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Reduction of Random Valued Impulse Noise using Optimized Thresholding

C.Nivedityaa[1] & K.Kalirajan[2]

[1,2]Assistant Professor

Department of ECE

Karpagam Institute of Technology, Coimbatore

Abstract—**In this paper, normalized absolute difference is calculated Impulse detection technique for the pixel under consideration with its neighborhood pixels. A non linear function is applied to absolute difference to increase the gap between the differences corresponding to noisy pixel and those due to noise free pixels. Sorted summation of values is compared with threshold, and noisy pixels are detected. In filtering stage, the weight for weighted median filter is decided on the basis of standard deviation in four main directions. The direction with minimum standard deviation is used to assign weight. Experimental results shows that the proposed technique is better compared to other existing techniques in terms of PSNR.**

I. Introduction

Digital images play an important role both in daily life applications such as Satellite television, Magnetic Resonance Imaging, Computer Tomography as well as in areas of research and technology such as geographical information systems and astronomy .Digital images are often corrupted by different types of noise during its acquisition and transmission phase.

The most common types of noise corrupting the digital images are Gaussian noise and Impulse noise. Median filtering is an efficient nonlinear technique used for impulse noise removal. Conventional filters such as Gaussian filter used for Gaussian noise removal smooths the noise but blur the edges. To overcome these drawbacks nonlinear methods are proposed.

So Image Denoising is a fundamental problem in the field of image processing. The goal of image denoising is to remove the noise while retaining the important signal features.

NOISE MODELS

The principle sources of noise in digital images arise during image acquisition or transmission. The performance of image sensor is affected by a variety of factors such as environmental conditions during image acquisition, and by the quality of the sensing elements themselves. In acquiring images with camera, light levels and sensor temperatures are major factors affecting the amount of noise in the resulting image. Images are corrupted during transmission principally due to interference in the channel used for transmission. For example, an image transmitted through a wireless network may be corrupted as a result of lightning or other atmospheric disturbances.

Random Valued Impulse Noise

The present project deals with impulse noise and a special kind of noise called random valued impulse. The normal values of impulse noise is 0 or 255, Where as the noise value of random valued impulse noise can be of any number between 0 to 255,0 or 255.This noise is introduced into the image by replacing the noise free pixels in the original image by some random values . To find the noise value in a given image which is affected by random valued impulse noise (RVIN), the procedure is as follows:

1) To find the pixel values of all the pixels present in an image.
2) To increment the count if pixel values are same.
3) Finally the pixel value which is having maximum count will be treated as the noise value of the image which is affected by random valued impulse noise.

II. Related Work

In this chapter different types of image denoising algorithms related to Random valued impulse noise removal by non linear filtering techniques in literature is discussed.

Center Weighted Median Filters And Their Applications To Image Enhancement

Center weighted median (CWM) filter [5], is where more weight is given only to the central value of each window. The central weight should be carefully selected depending on both the characteristics of the input image and its noise.

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A New Directional Weighted Median Filter For Removal Of Random-Valued Impulse Noise

A novel method for removal of random-valued impulse noise is directional weighted median filter (DWM) [8]. This filter uses a new impulse detector, which is based on the differences between the current pixel and its neighbours aligned with four main directions.

High Performance Detection Filter For Impulse Noise Removal In Images

A high performance detection (HPD) filter [9] is proposed for impulse noise removal in images. In this approach, the noisy pixels are detected iteratively through several phases.

III. Removal Of Random Valued Impulse Noise Using Optimized Threshold

In an image contaminated by random-valued impulse noise, the detection of noisy pixel is more difficult in comparison with fixed valued impulse noise, as the gray value of noisy pixel may not be substantially larger or smaller than those of its neighbours. Due to this reason, the conventional median-based impulse detection methods do not perform well in case of random valued impulse noise. In order to overcome this problem, we use a non linear function to transform the pixel values within the filter window in a progressive manner. This operation widens the gap between noisy pixel and the other pixels in the window.

3.1 *Algorithm*

STEP 1: Read the input image and add Random Valued Impulse Noise to the image.

STEP 2: In the detection technique, the central pixel *x (i, j)* of each window is subtracted from all the pixels in the window and normalized absolute differences are obtained using following equation,

Where &

STEP 3: The normalized absolute differences, are then transformed by a nonlinear function using following equation to increase the gap between the differences corresponding to noisy pixels and those due to noise-free pixels,

(4.2)

Where denotes the transformed value of and is a constant which varies with iterations. The transformed values are sorted as
$2\leq\ldots$ *(9)* in ascending order where $1, 2,\ldots$ *(9)*
are the transformed values of.

STEP 4: Sorted summation of values are compared with the threshold ,using following equation, the central pixel is considered noisy for a filtering window of size 3 3 if

The output of the detector is represented by a binary flag image , where indicates that the pixel is noisy; for noiseless pixel, .Above Equation is used for the noise percentage of more than 40%, a bigger window of size 5 5 is used and the central pixel is considered noisy if

STEP 5: For filtering the image, a weighted median filter with 3 3 window is employed. The weight of a pixel is decided on the basis of standard deviation in four pixel directions (vertical, horizontal and two diagonals) as in. Let S denote the set of pixels in the direction with minimum standard deviation. Accordingly, the noisy pixel is restored using following equation,

$\Diamond$

Where the weight and the operator $\Diamond$ denotes repetition operation.

