Restoration of a Distorted image using Digital Image Processing

A

Project Report

Submitted in partial fulfillment of the

requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

In

COMPUTER SCIENCE & ENGINEERING

Specialization in

CCVT

by

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CANDIDATE'S DECLARATION

We hereby certify that the project work entitled "Restoration of a Distorted Image Using Digital Image Processing " in partial fulfilment of the requirements for the award of the Degree of BACHELOR OF TECHNOLOGY in COMPUTER SCIENCE AND ENGINEERING with specialization in CCVT and submitted to the Department of Virtualization at School of Computer Science, University of Petroleum & Energy Studies, Dehradun, is an authentic record of my/ our work carried out during a period from **January**, **2020** to **May, 2020** under the supervision of **Dr. Shamik Tiwari, Associate Professor (SCS), Department of Virtualization (School of Computer Science).**

The matter presented in this project has not been submitted by me/ us for the award of any other degree of this or any other University.

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This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Date:______________2020

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ABSTRACT

Blurring of an image is commonly caused due to two main degradation phenomenon i.e. Out-of-Focus blur and Motion blur. However, Image deblurring has been amongst the most dynamic and experimental subjects in computational photography and Digital Image Processing in recent years. With the goals of restoring a distorted image, image enhancements techniques attempt to reconstruct an image that is distorted by a known degradation phenomenon. The most optimal procedure is to identify and model the degradation phenomenon and implement the inverse process in order to reconstruct the actual image rather than considering the heuristic approaches which is largely subjective. Firstly, the proposed method is used to find the amount and direction of motion blurs in the image which is further used to estimate the Point Spread Function (PSF). With the aid of a deconvolution algorithm, we expect the proposed method will achieve the satisfactory results when implemented over a motion-blurred image.

KEYWORDS: ***Motion Blurring, Out-of-Focus Blurring, Digital Image Processing, Heuristics, Point Spread Function (PSF), Deconvolution Algorithm.***

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1. INTRODUCTION

1.1 History

The Image processing field is constantly evolving. In the past five years the level of interest in image morphology, neural networks, full color image processing, image data compression, image recognition, and knowledge-based image analysis systems has increased significantly.

Image processing methods stem from two key areas of application: enhancement of pictorial information for human understanding, and autonomous computer perception of scene details.

Image is better for our human being to interpret that than any other form of knowledge. Vision helps us view and appreciate the world around us. Image understanding, image analysis, and computer vision aim to duplicate the effect of human vision by electronically (= digitally, in the present context) perceiving and understanding image(s)In digital image processing system, The method is Image Acquisition, which involves the acquisition of an image. After acquiring a digital image, the next step of Preprocessing is to refine the image of ways that maximize the chances of success of other processes.

The next step involves partitioning an input image into its constituent parts or artifacts, Representation & Description deals with rendering data in a form appropriate for computer processing, and then Identification is that assigns a mark to an entity, and last Interpretation involves the assembly of recognized artifacts as meaning.

1.1 Requirement Analysis

SOFTWARE REQUIREMENTS (Recommendations)

Operating System	:	Windows 10 or above
Programming Language	:	Python
Compiler	:	Jupyter Notebook

HARDWARE REQUIREMENTS (Recommendations)

Processor	:	Intel® Core™ i5-7200U CPU @ 2.50GHz
Disk Drive	:	Hard Disk Drive
RAM	:	8 GB or higher

1.2 Main Objective

- To generate the Point Spread Function (PSF) of the Motion Blurred Image.
- Restoration of the Distorted Image due to Motion Blur.
- Implement Filters like inverse & noise for image enhancements.

