Blur Estimation and Identification of Degraded Images

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Abstract— During the process of image acquisition, sometimes images are degraded by various reasons. Image restoration is a challenging task in the field of Image processing. The process of recovering such degraded or corrupted image is called Image Restoration. Restoration process improves the appearance of the image. The degraded image is the convolution of the original image, degraded function, and additive noise. Process of restoration is deconvolved this degraded image to obtain noiseless and deblurred original image. This paper proposed the easiest method for blur estimation and identification. Usual types of blur such as motion, defocus, Gaussian have been taken as Point Spread Function (PSF).

Key words: Blur, Motion, Defocus, Degradation

I. INTRODUCTION

Image restoration is a process which takes imperfect or distorted images and perform the inverse operation of degradation on those images. There are many reasons of image degradation like defective of optical lenses, relative motion between camera and an object, wrong focus, atmospheric turbulence in remote sensing. Restoration of image is attempting to reverse process of degradation so very first it is necessary to identify the degradation process. In other words, image restoration process recovers the degraded images which are distorted by blur and noise. Blur may occur due to atmospheric-turbulence, motion of object and camera miss-focus. Image restoration is almost similar to Image enhancement but it is more objective. To recover the original image, prior knowledge of degradation should be available. Because image restoration involve modelling of degradation and then applying inverse process to that model. Figure 1. Shows sample degraded image as well as restored image.

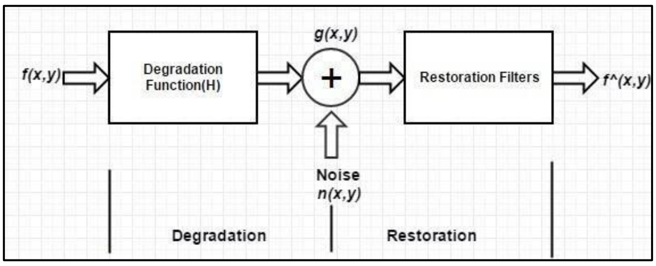

Fig. 1: Degradation-restoration model

Reconstruction of the image can be performed using 2 types of model (i) Degradation Model (ii) Restoration Model. To restore the image there must have knowledge of degradation. Restoration process improves the appearance of the image.

There are many reasons available for degradation such as sensor noise, camera-misfocus, relative object-camera motion, random atmospheric turbulence, random variation of brightness or color information in the image is called noise it can be produced by sensor and circuitry of a scanner or digital camera [1]. While object moves to the camera or vice versa, motion blur can be caused [2][3]. While the object is out of focus of the camera during exposure, the object region in the image is also blurred. This kind of blur is called defocus blur [4][3]. Imaging system is affected by atmospheric turbulence by virtue of wave propagation through a medium with non- uniform index of refraction.

After determining whether an image is blurred or not it is important to evaluate the image's Point Spread Function (PSF) to estimate the degree of degradation for further image restoration. Depending on the type of degradation, the blur may be parameterized differently. The image degradation process can be modelled by the following convolution process [5][6]

$$g(x,y) = h(x,y) * f(x,y) + n(x,y) \tag{1}$$

Equation (1) shows g(x, y) is the degraded image in spatial domain, f(x,y) is the uncorrupted original image in the spatial domain, h(x,y) is the point spread function that caused the degradation and n(x,y) is the additive noise. Since, convolution in spatial domain is equal to the multiplication in frequency domain, (1) can be written as

$$G(u,v) = F(u,v)H(u,v) \tag{2}$$

Equation (2) shows degradation model in frequency domain where G(u,v) is degraded image as g(x,y) in time domain. F(u,v) is undistorted image and H(u,v) is degradation function. In order to develop reliable blur detection, it is essential to understand the image degradation process. Degradation function may be due to improper opening and closing of shutter, atmospheric turbulence, out of focus of lens or due to motion blur. The noise and degradation functions have contradicting effects on the image spectrum. The degradation function gives averaging effect on the image data and behaves like a low pass filter, whereas noise often introduces additive broad band signals in the image data. When an object or the camera is moved during light exposure, a motion blurred image is produced. The motion blur can be in the form of translation, rotation, and sudden change of the scale or some combinations of these forms.

In the case of a motion blurred image this estimate gives the number of pixels in the blur and the blur direction. However, in the case of defocus blur the PSF is parameterized by the radius of the circle of confusion. Due to uncertain, short lived nature of the degradation process and due to the loss of information due to the blurring, the PSF recovery problem is an ill-posed problem [7]

