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A Comparative Study & Analysis of Image Restoration by Non Blind Technique

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Abstract: ***The process of retrieving and analyzing the pictorial information by a digital computer is known as digital image processing. Vision is the foremost trusted source of information compare to other human perceptions. And image is the basic container of any pictorial information. Image deblurring is usually the first process that is used in the analysis of digital images. The improvement of pictorial information for human interpretation and processing of scene data for autonomous machine perception are the root application areas that had shown the interest in image processing field decades ago. There are several methods for image denoising; these are averaging filters, mean filters, and median filters which are used in digital image processing for such purposes. In this research paper author has done comparison of various techniques for the non-blind image deblurring. The various techniques are Horizontal deblurring algorithm, Vertical deblurring algorithm, combination of both algorithms and SALSA (Split Augmented Lagrangian Shrinkage Algorithm) in Matlab.***
Keywords- PSF, PDE, SALSA, ALM, TV, KL, PSNR, AL, FISTA, Deblurring, Non Blind Image.

I. INTRODUCTION

Vision is the foremost trusted source of information compare to other human perceptions. And image is the basic container of any pictorial information. The process of retrieving and analyzing the pictorial information by a digital computer is known as digital image processing. The improvement of pictorial information for human interpretation and processing of scene data for autonomous machine perception are the root application areas that had shown the interest in image processing field decades ago[7]. A blurred or degraded image can be approximately described by this equation k = Hf + n, where the k is the blurred image, the H is the distortion operator also called the point spread function(PSF), f is the original true image, n is the additive noise, introduced during image acquisition, that corrupts the image. Image deblurring is usually the first process that is used in the analysis of digital images. In any image denoising technique it is very important that the denoising process should not have any blurring effect on the image, and makes no changes on the preserving of images to image edges. There are several methods for image denoising; these are averaging filters, mean filters, and median filters [2] which are used in digital image processing for such purposes. But these filters have adverse effects on the sharp edges which make softening of the image and provide better smoothing the image. The softening of sharp images can be overcome using the partial differential equations (PDEs)[5] –based methods and SALSA which have been introduced in the literature [3,4]. The partial differential equation is used to describe the implementation details of the Horizontal deblurring algorithm, Vertical deblurring algorithm, combination of both algorithms and SALSA (Split Augmented Lagrangian Shrinkage Algorithm). The relative motion of camera in vertical direction and the joint effect of the motion in two directions by introducing blur component in horizontal and vertical directions. SALSA can be used with different types of regularization, is based on a variable splitting technique which yields an equivalent constrained problem.

II. OBJECTIVE

The objective of research paper is to compare various deblurring techniques for the non- blind image deblurring. The various techniques are Horizontal deblurring algorithm, Vertical deblurring algorithm, combination of both algorithms and SALSA (Split Augmented Lagrangian Shrinkage Algorithm) in Matlab. We are also considering relative motion of camera in vertical direction and the joint effect of the motion in two directions by introducing blur component in horizontal and vertical directions. SALSA can be used with different types of regularization, is based on a variable splitting technique which yields an equivalent constrained problem. Then results are compared for various deblurring techniques on the calculated PSNR.

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III. RESEARCH WORK

The median filtering, mean filtering and other image denoising techniques are used for the better smoothing the image but PDE and SALSA have proven a significant improvement over these techniques. In this section we introduce the different techniques of image deblurring.

A. Weiner Filter

The method is founded on considering image and noise as random process and objective is to find an estimate of deblurred image of the uncorrupted image such that mean square error between them is minimized. The simplest approach is to restore the original image simple by dividing the transform of degraded image by degradation function.

$$F'(u,v)=F(u,v)+N(u,v)/H(u,v)$$

These are the frequency transform of deblurred image, original image, noise density and degraded function.