1.3 Pert Chart Legend

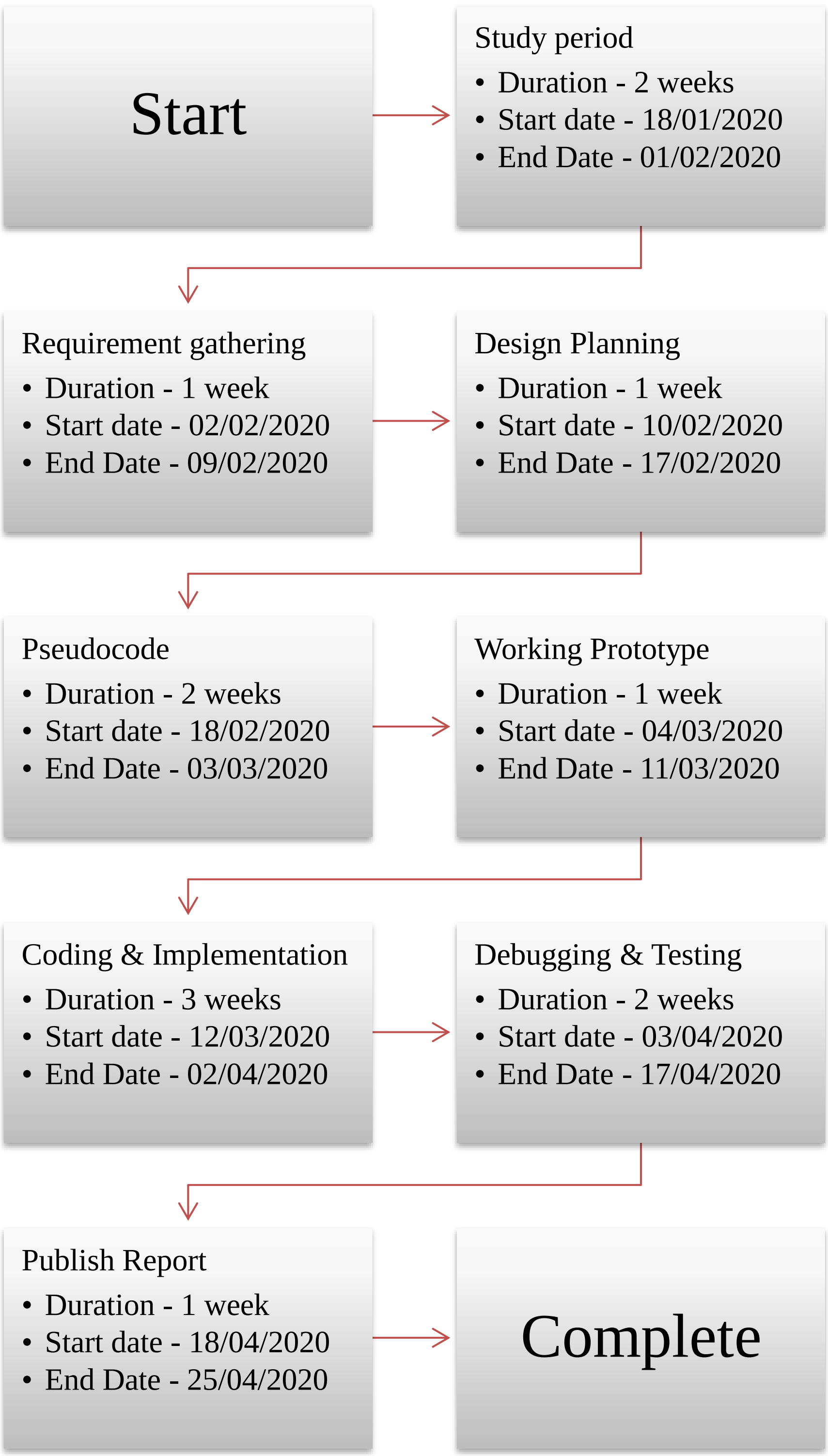

Figure 1.1 Pert Chart

2. SYSTEM ANALYSIS

2.1 Motivation

Digital image processing deals with digital image manipulation by means of a digital computer. It is a subfield of signals and systems but especially focuses on images. DIP focuses on the development of a computer program that can perform image processing. The system's input is a digital image, and the system process the image uses powerful algorithms, and produces an image as output. The most common example is Adobe Photoshop. It is one of the widely used application for processing digital images.

2.2 Methodology

Let's suppose the following notations to make the procedure easier to understand.

f(x, y) – actual image(non - blurred);

h(x, y) - blurring function;

n(x, y) - additive noise;

g(x, y) - blurring result image.

The blurring process can be defined as :-

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

The blurring function is responsible for the blurring of the image. The blurring function is also known as Point Spread Function (PSF), kernel, etc. The process of applying a blurring function to another is called convolution. The inverse process is called Deconvolution which is actually the restoration of the image. The inverse filter of the blurring function is applied to reconstruct the subject image.

