

Implementation of Partial Derivatives for Image Enhancement

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Abstract- Digital images are subject to a wide variety of distortions during acquisition, processing, compression, storage, transmission and reproduction, any of which may result in a degradation of visual quality for applications in which images are ultimately to be viewed by human beings, the only "correct" method of quantifying visual image quality is through subjective evaluation.

In this project the noisy and blurred images are de noised and sharpened and enhancement of the image is achieved. Here PDE based bilateral filter has been used for speckle noise removal. This proposed model relates different color components using bilateral filter and PDE'S higher than fourth order.

By means of nonlinear combination of nearby image values bilateral filtering smoothers images and where images are preserved. Based on geometric closeness and photometric similarity blue levels or colors are combined and near values are preferred than distant values in both domain and range. Here noise is added to the blur component to get more quality.

The proposed model is more efficient and the denoising and deblurring of color images can be done with proposed method without creating false colours, than the other filters and previous works. The performance of the presented algorithm can be analyzed based on peak signal to noise ratio and mean square error values.

Index Terms- Fast RGB Color image; Noise analysis; Filter Process; Blurriness and Sharpening; Partial Differential Equation (PDE).

1. INTRODUCTION

Digital image processing deals with manipulation of digital images through a digital computer. It is a subfield of signals and systems but focuses particularly on images. Digital image processing focuses on developing a computer system that is able to perform processing on an image. The input of that system is a digital image and the system process that

image using efficient algorithms, and gives an image as an output.

2. IMAGE ENHANCEMENT

Image enhancement is basically improving the interpretability or perception of information in images for human viewers and providing 'better' input for other automated image processing techniques. The principal objective of image enhancement is to modify attributes of an image to make it more suitable for a given task and a specific observer.



The image shown in the above figure, illustrates the enhancement. During this process, one or more attributes of the image are modified. The choice of attributes and the way they are modified are specific to a given task. Moreover, observer-specific factors, such as the human visual system and the observer's experience, will introduce a great deal of subjectivity into the choice of image enhancement methods. There exist many techniques that can enhance a digital image without spoiling it. The enhancement methods can broadly be divided into two categories,

1. Spatial Domain Methods.
2. Frequency Domain Methods.

Spatial domain methods, are based on direct manipulation of pixels. In frequency domain

methods, the image is first transferred into frequency domain. Then, enhancement operations are performed in frequency domain. Here we concentrate on spatial domain methods. Again spatial domain methods are divided into

1. Smoothing filters and
2. Sharpening filters.

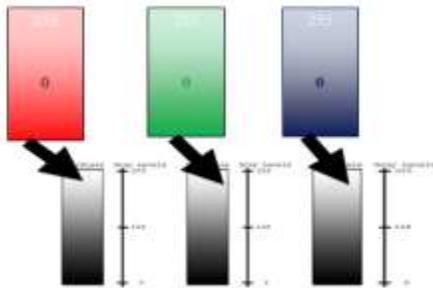
Smoothing Filters:

These filters are used for blurring and noise reduction. Blurring is used in preprocessing steps.

Sharpening Filters:

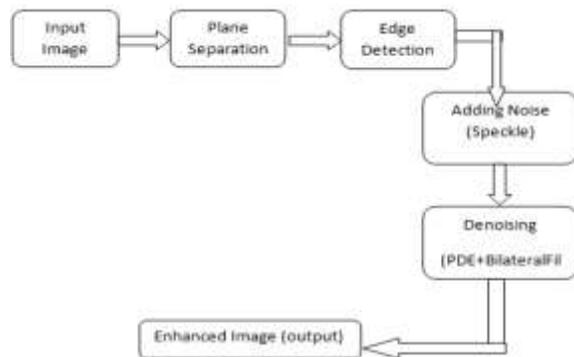
Objective of sharpening is to high light fine detail in an image or to enhance detail that has been blurred in image acquisition. High pass filtering and Derivative filters come under this category.

Color photography and color television are typical examples of tricolor systems, in which the visible spectrum is divided into three bands, red, green, and blue (RGB model), approximating the behavior of the human eye. A tricolor digital image is commonly managed as an ordinary two-dimensional image having three grey levels (e.g. red, green, blue) at each pixel, or an image composed of three color planes respectively as shown in Fig.



