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Removal Salt & Pepper Noise from Image by using adaptive Median Filter

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Abstract: This paper proposed a new algorithm called adaptive median filter (AMF).this algorithm is work with combined the mean filter and median standers filter to remove the salt & pepper noise by two level of the removal, first level to remove noise in the meddle image, and the second level remove the noise from the edge image. Experimental and comparing results showing this algorithm is removal the salt & pepper noise by high efficiency especially if the noise intensity more than 60%.

Keywords: Noise, Types of Noise, filtering Methods

I. INTRODUCTION

Digital image processing is the most important technique used in remote sensing. It has helped in the access to technical data in digital and multi-wavelength, services of computers in terms of speed of processing the data and the possibilities of big storage. Several studies can also take the benefit of it such as technical diversity of the digital image processing, replication sites and maintaining the accuracy of the original data. They proposed A new robust statistics based filter to remove low to medium density salt and pepper noise with edge preservation in digital images The proposed method restore the original image much better than standard non linear median-based filters and some of the recently proposed algorithms. The Proposed filter requires less computation time compared to other methods [1]. Weight Median Filter (WMF) based on threshold decomposition removes impulsive noise with an excellent image detail processing capability compared to nonlinear filter and linear filter [2]. Standard Median Filtering (SMF) is a non-linear, low-pass filtering method which can be used to remove 'speckle' noise from an image. A median filter can outperform linear, low pass filters, on this type of noisy image became it can potentially remove all the noise without affecting the 'clean' pixels. Median filters remove isolated pixels, whether they are bright or dark. Adaptive Median Filter (AMF) is designed to eliminate the problems faced by the Standard Median Filter [3]. Adaptive Filter (AF) changes its behavior based on the statistical characteristics of the image inside the filter window. Adaptive filter performance is usually superior to non-adaptive counterparts. The improved performance is at the cost of added filter complexity. Mean and variance are two important statistical measures using which adaptive filters can be designed [4].There are many methods for reducing noise. Traditional median filter and mean filter are used to reduce salt-pepper noise and Gaussian noise respectively. When these two noises exist in the image at the same time, use of only one filter method cannot achieve the designed result [5].

II. NOISE

Noise can be defined as any disturbance tending to interfere with the normal operation of a device or system. Image noise is a random, usually unwanted, variation in brightness or color information in an image. Image noise can originate in film grain, or in electronic noise in the input device (scanner or digital camera) sensor and circuitry, or in the unavoidable shot noise of an ideal photon detector.
Noise is any undesired information that contaminates an image. Noise appears in image from various sources. The digital image acquisition process which converts an optical image into a continuous electrical signal that is then sampled is primary process by which noise appears in digital image

III. TYPES OF NOISE

There are common types of image nose:

A. Gaussian Noise

The Gaussian noise is most often used to model natural noise processes, such as those occurring from electronic noise in the image acquisition system.

B. Uniform Noise

Uniform noise is useful because it can be used to generate any other type distributed and is often used to degrade images for the evaluation of image algorithms because it provides the most unbiased or neutral noise model.

C. Salt and Pepper Noise

The salt-and-pepper type noise is typically caused by errors in the data transmission malfunctioning pixel elements in camera sensors, faulty memory locations, or timing errors in the digitization process
Salt & pepper distribution noise can be expressed by:

$$p(x) = \begin{cases} p1, & x = A \\ p2, & x = B \\ 0, & otherwise \end{cases}$$

Where: *p1*, *p2* are the Probabilities Density Function (PDF), *p(x)* is distribution salt and pepper noise in image and *A, B* are the arrays size image. Gaussian and salt & Pepper are called impulsive noise.

D. Speckle Noise

If the multiplicative noise is added in the image, speckle noise is a ubiquitous artifact that limits the interpretation of optical coherence of remote sensing image. The distribution noise can be expressed by:

$$J = I + n*I$$

Where, *J* is the distribution speckle noise image, *I* is the input image and *n* is the uniform noise image by mean *o* and variance *v*.

IV. ALGORITHMS

A. Mean Filter (MF)

Mean Filter (MF) is a simple linear filter, intuitive and easy to implement method of smoothing images, i.e. reducing the amount of intensity variation between one pixel and the next. It is often used to reduce noise in images. The idea of mean filtering is simply to replace each pixel value in an image with the mean (average) value of its neighbors, including itself. This has the effect of eliminating pixel values which are unrepresentative of their surroundings. Mean filtering is usually thought of as a convolution filter. Like other convolutions it is based around a kernel, which represents the shape and size of the neighborhood to be sampled when calculating the mean.

