Restoration of blurred images using Blind Deconvolution Algorithm

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Abstract

Image restoration is the process of recovering the original image from the degraded image. Aspire of the project is to restore the blurred/degraded images using Blind Deconvolution algorithm. The fundamental task of Image deblurring is to de-convolute the degraded image with the PSF that exactly describe the distortion. Firstly, the original image is degraded using the Degradation Model. It can be done by Gaussian filter which is a low-pass filter used to blur an image. In the edges of the blurred image, the ringing effect can be detected using Canny Edge Detection method and then it can be removed before restoration process. Blind Deconvolution algorithm is applied to the blurred image. It is possible to renovate the original image without having specific knowledge of degradation filter, additive noise and PSF. To get the effective results, the Penalized Maximum Likelihood (PML) Estimation Technique is used with our proposed Blind Deconvolution Algorithm.

Keywords: Blind Deconvolution Algorithm, Canny Edge Detection, Degradation Model, Image restoration, PML, PSF

I. INTRODUCTION

Image deblurring is an inverse problem which whose aspire is to recover an image which has suffered from linear degradation. The blurring degradation can be space-invariant or space-in variant. Image deblurring methods can be divided into two classes: nonblind, in which the blurring operator is known. And blind, in which the blurring operator is unknown.

Blurring is a form of bandwidth reduction of the image due to imperfect image formation process. It can be caused by relative motion between camera and original image. Normally, an image can be degraded using low-pass filters and its noise. This low-pass filter is used to blur/smooth the image using certain functions.

Image restoration is to improve the quality of the degraded image. It is used to recover an image from distortions to its original image. It is an objective process which removes the effects of sensing environment. It is the process of recovering the original scene image from a degraded or observed image using knowledge about its nature. There are two broad categories of image restoration concept such as Image Deconvolution and Blind Image Deconvolution.

Image Deconvolution is a linear image restoration problem where the parameters of the true image are estimated using the observed or degraded image and a known PSF (Point Spread Function). Blind Image Deconvolution is a more difficult image restoration where image recovery is performed with little or no prior knowledge of the degrading PSF. The advantages of Deconvolution are higher resolution and better quality.

This paper is structured as follows: Section 2 describes the degradation model for blurring an image. Section 3 represents Canny Edge Detection. Section 4 describes the deblurring algorithm and overall architecture of this paper. Section 5 describes the sample results for deblurred images using our proposed algorithm. Section 6 describes the conclusion, comparison and future work.

II. DEGRADATION MODEL

In degradation model, the image is blurred using filters and additive noise. Image can be degraded using Gaussian Filter and Gaussian Noise. Gaussian Filter represents the PSF which is a blurring function. The degraded image can be described by the following equation (1)

$$g = H * f + n \rightarrow (1)$$

In equation (1), g is degraded/blurred image, H is space invariant function (i.e.) blurring function, f is an original image, and n is additive noise. The following Fig.1 represents the structure of degradation model.

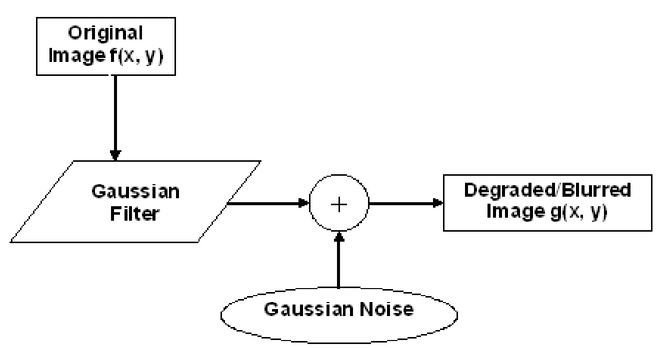


Fig. 1 Degradation Model

Image deblurring can be done by the technique, Gaussian Blur. It is the convolution of the image with 2-D Gaussian function.

