A Decision Tree Based Denoising Method for Removal of Impulse Noise in Images Processing

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ABSTRACT: Noise is an important factor that influences image quality, which is mainly produced in the processes of image acquirement and transmission. Noise reduction is necessary for us to do image processing and image interpretation so as to acquire useful information that we want. Images are prone to a variety of types of noise. Noise is the result of errors in the image acquisition process that result in pixel values that do not reflect the true intensities of the real scene. There are several ways that noise can be introduced into an image. Images get corrupted with impulse noise due to the process of image transmission and image acquisition. In the process of impulse noise filtering it is necessary to preserve edges and details of the image. Also to avoid image smoothing, only corrupted pixel must be filtered.This paper illustrates the different low complexity methods such as Median Filter, Adaptive Median Filter (AMF).The most effective technique to remove random valued impulse noise without losing useful information is decision tree based denoising method. It has two component decision-tree-based impulse noise detector and edge-preserving filter. The decision-tree-based impulse detector is used to detect the noisy pixels, and an edge-preserving filter to reconstruct the intensity values of noisy pixels. The performance of any filtering scheme is dependent on the detection mechanism. The better is the detector, the superior is the filtering performance. Hence the performance of a detector plays a vital role. The detector performance is solely dependent on a threshold value which is compared with a pre computed numerical value.Then, PSNR is calculated to evaluate the processed image. Results suggest that the methods used in this paper are suitable in processing impulse noise.

KEYWORDS*:* Impulse noise, corrupted pixel, impulse noise detector, edge preserving filter.

I.INTRODUCTION

The aim of digital image processing is to improve the potential information for human interpretation and processing image for storage transmission and representation for autonomous machine perception. Digital images are often corrupted by impulse noise in transmission error, malfunctioning of pixel elements in the camera, sensor's faulty memory locations, and timing error in the Analog to Digital conversion. The different types of noise occur during image processing and they affect the image and degrade the quality of the image. The different type of noise are Additive White Gaussian Noise, Rayleigh noise impulse noise. Different types of noise corrupt an image during the process of acquisition, transmission, and reception, and storage and retrieval. Then the two type of impulse noise are salt and pepper noise and the random valued noise. For image corrupted by salt and pepper noise (Random valued noise) the noisy pixels can take only the maximum and minimum values (Random value) in the dynamic range.There are many applications in image processing such as face recognition, edge detection, medical imaging, scanning, printing, license plate detection where it is important to remove noise in the images before these subsequent processes.

According to the distribution of noisy pixel values,impulse noise is classified into two methods based on distribution of the pixel values. The noise which has either minimum or maximum pixel value in grey scale image is called fixed valued impulse noise. It is also known as salt and pepper noise. The noise in which pixel values are uniformly distributed in the rang [0 255] in grey scale image is known as random valued impulse noise. Removal of salt and

pepper noise in image is easy as compared with random valued impulse noise. There are most of the techniques which are reported till now works very well for salt and pepper noise but fails under random valued impulse noise. It is also observed that detection mechanism decides the performance of the filtering scheme. Thus better detector gives the good performance of filtering scheme. So performance of the detector is very important. The performance of the detector is depend on the threshold value which is compared with pre computed numerical value. The performance of the detector can be improved with adaptive threshold. This threshold can be determined by noise present in the image and characteristic of image. Preserving the edge details and attenuation of noise are the two important issues in image processing. There are different adaptive techniques to remove impulse noise present in the image. These technique consist of main two steps first is noise detection and then application of non-linear filter. If the incoming pixel value is corrupted then only adaptive filter is applied to reconstruct the pixel value. If pixel value is noise-free then original value is not changed.

II.DECISION TREE BASED DENOISE METHOD

DTBDM consists of two components: decision-tree based impulse detector and edge-preserving image filter. The decision-tree-based impulse detector is detector part which detects the noisy pixel in an imageThe window size for the Denoising process is 3x3. Assume the pixel to be denoised is located at coordinate (i,j) and denotes as $p_{i,j}$. The mask under consideration is shown in Fig 1.