II. LITERATURE SURVEY

Paper [8] presents the comparative analysis of restoration algorithm. They implemented wiener filter, constrained least square, Lucy-Richardson algorithm and blind deconvolution methods in presence of different artifacts. Performance measures like Peak signal to noise ratio (PSNR), Mean square error (MSE) and Correlation index (CI) are used to quantify the performance of the restoration filters. Results and analysis shows that CLS filter is comparatively better in restoring the degraded image. Paper [9] proposed adaptive blind restoration algorithm where the large estimation error of PSF and the complex computation in blind image restoration methods. According to the feature certain blur may lead to the specific frequency component distortion of the image frequency spectrum. Fourier transform is used for blur identification because three usual types of blur are used in input images are motion, defocus and Gaussian which recover by using wiener restoration algorithm and for other than usual blur author used NAS-RIF algorithm. Paper [1] a novel approach for image restoration has been developed. To show the analysis of performance of this noel restoration procedure GUI has been developed. It shows the Restoration of Degraded image on various noises by different Filters. In implementation of the approach first, image is degraded by adding different types of noises in sample images and then convolving images with different kinds of filters (Mean Filters, Min and Max Filters). Proposed image restoration method’s analysis on performances of denoising techniques Graphical User Interface has been developed as a part of this research. In this paper true colour sample images are degraded with different noise and then is restored back. The performance analysis of the present approach with state of art techniques are in terms of mean square error, peak signal-to-noise ratio, and normalized absolute error is also provided. In comparisons with other state of art methods, present approach yields better to optimization, and shows to be applicable to a much wider range of noises. Paper [10] is presenting comparative study of restoration methods for space variants motion blurred image using kalman and wiener filter. Performance verified by improvement in signal to noise ratio (ISNR).

Paper [2] solve the problem of setting the initial condition in 2D block kalman filter on degraded image for image restoration. The innovation of this paper are setting reasonable filtering initial condition which are associated with image information and Increase interpolation with edge protection function then layering is performed. Paper [11] presented algorithm which contributes to the faster and efficient restoration with DWT Haar Transformation. The performance evaluation and analysis is done using various image restoration techniques like FFT and DWT transformation with different Wavelet functions like Haar, Daubechies, Symlets and Coiflets and also compared with FFT. On the basis of evaluation it has been concluded that DWT transformation is better than FFT. Later on, we have done analysis on the basis of wavelet functions and found that Haar wavelet function gives higher value of PSNR and lower value of MSE.

Paper [12] blurred image regions are first detected by examining singular value information for each image pixels. The blur types (i.e. motion blur or defocus blur) are then determined based on certain alpha channel constraint that requires neither image deblurring nor blur kernel estimation. Extensive experiments have been conducted over a dataset of 200 blurred image regions and 200 image regions with no blur that are extracted from 100 digital images. Experimental results show that the proposed technique detects and classifies the two types of image blurs accurately. The proposed technique can be used in many different multimedia analysis applications such as image segmentation, depth estimation and information retrieval. Paper [5] in which blurred image transformed from time domain to frequency domain for the appearance of the blur pattern. Features are extracted in wavelet domain and a feed forward neural network is designed with these features.

III. PROPOSED WORK

In this section three usual types of of blurred image are taken as an input. Images is convolved with low pass filtering then it becomes blurry. Blur types are (i) motion- where the time variant component are used to show the motion direction in x axes and y axes. At the time of image acquisition relative motion occurred between object and camera lens. Parameter estimated in motion blur images are length and theta. (ii) defocus- occurred when object has been out of focus while capturing the image. (ii) Gaussian- where occurred by atmospheric turbulence and the estimation of variance is important. In which the default blur kernel size is 3x3 and default standard deviation is 0.5(verify it). As we know the restoration is the inverse process of degradation, so be careful about the information of PSF kernel. In our proposed technique estimation of blur that up to what extent of blur exists in the image. Identification step of blur is needful when images to be recover and there are lot of images found in dataset with generic degradation. For blur estimation different focus measures are available in the field of image processing such as gradient-based operator, Laplacian-based operator, wavelet-based operator, statistic-based operator and DCT-based operator [13]. In the proposed methodology Laplacian-based operator is used, the goal of these operators is to measure the amount of edges present in images, although through the second derivative or Laplacian. The Laplacian matrix is:

$$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

The SFF (Shape-from-Focus) process consists of two main stages: focus measure and scene reconstruction. The first step aims at measuring the degree of focus of an image (or imaged point), whereas scene reconstruction aims at generating accurate 3D shapes (generally depth-maps) from the focus information obtained from the processed images.

Now, the proposed flow diagram is of:

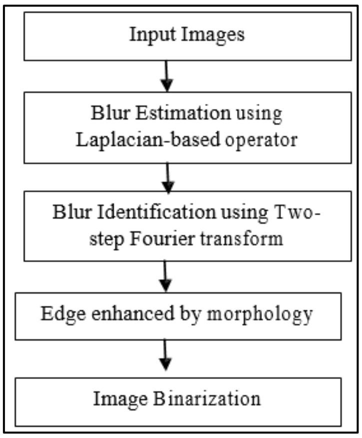

Fig. 2: Proposed Flow

This is how our flow of proposed technique. After taking input images necessary to verify whether image is degraded by blur or not. As we know if blur is exist in the image, maximum amount of blur would be on the edges of the image. So Laplacian –based operator is best for detection of blur on the edges of the image. Steps for estimation of blur in the image:

Step 1 : Take an image
Step 2 : Convolve it with Laplacian operator
Step 3 : Compute variance of result
Step 4 : Take mean of output image of above step.