B. Order Statistics Filters

These are the spatial filters whose response is based on the ordering of the pixels contained in the image area and compassed by the filter. The response of the filter at any point is determined by ranking result.

$$F1(x,y)=\text{median}\{g(s,t)\}$$

$$F1(x,y)=\max\{g(s,t)\}$$

$$F1(x,y)=\text{mean}\{g(s,t)\}$$

C. PDE Deblurring

A generalized PDE [5] based image model is proposed to model the phenomenon of blurred image formation due to relative motion between camera and the object and further the recovery of original image in spatial domain. Lax scheme is used to discretize the resulting PDE which is mathematically stable and produces good result. Therefore, with the use of Lax method for discretizing the proposed PDE that was initially a flux conservative equation transforms to a ID flux conservative equation with an added diffusion term which is in the form of Navier-Stokes equation. The, additional diffusion term contributes towards further smoothing of image.

D. The Vertical Deblurring Algorithm

The Algorithm for this scheme is as follows:-

1) Read the original image s of size mxn.
2) Introduce the motion blur in y direction to get s(y, x, t) or alternatively we can directly have the blurred image s(y, x, t). Id =s(y, x): Initial Image
3) Set dy=0. 1,dt = 0.1
4) for t=1: n iterations
   Display the image

E. SALSA

The SALSA is based on the technique known as variable splitting. Since the objective function to be minimized is the sum of two functions, the idea is to split the variable x into a pair of variables, say x and v, each to serve as the argument of each of the two functions, and then minimize the sum of the two functions under the constraint that the two variables have to be equal, so that the problems are equivalent. Although variable splitting is also the rationale behind the recently proposed split- Bregman method.The constrained optimization problem resulting from variable splitting is then dealt with using an Augmented Lagrangian (AL) scheme, which is known to be equivalent to the Bragman iterative methods recently proposed to handle imaging inverse

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problems. The term SALSA (split augmented Lagrangian shrinkage algorithm), comes from the fact that it uses (a regularized version of) the Hessian of the data fidelity term of, that is, AH A, while the above mentioned algorithms essentially only use gradient information.

IV. PERFORMANCE PARAMETER

In this section we discuss the two performance measuring parameters on which the above discussed techniques are based.

A. *MMSE(Minimum mean square error)*

In statistics and signal processing first error metrics, a minimum mean square error (MMSE) estimator is an estimation method which minimizes the mean square error (MSE) of the fitted values of a dependent variable, which is a common measure of estimator quality. Let x be a n*1 unknown (hidden) random vector variable, and let y be a m*1 known random vector variable (the measurement or observation), both of them not necessarily of the same dimension. An estimator $\hat{x}(y)$ of x is any function of the measurement y. The estimation error vector is given by $e = \hat{x} - x$ and its mean squared error (MSE) [6] is given by the trace of error covariance matrix $MSE = tr[E\{(x x)(\hat{x} - x)^T\}]$ the expectation is taken over both x and y. When x s a scalar variable.

B. *PSNR(Peak Signal to Noise Ratio)*

Second of the error metrics used to compare the various image deblurring technique is the (Mean Square Error and PSNR) Peak Signal to Noise Ratio (PSNR) [7]. The MSE is the cumulative squared error between the compressed and the original image, whereas PSNR is a measure of the peak error.

V. EXPERIMENTAL RESULTS

To compare the performance of the above described techniques in image denoising, they have been implemented using Matlab. In these experiments, to make the images noisy, the Gaussian noise has been used with 64 as the average value for both of the noises, and a variance of 400 for the Gaussian noise, respectively.