a	B	c
d	$f_{i,j}$	e
f	G	h

Figure 1: 3X3 mask window

The system architecture as shown below in Fig 2, the noise detection algorithm is based on the concept of aggregated distances assigned to the pixels belonging to the filtering window.
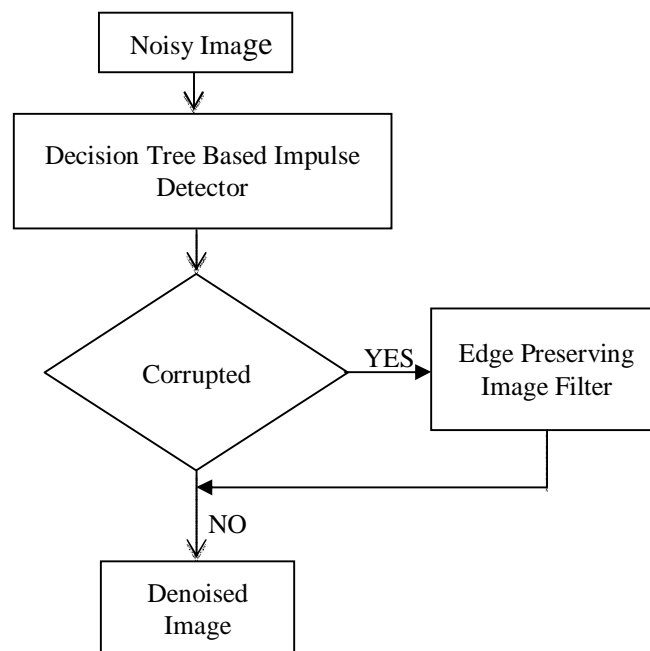

Figure 2: Data Flow of DTBDM

Three modules are designed namely Isolation module (IM), Fringe module (FM) and Similarity module(SM). We have decided the pixels in the window as Top Half and Bottom Half. Three concatenating decisions of these modules make a decision tree. Then the corrupted image is given to the edge- preserving filter to generate reconstructed image.

1. ISOLATION MODULE: Isolation module to decide whether the pixel value is in a smooth region. If the result is negative, the current pixel belongs to noisy free. Otherwise current pixel might be noisy pixel or just situated on an edge. According to the above concepts, first the maximum and minimum luminance values in$W_{TopHalf}$, named as TopHalf_max, TopHalf_min is detected and calculate the difference between them, named as TopHalf_diff. For$W_{BottomHalf}$, the same idea is applied to obtain BottomHalf_diff. The two difference values are compared with a threshold Th_IM_a to decide whether the surrounding region belongs to a smooth area.

2. FRINGE MODULE: The fringe module is used to confirm the result. If the current pixel is situated on an edge, the result will be negative (noisy free), otherwise the result will be positive. In order to deal with this case, four directions are defined, from E1 to E4, as shown in Fig. 3.
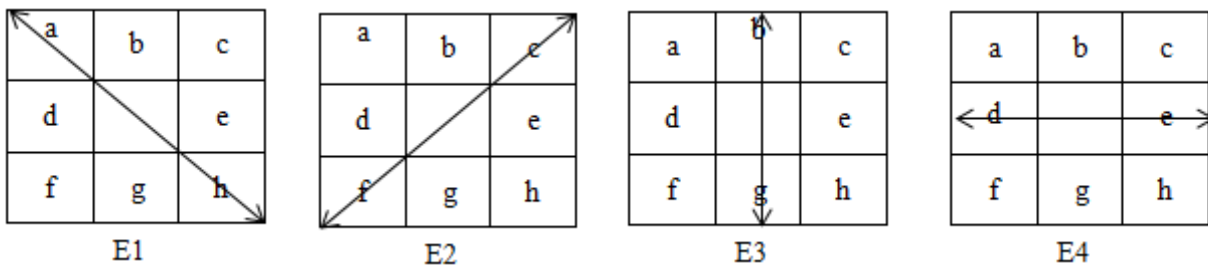

Figure 3: Four Directions in DTBDM

3. SIMILARITY MODULE: If isolation and fringe module cannot determine whether current pixel belongs to noisy free, the similarity module is used to decide the result. The luminance values in mask W located in a noisy-free area might be close. The median is always located in the center of the variation series, while the impulse is usually located near one of its ends. Hence, if there are extreme big or small values, that implies the possibility of noisy signals. According to this concept, nine values in ascending order is sorted and obtain the fourth, fifth, and sixth values which are close to the median in mask W.