STEP 6: The output of the filter is expressed using following equation,

Where If the central pixel is noisy, then is greater than in case of noise-free central pixel. Thus, of a noisy image indicates the noise level. The empirical relationships between and for several noise-free natural images. It can be observed that the index can indicate the value of for a noise-free image as,

In case of noisy image also, it is observed that the roughness index obtained from the noisy image after three iterations, has the following relationship with of the corresponding noise- free image. The value of the index is now given as,

Thus in the proposed method, the value of obtained from the above equation serves as the target value to obtain the noise-free image.

Stopping Criterion

The detection and filtering operations are performed in each iteration. After each iteration, the index is computed. The roughness index is computed after three iterations and the target value of index is computed from the equation. The detection and filtering operations are stopped when

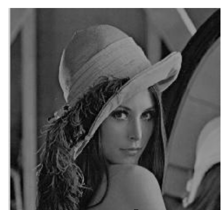
The final output of the proposed filtering scheme is taken as the output of filtering operation of iteration . To study the performance of our proposed method, we compare it with several methods including Median filter. The test images in the simulation are of size 512 x 512. The PSNR is used as an objective measurement of the restored image quality.

From the results, it is observed that the proposed filter is comparable to the best methods is comparable to the best methods at low noise rates, but it clearly outperforms all these methods at medium to high noisy rates .Results for the subjective visual qualities are shown in the figures for 50% of noise corrupted Lena image. It is clear that the restored image of the other methods are still seriously corrupted with patches of impulse noise clearly, the filter has the lowest number of false pixels amongst the others.

IV. Results and Discussions

In order to access the performance of the proposed scheme the Lena and Pepper gray scale image with 512 x 512 are used as test images. Restoration performance of different filters with different noise rate is compared distinctly. The test images are corrupted with RVIN.

This chapter summarizes all the experimental results obtained in adopting the proposed method and existing method on the random valued impulse noise to achieve the expected result and the performance is compared. In order to know about the performance of the proposed filter, their results have been tabulated. The efficacy of the proposed method is demonstrated by extensive simulations. The experimental results exhibit significant improvement in the performance over several other methods.



Lena original image

TABLE 5.1 OUTPUT OF PROPOSED METHOD FOR LENA IMAGE

RVIN NOISE%	**Noisy Image**	**Reconstructed Image**
10		

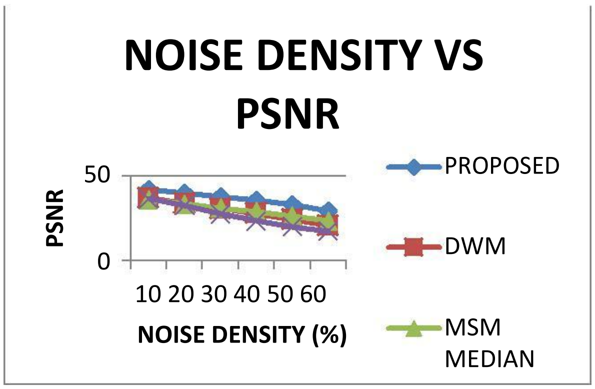
RVIN NOISE %	**Noisy Image**	**Reconstructed Image**		
20				
30				
40				

To assess the performance of the proposed scheme, the standard gray-scale Lena image of size 512 x 51 is used in experiments. The test images are corrupted with random valued impulse noise. To evaluate the image restoration performance, PSNR is used as the criterion. The noise density in the noisy images is varied from 10% to 60%.

Comparison of PSNR values of proposed techniques for Lena image of size 512x512.

METHOD	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**
Median	36.6	32.5	27.7	23.5	20	17.4

MSM	36.0	33.3	31.2	29.0	26.5	23.4
DWM	36.9	33.6	30.9	28.0	24.3	20.7
Proposed Method	41.775	39.652	37.646	35.644	32.849	29.28



Performance analysis of proposed algorithm for Lena image

V. Conclusion

Digital images play an important role both in daily life applications such as Satellite television, Magnetic Resonance Imaging, Computer Tomography as well as in areas of research and technology such as geographical information systems and astronomy .Digital images are often corrupted by different types of noise during its acquisition and transmission phase.

The most common types of noise corrupting the digital images are Gaussian noise and Impulse noise. Median filtering is an efficient nonlinear technique used for impulse noise removal. Conventional filters such as Gaussian filter used for Gaussian noise removal smooths the noise but blur the edges. To overcome these drawbacks nonlinear methods are proposed.

A filtering scheme to remove Random-Valued Impulse from noisy images is presented. The detection of noisy pixels is based on the iterative applications of a nonlinear function that progressively increases the gray level separation between noisy and noise-free pixels. The performance of the proposed scheme has been compared with many existing techniques. The efficacy of the proposed method is demonstrated by extensive simulations. The experimental results exhibit significant improvement in the performance over several other methods. In this paper, future enhancement is done to reduce overall computational time. The number of misdetection and fault detection is expected to reduce using better impulse detection for high density noise.

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