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PURPOSE OF BLIND DE-CONVOLUTION ALGORITHM FOR IMAGE RESTORATION

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ABSTRACT

Image restoration is the process of recovering the original image from the degraded image and also understand the image without any artifacts errors. Image restoration methods can be considered as direct techniques when their results are produced in a simple one step fashion. Equivalently, indirect techniques can be considered as those in which restoration results are obtained after a number of iterations. Known restoration techniques such as inverse filtering and Wiener Filtering can be considered as simple direct restoration techniques. The problem with such methods is that they require knowledge of the blur function that is point-spread function (PSF), which is, unfortunately, usually not available when dealing with image blurring. In this paper Blind deconvolution for image restoration is discussed which is the recovery of a sharp version of a blurred image when the blur kernel is unknown.

Keywords: Blind deconvolution algorithm, degradation model, image restoration, PSF.

1. INTRODUCTION

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 images. 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. In digital image there are 3 common types of Blur effects [1]: Average Blur, Gaussian Blur and Motion Blur. Image deblurring can performed for better looking image, improved identification, PSF calibration, higher resolution and better quantitative Analysis.

1.1. Deblurring Model

A blurred or degraded image can be approximately described by this equation:

$$g = PSF*f + N,$$

Where: g the blurred image, h the distortion operator called Point Spread Function (PSF), f the original true image and N Additive noise, introduced during image acquisition, that corrupts the image [1]. Image deblurring is an inverse problem which is used to recover an image which has suffered from linear degradation. The blurring degradation can be space-invariant or space-in variant [2]. 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.

1.2. Image Deblurring Techniques

(*i*) ***Wiener Filter Deblurring Technique:*** The Wiener filter isolates lines in a noisy image by finding an optimal tradeoff between inverse filtering and noise smoothing. It removes the additive noise and inverts the blurring simultaneously so as to emphasize any lines which are hidden in the image. This filter operates in the Fourier domain [4], making the elimination of noise easier as the high and low frequencies are removed from the noise to leave a sharp image. The Wiener filter in Fourier domain can be expressed as follows:

$$W(f_1, f_2) = \frac{H^*(f_1, f_2)\, S_{xx}(f_1, f_2)}{|H(f_1, f_2)|^2\, S_{xx}(f_1, f_2) + S_{\eta\eta}(f_1, f_2)},$$

Where $S_{xx}(f_1, f_2)$, $S_{nn}(f_1, f_2)$ are power spectra of original image and additive noise and $H(f_1, f_2)$ is blurring filter.

(ii) Regularized Filter Deblurring Technique: Regulated filter is the deblurring method to deblur an Image by using deconvlution function deconverge which is effective when the limited information is known about additive noise.

1.3. Blind Image Deblurring Technique

(i) Blind Deconvolution Algorithm Technique: Blind Deconvolution is a subset of Iterative Constrained algorithms which produce an estimate of $h(x)$ concurrently with $f(x)$[3]. It does not need the PSF $h(x)$ to be measured. Other iterative constrained algorithms require $h(x)$ to be measured by acquiring data from sub resolution fluorescent beads.

$$g(x) = f(x) * h(x) + n(x)$$

Where $g(x)$: measurement, $f(x)$: unknown object, $h(x)$: unknown or poorly known PSF, $n(x)$: contamination.

The algorithm is producing the PSF from information within the data set $g(x)$. This is done by first assuming an $h(x)$, then (1), estimating which $f(x)$ could have caused $g(x)$. This calculation is followed by (2), estimating which $h(x)$ could have caused $g(x)$ from the estimated $f(x)$, and then steps (1) and (2) are repeated again and again. It is believable that the PSF information is in the data because one often sees the light spreading from fine point or line structures in the data, and this spreading makes up the PSF.

