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Implementation of Block based Mean and Median Filter for Removal of Salt and Pepper Noise

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ABSTRACT
Image de-noising plays an important role in a wide range of applications such as image restoration, visual tracking, image registration where obtaining the original image contents are essential for strong performance. There is one fundamental challenge in the field of image processing- image de-noising, where the underlying goal is to enhance the original image by removing noise from a noisy image. The main factor which reduces the quality of image is noise. It hides the important details and information of an image. Noise may be caused by the different internal or external environment. In this paper we discussed noise removal filter for different levels of noise.

Keywords:- Salt And Pepper Noise, Mean Square Error, Peak Signal Ratio, Normalized Coefficient, Root Mean Square Error, Image Enhancement Factor.

I. INTRODUCTION

The field of digital image analysis enables computers to extract, modify and enhance digital images. Noise is any undesired information that contaminates an image. Noise appears in image from a variety of sources. The acquisition process is the primary process which converts an optical image into a continuous electrical signal and by which noise appears in digital images. When an image gets corrupted with noise during the processes of acquisition, transmission, storage and retrieval, it becomes necessary to suppress the noise quite effectively without distorting the edges and the fine details in the image so that the filtered image becomes more useful for display or further processing.

Image filtering is a process by which we can enhance images. Image filtering is used to remove noise, sharpen contrast or highlight contours in the images. A filter is a software routine that changes the appearance of an image or part of an image by altering the shades and colours of the pixels in some manner. Filters are used to increase brightness and contrast as well as to add a wide variety of textures, tones and special effects to a picture. Filters can enhance the images by removing imperfections like noise, blur to some portion of image so that portion will be out of focus and so on.

The choice of filter is often determined by the nature of the task and the type and behaviour of the data. Noise, dynamic range, colour accuracy, optical artifacts, and many more details affect the outcome of filter functions in image processing. Images are often corrupted by random variations in intensity, illumination, or have poor contrast and can't be used directly.

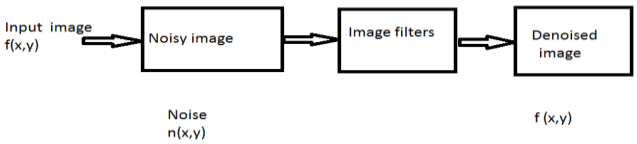

Fig 1. Denoising of the noisy image

II. SALT AND PEPPER NOISE

Salt and noise is a type of noise where the image contains pepper certain percentage of noisy pixels. The value of the noisy pixels is therefore completely uncorrelated with the same pixel in the clean image. Salt and Pepper noise contains random occurrences of both black and white intensity values. This noise can arise due to errors during transmission of an image. There are many image filters used to remove this noise from the noisy image like Standard Median Filter, Adaptive Median Filter and Switching Median Filter etc.

III. IMAGE QUALITY METRICS

The following images quality parameters are used to compare effect of noise at different noise density levels:-

A. MSE (Mean Square Error):- The first term is the MSE. The MSE is the cumulative square error between the reconstructed and the original

image. The MSE is often called quantization error variance σ_q^2 and its formula is given by

$$MSE=\sigma q2=\frac{1}{N}\sum_j \sum_k [f(j,k) - g(j,k)]^2 \qquad \text{Eq.1.1}$$

where the sum over j, k denotes the sum over all pixels in the image and N is the total number of pixels in an image. The lower the value of MSE, the lower the error.

B. ***RMSE (Root Mean Square Error):***-RMSE is a frequently used measure of the differences between values predicted by a model or an estimator and the values actually observed. RMSE is a good measure of accuracy. A lower value for RMSE means lesser error and this result in a high value of PSNR. Its formula is given by

$$RMSE= \sqrt{MSE} \qquad \text{(Eq….1.2)}$$

C. ***PSNR (Peak Signal to Noise Ratio):***-Other important term related to image quality metrics is the PSNR. PSNR is a **measure** of the peak error. It is used to test the change in the quality of image after applying various attacks. The mathematical formula is given by

$$PSNR=20*\log10\ (255/RMSE) \qquad \text{(Eq.…1.3)}$$

Where n is the number of bits used to represent per pixel value and 255 represents the maximum value of each pixel. 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. So we can say that a scheme having a lower RMSE and a high PSNR is a better scheme.

D. ***IEF (Image Enhancement Factor):-*** It is used to check the enhancement of image.The Formula for calculating IEF value is as follows:-

$$IEF = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}\{\eta(i,j)-Y(i,j)\}^2}{\sum_{i=1}^{\wedge}\sum_{j=1}^{\wedge}(Y(i,j)-Y(i,j))^2} \qquad \text{(Eq….1.4)}$$

E. ***Execution time:*** -Total time taken for the execution of algorithm. Units of execution time is in seconds.

IV. LITERATURE SURVEY

Karthik et al[3] stated that the algorithm replaced the noisy pixels by trimmed median values 0' and 255'0the noise pixels is replaced by the mean value of all the elements presented in the selected window. It provided the better results than the standard median filter, decision based algorithm, and modified decision based algorithm and progressive switched median filter. Modified cascade filter tested against different gray scale and color images and given better peak signal to noise ratio and image enhancement factor.

