An Efficient Algorithm Image Processing Technique Using Bilateral Filtering Method

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***Abstract* - A new and efficient algorithm for high-density salt and pepper noise removal in images and videos is proposed. The existing non-linear filter like Standard Median Filter (SMF), Adaptive Median Filter (AMF), Decision Based Algorithm (DBA) and Robust Estimation Algorithm (REA) shows better results at low and medium noise densities. At highnoise densities, their performance is poor. A new algorithm to remove high-density salt and pepper noise using modified sheer sorting method is proposed. The new algorithm has lower computation time when compared to other standard algorithms. Results of the algorithm is compared with various existing algorithms and it is proved that the new method has better visual appearance and quantitative measures at higher noise densities as high as 90%.**

***Index Terms* - Image Processing,Color Image,Image Filtering ,Hybrid Filter**

I. INTRODUCTION

Computer image processing methods mainly take two categories. First, the space domain processing; that is in the image space of the image processing. The other is the image spatial domain. It should be use frequency domain through the orthogonal transformation in various frequency domain. Next, do reversal processing further and then it can be finish processing for image. It is also based on the actual characteristics of the image, noise and spectral distribution of the demographic characteristics of the law. Scientists derived many de-noising approaches. One of the most intuitive ways of noise energy is generally concentrated in high-frequency and spectral images located in a limited range of this characteristic. And then low-pass filtering approach is used to de-noising or smoothing the image processing. This is the first class of image processing methods. Another way is processing in the frequency domain. (such as: Fourier transform, wavelet transform.) Image denoising is often used in the field of photography or publishing where an image was somehow degraded but needs to be improved before it can be printed. For this type of application we need to know something about the degradation process in order to develop a model for it. When we have a model for the degradation process, the inverse process can be applied to the image to restore it back to the original form. This type of image restoration is often used in space exploration to help eliminate arte facts generated by mechanical jitter in a spacecraft or to compensate for distortion in the optical system of a telescope. Image denoising finds applications in fields such as astronomy where the resolution limitations are severe, in medical imaging where the physical requirements for 2 high quality imaging are needed for analyzing images of unique events, and in forensic science where potentially useful photographic evidence is sometimes of extremely bad quality [1].

Colour images are considered as three band monochrome images, where each band is of a different colour. Each band provides the brightness information of the corresponding spectral band. Typical colour images are red, green and blue images and are also referred to as RGB images. This is a 24 bits/pixel image. There are various methods to help restore an image from noisy distortions. Selecting the appropriate method plays a major role in getting the desired image. The de noising methods tend to be problem specific. For example, a method that is used to de noise satellite images may not be suitable for de noising medical images. In order to quantify the performance of the various de noising algorithms, a high quality image is taken and some known noise is added to it. This would then be given as input to the de noising algorithm, which produces an image close to the original high quality image. In case of image de noising methods, the characteristics of the degrading system and the noises are assumed to be known beforehand. The image $s(x, y)$ is blurred by a linear operation and noise $n(x, y)$ is added to form the degraded image $w(x ,y)$. This is convolved with the restoration procedure $g(x, y)$ to produce the restored image $z(x, y)$.

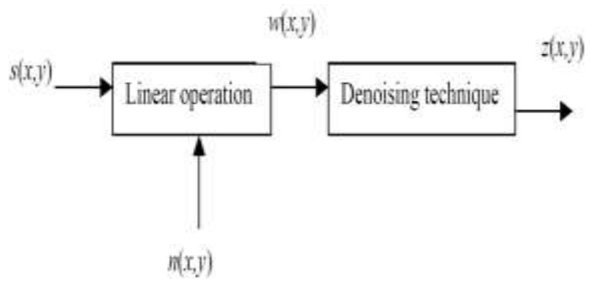


Figure 1.1: De noising concept

II. IMAGE FILTERING

2.1 Alpha Trimmed Median Filter

Alpha Trimmed Mean Filtering (ATMF) is a symmetrical filter[2] where the trimming is symmetric at either end. In this procedure, even the uncorrupted pixels are also trimmed. This leads to loss of image details and blurring of the image. In order to overcome this drawback, an Unsymmetric Trimmed Median Filter (UTMF) is proposed. In this UTMF, the selected 3x 3 window elements are arranged in either increasing or decreasing order. Then the pixel values 0's and 255's in the image (i.e., the pixel values responsible for the salt and pepper noise) are removed from the image

2.2 Hybrid Filtering

Noise is the most annoying problem[3] in image processing. One way to get rid of this problem is the development of such a robust algorithm that can perform the processing tasks in presence of noise. The other way is to design a filtration process to eliminate the noise from images while preserving its features, edges and details. Noise introduces random variations into image that fluctuate the original values to some different values. Causes which may introduce noise to images include flaws in data transmission, imperfect optics, sensor malfunctioning, processing techniques and electronic interference .Mathematical morphology is a methodology specifically designed for the analysis of geometrical structures in an image by probing it with small patterns called structuring elements. The resultant image operators are nonlinear and found useful for many applications like edge detection object segmentation, noise suppression and exploring geometrical structures of images. Alternate sequence filters (ASFs) are recognized as one of these important operators and have been widely used and researched.

