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A Restoration Method for the Removal of Noise Using Denoising Algorithm

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***Abstract* - The main purpose of this paper is to remove the additive noise present in the images such as Gaussian noise and dependent noise. The denoising concentrates on removal of both impulse noise and Gaussian noise from images. The DTBDM requires high computation time for processing. In DTBDM, the degradation in denoising performance as the algorithm works on noiseless pixels also. In proposed it works only on noisy pixels and it requires less computation time. In order to remove noise, a new noise detection mechanism and also filtering is performed using Non-Local means (NLM) method. To achieve the detection results more robust and more accurate, the strategy coarse-to-fine stage and the iterative method are used. The numerical results will confirm that proposed methods yields the better performance, in the terms of peak signal to noise ratio (PSNR).**

***Index Terms* - Image Denoising, Impulse noise, Gaussian noise**

I. INTRODUCTION

Digital image processing is a two-dimensional function f(x, y). where (x, y) are spatial coordination and f are discrete validation. Pixel is the term most widely used to denote the elements of a digital image. Some knowledge about the additive noise term ŋ(x, y), the objective of restoration is to obtain an estimate f(x, y) of the original image. Image sensors are affected by environmental conditions, CCD camera light levels and sensors and wireless networks.

Image denoising and image deblurring are the two sub-areas of image restoration. Image denoising methods are most widely used for the removal of both impulse noise and Gaussian noise. Impulse noise can be classified into two-categories, namely salt and pepper noise and random valued impulse noise. Removal of noise is carried out using a non-linear filter. Impulse noise can be classified as salt-and-pepper noise (SPN) and random-valued impulse noise (RVIN).

The impulse noise is given by

$$P(z) = \begin{cases} P_a & \text{for } z=a \\ P_b & \text{for } z=b \\ 0 & \text{otherwise} \end{cases}$$

If b>a, gray-level will appear as a light dot in the image. Equally, level a will appear like a dark dot. If either p_a or p_b is zero, the impulse noise is called unipolar. Bipolar impulse noise also called salt-and-pepper noise. Shot and spike noise also are terms used to refer to this type of noise. Noise impulses can either be negative or positive. As a result, negative impulses appear as black points in an image. For the similar reason, positive impulses appear white noise. For an 8-bit image this means that a=0(black) and b=255(white). The metric used for performance comparison of different filters are defined below.

A. Peak signal to noise ratio

In statistics, the mean squared error or MSE of an estimator is one of many ways to quantify the amount by which an estimator differs from the true value of the quantity being estimated. Here it is used to calculate the difference between an original image with a restored image. PSNR analysis uses a standard mathematical model to measure an objective difference between two images. The reconstructed images with higher PSNR are better. Given an original image Y of size (M×N) pixels and a reconstructed image ŷ the PSNR (DB) is defined as

$$\text{PSNR (DB)} = 10\log_{10}\left(\frac{255^2}{\frac{1}{(M*N)}\sum_{i=1}^{M}\sum_{j=1}^{N}(Y_{i,j}-\hat{Y}_{i,j})^2}\right)$$

B. Subjective or qualitative measure

Along with the above performance measure subjective estimation is also needed to measure the image quality. In a subjective estimation measures characteristics of human perception become paramount, and image quality is associated with the preference of observer or the performance of an operator for some specific task. However perceptual quality evaluation is not a deterministic process.

II. REVIEW OF LITERATURE

H. Hwang and R.A. Haddad proposed adaptive median filters: new algorithms and results. The techniques used are ranked-order based adaptive median filter and impulse size based adaptive median filter. The ranked-order based adaptive median filter, is based on a test for the presence of impulses in the center pixel itself followed by the test for the presence of residual impulses in the median filter output. The impulse size based adaptive median filter (SAMF) is based on the detection of the size of the impulse noise. Here the gaussian noise and impulse noise are mixed and image sharpness will be poor.

E. Abreu, M. Lightstone, K. Arakawa and S. K. Mitra describes a new efficient approach for the removal of impulse noise from highly corrupted images and the technique used is rank-ordered mean filter. Here also the gaussian noise and impulse noise are mixed. High corruption rate (>10%) and poor visual quality.