Ahmed et al [1] presented novel two stage filter for removal of salt and pepper noise. Noisy pixels detected by adaptive fuzzy filter. Weighted mean filter is used to denoising. Experimented results shown that the proposed filter is superior to state-of-the-art filters, and moreover, can restore meaningful image detail at levels of corruption as high as 97%.

Zhang et al [5] provided an improved method based on AMF that performed better in restoring image corrupted by high levels of SPN. It has much higher detection accuracy than AMF especially for high-level SPN. The computational time is similar for each level of SPN. Experimental tests have shown that the proposed AWMF method could perform better than many other existing filters.

Yadav et al [3] proposed algorithm replaced 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 remaining noisy pixels are replaced by mean value. The gray-scale image of mandrill and Lena were tested via proposed method.Proposed method takes a very short little time between 2 to 5 second in10 to 90% noise density, that's why our proposed method is good for field program gate array (FPGA) simulation. Time consumption shows that the complexity level of our proposed method is very low.

Eurasip et al [2] applied the block matching and 3D filtering (BM3D) scheme in order to refine the output of the decision base, adaptive median techniques obtained results are excellent surpassing current state of the art for about 2 DB for both gray scale and colour images.

V. PROPOSED ALGORITHM

A block based mean and median approach is used for the denoising. To remove the salt pepper noise, the process and flowchart of proposed algorithm is as follows:

Step1:- Read the noisy image y (i, j).

Step2:- Initialize the window size with 3x3, 5x5 or 7x7.

Step3:- Select 3x3 window with target pixels 0, 255.

Step4:- If condition 0<y<255 is true then no noise in image. Else go to step 5.

Step5:- select non noisy pixel with window size 3x3or5x5or7x7.

Step6:- Check the length of noisy pixel.

Step7:- If no of noisy pixel<block*block/2 is true then go to step 8 else first find the minimum no and find maximum no from the block and go to step 9.

Step8:- For 0 calculate the mean and for 255 calculate the median.

Step9:- Generate the random numbers with range minimum and maximum.

Step10:- For 0 calculate the mean and for 255 calculate the median.

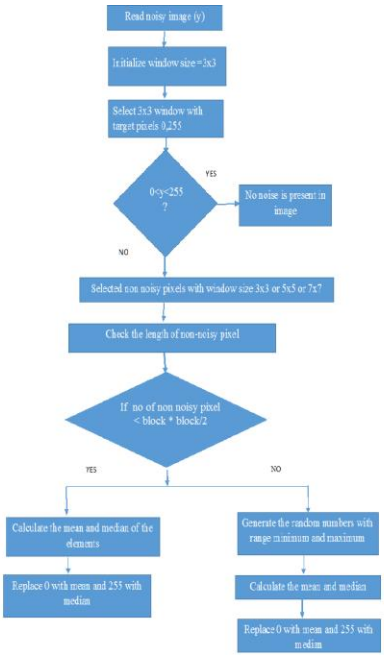

Fig.2. Flowchart for Image denoising

VI. RESULTS &DISCUSSIONS

The experimental results of the proposed method are tested on the Lena image as shown in figure 3. Salt and pepper noise added into image and then this image is used for salt pepper noise removal method. This method take the image in its original form and adds noise in it different variance.

The results of proposed image are shown in tables I to III with different noise level range from 10% to 90%. Bar graphs shown in figure 4 to 6 represent the PSNR, MSE, RMSE and IEF values of the denoised image.In proposed algorithm PSNR, MSE, RMSE, IEF are decreased with noise density is increased.

Fig 3: Lena image

TABLE I: PSNR, MSE, RMSE, IEF VALUES WITH WINDOW 3*3

NOISE (%AGE)	PSNR	MSE	RMSE	IEF
10	32.9274	31.0922	5.5760	265.9384
20	31.9366	39.0590	6.2497	211.7025
30	31.2580	45.6659	6.7577	181.0809
40	29.8720	56.7282	7.5318	145.7758
50	28.5895	76.2172	8.7302	108.5082
60	25.5692	152.1008	12.3329	54.3346
70	21.2804	408.3244	20.2071	20.2555
80	17.0441	1204.9	34.712	6.8643
90	11.9615	3365.6	58.013	2.4577

