A Innovative Technique to Minimize Salt-Pepper Noise Using a Fuzzy Set for Gray Level Imaging

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Abstract

Eliminating noise from the image is one of the deep challenges in the area of image processing and computer vision, where the core objective is to estimate the experimental image, smoothing noise from a noise-impure version of the image. Image noise can be caused by unlike intrinsic and extrinsic conditions that are repeated not possible to avoid in realistic state.. Therefore, denoising image plays an vital role in a ample range of purpose such as image restoration, visual tracking, image registration, image segmentation and classification, where to obtain image content The original is crucial for performance solid. Noise reduction is the process of eliminating noise from images; Each pixel in the image will change from the original values in a small amount. A noise elimination algorithm is to achieve noise reduction and resource preservation, but due to the limitations of the methods, it is blurred. The noise in different pixels can be correlated or not, because noise modeling is a very difficult task. We observed that the performance of the proposed study's diffuse set and the 3x3, 3x5, 2x3 size filter windows, the adaptive weighted average filter and the medium filters were used to reduce the salt and pepper noise filters and the elimination context noise, the most relevant value Accuracy is recovered. Finally, our results are compared with the image improvement factor (IEF), the mean square error (MSE) and the peak signal-to-noise ratio (PSNR)

Keywords: *Image Processing, Fuzzy Logic, Noise Reduction, Median Filter, Mean Filter, Salt-Pepper Noise*

1. Introduction

Noise removal or image repair in image processing takes an important place. Image repair, image acquisition It is to eliminate or reduce the distortions while being [1]. Edges and other to remove noise in the distorted image preserving detailed features as much as possible removal is applied. Noise defects of every digital camera, called noise, affects the visual quality and other features of the image [2nd]. Image noise, fake and unnecessary information to the original image and the image is undesirable by the

receiver is the noise that causes it. Therefore, image processing One of the most important operations in the field is damaged original information to remove from the image. Image filtering methods Some improvements can be achieved in images by using. The main purpose of image filtering is to to improve contrast or provide better detection is to eliminate the noise in the image. Image filtering; image analysis, computer vision, robot navigation, medical in many applications such as viewing, security surveillance is used [3]. During transmission, a few that cause noise in the image There are factors. Depending on the source, the noise differs from the image can significantly affect [4] Types of image noise in the literature; Gaussian Noise, White Noise, Fractal Noise, Impulse Precious Noise (Salt Pepper Noise), Periodic Noise, Quantization Noise, Speckle Noise, Poisson Noise, Poisson Gauss Noise, Structured Noise, Gamma Noise and can be listed as Rayleigh Noise [5]. Salt and pepper noise means that every pixel in the digital image a certain percentage is digitized randomly into two extreme densities it is a special impulse noise. Normally, these densities are maximum and minimum densities. Salt and pepper noise occurs in the process of obtaining the most images and / or recording It comes. For example, bad memory areas or corrupt pixel sensors, with the salt and pepper noise of the digital image it may cause corruption [6]. Median filter to remove noise in recent years [7], such as adaptive median filter [8] and weighted median filter [9] Several impulsive filtering techniques have been developed. These filters to resist impulsive noise in images although useful, they can be used to separate fine details from noise. sometimes they fail. Therefore, image filtering techniques uncertainties in different parts of the image It should be developed to lift. In the literature, this problem fuzzy logic based approaches for solution used. [10] in Tang and his friends, the edge of the gradient a new blur based on the logic that it can perceive its properties they proposed a filter algorithm. Noise is eliminated with this algorithm uninstalling the image edge can be perceived and It can be backed up. [11] in Vin Toh et al., Noise Adaptive Fuzzy (Adaptive Fuzzy Switching Median, a new salt-pepper called NAFSM) filter they suggested a noise filter. NAFSM filter is a simple adaptive of a fuzzy switched median filter with a median filter It consists of a combination. In this study, [11] study was taken as a base. Different a fuzzy set and filtering in 3x3, 3x5, 2x3 sizes Average and median filters are used for windows. Then the performances of the proposed methods peak signal noise ratio (Peak Signal-to-Noise Ratio, PSNR) and average According to the square error (Mean Square Error, MSE) criteria It was compared.