B. Standard Median Filter (SMF)

Standard Median Filtering (SMF) is a non-linear, low-pass filtering method which can be used to remove 'speckle' noise from an image. A median filter can outperform linear, low pass filters, in this type of noisy image became it can potentially remove all the noise without affecting the 'clean' pixels. Median filters remove isolated pixels, whether they are bright or dark.

C. Proposed Adaptive Median Filter (PMF)

The Proposed Adaptive Median Filter (PMF) is designed to eliminate the problems faced with the Standard Median Filter. The basic difference between the two filters is that in the Adaptive Median Filter, the size of the window surrounding each pixel is variable. This variation depends on the median of the pixels in the present window. If the median value is an impulse, then the size of the window is expanded.

The adaptive filter works on a rectangular region Sxy. The adaptive median filter changes the size of Sxy during the filtering operation depending on certain criteria as listed below. The output of the filter is a single value which replaces the current pixel value at (x,y) the point on which Sxy is centred at the time.

The adaptive median filter works in two levels denotes Level A and Level B as follows:

Level A: A1 = Zmed – Zmin

A2 = Zmed – Zmax

If A1>0 AND A2<), Go to level B

Else increase the window size

If window size <=Smax repeat level A

Else output Zxy.

Level B: B1 = Zxy – Zmin

B2 = Zxy – Zmin

If B1>0 And B2<) output Zxy

Else output Zmed-

Where,

Zmin = Minimum gray level value in Sxy

Zmax = Maximum gray level value in Sxy

Zmed = Median of gray levels in Sxy

Zxy = gray level at coordinates (x,y)

Smax = Maximum allowed size of Sxy

V. EXPERIMENTS VERIFICATIONS

A. Testing Procedure

The filters were implemented using (MATLAB R2007a, 7.4a) and tested Salt & Pepper Noise corrupted on the one image illustrated in the Fig. 1.

Figure.1 – Lena Image

For this image, its performance for salt & pepper noise with probabilities from 10% to 60%. Mean Filter, Median Filter proposed Adaptive Median Filter is applied and comparing.

B. Simulation Results

The performance evaluation of the filtering operation is quantified by the PSNR (Peak Signal to Noise Ratio) and MSE (Mean Square Error) calculated using formula:

$$PSNR = 10log_{10}\left(\frac{255^2}{MSE}\right)$$

Where,

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{i=1}^{N}[g(i,j) - f(i,j)]^2$$

Where, *M* and *N* are the total number of pixels in the horizontal and the vertical dimensions of image. *g* denotes the Noise image and *f* denotes the filtered image

Figure.2: Removal Noise from Image Corrupted by 80% salt & pepper Noise

Figure.3: Removal Noise from Image Corrupted by 30% salt & pepper Noise

Figure.4: Removal Noise from Image Corrupted by 60% salt & pepper Noise

Figure.5: Removal Noise from Image Corrupted by 40% salt & pepper Noise

Table 1: Restoration Result PSNR for Salt and Pepper Noise

Filter Type	10%	20%	30%	40%	50%	60%
MF	29.322	28.61	28.09	27.83	27.63	27.49
SMF	33.74	31.93	30.78	29.90	29.23	28.65
PMF	34.30	32.58	31.34	30.40	29.62	28.95

Table 2: Restoration Result MSE for Salt & Pepper Noise

Filter Type	10%	20%	30%	40%	50%	60%
MF	44.34	55.12	65.81	75.73	85.85	95.78
SMF	27.52	41.71	54.39	66.53	77.65	88.64
PMF	27.24	41.50	54.24	66.38	77.55	88.39

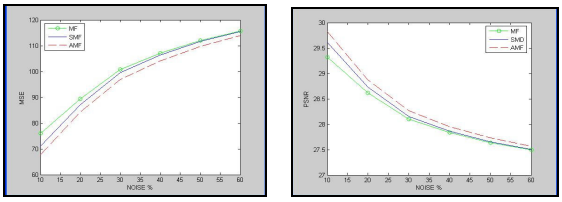

Figure.6– PSNR and MSE Analyses for Salt & Pepper Noise

VI. CONCLUSION

In this paper, the comparative studies are explained & experiments are carried out for mean filter, median filter and comparing with the proposed Adaptive Median Filter. (PMF) is the more efficiency filter to remove Salt & Pepper noise of image and see this in the fig.4. Especially when the noise density is more than 40%, it doesn't leave any blurring in the image and Standard Median Filter (SMF) is good filter for SPN with less than 40% density noise see in the fig.2, 3. 4 and 5.

The comparative study explained with help of PSNR and MSE which confirmed results illustrated in the fig. (6) With values illustrated in the table (1) and (2).

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