the object look like in the image. Here, the blurring function is said to be PSF and is represented as h[m,n]. If we know h[m,n] then,

g[m,n] = h[m,n]*f[m,n]————————(1)

g[m,n] – observed image

h[m,n] – blur

f[m,n] – clean image

Taking Discrete Fourier Transform(DFT) (1) becomes,

G(u,v) = H(u,v)*F(u,v)

i.e, F(u,v) = G(u,v)/H(u,v)

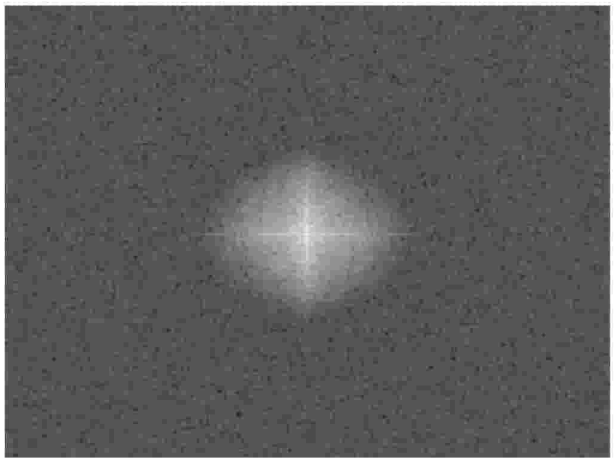
Then take the inverse Fourier Transform. Thus we get the clean image f[m,n].

Using MATLAB code, image restoration was carried out on a dull image. Here we explain an example where image restoration is performed.

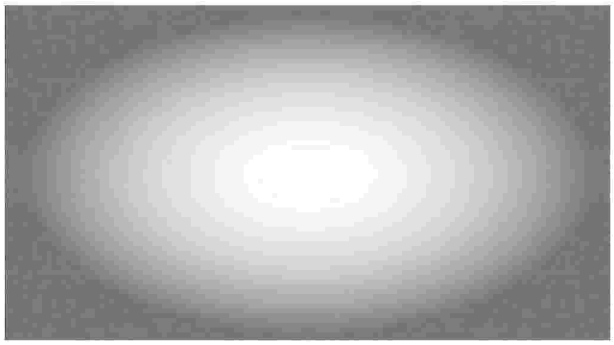
```
clear all
close all

f = im2double(imread('blur 2.jpg'));

h = fspecial('gaussian',15,0.5);
blurred = imfilter(f,h,'circular');
noise = 0.001*randn(size(f));
g = blurred + noise;
figure, imshow(g, []);

G = fftshift(fft2(g));
figure, imshow(log(abs(G)), []);

h = ifftshift(fspecial('gaussian',[195 259],0.5)); //change the image size according to the source used//
figure,imshow(h,[]);

H = fftshift(fft2(h));
figure, imshow(log(abs(G)),[]);

F = zeros(size(f));
R = 60; //change the image size according to the source used//
for u=1: size(f,2)
   for v=1:size(f,1)
      du = u - size(f,2)/2;
      dv = v - size(f,1)/2;
      if du^2 + dv^2 <= R^2
         F(u,v) = G(u,v)/H(v,u);
      end
   end
end
figure, imshow(log(abs(fftshift(F))),[]);

fRestored = real(ifft2(ifftshift(F)));
figure, imshow(fRestored, []);
```

