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Diminishing Impulse Noise using Fuzzy Mean Filter

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***Abstract*-This research work presents a simple, yet efficient way to remove noise from digital images. The method comprises two phases: the first phase is to detect the noise in the image. In this phase, based on only the intensity values, the pixels are roughly divided into two classes, which are "noise-free pixel" and "noise pixel". Then, the second phase is to remove the impulse noise from the image. In this phase, only the "noise-pixels" are processed. The "noise free pixels" are copied directly to the output image. In this research paper, present a new method for the removal of noise from digital images. The noise is exactly estimated through the proposed operator. The distinctive feature of the proposed operator is that it offers well line, edge, detail and texture preservation performance while, at the same time, effectively removing noise from the input image. Fuzzy Mean filter is capable of removing all kind of noise.**

Index Terms: Noise reduction, median filter, low pass and high pass filter, adaptive fuzzy mean filter, and fuzzy inference system

I. INTRODUCTION

From ancient times to now-a-days, the image processing techniques have been well developed, but there are still some bottlenecks on which researchers have their focus. Unfortunately, during image acquisition, transmission and storage, many types of distortion contaminate the quality of received images. Digital images are corrupted by many types of noises such as malfunctioning pixels in camera sensors, faulty memory locations in hardware or transmission of image in a noisy channel and some other causes also. Noise affect the accuracy of many image processing applications such as image segmentation, image classification, edge extraction, image compression, etc,. Many image processing algorithms cannot work well in noisy environment.

Specifically for removal of noise from an input image there are several filters that can be considered as the state-of-art methods given their impressive performance. For instance, low, high and median pass filter is one of the order-statistic filters, which falls in the group of non-linear filter. Median pass filter is used in variety of application to remove impulse noise from corrupted images [11], [12]. But the conventional Median pass filter method can treat all the pixels in the image equally. This will result the elimination of fine details such as thin lines and corner, blurring and distortion in the image. So, to overcome this problem, various types of filters are come into picture such as Switching median filter, Center weighted median filter, rank ordered mean filter, noise detection based median filter [1]-[10].

In paper [1], CAFSM filter is capable of filtering all kinds of impulse noise the random-valued and/or fixed-valued impulse noise models. In [2] paper presents an efficient way to remove impulse noise from digital images. The experimental result shows that the average processing time to process an image that contains noise percentage 95%, it takes less than 2.7 seconds to process the image. In [3] paper presents a novel method for the suppression of Random-Valued Impulsive Noise from corrupted images. The noise free intensity values can be restored by using Triangle-Based Linear Interpolation. In paper [4], use soft computing techniques, a noisy image is used as input data; a performance index is then evaluated by considering the mean square error (MSE) between the filtered data and the original noise-free image. Abreu et al. [6] propose an efficient nonlinear algorithm to suppress impulse noise from highly corrupted images while preserving details and features. In [8] the center weighted median filter, which a weighted median filter is giving more weight only to the central value of each window. This filter can preserve image details while suppressing additive white and/or impulsive-type noise. In [10] Multi-dimensional Weighted Fuzzy Mean (MWFM) filter used in color image restoration is proposed and analyzed in this paper. MWFM is the extension of Weighted Fuzzy Mean (WFM) filter [8] by embedding a fuzzy detector and a dynamic selection procedure into WFM to overcome the drawback of WFM in detail signal preservation. One major issue is that all the above filters either work on high corrupted images or low corrupted images. And, also there is no option for user choice whether the user is satisfied or not or he/she wants to apply the filter again. These major drawbacks will be overcome in this research paper.

In this Research Paper we focus on developing a robust filter that caters for any type of noise models. We propose a hybrid filter that is the combination of adaptive fuzzy switching median filter and low, high and median pass filter. The proposed filter operates of a wide range of noise densities without jeopardizing image fine details and textures. We also focus our attention to develop a fast and automated algorithm. The ASFM filter yields better result as compared to other filter in terms of subjective and objective qualities in the filtered images when applied recursively and iteratively. The proposed filter shows excellent restoration results in denoising color images. In this research paper, the proposed filter can deal with any type of noise as well as the image of any size.