A) Gaussian Filter:

Gaussian filter is used to blur an image using Gaussian function. It requires two parameters such as mean and variance. It is weighted blurring. Gaussian function is of the following form

$$G(x, y) = 1/2\pi\sigma^2 * e^{-x^2+y^2/2\sigma^2} \rightarrow (2)$$

where σ is variance and x and y are the distance from the origin in the horizontal axis and vertical axis respectively. Gaussian Filter has an efficient implementation of that allows it to create a very blurry blur image in a relatively short time.

B) Gaussian Noise:

The ability to simulate the behavior and effects of noise is central to image restoration. Gaussian noise is a white noise with constant mean and variance. The default values of mean and variance are 0 and 0.01 respectively.

C) Blurring Parameter:

The parameters needed for blurring an image are PSF, Blur length, Blur angle and type of noise. Point Spread Function is a blurring function. When the intensity of the observed point image is spread over several pixels, this is known as PSF. Blur length is the number of pixels by which the image is degraded. It is number of pixel position is shifted from original position.

Blur angle is an angle at which the image is degraded. Available types of noise are Gaussian noise, Salt and pepper noise, Poisson noise, Speckle noise which are used for blurring. In this paper, we are using Gaussian noise which is also known as White noise. It requires mean and variance as parameters.

D) ***Algorithm for Degradation Model***

Input:

Load an input image 'f'
Initialize blur length 'l'
Initialize blur angle 'theta'
Assign the type of noise 'n'
PSF (Point Spread Function), 'h'

Procedure – I

h=create (f, l, theta) %Creation of PSF
Blurred image (g) = f*h + n
g= filter (f, h, n,"convolution")
If 'g' contains "ringing" at its edge then
Remove ringing effect using edge taper function
Else
Go to Procedure – II

End Procedure – I

III. CANNY EDGE DETECTION AND RINGING EFFECT

The Discrete Fourier Transform used by the deblurring function creates high frequency drop-off at the edges of images. This high frequency drop-off can create an effect called boundary related ringing in deblurred images. For avoiding this ringing effect at the edge of image, we have to detect the edge of an image. There are various edge detection methods available to detect an edge of the image.

The edge can be detected effectively using Canny Edge Detection method. It differs from other edge-detection methods such as Sobel, Prewitt, Roberts, Log in that it uses two different thresholds foe detecting both strong and weak edges. Edge provides a number of derivative (of the intensity is larger than threshold) estimators. The edge can be detected for checking whether there exists ringing effect in an input image.

A) Canny Edge Detector

Canny edge detection method finds edges by looking for local maxima of the gradient of f(x, y). The gradient is calculated using the derivative of a Gaussian Filter. The method uses two thresholds to detect strong and weak edges, and includes the weak edges in the output only if they are connected to strong edges. Therefore, this method is more likely to detect true weak edges.

1) Steps involved in canny method:

- The image is smoothed using Gaussian Filter with a specified standard deviation, σ, to reduce noise
- The local gradient, g(x, y) and edge direction are computed at each point.
- The edge point determined give rise to ridges in the gradient magnitude image. This ridge pixels are then thresholds, T1& T2, with T1<T2.

Ridge pixels with values greater than T2 are said to be 'strong' edge pixels. Ridge pixels with values between T1 & T2 are said to be 'weak' edge pixels.

B) Edgetaper for Ringing Effect:

The ringing effect can be avoided using edge taper function. Edgetaper function is used to preprocess our image before passing it to the deblurring functions. It removes the high frequency drop-off at the edge of an image by blurring the entire image & then replacing the center pixels of the blurred image with the original image.

IV. OVERALL ARCHITECTURE AND DEBLURRING ALGORITHM

The following Fig. 2 represents the overall architecture of this paper.

The original image is degraded or blurred using degradation model to produce the blurred image. The blurred image should be an input to the Deblurring algorithm. Various algorithms are available for deblurring. In this paper, we are going to use Blind Deconvolution Algorithm. The result of this algorithm produces the deblurring image which can be compared with our original image.