2.3 Sharpening Filters: The sharpening method highlight fine details in an image or it can enhance the detail of image which is blurred by the noise. Hence visibility of image can be improved by using sharpening technique. As image blurring is achieved by using averaging filters hence sharpening can be achieved by using operators that invert averaging operators. In mathematics averaging is equivalent to the concept of integration and to inverts integration differentiation is used. Hence sharpening filters can be represented by using partial derivatives. Laplacian Filtering is an image sharpening technique. Unsharp Masking (UM) and High boost filtering are most commonly used filtering techniques used for image sharpening. Histogram processing can also be used for image enhancement. Inhistogram processing normalization of image histogram is done which makes it as flat as possible. A such kind of technique of image sharpening is Histogram Equalization (HE). UM and HE techniques of image sharpening are discussed below:

a) Unsharp Masking

Unsharp masking is an efficient technique for the sharpness enhancement. It sharpen the edges in the image by subtracting an unsharp or smoothed version of an image from the original image. The basic procedure followed in unsharp masking is show below:

Unsharp masking produces an edge image g(x,y) from an input image f(x,y)

g(x,y) = f(x,y) - f_{smooth}(x,y) Eq.(2.1)

Wheref_{smooth}(x,y) is a smoothed version of f(x,y).

The fig. below shows the unsharp masking filter algorithm:

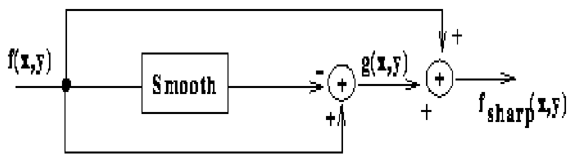


Fig.2.1Unsharp Masking Filter.

The Generation of unsharp mask is shown in the following figure:

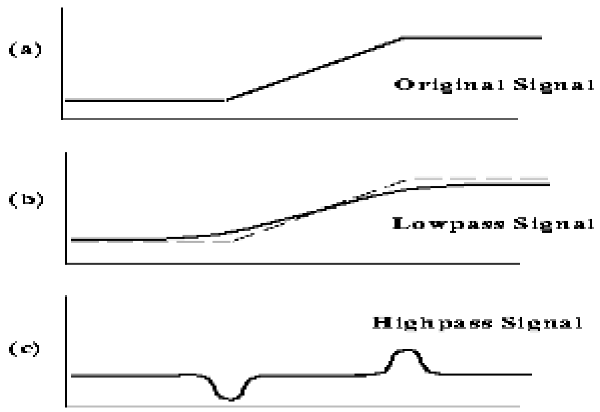


Fig.2.2 Calculating the Unsharp mask.

Now if the edge image which is calculated in above figure is added to the original image it will sharpen the original image as follows:

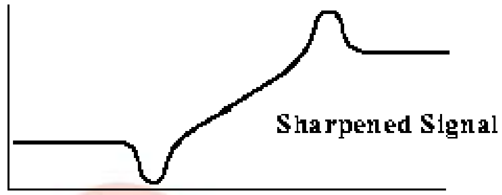


Fig.2.3 Sharpening of original image using Unsharp mask.

Now the equation will become as:

$f_{sharp}(x,y) = f(x,y) + k*g(x,y)$ Eq. (2.2)

iii.Proposed Method

Removing or reducing impulse noise is a very active research area in image processing. Impulse noise is caused by errors in the data transmission generated in noisy sensors or communication channels, or by errors during the data capture from digital cameras. Noise is usually quantified by the percentage of pixels which are corrupted. Corrupted pixels are either set to the maximum value or have single bits flipped over. In some cases, single pixels are set alternatively to zero or to the maximum value. This is the most common form of impulse noise and is called salt and pepper noise. Nevertheless other types of impulse noise are possible as well.

The detailed operation of our proposed method for the removal of salt and pepper noise from images shown. The stepwise operation of proposed method is as follows:

(i) Read the noisy image which is corrupted with salt and pepper noise.