Comparison of various deblurring techniques for Gaussian noise

Technique used	Performance	PSNR values
SALSA	Very Efficient	40.001
PDE_ Vertical	Efficient	38.8836
Weiner_Vertical	Worst Results	11.1457 +13.6438i
Median_Vertical	Better	26.6929

A. *Results for Image deblurring using SALSA*

Original Image

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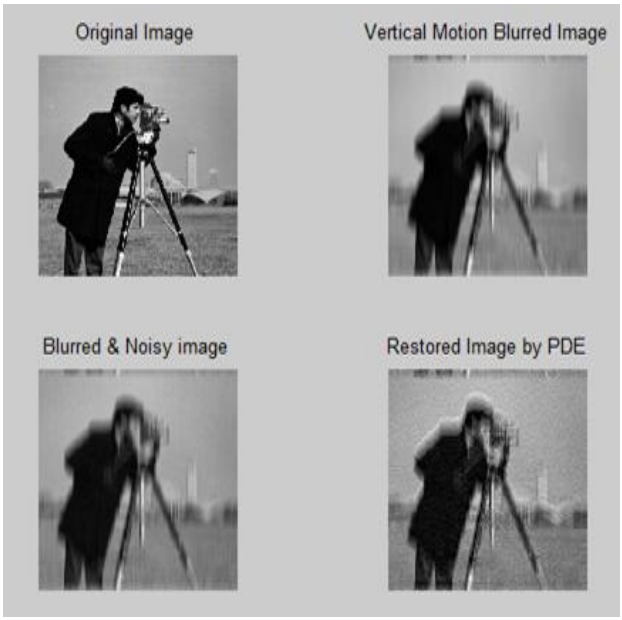
Blurred and Noisy Image

Estimated Image using SALSA

B. Results for Image deblurring using PDE



5.3 Results for image deblurring using Wiener filter

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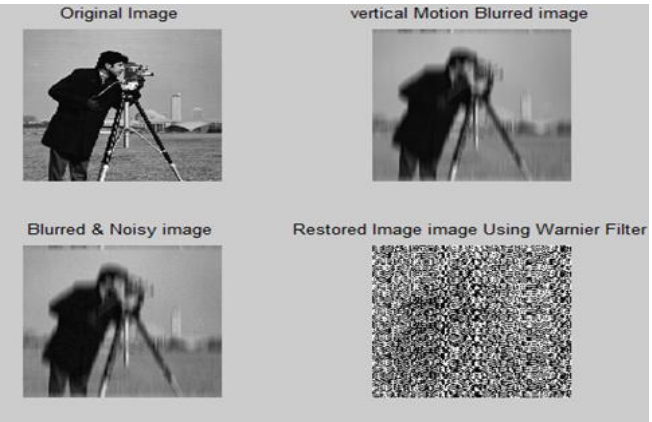
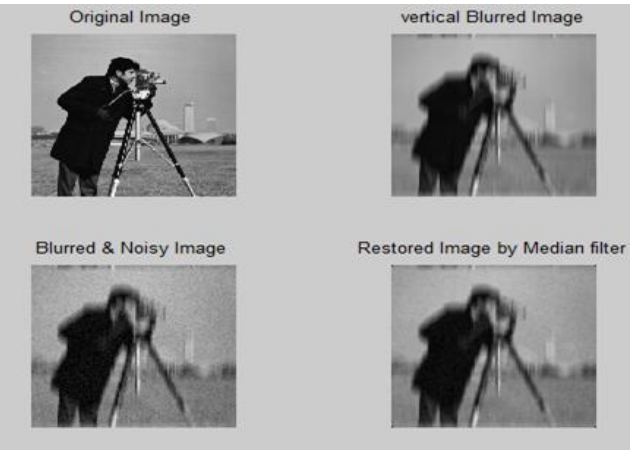


5.4 Results for image deblurring using Median filter



VI. CONCLUSION

In this research various methods for noise reduction have been analyzed. In the analysis, various well-known measuring metrics have been used. The results show that by using the SALSA noise reduction is much better compared to other methods. In addition, by using this method the quality of the image is better enhanced. Using SALSA the unconstrained image problem can be easily done regularized. The median, mean and wiener filters have low PSNR values for Gaussian noise. Weiner filtering is the worst case for such noises. The PDE technique is much efficient than these for the motion blurring. The vertical deblurring shows the better results than horizontal and combined deblurring in PDE but still it is less efficient than the SALSA.

