Deblurring of Shaken Images - A Comparative Study of Various Algorithms

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Abstract-- In this paper study of Restored Gaussian Blurred Image by using four types of techniques of deblurring image as Wiener filter, Regularized filter, Lucy Richardson deconvolution algorithm and Blind deconvolution algorithm with an information of the Point Spread Function (PSF) corrupted blurred image and then corrupted by Gaussian noise, the number of iterations and the weight threshold of it. To choose the base guesses for restored or deblurring image of this techniques.

Keywords-- Blur/Types of Blur/PSF Deblurring/Deblurring Methods/simulation with MATLAB

1. INTRODUCTION

The three dimensional rotation of the camera is the main reason for blur, resulting in a blur kernel that can be significantly non uniform across the image. However, most of the current deblurring methods model the observed image as a convolution of a sharp image with a uniform blur kernel. The restoration of image is very important process in the image processing to easily understand this image without any errors. In this case there are many studies undertaken and following are the some of these studies: In blind deconvolution, the goal is to de-blur an image with (total of partial) lack of knowledge about the blurring operator. To solve these problems here proposed two alternative approaches to blind deconvolution: (i) Simultaneously estimate the image and the blur (ii) Perform a previous step of blur estimation and then feed this blur estimate to a classical non-blind image deblurring algorithm [1]. There is a novel algorithm to estimate direction and length of motion blur, using Radon transform and fuzzy set concepts. This method was tested on a wide range of different types of standard images that were degraded with different directions (between 0° and 180°) and motion lengths (between 10 and 50 pixels). The method works highly satisfactory for SNR ≥22 dB and supports lower SNR compared with other algorithms [2]. For correct restoration of the degraded image; it is useful to know the point-spread function (PSF) of the blurring system. In this paper we proposed a method to restore Gaussian blurred images using only the blurred image itself, the method first identifies the PSF of the blur and then uses it to restore the blurred image with Standard restoration filters [3]. The conventional Lucy-Richardson (LR) method is nonlinear and therefore its convergence is very slow.

2. BLURRING

The un-sharp image area caused by moment of camera or subject, focusing camera inaccurate, or the use of an aperture that gives shallow depth of field is blur. The Blur effects are filters that smooth transitions and decrease contrast by averaging the pixels next to hard edges of defined lines and areas where there are significant color transition.

2.1 Blurring Types

There are 3 common types of Blur effects in digital image:

Average Blur

The Average blur is one of several tools you can use to remove noise and specks in an image. Use it when noise is present over the entire image. The Average blurring can be distribution in horizontal and vertical direction and can be circular averaging by radius R which evaluated by the formula:

\[
R = \sqrt{h^2 + v^2}
\]

Where: \(h\) is the direction of horizontal size blurring and \(v\) is direction of vertical blurring.

Gaussian Blur

Gaussian Blur is that pixel weights that are not equal – they decrease from kernel center to edges according to a bell-shaped curve. A filter that blends a specific number of pixels incrementally, following a bell-shaped curve is the Gaussian Blur effect. The blurring is more in the center and decreases at the edge. Apply Gaussian Blur to an image when you want more control over the Blur effect. Gaussian blur depends on the Size and Alfa.

Motion Blur

A filter that makes the image appear to be moving by adding a blur in a specific direction is the Motion Blur effect. The motion can be controlled by angle or direction (0 to 360 degrees or -90 to +90) and/or by distance or intensity in pixels (0 to 999), based on the software used.
3. DEBLURRING

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

\[ g(x, y) = \text{PSF} \ast f(x, y) + \rho(x, y) \]  

(2)

Where: \( g \) the blurred image, \( \text{PSF} \) distortion operator called Point Spread Function, \( f \) the original true image and \( \rho \) Additive noise, introduced during image acquisition that corrupts the image.

**Point Spread Function (PSF)**
The extent to which an optical system blurs (spreads) a point of light is Point Spread Function (PSF). The PSF is the inverse Fourier Transform of Optical Transfer Function (OTF). In the frequency domain, the OTF describes the response of a linear, position-invariant system to an impulse. OTF is the Fourier transfer of the point (PSF).

