Removal of Impulse Noise using Improved Mean Filter for Image Enhancement

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***Abstract*-In this paper we have introduced a new method for the enhancement of gray scale images, when images are corrupted by fixed valued impulse noise (salt and pepper noise). Our proposed method gives a better output for low-density impulse noise as compare to the other famous filters like Standard Median Filter (SMF), Decision Based Median Filter (DBMF) and Modified Decision Based Median Filter (MDBMF) and so on. In our proposed method we have improved the Peak signal to noise ratio (PSNR), visual perception and also reduce blurring in the image. The proposed algorithm replaces the noisy pixel by trimmed mean value. When previous pixel values, 0's and 255's are present in the particular window and all the pixel values are 0's and 255's then the remain noisy pixels are replaced by mean value. Different gray-scale images are tested via proposed method. The experimental result shows better Peak Signal to Noise Ratio (PSNR) value and with better visual and human perception.**

***Index Terms*-- Blurring, Human and visual perception, Modified Nonlinear filter, Peak Signal to Noise Ratio (P.S.N.R.), Salt and Pepper noise, Image enhancement factor (IEF).**

I. INTRODUCTION

IN the field of image processing, digital images are often corrupted by several kinds of noise during the process of image acquisition malfunctioning pixels in camera sensors, faulty memory locations in hardware, or transmission in a noisy channel [1]. These are the main reasons of generation of the impulse noise in our digital world. In the field of image processing, digital images are mainly corrupted by the impulse noise [2]. For the last decades, researchers are involved in the field of image de-noising to find out an effective method which preserves the image details and reduces the noise of digital images and also try to improve the quality of the image. Image quality measurement is mainly done some image parameters like peak to single noise ratio, mean square error, image enhancement factor, but in case of image processing one more thing is important that is human perception [3]. Impulse noise is one the most severe noise which usually affects the images. So, the researchers focus on the removal of impulse noise while minimizing the loss of details as low as possible. There are two types of impulse noise, namely, the salt-and-pepper noise also known as the fixed valued impulse noise and the random-valued impulse noise [6]. Here in this paper we focus on salt and pepper noise. The salt and pepper noise corrupted pixels of image take either maximum or minimum pixel value Salt and pepper noise. Fixed valued impulse noise is producing two gray level values 0 and 255. Random valued impulse noise will produce impulses whose gray level value lies within a predetermined range. The random value impulse noise in between 0 and 255.

Generally the spatial domain filters have a detection stage which identifies the noisy and noise free pixels of the corrupted image, after that noise removal part removes the noise from the corrupted image under process while preserving the other important detail of image [5].

Initially standard median filter was popularly used, but later on switching based median filters came into existence which provides better results. Any other result oriented standard median filters are, weighted median filter, SD-ROM filter, centre weighted median filter, adaptive median filter, rank order median filter and many other improved filters. The performance of median filters also depends on the size of window of the filter. Larger window has the great noise suppression capability, but image details (edges, corners, fine lines) preservation is limited, while a smaller window preserves the details, but it will cause the reduction in noise suppression. Noise detection is a vital part of a filter, so it is necessary to detect whether the pixel is noise or noise free. However, further reduction in computational complexity is enviable.

II. NOISE MODAL

Salt-and-pepper noise is one common noise type of digital image processing. The noisy image y can be modeled as-

$$(X_{ij}) = \begin{cases} Y_j \ \textit{with probabilty} & 1-p \\ Z_j \ \textit{with probabilty} & p \end{cases}$$

Where j is the 2D pixel position vector, $x_j$is the j'th pixel value in the clean image x and $z_j$the j'th pixel value in the noise image, which is usually an iid random process with the binary value range of $\{0, v_{max}(255)\}$ with $P(x_j = v_{max}) = q$ for $q \in [0, 1]$. Although in practice more noise types are present, in this paper we will work only the salt and pepper noise modal.

Impulse noise is modeled as salt-and-pepper noise. Pixels are randomly corrupted by two fixed values, 0 and 255 generated with the equal probability. We can mathematically represent salt-and-pepper impulse noise as:

$$N(x) = \begin{cases} 1 - B & for \quad x = W(i,j) \\ B & for \quad x = 0 \, or \, 255 \end{cases}$$

. Where $W_{i,j}$ is the gray level value of the noisy pixel.