(ii) Select a 2D window of size 3 $\times$ 3. Assume that the processing pixel is $f(x,y)$.

(iii) If $0 < f(x,y) < 255$ then $f(x,y)$ is a noise free pixel and will be left unchanged.

(iv) If $f(x,y) = 0$ or 255 then $f(x,y)$ is noisy pixel. Hence two cases will be possible:

Case (i): If selected window contain all values as 0 and 255 then replace $f(x,y)$ with mean of values in selected window.

Case (ii): If selected window also contains values other than 0 and 255 then apply the TMASBF on the processing pixel.

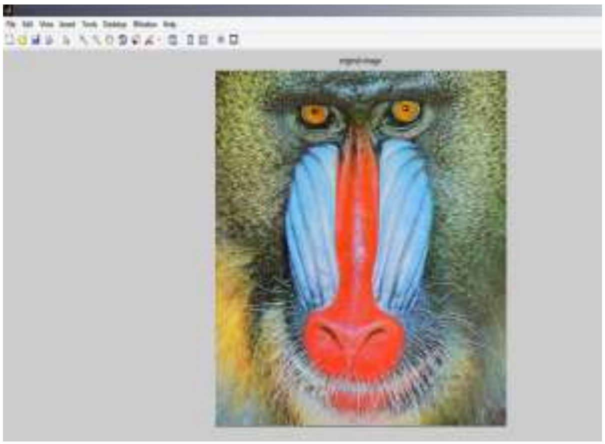
(v) The output will be the denoised image $\tilde{f}(x,y)$.

Algorithmic Design

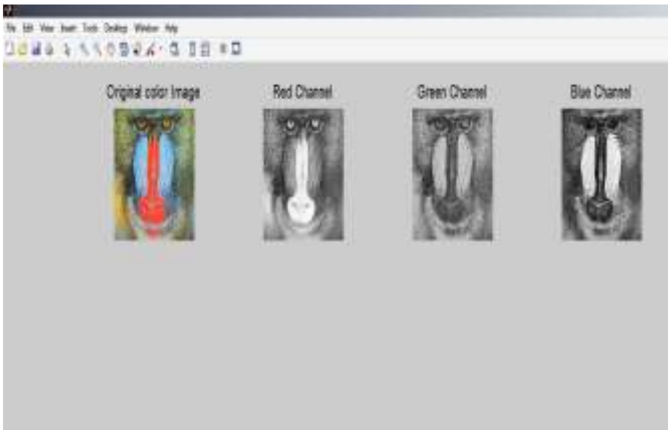
1. Read color noise image.
2. Separate the three plane of color of color image i.e. red-green-blue plane.
3. Select either of the planes(R/G/B).
4. Select 2-D window of size 3×3. Assume that the pixel being processed is P_{ij}.
5. If the processing pixel has values either greater than 0 and less than 255 i.e. $0<P_{ij}<255$ then P_{ij} is an uncorrupted pixel and its value is left unchanged.
6. If $P_{ij}=0$ or $P_{ij}=255$ then it is a corrupted pixel and further proceeding is based on following conditions
7. Case i): If the selected window contains all the elements as 0's and 255's. Then replace with the mean of the element of window.
8. Case ii): If the selected window contains not all elements as 0's and 255's. Then eliminate 255 and 0's and find the median value of the remaining elements. Replace with the median value.
9. Repeat steps 4 to 6 until all the pixels in the entire plane are processed.
10. Go to step 3 and Select next plane.
11. Restored all three de noise plane.

V. Simulation Results

Step1 Load the original color image.

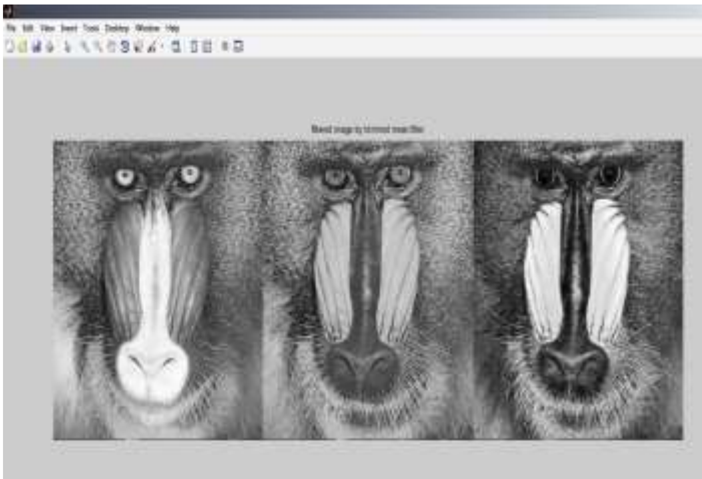


Step-2 Separate the three plane of color of color image i.e. red-green-blue plane.