2. IMAGE DEGRADATION MODEL

In the model of image degradation [5] figure 1, the observed image $g(x, y)$ is modeled as the output of a 2-D linear system and can be characterized by its degradation function $h(x, y)$. The noise $n(x, y)$ is assumed to be a Gaussian white noise with zero mean. If the degradation function $h(x, y)$ is linear and space invariant function, then the observed blurred/noisy image in spatial domain is given by

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

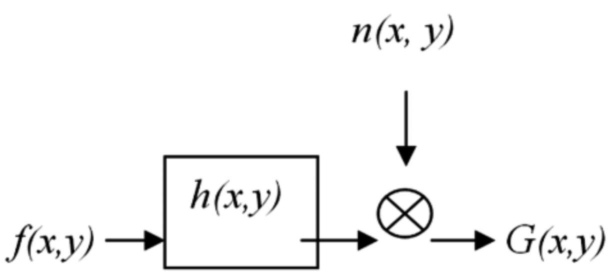

Figure 1: Image Degradation Model

2.1. 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 functions of the following from

$$G(x, y) = 1/2\ \pi\sigma^2 * e^{-x2+y2/2\sigma2}$$

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 relatively short time.

2.2. 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 which is represented by a series of outputs Y_i at discrete time event index i. Y_i is the sum of the input X_i and noise, Z_i, where Z_i is independent and identically-distributed and drawn from a zero-mean normal distribution with variance n (the noise). The Z_i are further assumed to not be correlated with the X_i. The default values of mean and variance are 0 and 0.01 respectively.

$$Z_i \sim N(0, n)$$

$$Y_i = X_i + Z_i$$

2.3. 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 is 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.

3. ARCHITECTURE OF IMAGE DEGRADATION AND AMPUTATION OF MOTION BLUR

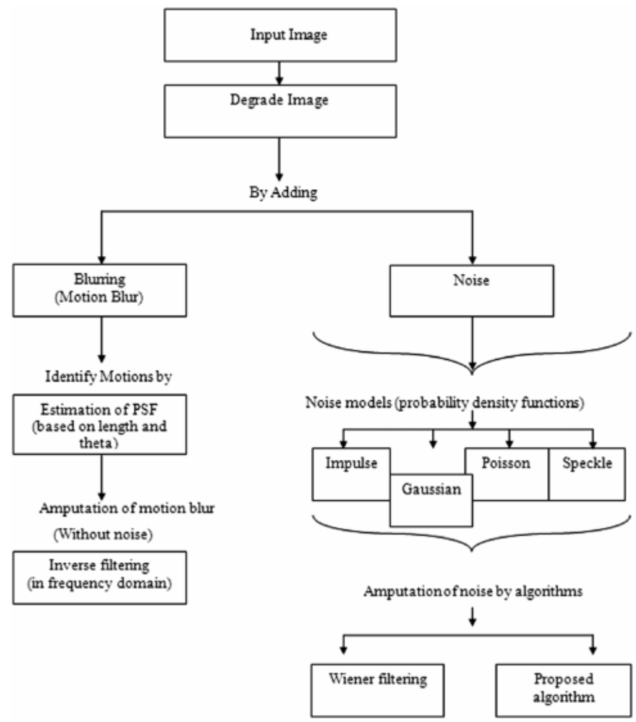

Figure 2: Block Diagram of Image Degradation and Amputation of Motion Blur with and Without Noise.

Figure 2 illustrate that 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.

4. 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).

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 values of PSF Else

Specify the PSF of degraded image

Restored Image *f* = Deconvolution (*g*, *h*, *i*, *w*, *a*)

End Procedure-II

5. SAMPLE RESULTS

The below images Figure 3 represents the result of degradation model using Gaussian blur. The sample image after applying the proposed algorithm will be as follows.

Original image | Blurring original image using Gaussian blur | Deblurring with blind deconvolution algorithm

Figure 3: Deblurring Image with No Information of PSF.

6. 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 The advantage of our proposed Blind Deconvoultion 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.

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