4. EDGE PRESERVING IMAGE FILTER: To locate the edge existing in the current W, a simple edge preserving technique which can be realized easily. Here, eight directional differences are considered, from D1 to D8, to reconstruct the noisy pixel value, as shown in Fig. Only those composed of noise-free pixels are taken into account to avoid possible misdetection.
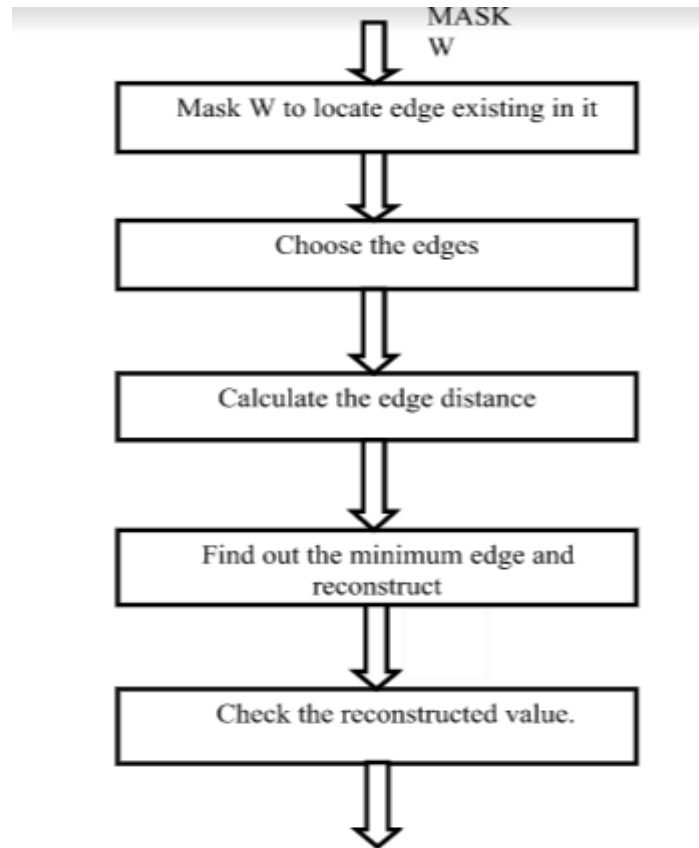
Fig 4: Data Flow of Edge-Preserving Image Filter

To locate the edge existing in the current W, a simple edge preserving technique is consider.. The dataflow of edge-preserving image filter are shown in Fig.4 respectively.

III.RESULTS

The path of the input image is defined in MATLAB. Input image of size 256x256 pixels is defined in MATLAB and converted into grayscale image if image is color image using matlab code. The 2-D image is converted into 1-D image. Random valued impulse noise is added in input images in MATLAB environment. 5% impulse noise is added and tested for input images.
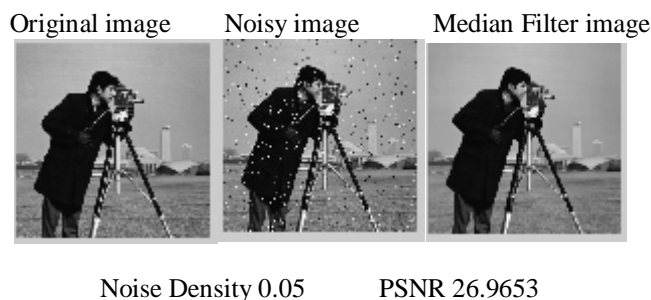

Noise Density 0.05   PSNR 26.9653

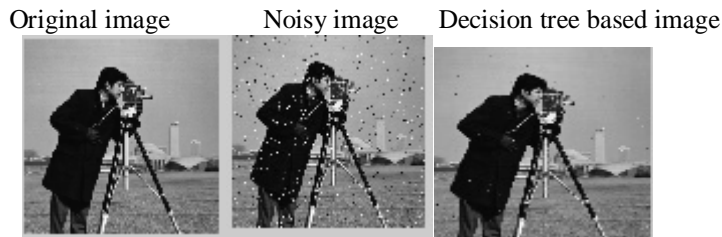**Fig 5:5% Noise affected image and denoised image using Median Filter.**