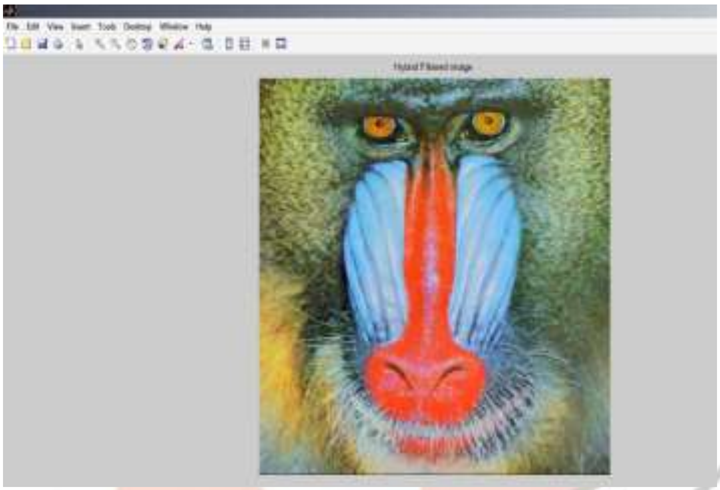


Step3 Load the Distorted grayscale image Leena, Babon,Peepers,Boat of at the nose density level 0.9 ,we may include this density level 0.1 to 0.9. In this work we use the maximum density level of noise, through which we easily check the performance of the our filters ,and also calculate the image matrices like, PSNR,IEF,MSE

Step 4 : filtered image by Trimmed Filter



Step 5 : filtered image by Hybrid Filter



Step 6 : filtered image by Purposed Filter

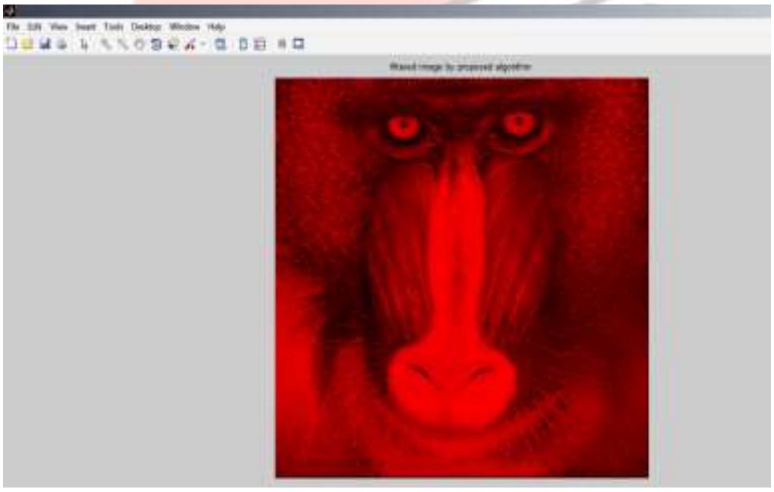


Table No-5.1 Comparative analysis of Image Metric parameter(PSNR) using different filter

Density level	PSNR by Adaptive filter	PSNR by Hybrid filter	PSNR by conventional filter	PSNR by Trimmed filter	PSNR by DBA Filter	PSNR by Purposed Filter
0.9	**5.3442**	**5.8275**	**7.7313**	**15.7821**	**18.3642**	**30.4421**
0.8	**5.3006**	**5.8192**	**9.0932**	**19.7079**	**20.6720**	**35.4012**
0.7	**5.5521**	**5.8278**	**11.9220**	**22.6392**	**24.2185**	**38.4220**

0.6	**5.8079**	**5.6932**	**14.2016**	**25.8731**	**26.7232**	**40.4625**
0.3	**5.1563**	**5.6594**	**22.6231**	**37.6734**	**38.4532**	**46.8550**
0.1	**5.2356**	**6.1023**	**28.5356**	**41.2341**	**42.5123**	**47.5412**