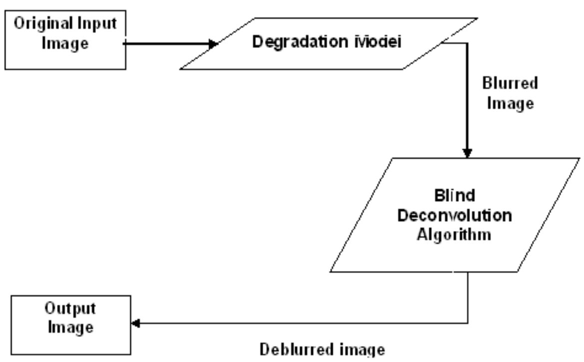


Fig. 2 Overall Architecture

A) Blind Deconvolution Algorithm:

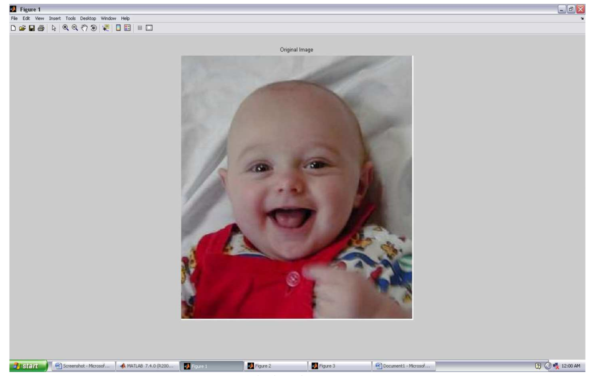
Blind Deconvolution Algorithm can be used effectively when no information of distortion is known. It restores image and PSF simultaneously. This algorithm can be achieved based on Maximum Likelihood Estimation (MLE).

1) Algorithm for Deblurring:

Input:
Blurred image ‘g’
Initialize number of iterations ‘i’
Initial PSF ‘h’
Weight of an image ‘w’ % pixels considered for restoration
a=0 (default) %Array corresponding to additive noise
Procedure – II
If PSF is not known then
    Guess initial value of PSF
Else
    Specify the PSF of degraded image
Restored Image f’= Deconvolution (g, h, i, w, a)
End Procedure – II

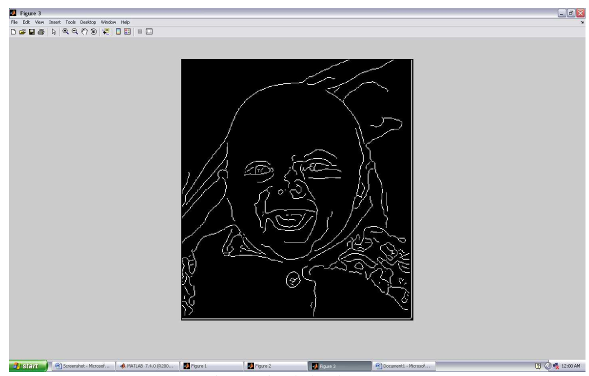
V. SAMPLE RESULTS

The below images represent the result of degradation model using Gaussian blur. First image represented the original image and its edge can be estimated by Canny Edge detection method.



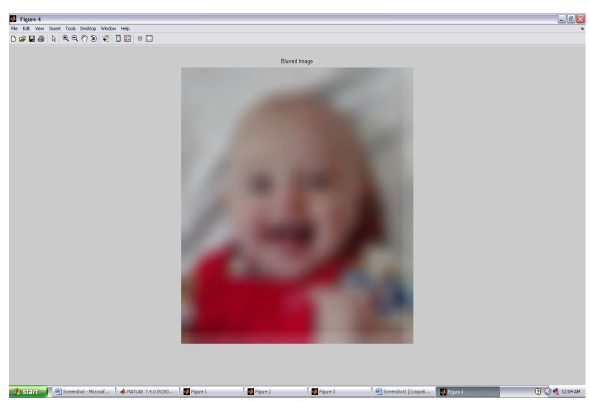
Original Image

The edge detection can be applicable to Gray Image. Therfore the origianl RGB image can be converted to gray image. After that Canny Edge Detection is applied for getting the Edges of the original image.

