Detection of Noise in an Image using Blind Deconvolution Method

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Abstract

Image Restoration is a field of Image Processing which deals with recovering an original and sharp image from a degraded image using a mathematical degradation and restoration model. This study focuses on restoration of degraded images which have been blurred by known or unknown degradation function. On the basis of knowledge of degradation function image restoration techniques can be divided into two categories: blind and non-blind techniques. Images are considered for analyzing the various image restoration techniques like Deconvolution using Lucy Richardson Algorithm (DLR), Deconvolution using Weiner Filter (DWF), Deconvolution using Regularized Filter (DRF) and Blind Image Deconvolution Algorithm (BID). The analysis is done on the basis of various performance metrics like PSNR(Peak Signal to Noise Ratio), MSE(Mean Square Error) and SSIM(Structural Similarity Index for Measuring Image

Keywords

Lucy Richardson Algorithm, Weiner Filter, Regularized Filter, Blind Image Deconvolution, Gaussian Blur, Point Spread Function, PSNR, MSE, RMSE.

I. Introduction

The main objective of Image Restoration is to recover the original image from a degraded image which is blurred by a degradation function, commonly by a Point Spread Function (PSF). Image Restoration Techniques are divided into two categories on the basis of knowledge about Point Spread Function (PSF).

1) Blind Image Restoration

This Technique allows the reconstruction of original images from degraded images even when we have very little or no knowledge about PSF. Blind Image Deconvolution (BID) is an algorithm of this type.

2) Non-Blind Restoration

This Technique helps in the reconstruction of original images from degraded images when we know that how image was degraded i.e. we have a knowledge about PSF. Deconvolution using Lucy Richardson Algorithm (DLR), Deconvolution using Weiner Filter (DWF), Deconvolution using Regularized Filter (DRF) are Non Blind Algorithms.

Degradation Model

In degradation model, the original image is blurred using degradation function and additive noise. The degraded image is described as follows:

\[ g = h * f + n \]  (1)

In equation (1), g is the degraded image, h is the degradation function, f is an original image and n is the additive noise. The degradation Model is structured as follows:

Original Image (f)  
\[ + \]  
Degradation Function (h)  
\[ = \]  
Degraded Image (g)
Restoration Model

In Restoration model, the degraded image is reconstructed using restoration filters. It performs the inverse process of degradation by removing additive noise and blur factor. We get an estimate of the original image as a result of restoration. The closer the estimated image is to the original image the more efficient is our restoration filter.

Deconvolution using Lucy Richardson Algorithm

DLR is a non blind technique of image restoration, used to restore a degraded image that has been blurred by a known PSF. It is an iterative procedure in which the pixels of the observed image are represented using the PSF and the latent image as follows:

\[ d_i = \sum p_{ij} u_j \]  

In equation (2), \( d_i \) is the observed value at pixel position “i”, \( p_{ij} \) is the PSF, the fraction of light coming from true location “j” that is observed at position “i”, \( u_j \) is the latent image pixel value at location “j”.

Deconvolution using Wiener Filter

Weiner Filtering is also a non blind technique for reconstructing the degraded image in the presence of known PSF. It removes the additive noise and inverts the blurring simultaneously. It not only performs the deconvolution by inverse filtering (high pass filtering) but also removes the noise with a compression operation (low pass filtering). It compares with an estimation of the desired noiseless image. The input to a wiener filter is a degraded image corrupted by additive noise. The output image is computed by means of a filter using the following expression:

\[ f' = g * (f + n) \]

In equation (5), \( f \) is the original image, \( n \) is the noise, \( f' \) is the estimated image and \( g \) is the wiener filter’s response.

Deconvolution using Regularized Filtering

Regularized filtering is used effectively when constraints like smoothness are applied on the recovered image and limited information is known about the additive noise. The blurred and noisy image is restored by a constrained least square restoration algorithm that uses a regularized filter. Regularized restoration provides similar results as the wiener filtering but it has a very different viewpoint. In regularized filtering less prior information is required to apply restoration. The regularization filter is often chosen to be a discrete Laplacian. This filter can be understood as an approximation of a Wiener filter.

Blind Image Deconvolution

As the name suggests, BID is a Blind technique of image restoration which restores the degraded image that is blurred by an unknown PSF. It is a
deconvolution technique that permits recovery of the target image from a single or set of blurred images in the presence of a poorly determined or unknown PSF.

In this technique firstly, we have to make an estimate of the blurring operator i.e. PSF and then using that estimate we have to deblur the image. This method can be performed iteratively as well as non-iteratively. In iterative approach, each iteration improves the estimation of the PSF and by using that estimated PSF we can improve the resultant image repeatedly by bringing it closer to the original image. In non-iterative approach one application of the algorithm based on exterior information extracts the PSF and this extracted PSF is used to restore the original image from the degraded one.

III. Comparison & Simulation Result

In this paper, we take two images & apply different algorithm both images. Ist one Vegetables & IInd is Bottle Image. Comparison of different algorithm is given by Table 1 & Table 2. Table 1. Gives Comparison of different Algorithm for Cameraman Image while Table 2. Comparison of different Algorithm for Lena Image. Images are compared with three algorithms Lucy Richardson algorithm Deconvolution using Regularized Filter, Wiener filter and Blind deconvolution.

A. Vegetables

Fig 3. Vegetables Image a) Original Image b) Degraded Image

Fig 4. Restored Image (a) Lucy Richardson algorithm (b) Weiner Algorithm

Fig 5. Restored Image (a) Deconvolution using Regularized Filter (b) Blind Deconvolution (EM Algorithm) (c) Blind Deconvolution (MAP Algorithm)

B. Bottle
Fig 6. Vegetables Image a) Original Image b) Degraded Image

Fig 7. Restored Image (a) Lucy Richardson algorithm (b) Weiner Algorithm

Fig 8. Restored Image (a) Deconvolution using Regularized Filter (b) Blind Deconvolution (EM Algorithm) (c) Blind Deconvolution (MAP Algorithm)

<table>
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<tr>
<th>Sr. No.</th>
<th>Algorithm</th>
<th>MSE</th>
<th>PSNR</th>
<th>SSIM</th>
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<tr>
<td>1</td>
<td>Degraded Image</td>
<td>106.9778</td>
<td>64.125</td>
<td>0.142979</td>
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<td>2</td>
<td>Lucy</td>
<td>109.2453</td>
<td>63.889</td>
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<td>3</td>
<td>Weiner</td>
<td>128.1627</td>
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<td>Regularized Filter</td>
<td>102.2647</td>
<td>64.549</td>
<td>0.185504</td>
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<tr>
<td>5</td>
<td>Blind Deconv EM</td>
<td>117.1846</td>
<td>63.187</td>
<td>0.485504</td>
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<tr>
<td>6</td>
<td>MAP</td>
<td>0.026639</td>
<td>56.277</td>
<td>0.999720</td>
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</table>

Table 1. Comparison of different Algorithm for Vegetable Image
Table 2. Comparison of different Algorithm for Bottle Image.

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>IV. Conclusion</th>
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<tr>
<td>Weiner</td>
<td>We have discussed efficient noise detection algorithms for the detection of noise in the degraded image and to determine effective filtering technique required for removal of detected type of noise. This algorithm can be beneficial to enhance the quality of corrupted image. Blind deconvolution Method is best algorithm for detection of Noise.</td>
</tr>
<tr>
<td>Regularized Filter</td>
<td></td>
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<tr>
<td>Blind Deconvolution</td>
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<td>MAP</td>
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References