Mathematically, for an image *f* with dimensions M x N and the blurring function *h* with dimensions m x n it can be written down as follows:

$$g(x,y) = h(x,y) * f(x,y) = \sum_{i=-a}^{a} \sum_{j=-b}^{b} h(i,j) f(x+i, y+j)$$

Where *a = (m - 1) / 2, b = (n - 1) / 2.*

The Convolution theorem used the Fourier transformation for the simplicity of the calculations of the equations which is very essential to reconstruct the image.

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

Where *H(u, v), F(u, v)* - Fourier functions for h(x,y) and f(x,y).

Using the Fourier Transformation and the PSF, the deconvolution process uses the Wiener algorithm to reconstruct the image.

Deconvolution process includes various algorithms such as Weiner, Tikhonov, Lucy-Richardson, Blind Deconvolution.

The inverse filter uses the Weiner Deconvolution which actually uses the Fourier Transformation which is defined as:

$$\hat{F}(u,v) = F(u,v) + \frac{N(u,v)}{H(u,v)}$$

But this filtering actually never works in practical. The it is utterly important to convert the source image to its grayscale image in order to implement the algorithm and get the desired results.

However, the noise function also plays an important role and can actually disturb the results. So it is equally essential to address the problem and find a solution to it.

And the existing approach for deconvolution process is:

$$\hat{F}(u,v) = \left(\frac{1}{H(u,v)} \frac{|H(u,v)|^2}{|H(u,v)|^2 + S_\eta(u,v)/S_f(u,v)}\right) G(u,v)$$

It considers the image and the noise as random processes and finds such a value of *f′* for a distortion-free image *f*, that the mean square deviation of these values was minimal. The minimum of such deviation is achieved at the function in the Frequency domain.

4. IMPLEMENTATION

3.1 Algorithm

1. Start
2. Take an original input image for processing.
3. Generate a blurring function for the input image.
4. Pass it through the blurring filter
5. Use the resultant image to pass it through the Inverse filter
6. Use the same resultant image to pass it through the Weiner Filter
7. Now, Use the initially blurred image to pass it through a noise filter to add some noise in the blurred image.
8. Again, Use the Noise & Blurred Image (NMBI) to pass it through the deblurring filters.
9. Pass this NMBI to Inverse Filter.
10. Pass the NMBI through the Weiner Filter again to deblur it.
11. Display all the resultant images.
12. Stop.

3.2 Pseudocode

```
def make_blurred(input_image, psf, eps):
    input_fft = fft.fft2(input_image)
    psf_fft = fft.fft2(psf) + eps
    blurred = fft.ifft2(input_fft * psf_fft)
    blurred = np.abs(fft.fftshift(blurred))
    return blurred
```

Figure 2.1 Blurring Process

```
# This is the motion deblurring function.
# Image size is the dimesnions of the image while motion_angle is theangle by which the motion blurring is happening.
# centre postion of the image is used for applying the blurring function w.r.t the angle of motion and a psf is generated.

def motion_process(image_size, motion_angle):
    psf = np.zeros(image_size)
    print(image_size)
    center_position = (image_size[0] - 1) / 2
    print(center_position)

    slope_tan = math.tan(motion_angle * math.pi / 180)
    slope_cot = 1 / slope_tan
    if slope_tan <= 1:
        for i in range(15):
            offset = round(i * slope_tan)
            psf[int(center_position + offset), int(center_position - offset)] = 1
        return psf / psf.sum()
    else:
        for i in range(15):
            offset = round(i * slope_cot)
            psf[int(center_position - offset), int(center_position + offset)] = 1

        return psf / psf.sum()
```

Figure 3.2 Motion Deblurring Process

```
# This is the Inverse Filter.

def inverse_filter(input_image, psf, eps):
    input_fft = fft.fft2(input_image)
    psf_fft = fft.fft2(psf) + eps
    result = fft.ifft2(input_fft / psf_fft)
    result = np.abs(fft.fftshift(result))
    return result
```

Figure 4.3 Inverse Filter

```
# This is the Weiner Filter.

def wiener_filter(input_image, psf, eps, K=0.01):
    input_fft = fft.fft2(input_image)
    psf_fft = fft.fft2(psf) + eps
    psf_fft_1 = np.conj(psf_fft) / (np.abs(psf_fft) ** 2 + K)   # This is the weiner formula for deconvulation.
    result = fft.ifft2(input_fft * psf_fft_1)
    result = np.abs(fft.fftshift(result))
    return result
```