2. Proposed Technique

2.1 Salt Pepper Noise and Noise level

Image independent noise can often be defined by an additive noise model, where the recorded image F (m,n) is the sum of the true image I (m ,n)and the noise N (m ,n)

$$F(m, n) = I(m, n) + N(m, n) \qquad 2..1$$

The variance of image is given by σ_s^2 and the noise $N(m, n)$ is repeatedly zero-mean and defined by its variance σ_n^2 . Salt and Pepper Noise (SPN) appears as black and white dots superimposed on the image. This is caused generally due to errors in data transmission. It has only two

possible values, ‘a’ and ‘b’. The probability of each is typically less than ‘0.1’. The Probability Density Function (PDF) of Salt and Pepper Noise is given by;$f(x) =$

$$\begin{cases} pa\ for\ z = 0 \\ pb\ for\ z = 255 \\ 0\ otherwise \end{cases} \qquad 2.2$$

the image noise variance is not even in an image, granularity of noise-level estimation needs to be smaller in order to recover denoising performance. Pixelwise noise-level estimation is the vital form**.**

2.2 Median Filter

The pixel values in the particular window are greater than
Arranging from small to small or large to the window
It is the filter that replaces the outlier with the median value.

$$W = (q, t) - N \leq q \leq N, -N \leq q \leq N \qquad 2.3$$

$$Y(i, j) = MED(X(i + q, j + q)(q, t) \in W \qquad 2.4$$

2.3. Adaptive median filter (AMF)

Adaptive median filter (AMF) make use of median filters adaptively. It mostly enlarge the window size by comparing evaluate median value with acute values of image. The problem with AMF is that there might have background pixels which equal the acute values of image. In such a condition, AMF will remain extending its window size until the window contains a median value that is not equal to one of two extreme values. To get better the performance, weighted median (WM) filter]was proposed by assigning weight age to each location with the help of weighted window. WM value of a pixel X(i, j) is

$$WM(i, j) = MED(X(i + q, j + q)(q, t) * W(i + q, j + q)(q, t) \in W$$

2.5

where ◊ is the repetition operator such that K◊X ¼ X; X; X; ……; X z}|{

2.4 Adaptive Fuzzy Filter

Triangle type membership function of fuzzy filter uncertainty zone and membership limits defined for According to the fuzzy filter rules are determined. These rule
by; representing noise 0, 255 and these pixels 0 membership degrees at close values, from these values the degree of membership approaching 1 as you move away and the window average value equal to the smallest or largest value if there is a membership degree equal to 1 fuzzy inferences are obtained. Fuzzy rules these inferences are the coefficients of the F fuzzy filter. It has determined. K = 1 and 3x3 dimensions window matrix with MxN size image from left scanned to the right and from top to bottom. Each of the filter F blurry filter by repeating all the rules in motion coefficients were recovered and the fuzzy filter adaptive work was provided. Adaptive fuzzy filter flow diagram and triangle of fuzzy filter
The membership function of the type is Figure 1 and Figure, respectively.

It is shown in 2.