Z. Wang and D. Zhang proposed a progressive switching median filter for the removal of impulse noise from highly corrupted images. Here also the impulse noise is fixed value. Then the good pixels are also modified.

I .Aizenberg and C. Butakoff proposed effective impulse detector based on rank-order criteria and the differential rank impulse detector technique was used. Here the impulse noise is random and then low corruption rate.

Y. Dong and S. Xu describes a new directional weighted median filter for removal of random-valued impulse noise. The technique used is impulse detector and directional weighted median filter. Here the threshold value is fixed and damage non-noisy value and time consuming.

X. Zhang and Y. Xiong proposed impulse noise removal using directional difference based noise detector and adaptive weighted mean filter. Noise detector and adaptive weighted mean filter technique used. Here also fixed random impulse noise and high computational complexity and time consuming (<=90%).

P.-Y. Chen, C.-Y. Cien and H.-M. Chuang describes a low cost VLSI implementation for efficient removal of impulse noise. Reduced simple edge-preserving denoising method is used. Then low complexity and poor image quality (3 directional differences).

Chih- Yuan, Chien-Chuan Huang, Pei-Yin Chen describe an efficient denoising architecture for removal of impulse noise in images. The technique used here is decision-tree based impulse detector and edge-preserving image filter. Here high computational complexity and time consuming. Removal of noise only in low noise density.

III. PROPOSED DENOISING METHOD

The NLM method proposed is based on the self-similarity concept. Two issues are involved in developing a decision process. First, a decision measure should be defined as a statistical parameter to capture and represent the local property of the region. Second, a mechanism to compute a threshold value should be determined. Existing impulse noise removal methods use many different techniques to determine whether a given pixel is an impulse one in this sense. The most basic impulse detectors are based on two-state methods that attempt to definitely characterize each image pixel as either an impulse or an uncorrupted pixel. The underlying goal of these two-state methods is to find pixels that are significant outliers when compared to their neighbours.

First, we set the image in a particular window size as we needed to test. Then, the boundaries of the image is detected. After that the threshold values are calculated. And if there is a noisy pixels it replaces with the median value and then denoising is done to preserve the image details. If there is no noisy pixels the testing is completed. This is clearly shown in fig 1.

In this proposed method of non-local means, a new detection mechanism followed by filtering such as adaptive center weighted median-filter and it is described below.

A.ADAPTIVE CENTER-WEIGHTED MEDIAN FILTER (ACWM)

It devices a novel adaptive operator, which forms assessments based on the differences between the current pixel and the outputs of center-weighted median (CWM) filters with varied center weights. It works the switching scheme based on the impulse detection mechanisms. It operates the center-weighted median filter that have varied center weights to define a more general operator, which recognizes the impulse detection by using the differences defined between the outputs of CWM filters and the current pixel of concern.

The ultimate output is switched between the median and the current pixel itself. This is a good filter and is robust for a wide variety of images. But it is inefficient recovering the exact values of the corrupted pixels. As the name suggests it employs median filter on the noisy image twice. In our method, the simple switching-median decision rule with different thresholds is used in different clusters. In fact, other good decision methods can be applied to different clusters according to the principle of our detection mechanism. The ACWM can also be used to detect noisy pixels instead of the simple switching-median rule in every cluster.

The ACWM and the proposed mechanism both use statistical parameter, it reveals that the proposed mechanism is different from the existing method. The proposed method is more stable and more robust to the noise ratio. Our detection method is also available for the impulse and gaussian mixed noise.

B.STEPS IN FILTERING

The basic steps in ACWM filter are given below

1. Initialize the noisy image to be observed.
2. Apply ACWM with the 4 thresholds to the noisy image to get the noisy candidates.
3. Using 3×3 windows compute median absolute deviation (MAD).
4. The median of absolute deviations from the median (MAD), is a robust estimate of dispersion and its scaled forms are used as the thresholds. Here 0.1 is chosen as the scaling factor ($0 \le s \le 0.6$).

