Image Restoration Using Two Statistical Modeling Methods

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Abstract: *The process of image restoration is to restore the degraded image to its original form. The quality of image degraded because of blur and noise added in an image. The quality of image may degrade due to motion of camera, miss-focus between original scene and camera etc... The objective of image restoration is to recover the quality of an image nearly equal to its original form So that it is necessary to find out the type of blur is present in an image to recover it or to perform inverse operation of it. The degradation process first identifies the type of blur and noise is present and after that inverse process takes place to improve the corrupted or degraded image. Restoration of degraded quality image is very essential in various application areas. The priori knowledge about an image is very important to perform image restoration task. There are many types of blur models such as motion blur, gaussian blur, uniform blur etc. This paper proposes image deblurring by using local statistical modeling. In this paper various image deblurring methods are discussed which are used to remove blur from the images.*

Keywords: Image blurring, Local statistical modeling, Non local statistical modeling, Image deblurring.

1. Introduction

In an image processing, digital images are used to transmit the visual information for various application purposes in the today's world [1]. After the transmission of the image, the image may be corrupted with noise and blur is obtained in an image. Image restoration is used to enhance or improve the quality of an image which is blurred and noised which harm the quality of an image. The most of degradation is done in motion blur. There are various methods for removing the noise from the images. The noise is added in an image due to camera, transmission channel error, miss-focus, atmospheric turbulence, camera motion etc… [1]. Such harmful damages are not an easy task to avoid. So the received image needs to process it for the different applications purpose.

Image deblurring is an old concept in image processing for image restoration, but it continues to evoke the attention of researchers still continues to work on it. In image restoration the larger number of image inverse problems are initiated in all kinds of scientific, medical problem and theoretical problems. To deblur the image, it is necessary to know a mathematical description about how it was blurred. There are different types of blur models such as motion blur, gaussian blur, uniform blur etc. [2]. The blur model may be uniform or non uniform. The image quality can be degraded by the motion of camera that causes the motion blur. In this paper, various motion deblurring techniques has been discussed.

Deblurring is the process of solving the image inverse problems. Image deblurring techniques are used to remove blurring artifacts which is present in an image due to defocus variation in camera and original scene or due to motion blur [2]. The blur is nothing but the convolution operation of a point spread function with a input image i.e. sharp input image, where both the sharp input image and the point spread function are unknown. In almost all cases, there is insufficient information or knowledge in the blurred image to uniquely find out a probable original image, making it an image inverse problem. In addition point that blurred image contains additional noise which not an easy the task to find out the original image. The regularization term is used to solve the optimization problem. This paper gives an idea in brief about various image deblurring methods.

Blur Models:

Motion Blur:
The image can become unfocused to see or less distinct is called as blur. There are different types of blur. Motion blur, gaussian blur, 9 □ 9 uniform blur etc. When there is relative motion between the original scene and the camera then motion blur is occurs. The form of motion blur can be rotation, translation and change of scale or atmospheric turbulence etc. It occurs in the imaging of astronomy imaging system.

Gaussian blur:
The gaussian function is used to blur the image. This type of blur is called as gaussian blur. Gaussian blur is also called as gaussian smoothing. This can be used to remove noise from the graphics. Gaussian smoothing is also used as a pre-processing. Gaussian blur reduces the high-frequency components of an image.

2. Literature Review

There are various image restoration methods for image deblurring is present. Some important of them are discussed below;

2.1 Split augmented Lagrangian shrinkage method:

M. Afonso [3] proposed "Fast method for image recovery by using variable splitting and constrained optimization algorithm," This algorithm is also called as SALSA

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algorithm. There are various types of optimization problems are present. This algorithm consists of an unconstrained optimization problem. There are many types of regularization based frameworks are present to solve image restoration problems. This algorithm can be used with different regularization methods such as wavelet-based method, total variation method. These two methods are based on a variable splitting technique. The objective of this paper is a 2 data-fidelity term and a non smooth regularizer. The variable splitting is used to obtain an equivalence constrained optimization problem, which is then further used with an augmented Lagrangian method and alternating direction method of multipliers (ADMM). The algorithm uses a `2 data-fidelity term, which can be calculated efficiently for several types of problems. This proposed algorithm is faster than the other methods. But the drawback of this method is that there are still less cleaner and less sharp image edges are obtained.

2.2 Block matching and 3D filtering method:

K. Dabov [4] proposed, "Image restoration by using sparse 3D transform-domain filtering algorithm". There are two main modeling methods. This method performs a non-local modeling i.e. it achieves self similarity of images by gathering similar image patches in 3D arrays. This image restoration method is block matching and 3D filtering denoising filter. This method performs an extension of the BM3D filter which allows using a two-step deblurring algorithm to improve the regularization in discrete Fourier transform domain. The first step of the algorithm is obtain inversion of regularization frame work by using BM3D with collaborative hard-thresholding and the next step is a Wiener inversion of regularized framework by using BM3D with Wiener filtering. This algorithm gives best image restoration in case of improvement in signal-to-noise ratio. The drawback of this method is that it only works on non local modeling .

2.3 Shape-adaptive DCT method:

A. Foi [5] proposed "Pointwise shape-adaptive DCT algorithm for high-quality denoising of grayscale images and color images. The shape-adaptive discrete cosine transform algorithm retains a computational complexity in case of image restoration as compared to that separable block-DCT algorithm i.e. B-DCT. The SA-DCT algorithm is used to image filtering. The SA-DCT is used with the Anisotropic Local Polynomial Approximation-Intersection technique. The threshold SA-DCT coefficients are used to reconstruct a local estimation of the signal. This type of approach is used for various image-processing tasks in image processing. In this paper, the SA-DCT algorithm perform image denoising and image filtering and image deblocking task for image reconstruction and de ringing is also achieved through the compression of block-DCT. But the drawback of this method is that there are still less cleaner and less sharp image edges are obtained. It only works on one image property. Application of the SA-DCT is limited due to its energy compaction property.