Fig.5 shows the original image is affected by 5% impulse noise and this noise is removed by median filter method and PSNR is 26.9653.
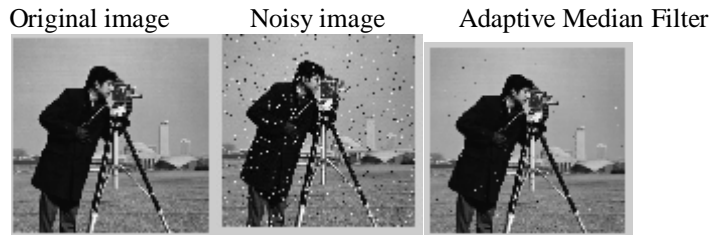
PSNR 28.5732

Fig 6:5% Noise affected image and denoised image using Adaptive Median Filter.

Fig.6 shows the original image is affected by 5% impulse noise and this noise is removed byadaptive median filter method and PSNR is 28.5732.

PSNR 29.5689

Fig 7:5% Noise affected image and denoised image using Decision Tree Based Method filtering

Fig.7 shows the original image is affected by 5% impulse noise and this noise is removed by decision tree based method and PSNR is 29.5698.

IV.COMPARISON OF RESULT

% of noise in image	Median Filter(PSNR)	Adaptive Median Filter(PSNR)	DTBDM(PSNR)
0.01	27.2872	30.97	30.94
0.02	27.1991	30.60	30.45
0.05	26.9653	28.5732	29.5689
0.2	24.83	20.8611	25.1427

Fig 8: Comparison of Result.

Above table shows the comparison of median filter, adaptive median filter and DTBDM method with 1%, 2%, 5% and 20% of impulse noise.

V.CONCLUSION

Image denoising using adaptive median and median filter was also performed and compared. From the image filtering operations performed by adaptive median and median, it was then compared with the proposed method. The result Denoising Method filtering perform better than any other techniques that have been dealt so far. From the above table the filtering techniques like adaptive median and Median filtering always show good performances only for low noise density i.e., for low noise that is being applied to the image. But if the noise increases then Decision Tree Based Method filtering always shows the best performances for all noises.

REFERENCES

1. Chih-Yuan Lien, Chien-Chuan Huang, Pei-Yin Chen, Member, IEEE, and Yi-Fan Lin, "An Efficient Denoising Architecture for Removal of Impulse Noise in Images," IEEE Trans.Computers, vol. 62, no. 4, pp. 631-643, April 2013.
2. T. Matsubara, V.G. Moshnyaga, and K. Hashimoto, "A FPGA Implementation of Low-Complexity Noise Removal," Proc. 17thIEEE Int'l Conf. Electronics, Circuits, and Systems (ICECS '10), pp. 255-258, Dec. 2010.
3. H. Yu, L. Zhao, and H. Wang, "An Efficient Procedure for Removing Random-Valued Impulse Noise in Images," IEEE Signal Processing Letters, vol. 15, pp. 922-925, 2008.
4.P.-Y. Chen and C.-Y. Lien, "An Efficient Edge-Preserving Algorithm for Removal of Salt-and-Pepper Noise," IEEE Signal Processing Letters, vol. 15, pp. 833-836, Dec. 2008.
5. W. Luo, "An Efficient Detail-Preserving Approach for Removing Impulse Noise in Images," IEEE Signal Processing Letters, vol. 13, no. 7, pp. 413-416, July 2006.
6. I. Andreadis and G. Louverdis, "Real-Time Adaptive Image Impulse Noise Suppression," IEEE Trans. Instrumentation and Measurement, vol. 53, no. 3, pp. 798-806, June 2004.
7. I. Aizenberg and C. Butakoff, "Effective Impulse Detector Based on Rank-Order Criteria," IEEE Signal Processing Letters, vol. 11, no. 3, pp. 363-366, Mar. 2004.
8. T. Chen and H.R. Wu, "Adaptive Impulse Detection Using Center-Weighted Median Filters," IEEE Signal Processing Letters, vol. 8, no. 1, pp. 1-3, Jan. 2001.
9. T. Nodes and N. Gallagher, "Median Filters: Some Modifications and Their Properties," IEEE Trans. Acoustics, Speech, Signal Processing, vol. ASSP-30, no. 5, pp. 739-746, Oct.1982.
10. R. C. Gonzalez and R.E. Woods, Digital Image Processing. Pearson Education, 2007.