3.1 ILLUSTRATION 1:

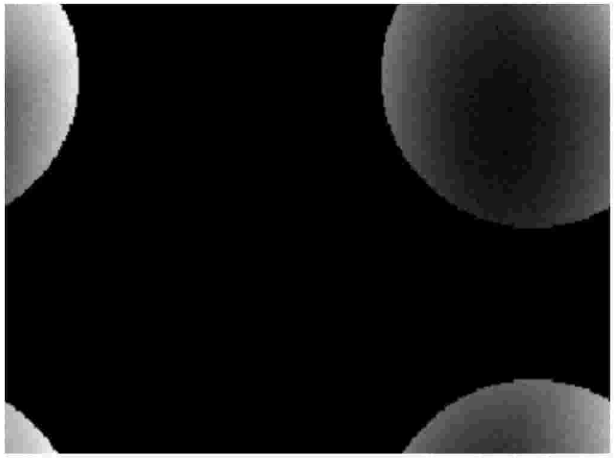
Blurred Image



Adding Noise using Gaussian Filter



Fourier Transform of the Observed Image

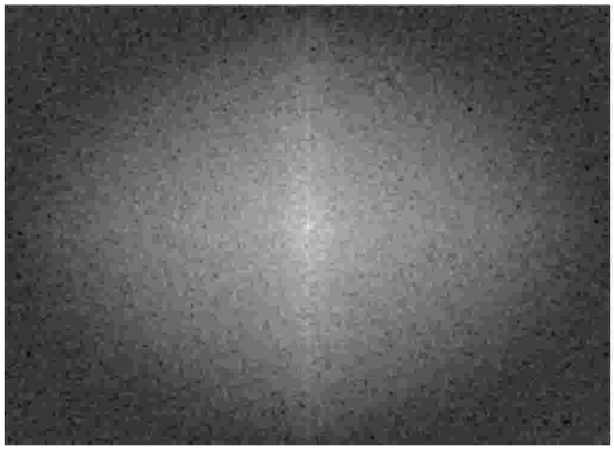


Fourier Transform of the Blurred Image

Restored Image

3.2 ILLUSTRATION 2:

Blurred Image



Adding Noise using Gaussian Filter

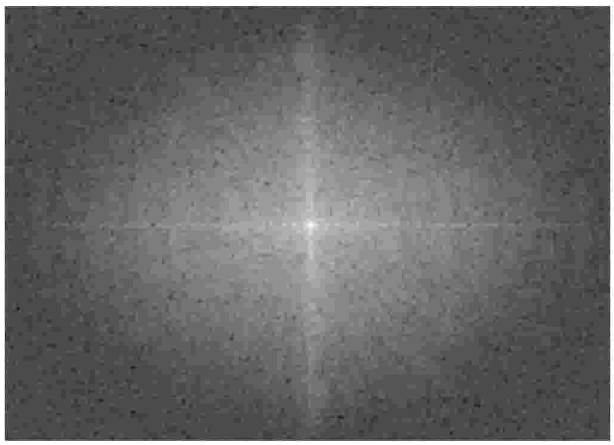
Fourier Transform of the Observed Image

Fourier Transform of the Blurred Image

Restored Image

3.3 ILLUSTRATION 3:

Blurred Image



Adding Noise using Gaussian Filter

Fourier Transform of the Observed Image

Fourier Transform of the Blurred Image

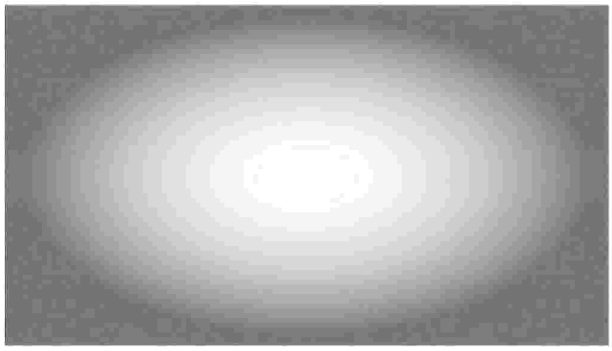
Restored Image

3.4 ILLUSTRATION 4:

Blurred Image

Adding Noise using Gaussian Filter

Fourier Transform of the Observed Image

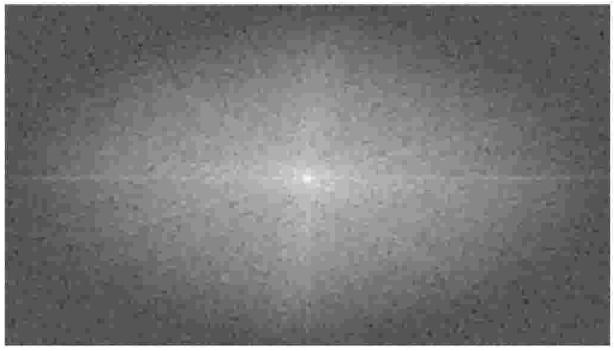


Fourier Transform of the Blurred Image

Restored Image

3.5 ILLUSTRATION 5:

Blurred Image



Adding Noise using Gaussian Filter

Fourier Transform of the Observed Image

Fourier Transform of the Blurred Image

Restored Image

Chapter 4

APPLICATIONS OF IMAGE RESTORATION

4.1 APPLICATIONS OF IMAGE RESTORATION

- **Historical Images: In early days the camera was not good as today.Long exposure time was required to capture a picture.For that both camera and the object should be motionless for a long time , which was a difficult task.And also the lenses used were also not perfect when compared to the modern lenses.The printing were also difficult at that time due to poor technology.Due to this reasons the images captured on that days were blurred. But we can restore those images very easily and quickly using MATLAB.**

- **Medical Imaging: Medical imaging gives doctors a clear picture of what is happening inside a patient's body. Better vision allows you to better understand your condition. In addition, medical imaging allows doctors to accurately predict the likelihood of developing diseases such as cancer. Image restoration remains one of the most important areas in medical imaging. Image restoration is the removal or reduction of image degradation that may occur during the capture process. The ability to restore medical images contributes to better diagnosis and treatment.**

- **Astronomical Images: Images taken through the Earth's atmosphere are distorted and diffracted by dust, water vapour, pol-**

lution, particles (dust, pollen, etc.), thermal convection, and many other physical properties.Turbulence and temperature variations in the Earth's atmosphere can also causes astronomical objects to appear to twinkle and form blurry images. This images can be restored using MATLAB.