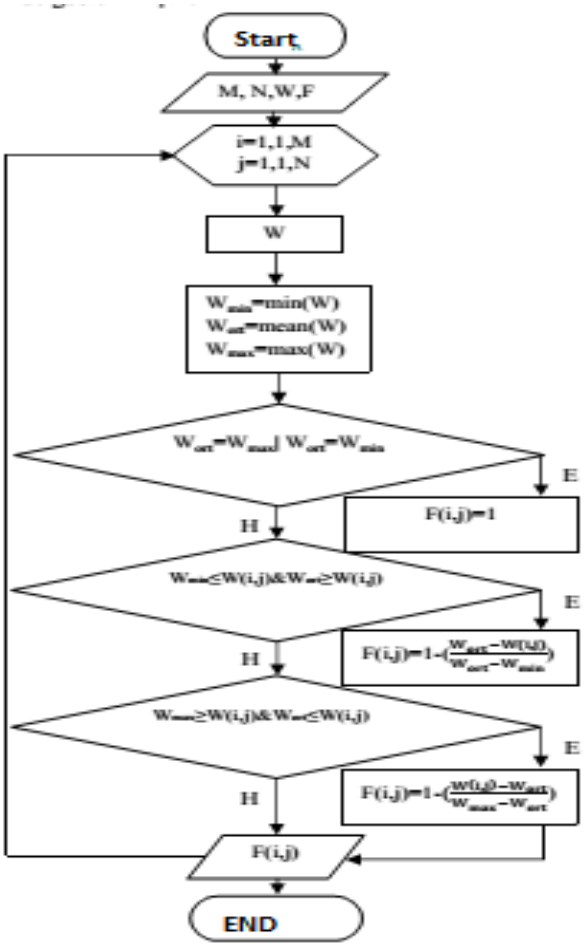

Figure 1: Adaptive fuzzy filter flow diagram.

W- adaptive image matrix (2K + 1) x (2K + 1),
i, j - index values of the window,
Waverage value of the window,
Wmin- the smallest value of the window,
Wmax- window's largest value

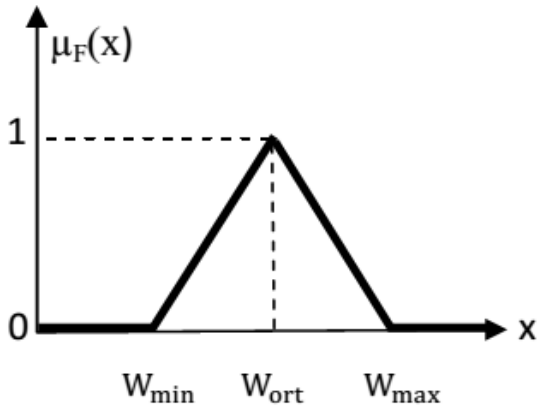

Figure 2: Fuzzy filter membership function

2.5 Image Quality Measure

The best way to calculate the quality of an image is to examine it, because human eyes are the best viewer. Subjective image quality refers to how the viewer perceives the image and gives their opinion on a specific image evaluation, based on mathematical models that approximate the results of the subjective quality estimate. The main objective evaluation is to develop quantitative measures that can predict the quality of the perceived image. The quantitative performance of the noise elimination algorithm is evaluated based on the signal-to-noise ratio (PSNR), mean square error (MSE), image enhancement factor (IEF), respectively.

The average square error (MSE) of an image in terms of image improvement is that the difference between the values found by an estimator and the actual values of the amount that is calculated. The MSE measures the athmetic mean of the squares of the "errors". The error is the quantity by which the value implied by the algorithm differs from the quantity to be estimated. The mathematical formula for MSE is given in the equation

$$\text{MSE} = \frac{\sum_i \sum_j (r_{ij} - x_{ij})^2}{m*n} \qquad 2.6$$

The fidelity of its representation. The PSNR is generally stated in terms of the logarithmic decibel scale. Equation 2.7 provides the PSNR metric. The value '255' is for the image '8' used throughout the

$$PSNR = 10log_{10}\left(\frac{255^2}{MSE}\right) \qquad 2.7$$

Image Enhancement Factor (IEF) is the ratio of Mean Square error of original and noisy image to the original and restored image as given in equation 2.8. This metric helps the researchers to estimate the increase in the quality of the image after restoration. The main property of the IEF is that it approaches the maximum value when the restoration is very good. The value diminishes towards zero with a feeble work of restoration

$$\text{IEF} = \frac{\sum_i \sum_j (n_{ij} - r_{ij})^2}{\sum_i \sum_j (x_{ij} - r_{ij})^2} \qquad 2.8$$

3. RESULTS OF PROPOSED ADAPTIVE FUZZY FILTER

The original image has been corrupted by the addition of Salt and Pepper noise of different variance. The IEF of the proposed blur reducing adaptive filter is compared with the IEF of median ,adaptive weighted filters and adaptive fuzzy filter. The IEF for the proposed new adaptive filter is found to be greater than mean, median filters, which shows the significant removal of noise. The IEF has been calculated for various filters with window size of 3X3, and TABLE 1 IEF FOR MIXED NOISE (GAUSSIAN NOISE IS OF VARIANCE 100) are given in Table 1. and Table 2. The impulses are eliminated, with the preservation of edges. Objective analyses of the filter performance shows that the mixture of white Gaussian noise and impulses are eliminated and edges are preserved with the reduction in blur the results of the proposed adaptive adaptive fuzzy filter for various amounts of noise with the window size of 3x3. represents the

image corrupted by the mixture of salt and pepper noise of an amount of 10% and Gaussian noise is of variance 200. The corresponding filtered image is depicted

