SALT & PEPPER NOISE REMOVAL USING FUZZY BASED ADAPTIVE FILTER

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***Abstract* – This paper is based on a novel of filter which includes detection and removal of salt & pepper noise using fuzzy based adaptive filter. Once the detection stage detects the noisy pixels, they are passed on to the next filtering stage. The noise-free pixels are retained unchanged. Simulation results shows good results.**

***Index Terms* – Adaptive filter, Fuzzy logic, Histogram, Salt & Pepper Noise.**

I. INTRODUCTION

Images are corrupted with the noise when they are transmitted or during image acquisition process. Mostly, images are corrupted with an impulsive noise that is, bipolar in nature. This impulsive (bipolar) noise is called salt & pepper noise. Salt & Pepper noise is a special case of impulsive noise, where a certain percentage of individual pixels in digital image are randomly digitized into two extreme intensities, that is, the maximum and the minimum intensities [1].

The occurrence of salt & pepper noise can severely damage the information or data embedded in the original image. So, it must be removed before subsequent image processing tasks such as edge detection or segmentation is carried out [1].

Luo in [2] proposed an efficient detail preserving approach (EDPA) based on alpha-trimmed mean statistical estimator. Also, an efficient edge preserving algorithm (EEPA) [3] was introduced for the removal of salt & pepper noise without degrading fine image details. Then, Chen and Wu [4] proposed the adaptive impulse detector with center-weighted median (ACWN)filter to remove effectively salt & pepper noise. These methods only perform well when an image is corrupted with 50% salt & pepper noise or lower. The decision based algorithm [5] filter and open-close sequence filter (OCS) based on mathematical morphology [6] and noise adaptive fuzzy switching median filter [7] are able to filter high density of salt & pepper noise corruption, but at the expense of fine image details or high computational time.

In this paper, a new kind of adaptive filter is designed for removal of salt & pepper noise.

II. FUZZY BASED ADAPTIVE FILTER

The proposed work is a recursive filter used to remove salt & pepper noise. The detection stage detects the noisy pixels and they are further passed to the next filtering stage. The noise-free pixels are retained as they are. The noisy pixels with maximum intensity (255 or white) is known as salt noise and with minimum intensity (0 or black) is known as pepper noise.

The detection and filtering stage includes 3x3 scanning and merge scanning process and applying the histogram approach. In 3x3 scanning, the scanning is performed by comparing the center pixel with the rest of the pixels in a 3x3 matrix of an image. The algorithm applied for 3x3 scan by considering centre pixel is

$$p(i,j) = |X(i+k, j+l) - X(i,j)| \text{ with } (i+k, j+l) \neq (i,j)$$

where p(i,j) is the absolute luminance difference, X(i,j) is the noisy pixel.

Little bit of salt & pepper noise is eliminated in this process. The noisy pixels after this process are passed on to the next filtering stage called merge scanning. In merge scanning process, a median is computed by taking four pixels of 3x3 matrix of an image and comparing it with the rest of the pixels. The algorithm applied for merge scanning is

$$f(i,j) = |p(i,j) - m(i,j)| / th$$

where f(i,j) is the merge scanning, p(i,j) is the absolute luminance difference, m(i,j) is the mean of the four pixels that are compared with the rest of the pixels, th is the threshold used for the scanning process.

However, after merge scanning much of the salt & pepper noise gets eliminated but the image details, that is edges and texture are not so finely preserved.

For this, histogram approach is applied in order to preserve the image details well.

III. SIMULATION AND RESULTS

Simulation results were performed to calculate better PSNR (dB) and time (ms). This proposed work is performed on ten standard test images, that is, (Baboon, Boat, Cameraman, Goldhill, Lake, Lena, Lighthouse, Parrot, Pepper, and Plane). The results were calculated from 5% noise to 95% noise.

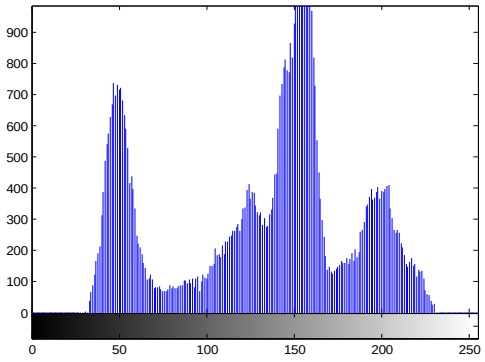
Below shows Lena image corrupted with 5% and 95% salt & pepper noise and after the filtering process:

5% Noise Added

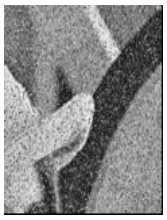
3x3 Scanning

Merge Scan

Histogram Method



Histogram (5%)

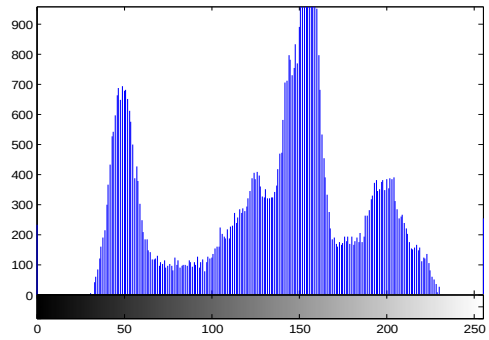


95% Noise Added

3x3 Scanning

Merge Scanning

Histogram Method



Histogram (95%)

The results of the Lena image shows that the salt & pepper noise is removed and the image details are very well preserved. There is no blurring of the image.

IV. CONCLUSION

The proposed paper "Salt & Pepper Noise Removal Using Fuzzy Based Adaptive Filter" is able to remove salt & pepper noise, at the same time preserving the image details, edges and textures very well. The proposed filter does not require any further tuning, once it is optimized.

REFERENCES

[1] Kenny Kal Vin Toh, Haidi Ibrahim, Muhammad Nasiruddin Mahyuddin, "Salt & Pepper Noise Detection and Reduction Using Fuzzy Switching Median Filter", IEEE Trans. On Consumer Electronics, vol. 54, no. 4 November 2008.

[2] Wenbin Luo, "An Efficient Detail-Preserving Approach for Removing Impulse Noise in Images" IEEE Signal Processing Lett., vol. 13, no. 7 July 2006.

[3] Pei-Yin Chen, Chih-Yuan Lien, "An Efficient Edge-Preserving Algorithm for Removal of Salt-and-Pepper Noise", IEEE Signal Processing Letters, vol. 15, 2008.

[4] Tao Chen, Kai-Kuang Ma, Li-Hui Chen, "Tri-State Median Filter for Image Denoising", IEEE Trans. On Image Processing, vol. 8, no. 12 December 1999.

[5] K. S. Srinivasan, D. Ebenezer, "A New Fast and Efficient Decision Based Algorithm for Removal of High-Density Impulse Noises", IEEE Signal Processing Letters, vol. 14, no. 3, March 2007.

[6] Z. F. Deng, Z. P. Yin, and Y. L. Xiong, "High probability impulse noise-removing algorithm based on mathematical morphology," *IEEE Signal Process. Lett.*, vol. 14, no. 1, pp. 31–34, Jan. 2007.

[7] Kenny Kal Toh, Nor Ashidi Mat Isa, "Noise Adaptive Fuzzy Switching Median Filter for Salt & Pepper Noise Reduction", IEEE Signal Processing Lett., Vol. 17, no. 3 March 2010.

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