- Forensic Images: It aims to objectively restore the content or quality of the original image from the degraded image. Image degradation is always generated in image transmission, such as distortion, blur. In modern video surveillance system, image restoration is significant for criminal investigation.

4.2 APPLICATIONS OF DIGITAL IMAGE PROCESSING

Nowadays digital image processing is an unavoidable factor in the technical area. The areas where digital image processing used is wide and varied. A large spectrum of human activities from remotely sensed image interpretations to biomedical interpretations, we use digital image processing. A few important examples are depicted here:

4.2.1 Gamma Ray Imaging

It is used in nuclear medicines and astronomical observations. In nuclear medicines, the patient is injected with a radioactive isotope and Images are produced from the emissions collected from the gamma ray detector. From these images we can find the tumour spot, infected areas etc.

4.2.2 X Ray Imaging

It is used in the field of medical diagnostic and also widely used in industrial field and astronomy. Eg: X Ray Tubes, Angiogram

4.2.3 Imaging in Ultraviolet Band

It is used in the field of lithography, industrial inspection, microscopy, laser, biological imaging and astronomical observations. Fluorescence

microscopy is a fast-growing field of microscopy.

4.2.4 Imaging in the Visible and Infrared Bands

It is used in light microscope, pharmaceuticals, remote sensing, automated visual inspection of manufactured goods. Weather observations and predictions.

4.2.5 Imaging in Microwave Band

The radar waves can penetrate through clouds, dry sand ice etc. Through those waves we can get information about the un accessed areas like huge rough mountainous area. Eg: space born radar image of mountain of South Tibet

4.2.6 Imaging in Radio Band

The important areas where radio band is used are: medicine, astronomy. For (MRI) Magnetic Resonance Imaging, radio waves are used. In this the patient is placed in a powerful magnet and radio waves are passed through their body as short pulses. In each pulse we'll get a responding pulse of radio waves to be emitted by the patient's tissues. We can locate the area by the strength of the responding pulse. Thus, we will get a two-dimensional picture of the patient's section.

4.3 CONCLUSION

Through this project we understood that we can restore any blurred image using MATLAB. And it has many applications in the field of traffic, since due to the misfocus of the camera and speed of the vehicles we get an unclear image of the vehicle and by doing this process we can enhance the quality of the image and make it clear.

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