Figure 5.4 Weiner Filter

3.3 Flow Chart

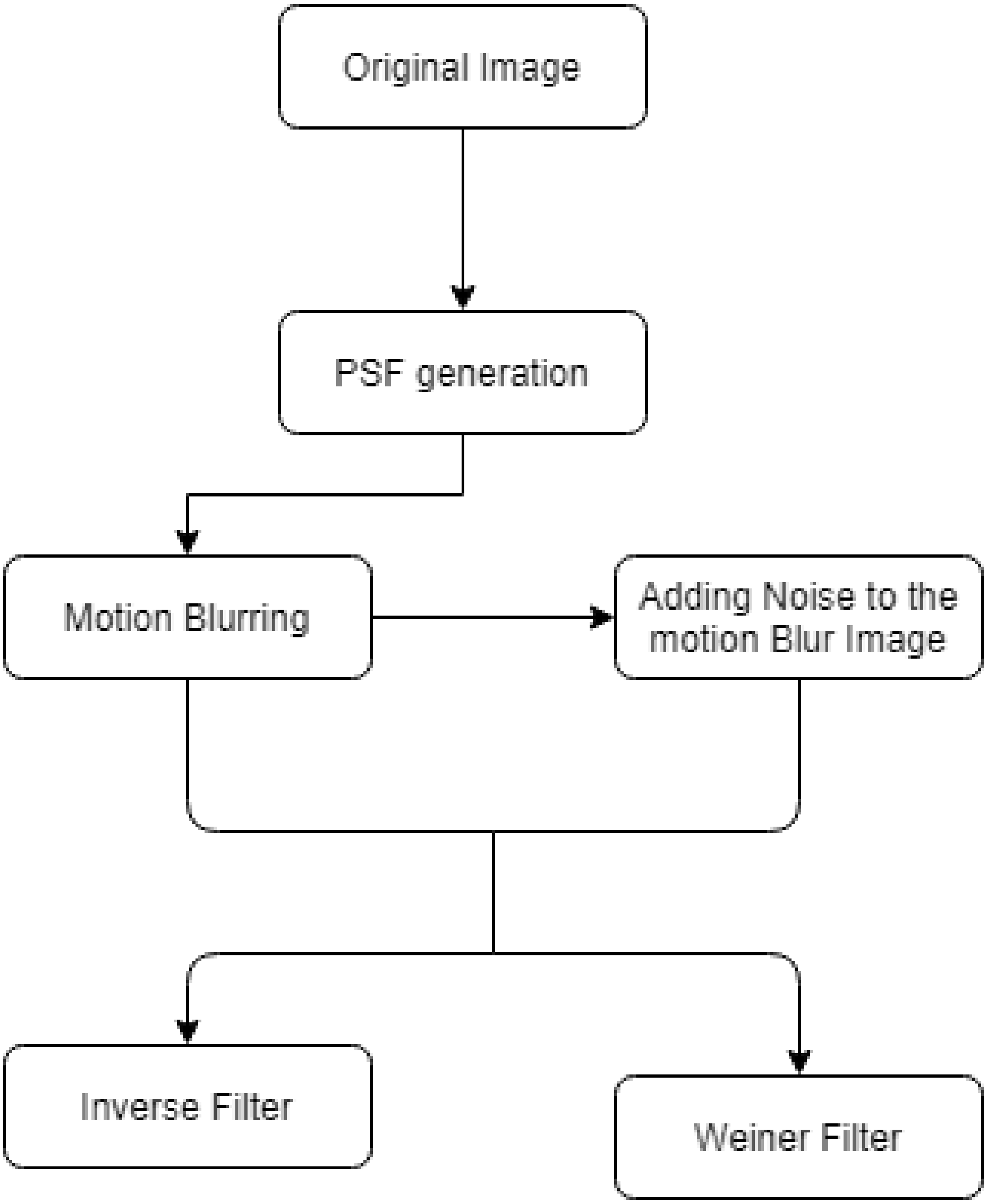

Figure 6.5 Flowchart

4. OUTPUT SCREEN

Figure 4.1 Original Image

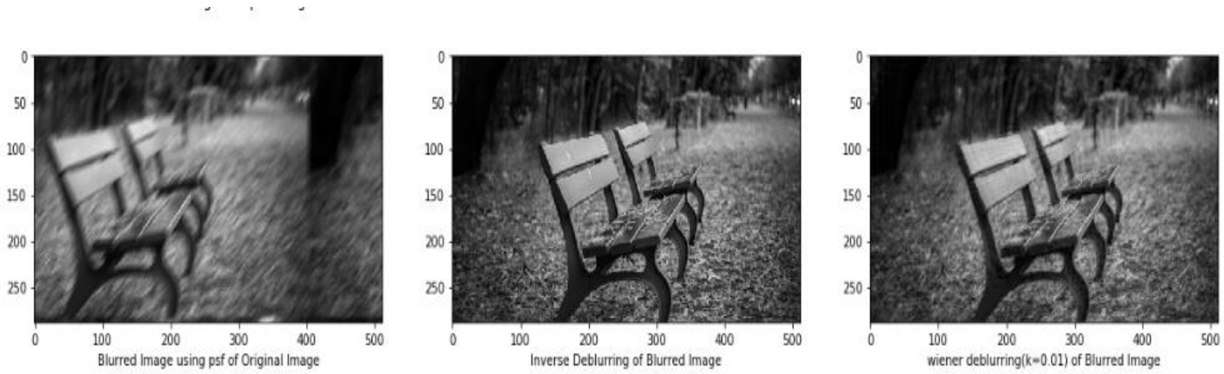

Figure 4.2 a) Motion Blurred; b) Inverse Deblurred; c) Weiner Deblurred

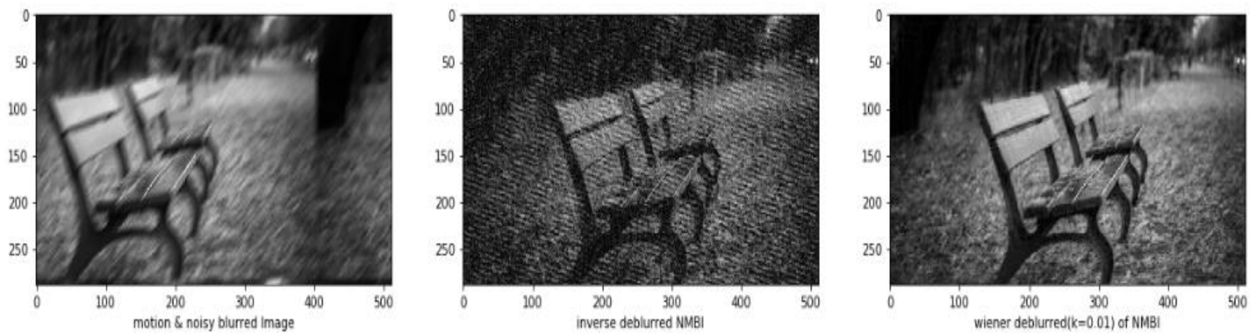

Figure 4.3 a) Noise & Motion Blurred Image; b) Inverse Deblurred of NMBI; c) Weiner Deblurred of NMBI

5. LIMITATIONS & FUTURE ENHANCEMENTS

Cue Integration

- Today: Perfection of cues such as edges, motion, depth, texture.
- Future: Integration of multiple cues.

Dynamic 3D

- Today: Excellent 3D capturing methods available.
- Future: But the world is 4D (3D+time).

Recognition of object categories

- Today: Vision system can recognize individual objects under varying circumstances.
- Future: General categorization problem unsolved (exceptions: face/OCR).

6. CONCLUSION

Digital image processing plays a crucial role in enhancing images that are of low quality. Particularly with the aid of digital image processing, data obtained from Automated Image Acquisition Systems which is in digital form can best be used. Image enhancement is an

Important components of digital image Processing. Image enhancement techniques help improve the visibility of any portion or photo feature which suppresses information in other portions or features. The goal of image enhancement is to boost an image's visual appearance or to provide a "better transform representation for future automated image processing." Apart from Forensic images, other images such as medical images, satellite photos, microscopic photos and even pictures of real life are impaired by poor contrast and noise in various disciplines.

In order to improve image quality, the contrast must be increased and the noise eliminated. Image Enhancement techniques improve the consistency (clearness) of images for both human viewing and computer perception, eliminate blurring and noise, increase contrast and reveal information are examples of enhancement operations. The enhancement technique varies according to its function from one area to another. However, this software’s needs a good computer which has high specification so that the processing for the image is efficient.

7. REFERENCE

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