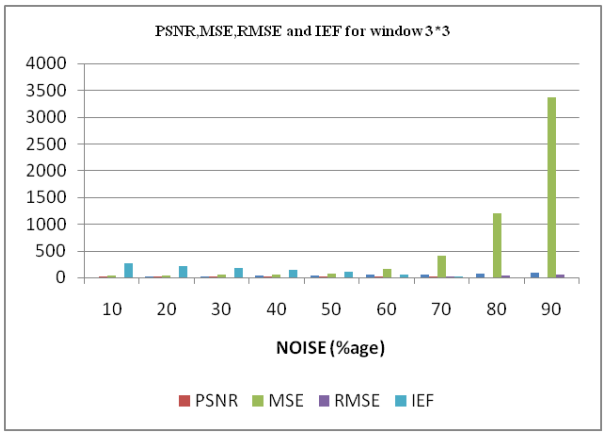

Fig 4. Graph of PSNR,MSE,RMSE and IEF for window 3*3

TABLE II:PSNR, MSE, RMSE, IEF VALUES WITH WINDOW 5*5

NOISE (%AGE)	PSNR	MSE	RMSE	IEF
10	28.0566	95.4468	9.7694	85.9664
20	27.5088	108.2105	10.4053	75.7834
30	26.8707	125.4487	11.1986	65.4303
40	26.6674	131.4383	11.4638	62.4903
50	26.1584	147.7589	12.1556	56.5393
60	25.2792	159.6743	12.6362	51.3963
70	25.4161	173.6951	13.1793	47.2495
80	23.7866	225.1631	15.0054	36.4493
90	18.6345	835.4941	28.9049	9.8237

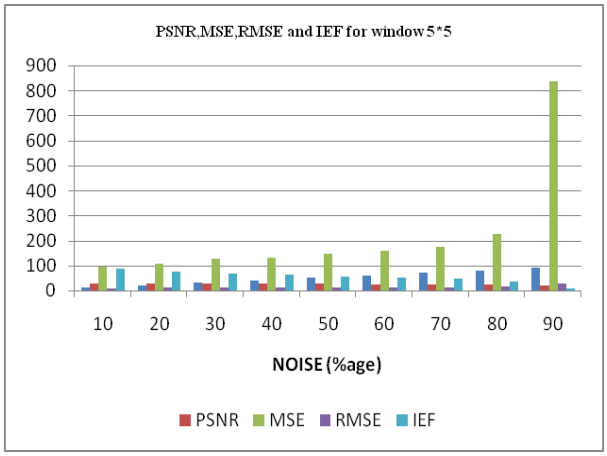

Fig 5. Graph of PSNR,MSE,RMSE and IEF for window 5*5

TABLE III:PSNR, MSE, RMSE, IEF VALUES WITH WINDOW 7*7

NOISE (%AGE)	PSNR	MSE	RMSE	IEF
0.1	25.5960	168.1890	12.9688	48.4077
0.2	25.1904	184.6541	13.5887	44.0934
0.3	24.3605	201.8136	14.2061	40.3454
0.4	24.3616	223.4767	14.9491	40.3454
0.5	24.0203	241.7505	15.5483	33.6837
0.6	23.81.6	253.7071	15.9282	32.0975
0.7	22.8816	277.3264	16.6531	29.3660
0.8	22.8229	286.2604	16.9192	28.4507
0.9	21.6234	365.4255	19.1161	22.2886

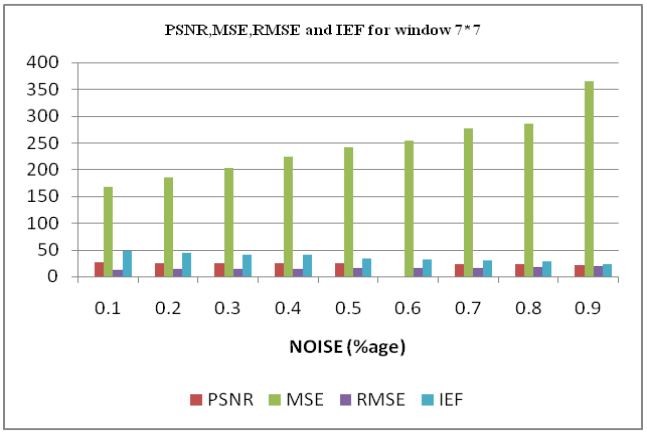

Fig 6. Graph of PSNR,MSE,RMSE and IEF for window 7*7

VII. CONCLUSION

After implementation of block based mean and median filter for image denoising, it has been observed that the value of PSNR,MSE,RMSE and IEF has been preserved with the increase in noise density. Furthermore, the window size has been changed to check the effect of incresing noise on the recovered image. It is observed that window size 3*3 gives better results than 5*5 and 7*7 window sizes as it contains less noisy pixels.

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