II. RELATED WORK

In this section of Research Work we present a short introduction for various methods for noise reduction in digital images are as follows:

1. *Cluster-Based Adaptive Fuzzy Switching Median Filter for Universal Impulse Noise Reduction*

In this paper, a novel method for the removal of impulse noise from digital images. The proposed filter, called the Cluster-based Adaptive Fuzzy Switching Median (CAFSM), is composed of an impulse detector and a detail preserving noise filter. Initially, the impulse detector classifies any possible impulsive noise pixels. Subsequently, the filtering phase replaces the detected noise pixels. In addition, the filtering phase employs fuzzy reasoning to deal with uncertainties present in local information. The CAFSM filter is capable of filtering all kinds of impulse noise – the random-valued and/or fixed-valued impulse noise models only. Extensive simulations conducted on 100 monochrome images under a wide range of noise densities show that the CAFSM filter substantially outperforms as compared to other noise filters.

2. *Simple Adaptive Median Filter for the Removal of Impulse Noise from Highly Corrupted Images*

This paper presents a way to remove impulse noise only from digital images. This novel method has two phases. The first phase is to detect the impulse noise in the image. In this phase, based on only the intensity values, the pixels are roughly divided into two classes, which are "noise-free pixel" and "noise pixel". Then, the second phase is to eliminate the impulse noise from the image. In this phase, only the "noise-pixels" are processed. The "noise free pixels" are copied directly to the output image. The method adaptively changes the size of the median filter based on the number of the "noise-free pixels" in the neighborhood. For the filtering, only "noise-free pixels" are considered for the finding of the median value. The results from this proposed method surpasses that it can efficiently work on highly corrupted images, where noise percentage is up to 95%. Average processing time needed to completely process images of 1600×1200 pixels with 95% noise percentage is less than 2.7 seconds. This proposed method is suitable to be implemented in consumer electronics products such as digital television, or digital camera.

3. *Removal of Random-Valued Impulsive Noise from Corrupted Images*

In this paper, present a novel method for Random-Valued Impulsive Noise from corrupted images only. The proposed method is composed of an efficient noise detector and a pixel-restoration operator. The noise detector has been used to discriminate the uncorrupted pixels from the corrupted pixels. The noise free intensity values of the corrupted pixels have been computed by using Triangle-Based Linear Interpolation and the values of tuning parameters of the proposed method have been optimized with Differential Evolution algorithm. Extensive simulation experiments indicate that the proposed method significantly outperforms all of the comparison methods mentioned in this paper. The success of the proposed method over comparison methods is due to its excellent detail preservation performance independent from the level of noise density. But, this method is some, how complex because of using Triangle-Based Linear Interpolation.

4. *Genetic-Based Fuzzy Image Filter and Its Application to Image Processing*

In this paper, we propose a Genetic-based Fuzzy Image Filter (GFIF) to remove additive identical independent distribution (i.e.) impulse noise from highly corrupted images. The proposed filter consists of a fuzzy number construction process, a fuzzy filtering process, a genetic learning process, and an image knowledge base. First, the fuzzy number construction process receives sample images or the noise-free image and then constructs an image knowledge base for the fuzzy filtering process. Second, the fuzzy filtering process contains a parallel fuzzy inference mechanism, a fuzzy mean process, and a fuzzy decision process to perform the task of noise removal. Finally, based on the genetic algorithm, the genetic learning process adjusts the parameters of the image knowledge base. By the experimental results, GFIF achieves a better performance than the state-of-the-art filters based on the criteria of Peak-Signal-to-Noise-Ratio (PSNR), Mean-Square-Error (MSE), and Mean-Absolute-Error (MAE). GFIF also results in a higher quality of global restoration.

5. *Noise Adaptive Soft Switching Median Filter For Image Denoising*

In this paper, we propose a novel noise adaptive soft-switching median (NASM) filter to effectively address the following issues mentioned below and achieve much improved filtering performance in terms of efficiency in removing impulse noise and robustness against noise density variations. We observed that there are certain fundamentally concerns commonly exist in some state-of-the-art switching-based median filters: (i) fixed thresholding for pre-assumed noise density, (ii) the noise decision accuracy at, high density impulse noise, and (iii) the filtering scheme adopted in response to pixel characteristic type identified. Experimental results also reveal that the performance of our NASM filter is fairly close to that of ideal-switching median filter.