3. Proposed Method

This paper proposes image restoration by using two statistical modeling methods in space and transform domain which achieves both local smoothness and nonlocal self-similarity of natural images. To solve image inverse problems Split Bregman-based algorithm is used. Damaged structure of images occurs in an image due to image inverse problem. Therefore to calculate and resolve image inverse problem it is important to know prior knowledge about that image. There are many image properties are there but to find out image inverse problem and to retain image quality in this algorithm the main two image properties are used such as local smoothness and non local self similarity.

3.1 Local Modeling

The local statistical modeling performs the operation on an image to deblur the image by smoothing the local area of an image. This is one of the important property of an image is local smoothness in which the values of neighboring pixels are nearly similar. To achieve the values of neighboring pixels nearly same it is necessary to take derivative of pixel values. The two difference operators are used i.e. horizontal direction and vertical direction i.e. D_h and D_v respectively. Apply this vertical and horizontal direction filters on an image at the same time in horizontal and vertical direction. In mathematical format local smoothness is achieved by using following equation,

$$\Psi_{LSM}(u) = ||D_v u||_1 + ||D_h u||_1 \qquad (1)$$

Where u is original input image, D_h and D_v are horizontal and vertical difference operators respectively. Local smoothness is achieved in 2D space domain at pixel levels. The above equation of local modeling to achieve local smoothness gives best solution than any other algorithms.

To perform LSM operations firstly takes any input image and then create the filters for both horizontal and vertical directions. Model the filters output by using generalized gaussian distribution [6]. And then solve the LSM equation (1).

3.2 Non Local Modeling

The only one image property cannot obtain unique solution for image restoration. Therefore non local modeling is also necessary to obtain image restoration. The non local modeling method performs image restoration at block level by finding the best match for each block in an image. The Split Bregman algorithm will be used for iteration purpose.

4. Result and Discussion

The figures to obtain the result can be used of any image. This is applicable to both grayscale images and color images. Some images have applied to the proposed method to the leaves image and the results will be given in the following: Figure.1 is the original input image. The original image is in

RGB format. To solve the storage issue first convert the RGB image into gray scale image by using MATLAB.

Figure 1: Input RGB Image

Figure 2: Gray Scale Image

Prior knowledge of an image is very important in image restoration. So the input image is blurred by using uniform blur. This result is for iteration number 2. The figure 3 shows the blurred image. This is for the 9 $\square$ 9 uniform blur image after LSM deblurred image is obtained shown in figure 4. The output image gives better result than SALSA [3], BM3D [4], and SA-DCT [5].
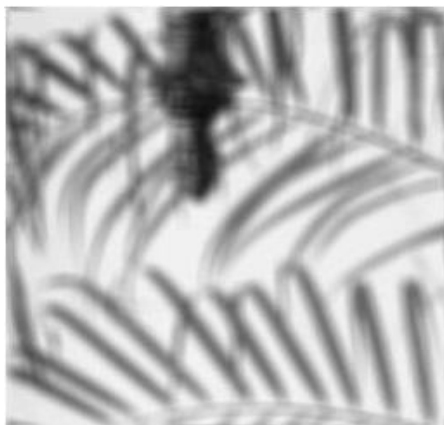

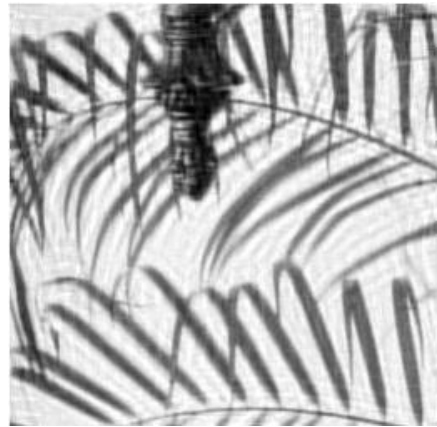**Figure 3:** Blurred Image for iteration 2

Figure 4: Deblurred Image for iteration 2

By changing the iteration number the change in quality of image is obtained. The result is obtained for iteration number 10 as shown in figure 5 and figure 6. As iteration number increases the better quality of image is obtained.
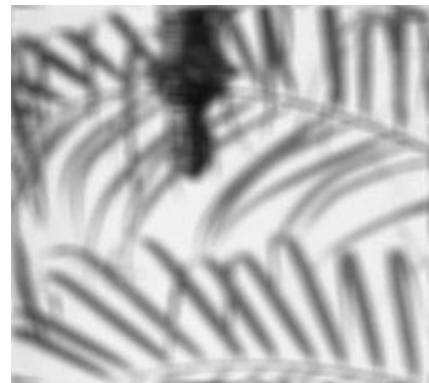

Figure 5: Blurred Image for iteration

Figure 6: Deblurred Image for iteration 10

5. Conclusion

The proposed method for image deblurring by using local statistical modeling is more effective and attractive than the methods discussed in literature. The previously studied methods for image deburring are surveyed and explained with their drawbacks. This paper proposed local statistical modeling to achieve image details and to achieve local smoothness.

The non local statistical modeling will be used to achieve non local self similarity. The split Bregman's iteration algorithm

will be used to solve optimization problem.This approach of image restoration will be applicable for image inpainting, removal of salt and pepper noise etc.

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