3.2 Deblurring Methods
In this analysis we apply four methods of deblurring image:

- **Wiener Filter Deblurring Method**
  Wiener filter is a method of restoring image in the presence of blur and noise. The frequency-domain expression for the Wiener filter is:
  \[ W(s) = \frac{H(s)}{F(s)} + \frac{H(s)}{S(s)} \]
  \[ F(s) = \text{blurred image}, \quad F(s) \text{ is causal}, \]
  \[ S(s) = \text{anti-causal}. \]

- **Regularized Filter Deblurring Method**
  Another approach to linear restoration is constrained least square filtering method. Use the deconvreg function to de-blur an image using a regularized filter. A regularized filter can be used effectively when limited information is known about the additive noise.
  \[ g = Hf + \text{Noise} \]

- **Lucy-Richardson Algorithm Method**
  An iterative procedure for recovering a latent image that has been blurred by a known PSF is the Richardson–Lucy algorithm, also known as Richardson–Lucy deconvolution. The Lucy-Richardson algorithm generates a restored image through an iterative method. The essence of the iteration is as follows: the \((n+1)\)th estimate of the restored image is given by the nth estimate of the restored image multiplied by a correction image. That is,
  \[ \text{Image}_{n+1} = \frac{\text{Image}_n \text{(original data)}}{\text{Image}_n \ast \text{PSF}} \ast \text{PSF} \]

4. EXPERIMENTS VERIFICATIONS

4.1 Testing Procedure
The software MATLAB R2010b is used for testing deblurring and tested Gaussian blur with help of PSF function corrupted on the images illustrated in the Fig.1.

5. SIMULATION RESULTS
The performance evaluations of the deblurring operation with known PSF can be implemented by two categories: the first category is a known amount of blur, but no noise, was added to an image, and second category is a known amount of blur and noise add to the image then the image was filtered to remove this known amount of blur and noise using Wiener, regularized and Lucy-Richardson, blind Algorithm deblurring methods.

In the absence of noise, blind deblurring technique produced what appeared to be the best results but it was surprising that the Lucy-Richardson technique produced check the result, and then restart the iterations from the point where processing stopped.

- **Blind Deconvolution Algorithm Method**
  Definition of the blind deblurring method can be expressed by:
  \[ g(x, y) = \text{PSF} \ast f(x, y) + \eta(x, y) \]
  \[ \eta(x, y): \text{additive noise term}. \]
the worst results in this instance see this result in the Fig.2

![Blurred Image](image1)
![WEINER DEBLURRING Image](image2)

![RL DEBLURRED Image](image3)
![BLIND DECONVOLUTION Image](image4)

Fig.2. Deblurring image without adding noise when PSF Known, image blurred by Gaussian blurred.

Table 1 shows image quality parameters of deblurred image without adding noise for Wiener filter, RL Algorithm, Blind deconvolution and Regularized filter method respectively.

5.2 Deblurring with known PSF and Noise

In second category when Gaussian noise was added to the image in addition to blur the blind deblurring method actually performed the best results from the Wiener, Regularized and Lucy- Richardson algorithm. These results can be seeing in the Fig.3

<table>
<thead>
<tr>
<th>Image Quality Parameter</th>
<th>Weiner Filter</th>
<th>RL Algorithm</th>
<th>Blind Deconvolution</th>
<th>Regularized Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSNR</td>
<td>18.8023</td>
<td>20.8976</td>
<td>22.6361</td>
<td>20.8252</td>
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<tr>
<td>Normalized Absolute Error</td>
<td>0.1858</td>
<td>0.0998</td>
<td>0.0732</td>
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<td>Average Difference</td>
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<td>Maximum Difference</td>
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<td>201</td>
<td>180</td>
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<td>Mean Square Error</td>
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<td>532.9897</td>
<td>357.1684</td>
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<td>1.0553</td>
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<td>Maximum Difference</td>
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6. CONCLUSIONS

In this paper, the comparative studies undertaken for two cases: The first case without adding noise and second case with addition of noise. We found blind deconvolution method produced good result with and without noise in terms of PSNR and mean square error (MSE).

7. REFERENCES