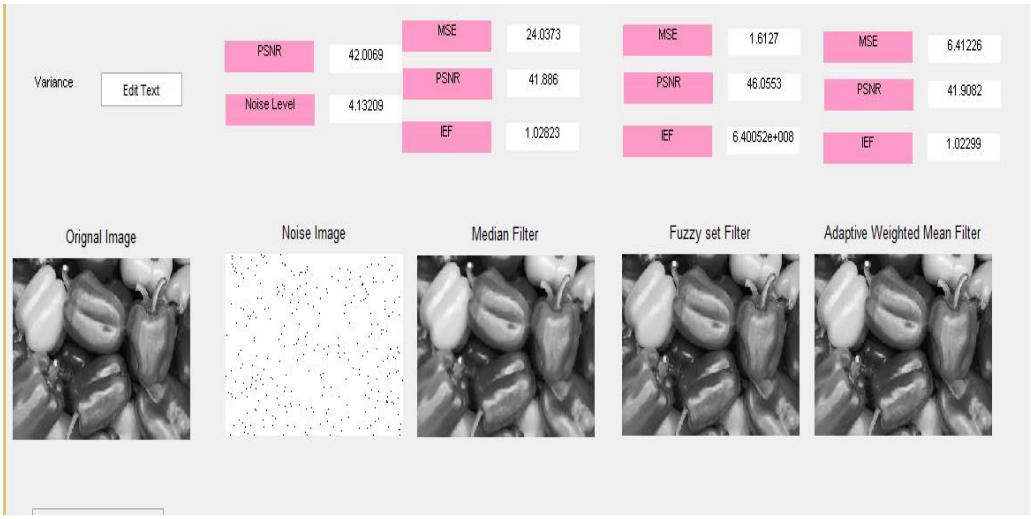

Figure 3 Comparision of Noise level & Median Filter ,Adaptive weighted filter and Adaptive Fuzzy Filtter

. Fig 3. shows the comparison of the results of the proposed blur reducing adaptive fuzzy filter with that of the results of Noise level & Median Filter,Adaptive weighted filter and Adaptive Fuzzy Filtter The comparison results for various amount of SPN noise is shown in Table 1The comparison results are made for various amount of mixed noise. It is found that IEF for the proposed filter increases as the amount of impulse noise increases and is greater than the IEF of other filters. The IEF decreases as the corrupted amount of Saltand pepper noise increases.

Table 1. Comparisons of Noise level

Sr no	Variance(%)	Noise Level	PSNR
1	0.001	4.132	42.069
2	0.002	3.457	42.0122
3	0.003	4.108	41.98
4	0.004	3.8269	42
5	0.005	4.089	42.015

Table 2. Comparisons of Median Filter

Sr. no	Variance(%)	mse	psnr	ief
1	0.001	24.073	41.886	1.0283
2	0.002	24.28	41.866	1.029
3	0.003	23.063	41.8849	1.0249
4	0.004	24.52	41.88	1.02894
5	0.005	24.25	41.885	1.0302

4. Conclusion

A simple and novel adaptive fuzzy filter has been proposed. The subjective and Objective analysis of the filter has been made. The image enhancement factor is found to be greater than the, median and fuzzy filters. The filter preserves the edges, which provides information. Since the value of alpha adapts itself, this filter is optimized for any type of noise and any type of image. The Pepper image is considered as the test image. Better noise elimination has been obtained while preserving the edges The proposed filter has been implemented in three stages using a threshold value to detect impulses and its removal, threshold value for the detection of edges and to reduce the blurring in images. The operation of this filter involves less complexity as it is compared with other filters. The performance of the proposed adaptive fuzzy filters are found to be better than mean, median, adaptive fuzzy filters without threshold

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