In which we take one original image save its blur level as a reference and check other degraded images' blur level according to reference blur level. After the estimation of blur image can be transform from spatial domain to frequency domain where we obtain two component value for each pixel in spatial domain. One component is for real part and another component is complex part [14]. We need to combine this and finally compute Fourier transform of it. Magnitude image will obtain in output for three different blur. Steps to perform discrete fourier transform of input image is:

Step 1 : Load the image
Step 2 : Convert Color image into Gray scale Image
Step 3 : Expand the size of image
Step 4 : In frequency domain, 2 values are obtained for each corresponding component in its spatial domain
Step 5 : Merge 2 planes which stored real values and complex values
Step 6 : Apply DFT on merged planes
Step 7 : Split both the planes
Step 8 : Find magnitude for visual purpose
Step 9 : Take logarithm of Magnitude

Computation of Discrete Fourier transform gives the output in complex form so separate two plan which for real and complex part which are merged earlier in step 5. Magnitude will be compute by following equation:

$$\mathrm{M} = \sqrt[2]{Re(DFT(I))^2 + Im(DFT(I))^2} \qquad (3)$$

Equation (3) is for computing the magnitude of Fourier transform of image. Because the value would be obtain after Fourier transform cannot be judge and which is not in visible form. So we find the magnitude by taking its logarithm. Now image can fit into the screen. The morphology method is a simple method; it can flexibly select the structural element and preserve the specific features well. So the morphology edge enhanced method is used in this paper for edge enhanced, and the structural element we used is

$$\begin{bmatrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

A global threshold selection method is used to calculate the gray threshold.

IV. RESULT ANALYSIS AND EXPERIMENT

Based on the above discussion, 450 blur images [15] with different blur types and different are simulated. The 3 sample data is chosen randomly from the motion blur, defocus blur and Gaussian blur to calculate the moment invariants respectively.

Fig. 3 (a) Fig. 3 (b)

Fig. 3: (a) Original sample image (b) Focus level and its blur level in percentage

Fig. 4 (a) Fig. 4 (b)

Fig. 4: (a) image with motion blur (b) its focus level and blur level

Fig. 5(a)

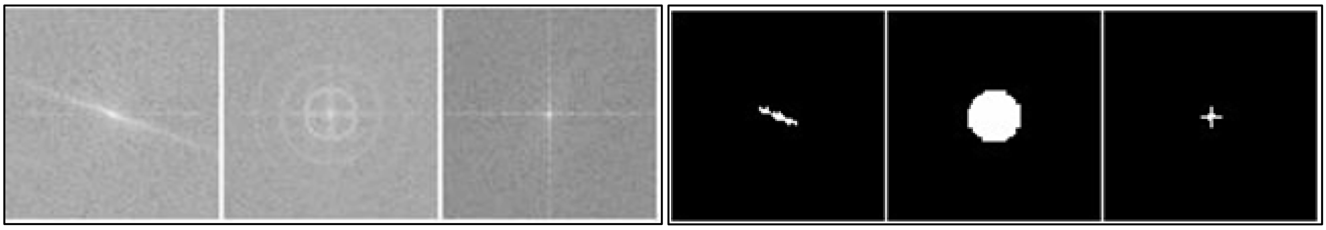

Fig. 5(b) Fig. 5(c)

Fig. 5: (a) lena images with motion, defocus, gaussian blur (b-c) its corresponding FT image and binary image

Fig. 6(a)

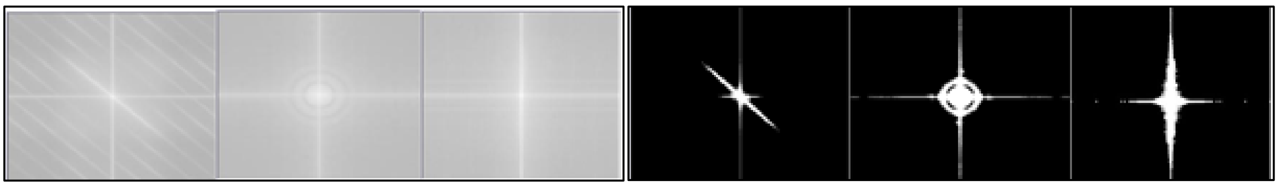

Fig. 6(b) Fig. 6(c)

Fig. 6: (a) image with motion, defocus and Gaussian blur (b-c) its FT image and binary image

V. CONCLUSION

Here proposed methodology for Estimation of blur, automatic blur identification, classification of imperfect image is performed. This is very efficient algorithm which can maximize speed for restoration. Proposed methodology started with the activity of converting the color image into gray scale image, Fourier Transform is applied on gray image for blur identification on input image. Binarization for blur region detection is performed.

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