2. Block Diagram:

Over all process of the project is shown block wise in Fig



Block diagram of presented method

The first step of the proposed method is plane separation of input image. Then canny edge detection is performed for the input image. Thirdly speckle noise is added to the blue color component of the image. Fourthly Sixth order Partial Differentiation Equation (PDE) and Bivariant filter is used for denoising.

ADDING SPECKLE NOISE TO IMAGE

Mathematically there are two basic models of Noise. One is Additive noise and second one is Multiplicative noise.

Additive noise is systematic in nature and can be easily modeled and hence removed or reduced easily. Whereas multiplicative noise is image dependent, complex to model and hence difficult to reduce.

Speckle noise in SAR is a multiplicative noise, i.e. it is in direct proportion to the local grey level in any area. The signal and the noise are statistically independent of each other. The sample mean and variance of a single pixel are equal to the mean and variance of the local area that is centered on that pixel.

Speckle is not a noise in an image but noise-like variation in contrast. Speckle is basically a form of multiplicative noise, which occurs when a sound wave pulse randomly interferes with the small particles or objects on a scale comparable to the sound wavelength. Speckle noise is defined as multiplicative noise. It is granular in pattern. It is the inherent property of ultrasound image and SAR image. Some examples images of Speckle noise are shown below in Fig.



Examples of speckle noise



SAR image corrupted due to speckle.

The above SAR image, Fig, shows the clearing areas between the river and coastline. The image appears "grainy " due to the presence of speckles.

Mathematically the image noise can be represented with the help of these equations below

$$V(x, y) = g[u(x, y)] + \eta(x, y)$$

$$g[u(x,y)] = \iint h(x,y;x',y') u'(x',y') dx' dy'$$

$$D(x, y) = f [g(u(x, y))] \eta_1(x, y) + \eta_2(x, y)$$

Here $u(x, y)$ represents the objects (means the original image) and $v(x, y)$ is the observed image. Here $h(x, y; x', y')$ represents the impulse response of the image acquiring process. The term $\eta(x, y)$ represents the additive noise which has an image dependent random components $f [g(w)] \eta_1$ and an image independent random component η_2 . A different type of noise in the coherent imaging of objects is called speckle noise. Speckle noise can be modeled as

$$V(x, y) = u(x, y)s(x, y) + \eta(x, y)$$

Where the speckle noise intensity is given by $s(x, y)$ and $\eta(x, y)$ is a white Gaussian noise. The main objective of image-de-noising techniques is to remove such noises while retaining as much as possible the important signal features. One of its main shortcomings is the poor quality of images, which are affected by speckle noise. The existence of speckle is unattractive since it disgraces image quality and affects the tasks of individual interpretation and diagnosis. An appropriate method for speckle reduction is one which enhances the signal-to-noise ratio while conserving the edges and lines in the image. Wiener filter was adopted for filtering in the spectral domain, but the classical Wiener filter is not adequate as it is designed primarily for additive noise suppression.

3. SIMULATION RESULTS AND PERFORMANCE

PERFORMANCE MEASUREMENT

Two of the error metrics used to compare the various image denoising and sharpening techniques are the Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR). The MSE is the cumulative squared error between the enhanced and the original image, whereas PSNR is a measure of the peak error. The mathematical formulae for the two

are

$$MSE = \frac{1}{MN} \sum_{y=1}^M \sum_{x=1}^N [I(x, y) - I'(x, y)]^2$$

$$PSNR = 10 \log_{10} \left(\frac{255 \times 255}{MSE} \right)$$

Where $I(x,y)$ is the original image, $I'(x,y)$ is the approximated version (which is actually the denoised or sharpened image) and M,N are the dimensions of the images. A lower value for MSE means lesser error, and as seen from the inverse relation between the MSE and PSNR, this translates to a high value of PSNR. Logically, a higher value of PSNR is good because it means that the ratio of Signal to Noise is higher. Here, the 'signal' is the original image, and the 'noise' is the error in reconstruction. If one has an enhancement scheme having a lower MSE (and a high PSNR), then it can be recognized as better one.