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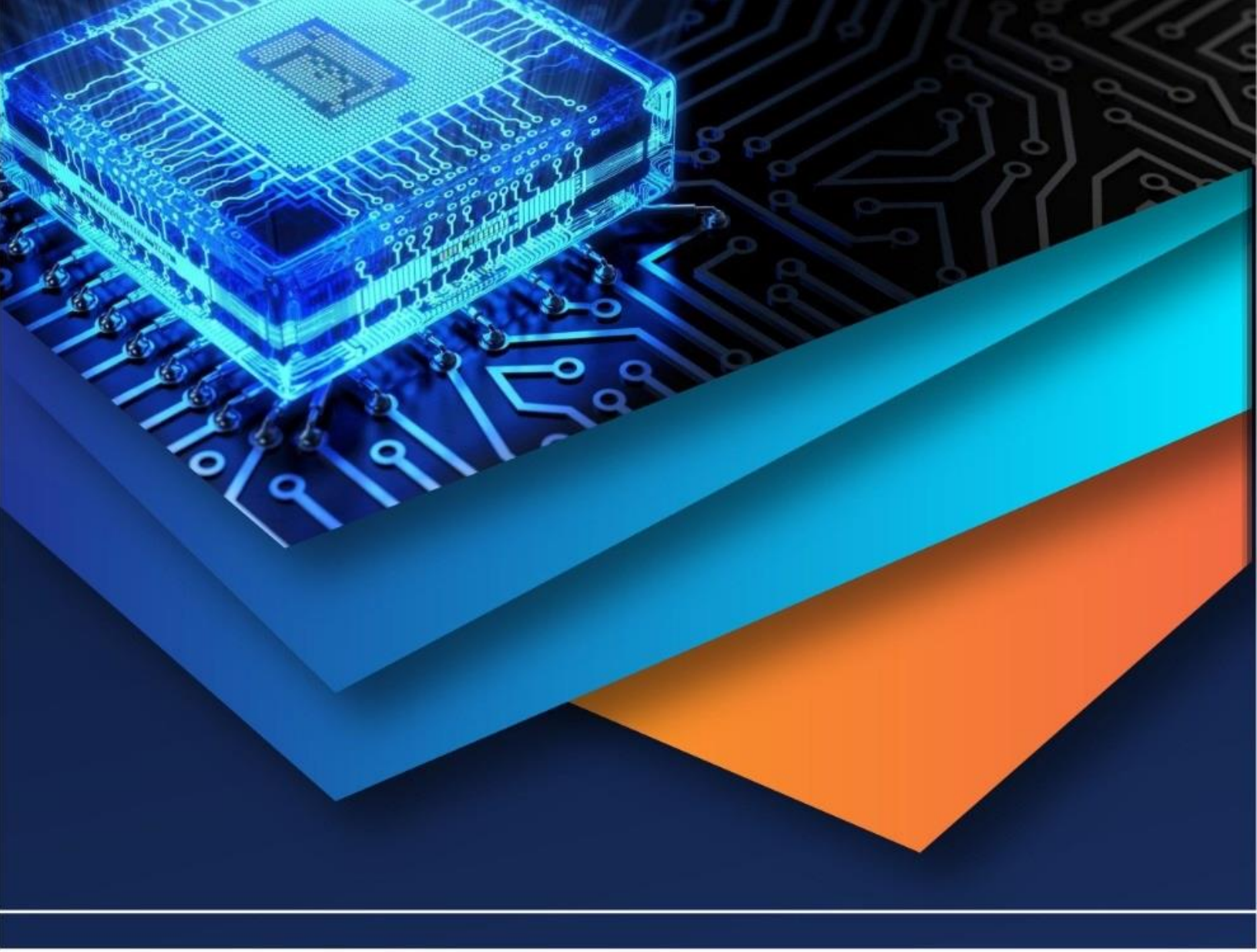

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