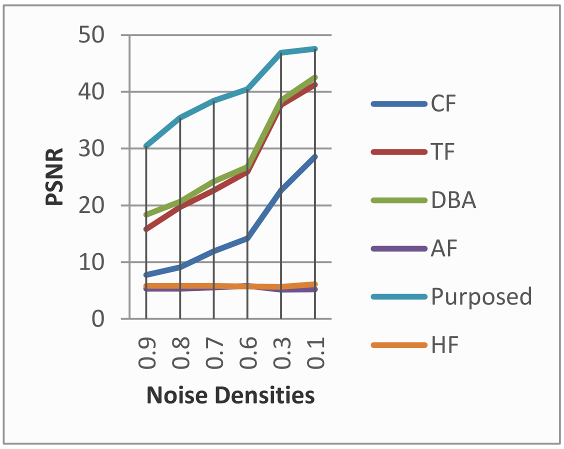


Fig. 5.1PSNR By Different Filter

Table No-5.2 Comparative analysis of Image Metric parameter(IEF) using different filter

Density level	IEF by Adaptive filter	IEF by Hybrid filter	IEF by conventional filter	IEF by Trimmed filter	IEF by DBA Filter	IEF by Purposed Filter
0.9	**0.8391**	**1.006**	**1.4908**	**9.8285**	**12.7687**	**230.1087**
0.8	**0.8395**	**1.121**	**1.6433**	**21.182**	**31.8550**	**232.1754**
0.7	**0.7118**	**1.311**	**2.4545**	**43.8782**	**65.1478**	**234.1712**
0.6	**0.6256**	**1.451**	**3.5547**	**73.1846**	**99.6078**	**234.7925**
0.3	**0.7651**	**1.5321**	**19.3214**	**300.5621**	**342.4531**	**584.5631**
0.1	**0.1673**	**1.7564**	**26.8754**	**462.3421**	**523.2356**	**662.3276**

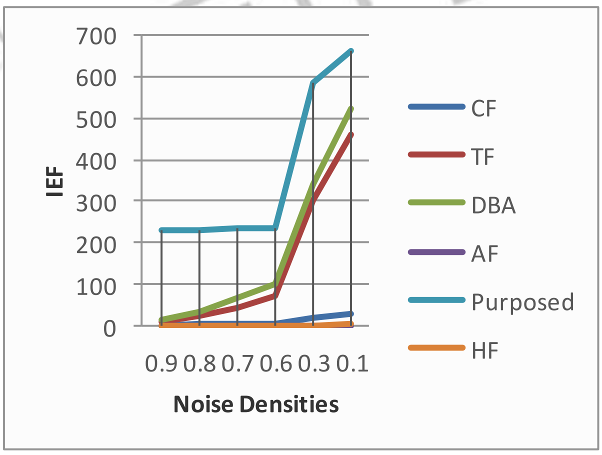


Fig. 5.2 IEF By Different Filter

Table No-5.3Comparative analysis of Image Metric parameter (MSE)using different filter

Density level	MSE by Adaptive filter	MSE by Hybrid filter	MSE by conventional filter	MSE by Trimmed filter	MSE by DBA Filter	MSE by Purposed Filter
0.9	**0.2641**	**0.3563**	**0.1522**	**0.0158**	**0.0193**	**11.8734**
0.8	**0.2771**	**0.3771**	**0.1312**	**0.0366**	**0.0167**	**11.8887**
0.7	**0.3332**	**0.3865**	**0.0209**	**0.0421**	**0.0222**	**10.5962**
0.6	**0.4232**	**0.3896**	**0.0178**	**0.0119**	**0.0419**	**12.6756**
0.3	**0.4423**	**0.6953**	**0.0132**	**2.4102**	**3.1121**	**6.9945**
0.1	**0.2786**	**0.7453**	**0.0123**	**4.9048**	**4.9241**	**5.7512**

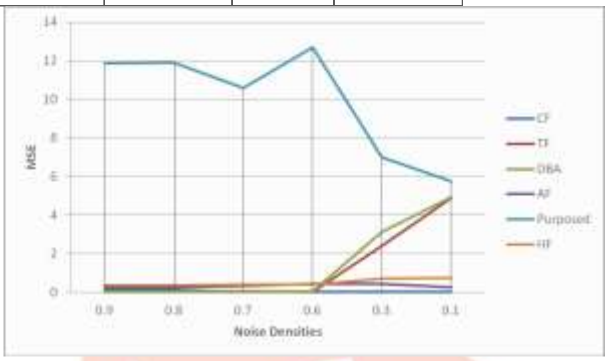


Fig. 5.3 MSE By Different Filter

v. Conclusion and Future scope

An efficient non-linear algorithm to remove high- salt and pepper noise is proposed. The modified sheer architecture reduces the computational time required for finding the median. This increases the efficiency of the system. The algorithm removes noise even at higher noise densities and preserves the edges and fine details. The performance of the algorithm is better when to the other architecture of this type.

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