III. RELATED WORK

There are many filters have been introduced for getting better results for corrupted images by salt and pepper noise. Among all these filters standard median filter (SMF) is consistent in performance. However, the major drawback of the Median filter (MF) is that it works sound only at low noise densities [11]. In case of high noise density image can't be enhanced and edge preservation of original image isn't trouble-free to preserve. Adaptive Median Filter (AMF) [11] performs superior outcome as compare to median filter at low noise densities. But in case of high noise densities the window size has to be raises not worked properly at that time and introduced image blurring. In the Switching Median Filter (SBMF) [4], [5] uses pre-defined threshold for noise removal, but it is also not perform well in the case of High noise density. The major drawback of this filtering technique is predefining threshold value, also these filtering technique's yields unsatisfactory results in preserving edge details at high densities of noise. To beat the above drawback of these filters, Decision Based Algorithm (DBA) is introduced [6]. In this filtering algorithm pixel is processed only when its value is either 0's or 255's or else left unaffected. But in case the result of the median will be 0's or 255's, which is noisy. In such type of case, neighboring pixel is used to substitute. Another algorithm was creating where in its place of just replacing corrupted pixel with a neighborhoodThere are many filters have been introduced for getting better results for corrupted images by salt and pepper noise, also these filtering technique's yields unsatisfactory results in preserving edge details pixel value it is replaced by mean of neighborhood pixels [6]. But both are unsuccessful in improving image at high noise densities. In order to evade their drawbacks, Decision Based un-symmetric Trimmed Median Filter (DBUTMF) is proposed [2]. But at high noise densities, if the selected window contains all 0's and 255's or both then, trimmed median is failing in this concession. To overcome above drawback modified decision based Unsymmetric trimmed median filter (MDBUTMF) is proposed [3], But the main problem of in this filter that is an image enhancement factor (IEF) low in case of low-density of noise is very poor that why it's performance is not very well with the low density of noise. Our proposed method Improved mean filter for image enhancement show better IEF and PSNR value. Infact in the case of low noise density our proposed filter performance is much better as compare to Modified Non-linear filter (MNF).

The rest of the paper is structured as follows; Section IV describes about the proposed algorithm and different cases of the proposed algorithm and also shows the flowchart of the proposed algorithm IV. Section V contains simulation results with Lena image. In section V show tables, comparative chats and different de-noised gray scale Lena images of proposed filter. Finally conclusions are drawn in Section VI.

IVPROPOSED METHOD

The proposed method is an enhanced by Modified Non-linear Filter (MNF) [03] algorithm. In this method first detecting the noisy pixels in the corrupted image. For detection of noisy pixels verifying the condition whether targeted pixel lies. If pixels are between maximum [255] and minimum [0] gray level values, then it is a noise free pixel, else pixel is said to be corrupted or noisy. Now we have processed only with the corrupted pixels to restore with noise free pixels. Further un-corrupted pixels are left unaffected. In the next steps we use Proposed Improved Mean filter (IMF) is elucidated as follows.

ALGORITHM

Step 1: First we take an initial image and apply on it fixed valued impulses noise (Salt and Pepper noise) on this image.

Step 2: In the second step check where the pixels are between 0 to 255 ranges or not, here two cases are generating.

X (i,j) = 0<Y (i,j)<255 condition true follow Case1

follow Case 2, Where X(i,j) is the image size and Y(i,j) all image targeted pixels

Case 1- If Pixels are between 0< Y (i,j)<255 then, they are noise free and move to restoration image.