6. *A Signal-Dependent Rank Ordered Mean (SD-ROM) Filter - A New Approach For Removal Of Impulses From Highly Corrupted Images*

In this paper, propose an efficient nonlinear algorithm to suppress impulse noise from highly corrupted images while preserving details and features. The method is applicable to all impulse noise models both fixed valued (equal height or salt and pepper) impulses and random valued (unequal height) impulses, covering the whole dynamic range. The algorithm is based on a detection-estimation strategy. If a signal sample is detected as a corrupted sample, it is replaced with an estimation of the true value, based on neighborhood information. Otherwise it is kept unchanged. The technique achieves excellent suppression of noise and preserving the details and edges. Extensive simulation tests indicate that our method performs better than other existing algorithms

7. *A Hybrid Filter based on an adaptive neuro-fuzzy inference system for efficient removal of impulse noise from corrupted digital images*

A novel method is proposed for impulse noise detector based on an adaptive neuro-fuzzy inference system (ANFIS) is presented. The proposed operator is a hybrid filter obtained by combining a median filtering and a wiener filtering and the ANFIS. The noise is exactly estimated through the proposed operator. The internal parameters of the ANFIS are adaptively optimized by training. The training is easily accomplished by using simple artificial images that can be generated in a computer. The distinctive feature of the proposed operator is that it offers well line, edge, detail and texture preservation performance while, at the same time, effectively removing noise from the input image. Simulation experiments show that the proposed operator yields superior performance over competing operator. This method works only on removing impulse noise only.

8. *Center Weighted Median Filters and Their Applications to Image Enhancement*

In this paper, the center weighted median (CWM) filter, which is a weighted median filter giving more weight only to the central value of each window. This filter can preserve image details while suppressing additive white and/or impulsive-type noise. It is shown that the CWM filter can outperform the median filter. Some relationships between CWM and other median-type filters, such as the Winsorizing smoother and the multiphase median filter, are derived. In order, to improve the performance of CWM filters, an adaptive CWM (ACWM) filter having a space varying central weight is proposed. We show that the ACWM filter is an excellent detail preserving smoother that can suppress signal-dependent noise as well as signal-independent noise. This method works only on removing impulse noise as well as additive white noise only.

9. *Histogram-Based Fuzzy Filter for Image Restoration*

In this paper, we present a novel approach to the restoration of noise-corrupted image. This is accomplished through a fuzzy smoothing filter constructed from a set of fuzzy membership functions for which the initial parameters are derived in accordance with input histogram. A principle of conservation in histogram is incorporated with input statistics to adjust the initial parameters so as to minimize the discrepancy between reference intensity and the output of defuzzification process. The proposed filter has the benefits that it is simple and it assumes no a priori knowledge of specific input image, yet it shows superior performance over conventional filters (including MF) for the full range of impulsive noise probability.

10.Multi-dimensional WFM Filter: An Application to Color Image Restoration

A Multi-dimensional Weighted Fuzzy Mean (MWFM) filter used in color image restoration is proposed and analyzed in this paper. MWFM is the extension of Weighted Fuzzy Mean (WFM) filter by embedding a fuzzy detector and a dynamic selection procedure into WFM to overcome the drawback of WFM in detail signal preservation. The fuzzy detector uses two fuzzy intervals and refers the WFM-filtered outputs to detect the amplitude of impulse noise which will be used in dynamic selection procedure. By the dynamic selection approach, MWFM not only preserves the high stability and performance of WFM on removing heavy additive impulse noise, but also improves the performance of WFM on light additive impulse noise. This method works only on removing impulse noise only.

III. PROPOSED WORK

In proposed work, first task is to detect the noise from the input image. For this, since the intensity of noisy pixel is different from its surrounding pixel, a noise pixel can be identified by the height in brightness jump in comparison with its neighboring pixels. Hence, the noise detection can be carried out by analyzing the local image statistics within a window patch whose size is bounded by the filter.

Fig. 1: Removal of Noise using Proposed System

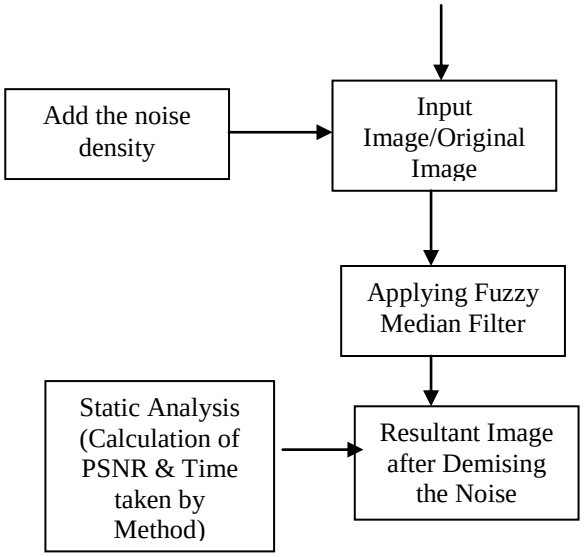

Fig. 2: Flow Chart of Proposed Method

In our proposed method, the window size is of K * K size. Now, at the end of the detection phase, we have identified noise-free pixel from noisy pixel. This process is useful for selecting noise-free pixel candidates for restoration and avoids altering any noise-free pixel. In this framework, we propose a fuzzy mean filter that will act as a "switch" by turning on the filter when a noise pixel is detected. Otherwise, the filtering action is skipped and noise free pixel is retained. It requires the pre-defined threshold values and these values are determined by threshold criteria selection method.