EXISTING FILTERS SIMULATION PROCESS

Here same input image is considered for existing methods and proposed method. And the colored image is resized into 256 X 256 pixels. And the input image is shown in Fig.



Input image

Wiener Filtering

The denoised image of Wiener filter is as shown in Fig. This filter also does not gives good performance. The performance values are MSE =546.7168 and PSNR = 20.7532 db.



Wiener filtered image

Alvarez-Mazorra Shock Filtering

The denoised image of Alvarez-Mazorra Shock filter is as shown in below fig. The performance values are MSE =1030 and PSNR = 18.0025db.



Alvarez-Mazorra shock filtered image

Fu Filtering

The denoised image of Fu Shock filter is as shown in below Fig. This filter gives better results than Alvarez-Mazorra the performance values are MSE = 728.9930 and PSNR = 19.5036db.

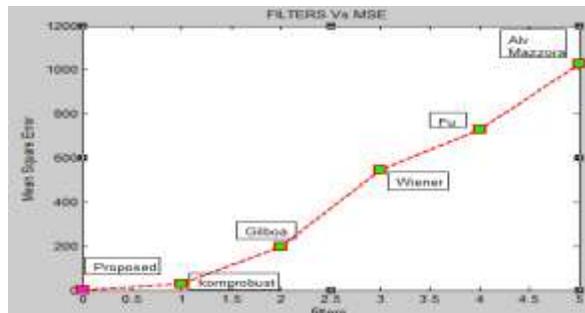


Fu filtered image

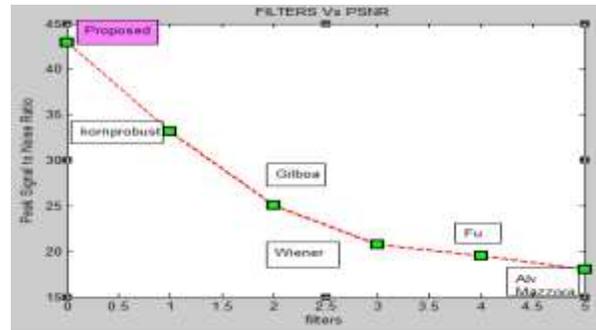
Comparison of Performance of filters:

Filters	MSE	PSNR
Presented filter	3.3253	42.9125
Kornprobust Filter	31.0778	33.2063
Gilboa Filter	200.2540	25.1150
Fu Filter	728.9930	19.5036
Alvarez Mazzora Filter	1030	18.0025
Weiner Filter	546.7168	20.7532

Filter Vs MSE Plot:



Filter Vs PSNR:



Performance comparison of filters is shown in above Table. In Fig. 6.13 filters versus MSE plot shows that presented method has less MSE. Fig.6.14 filters versus PSNR plot illustrates that PSNR value of proposed method is highest.

4. CONCLUSION AND FUTURE SCOPE

CONCLUSION

Image enhancement is having important role in medical field and radar communications. Speckle noise mainly occurs in these two cases. Hence, Speckle removal is crucial part of the presented method.

Existing Wiener and Shock filters cannot give expected results for image denoising, why because Speckle noise is random in nature and image dependent. Shock filters coupled with diffusion give better results for speckle removal than wiener and shock filters.

In presented method PDE based bilateral filter is used for Speckle noise removal. Canny edge detection method will find the strong edges as well as weak edges, so that we can remove the noise without loss of information and remove the blurriness properly. Sixth order Partial Differential Equation (PDE) method is used for denoising with preserving edges. Bilateral filter removes the noise of color image in each plane separately, due to which we get the denoised image without any false colors.

Presented method, PDE based bilateral filter denoised method gives good results than the existing filters. Proposed method gives 9.7062 db more PSNR value when compared Kornprobust shock filter having PSNR 23.507 db. Alvarez-Mazorra filter gives poor response than all having PSNR 18.0025 db.

FUTURE SCOPE

Other filters and other noises can be used to get better PSNR values. 7th order PDE can be used to get better PSNR and less MSE values. This presented method can be applied for the noise removing in Videos.

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