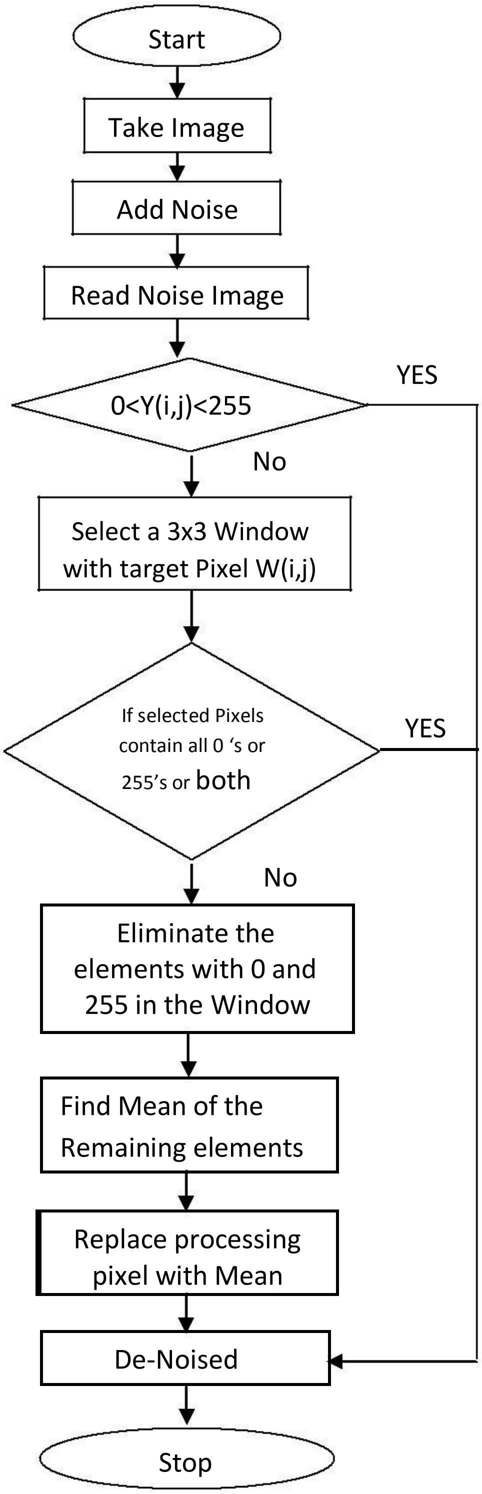
Case 2- If the pixels are not lying between in the range then they are moved to step 3.

Step 3: In the third step we will work on noisy pixel of step2 now select window of size 3 x 3 of image. Assume that the targeted noisy pixels are W (i,j).that is processed in the next step.

Step 4: If the preferred window contains not all elements as 0's and 255's. Then remove all the 0's and 255's from the window, and send to restoration image.Now find the mean of the remaining pixels. Replace W (i, j) with the mean value. This noised removed image restores in de-noised image at the last step. W(i,j) = [00] condition true send to Y (i,j) for Restoratio W(i,j) = [255]condition true send to Y (i,j) for RestorationCal. Mean remain (W (i,j))pixels] = replace by W (i,j),

Step 5: Repeat steps one to three until all pixels in the whole image are processed. Hence a better de-noised image is obtained with improved PSNR and also shows a better image with very low blurring and improved visual and human perception.

g.*1- Shows* a Flow-Chart of Proposed Method



V SIMULATIONS AND RESULT

The result of the proposed method for removal of fixed valued impulse noise is shown in this section. For simulation of proposed method we have to use MATLAB 8.0 software.

To perform our new approach we have to take a 'Lena' image size 256X256 as a reference image for testing purpose. The testing images are artificially corrupted by Salt and Pepper impulse noise by using MATLAB and images are corrupted by different noise density varying from 10 to 90 %. The performance of the proposed algorithm is tested for different gray scale a image.

De-noising performances are quantitatively measured by the PSNR as defined in (1):

The PSNR is expressed as:

$$PSNR = 10\log^{10}\frac{(255)_2}{\mathrm{MSE}} \quad \ldots\ldots\ldots\ldots.. (1)$$