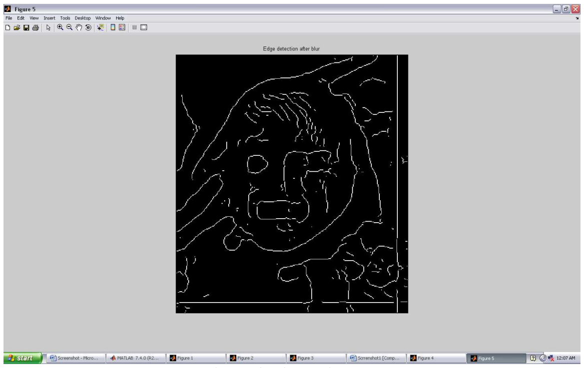


Edges of original Image

The original can be blurred using gaussian low pass filter by specifying the blur parameters. The following image is depicted as blurred image.

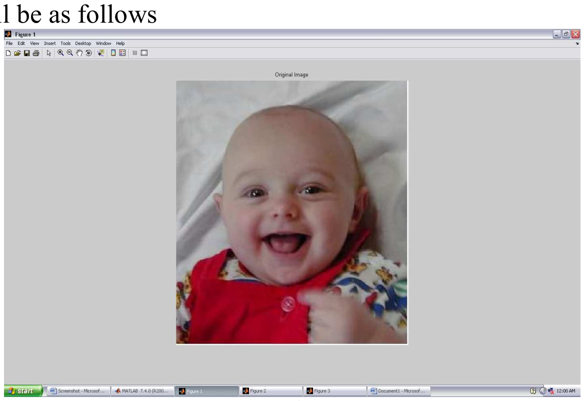


Blurred Image



Edge of Blurred Image

The sample image after applying the proposed algorithm will be as follows



Restored Image

VI. CONCLUSION

We have presented a method for blind image deblurring. The method differs from most other existing methods by only imposing weak restrictions on the blurring filter, being able to recover images which have suffered a wide range of degradations. Good estimates of both the image and the blurring operator are reached by initially considering the main image edges.

The restoration quality of our method was visually and quantitatively better than those of the other algorithms such as Wiener Filter algorithm, Regularization algorithm and Lucy-Richardson with which it was compared.

The advantage of our proposed Blind Deconvolution algorithm is used to deblur the degraded image without prior knowledge of PSF and additive noise. But in other algorithms, we should have the knowledge over the blurring parameters.

The future work of this paper is to increase the speed of the deblurring process that is reducing the number of iterations used for deblurring the image for achieving better quality image.

REFERENCES

[1] Mariana S.C. Almeida and Luis B. Almeida., **Blind and Semi-Blind Deblurring of Natural Images**, IEEE Transactions on Image Processing, Vol 19, pp.36-52, No. 1,January 2010.

[2] Michal Sorel and Jan Flusser, Senior Member, IEEE., **Space-Variant Restoration of Images Degraded by Camera Motion Blur**, IEEE Transactions on Image Processing, Vol 17, pp.105-116, No. 2,February 2008.

[3] Jian-Feng Cai, hui ji, Chaoqiang liu, Zuowei Shen., **"Blind Motion deblurring using multiple images**", journal of Computational physics., pp. 5057-5071, 2009.

[4] Shao-jie, WU Qiong, li Guo-hui., **"Blind Image deconvolution for single motion-blurred image**", Journal., 2009.

[5] D. Kundur and D. Hatzinakos, **"Blind image deconvolution,"** *IEEE Sig.Process. Mag.*, pp. 43–64, May 1996.

[6] Rafael C.Gonzalez, Richard E. Woods, Steven L. Eddins, *Digital Image Processing Using MATLAB* (Pearson Education, Inc., 2006)