IV. RESULTS

The PSNR evaluation scheme is used to access the strength of the filtered image, while processing time required for executing is filter is also taken into consideration as to measure the computational efficiency of the filter implemented. Since image is subjected to the human eyes, visual inspection is carried out on the filtered image as to judge the effectiveness of the filter in removing salt and pepper noise.

	PROPOSED METHOD			ASMF [1]		
	20% Noise	50% Noise	80% Noise	20% Noise	50% Noise	80% Noise
PSNR	41.113 db	38.624 db	36.290 db	36.40 db	34.50 db	33.42 db
ELAPSED TIME	0.11572 min	0.2481 min	0.3987 min	.2641 min	.2920 min	.4221 min

Table 1: Comparison of results with existing methods

V. CONCLUSION

In this research work, a novel algorithm is used to remove any type of noise from corrupted images. In this paper, the purpose of using both the filters offers well line, edge, detail and texture preservation while, at the same time, effectively removing noise from the given input image. Here, the input images are of any format like JPEG, TIF etc and also take variable size image as input. It can work on color images as well. Fuzzy Mean Filter provides better performance as compared to other filters based on the criteria of Mean Absolute Error and Mean Square Error.

REFERENCES

[1]. "Cluster-Based Adaptive Fuzzy Switching Median Filter for Universal Impulse Noise Reduction" Kenny Kal Vin Toh, Student Member, IEEE, and Nor Ashidi Mat Isa, Member, IEEE. IEEE Transactions on Consumer Electronics, Vol. 56, No. 4, November 2010.

[2]. "Simple Adaptive Median Filter for the Removal of Impulse Noise from Highly Corrupted Images" Haidi Ibrahim, Member, IEEE , Nicholas Sia Pik Kong, Student Member, IEEE, and Theam Foo Ng, IEEE Transactions on Consumer Electronics, Vol. 54, No. 4, November 2008.

[3]. "Removal of Random-Valued Impulsive Noise" Pinar Civicioglu, Contributed Paper Manuscript received August 26, 2009.

[4]. "Genetic-Based Fuzzy Image Filter and Its Application to Image Processing", Chang-Shing Lee, Shu-Mei Guo, and Chin-Yuan Hsu, IEEE Transactions on Systems, Man, and Cybernetics—part b: cybernetics, vol. 35, no. 4, august 2005.

[5]. H. I. Eng and K. K. Ma," Noise adaptive soft-switching median filter," IEEE Trans. Image Process., vol. 10, no. , pp. 24-251, Feb. 2001.

[6]. E. Abreu and S. K. Mitra," A signal-dependent rank ordered mean(SD-ROM) filter, "in proc. IEEE Int. Conf. Acoust., Speech, Signal Process., Detroit, MI, 1995, pp. 2371-2374.

[7]. Zhang Lei; Xiao mei; Ma Jian. and Song Hongxum, "A Hybrid Filter based on an adaptive neuro-fuzzy operator for efficient removal of impulse noise from highly corrupted digital images," IEEE Int. Conf. on Environmental Science and Information Application Technology, no. 1, pp. 1-7, 2010.

[8]. S. J. Ko and S. J. Lee," Center weighted median filters and their applications to image enhancement," IEEE Trans. Circuits Syst., vol.15, no. 9, pp.-984-993, Sep. 1991.

[9]. Jung-Hua Wang, Wen-Jeng Liu, and Lian-Da Lin, "Histogram-Based Fuzzy Filter for Image Restoration", IEEE Transactions on Systems and Cybernetics, vol. 32, no. 2, April 2009.

[10]. Chang-Shing Lee and Yau-Hwang Kuo, "Multi-dimensional WFM Filter: An application to color Image Restoration," IEEE Trans., 1996.

[11]. W. Luo, "Efficient removal of impulse noise from digital image," *IEEE* Trans. Consumer Electron., vol. 52, no. 2, pp. 523-527, May 2006.
[12]. R. C. Gonzalez and R. E. Woods, Digital Image Processing, 2nd Ed.,m Englewood Cliffs, Nj: Prentice Hall, 2002.