Where MSE (Mean Square Error) is

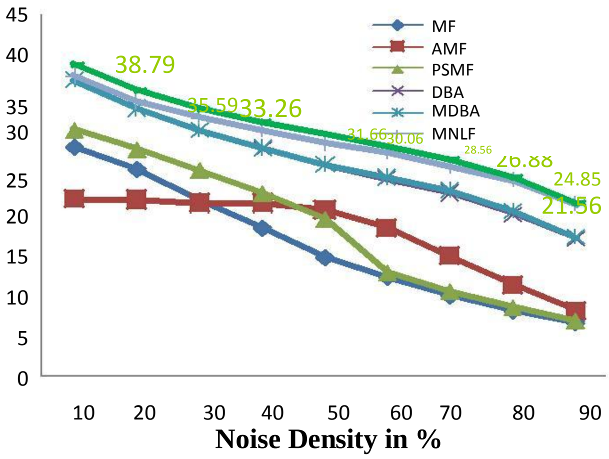
$$MSE = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}\{Y(i,j)-\hat{Y}(i,j)\}^2}{m\times n} \quad \ldots\ldots.. (2)$$

Where MSE acronym of mean square error, , M x N is the size of the image, Y denotes the original image, ^ shows the de-noised image, and η represents the noisy image. The PSNR values of the proposed algorithm are comparing with other existing algorithms by variable noise density of 10% to 90%. Table I shows the comparison of PSNR values of different de-noising methods for Lena image

The proposed new approach shows a better result as compare to other existing algorithms at different noise densities as shown in table I. Our method shows a better result in terms of PSNR , but also show a good result in visual and human perception is also shown in the fig

TABLE IComparison of PSNR values of different filtersfor LENA image

De-noising Method	**Noise density**				
	10%	**20%**	**30%**	**40%**	**50%**
MF	28.4938	25.7542	21.8465	18.4076	14.734
AMF	21.9845	21.9297	21.4735	21.4735	20.6542
PSMF	30.6494	28.2089	25.559	22.6909	19.4425
DBA	36.7565	33.2606	30.5659	28.2609	26.2846
MDBA	36.7569	33.2607	30.5308	28.2981	26.2503
MDBUTMF	38.129	34.6005	32.1427	32.0886	28.2175
MNF	37.3489	34.2358	32.1412	30.5796	29.0056
New Approach	**38.79**	**35.59**	**33.26**	**31.66**	**30.06**



PSNR dB Vs Noise Density %

The results in the Table I clearly show that the PSNR of the proposed method is much improved at different density of noise.

Graphical plots of PSNR values of different noise density compression with different filters against noise densities for Lena image is shown in Figure.

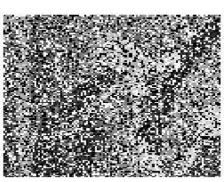
Original image

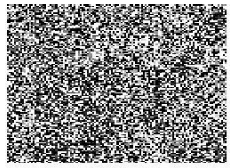
(a). 10% Noise Density (g) De-noised

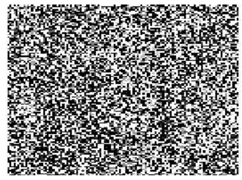
(b). 30% Noisy Density (h) De-noised

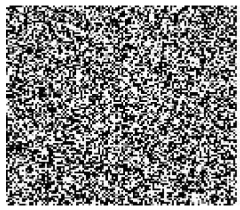
(c). 50% Noisy Density (i) De-noised

(d).70% Noisy Density (j) De-noised image

(e).80% Noisy Density (k) De-noised image

(f). 90% Noisy Density (l) De-noised image

VI. CONCLUSION

A new algorithm has been proposed to deal with the problems, namely, poor image enhancement at high noise density, which is frequently enhanced in the IMF. In this paper improved mean filtering is used for enhancing the peak signal to noise ratio (PSNR. The performances of proposed 'Improved Mean Filter'(IMF) are quantitatively vies as well as the visual and human perception vies shows better result in both conditions as compared to other existing filters. Results reveal that the proposed filter exhibits better performance in comparison with MF, AMF, DBA, MDBA, MDBUTMF, MNF filters in terms of higher PSNR. Indifference to AMF and other existing algorithms, the new algorithm uses a small 3x3 window having only eight neighbors of the corrupted pixel that have higher connection; this provides more edge information, more important to better edge preservation. The New algorithm filter also shows reliable and stable performance across a different range of noise densities varying from 10%-90%. The performance of the proposed method has been tested at low, medium and high noise densities on gray scales. Infect at high noise density levels the new proposed algorithm gives better performance as compare with other existing de-noising filters.

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