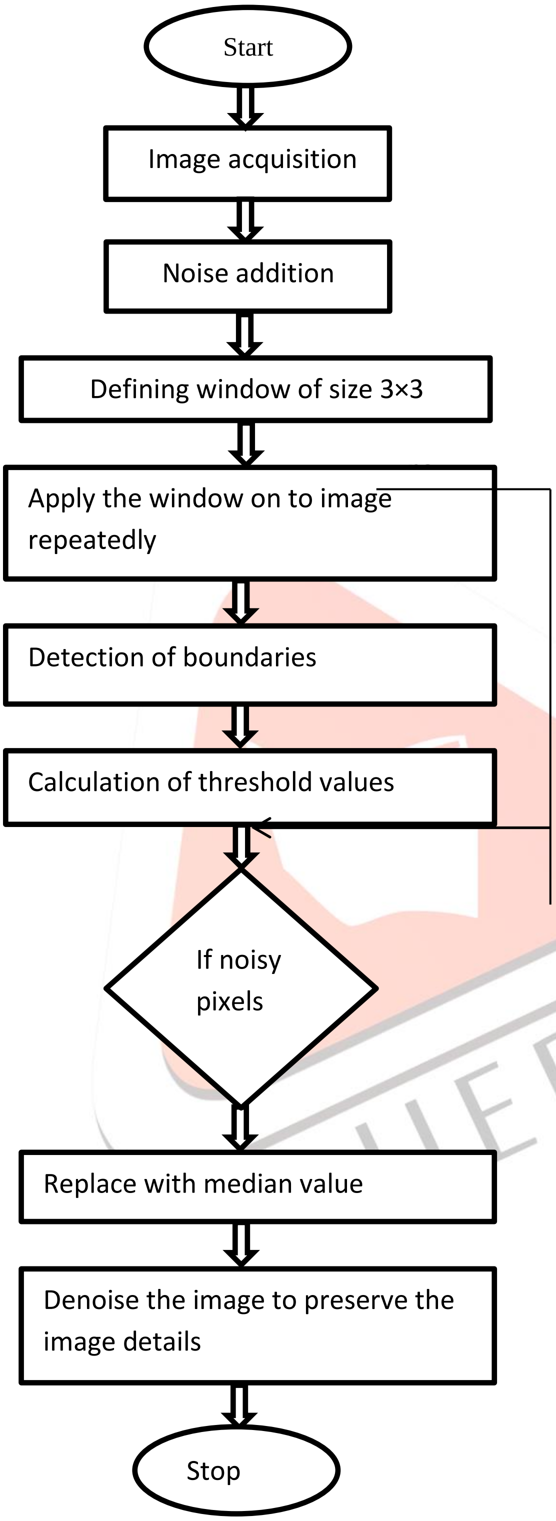

Fig 1 flow diagram for proposed denoising algorithm

IV. RESULTS

To demonstrate the effectiveness of the proposed algorithm on detecting impulse noises, by comparing the results with other existing method. The noise density is considered and it ranges from 10% to 90% with incremental step 10%.

The novel image is taken and noise is added for that image. Then using different methods we test the particular image noise density and shows that the proposed algorithm usage shows the better result when compare to other methods like median and DTBDM. It is clearly shown in fig 2.

(1) Novel image

(2) noisy image

(3) Median

(4) DTBDM

(5) Proposed

Fig 2 Results of various methods in restoring 50% of corrupted image

The noise density and PSNR calculations is done and shown in table 1. The proposed algorithm results shows better performance when compared to other methods.

Comparison result in PSNR (dB) corrupted by impulses

Table 1 Results of various methods in restoring 50% corrupted image

Noise density%	PSNR (dB)		
	Median filter	**DTBDM**	**Proposed**
1	30.45	32.63	35.68
5	30.10	31.23	34.48
10	29.42	30.05	32.93
20	28.70	29.59	31.75
50	15.49	16.29	17.93
70	12.94	13.63	15.49

V. CONCLUSION

A novel restoration method is proposed for image denoising which is based on non-local means algorithm. The noise is which defined as the difference between degraded image and the original image. A new impulse detector, which can efficiently identify noisy pixels while preserving image details. After noise detection, use output of the adaptive center weighted median filter to restore noise and the weight values are based on directions. The reconstructed edges are much sharper and more image fine structures are recovered easily. Non local means outperforms both in terms of noise rejection and retention of original image properties. The proposed scheme has been performing well under images up to 90% noise densities.

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