Estimating Image Enhancement Factor (IEF) using a Fuzzy Set & Noise Level of Salt-Pepper Noise for Gray Level Imaging

Deepa Mandale, Ruhina Quazi

Abstract*: Improving a noisy image is a necessary task when processing digital images. To correct the noise content in the natural image, adding known noise to the image before processing. Therefore, the simulated noise is added to the image just to understand the noise elimination process. A filtering technique that can be applied to eliminate noise from images. After observing the results of the quality measurement values, it is concluded that the filter works best to eliminate image noise in all chosen noise models. 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 aim 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 median filter and the median filters and also adaptive fuzzy filter 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*: Noise measurement, filters, restoration, Filtering, Mean square error, Image enhancement factor, Peak signal to noise ratio (PSNR),Adaptive Fuzzy Filter

I. INTRODUCTION

Noise is any disrepair in the image caused by outer disturbance. During image acquisition, digital images are often degraded by noise due to a various of malfunctioning of pixel elements in the discrete image process. A noise is generated in the broadcast medium due to a defective communication or noisy channel, errors arising during the quality process and during quantization of the data for discrete storage. Image disrepair comes from blurring as well as noise due to electronic and photometric sources. Blurring is a form of bandwidth drop of the experimental image caused by the malfunctioned pixel image configuration process such as relative activity between the camera and the new scene or by an optical system that is out of focus. In adding up to these blurring effects, the resultant image is corrupted by noises too. Elimination of unwanted marks on the image Many methods have been developed to date. One of the important situations in noise reduction these signs with high frequency values while softening the edge and detail information With the standard median of the image filtering is a special case of impulse noise quite in the elimination of salt and pepper noise is a useful method, but the standard median filter does not work effectively at higher percentage noise rates. Achieving success even at high noise rates A number of studies have been conducted aiming [1]. In [2] salt and pepper using a fuzzy transition median filter the issue of detecting and reducing noise has been examined and Images with 20% and 40% density noise evaluated and close to standard median filtering results were obtained. [3] also with impulse noise an adaptive fuzzy median in distorted images filtering algorithm has been proposed and details are few very successful results were obtained in the images. A noise for the switched median filter in [4] detection algorithm is proposed and the method its performance is tested on four different images different regions are few, especially high effective results in images containing noise It was observed. [5] fuzzy logic and intuitive median based noise detection and reduction method proposed and for images with high noise levels, rather than minor errors successful obtained results. [6] to noise adaptive fuzzy switching median filter (NAFSM) with high salt and pepper noise can be reduced but in the edge and detail information distortions were observed. [7] salt in image repair and pepper noise using fuzzy artificial neural network reduced by a mixed technique and details are shown to be preserved. This method is very good use training kit in response to giving results and a little bit due to the high amount of processing required It is slow. In this study, salt and pepper noise rapid, practical and efficient method of reducing It has been projected Fuzzy logic based method edge, detail and texture even at high noise levels effectively reducing noise by protecting information

Manuscript received on December 10, 2020.
Revised Manuscript received on December 20, 2020.
Manuscript published on January 30, 2020.
* Correspondence Author
Deepa Msndale*, Department of Electronics & Communication Engineering, Anjuman College of Engineering & Technology RTM NagpurUniversity/NagpurIndia. Email: dsmandale@gmail.com
Ruhina Quazi Department of Electronics & Communication Engineering, Anjuman College of Engineering & Technology RTM NagpurUniversity/NagpurIndia. Email: uhinaquaziacet@gmail@gmail.com

II. PROPOSED METHODOLOGY

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)

$F\ (\ m,\ n) = I\ (\ m,\ n) + N\ (\ m,\ n)$ 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; $f(x) =$

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

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.

$$\mathrm{W} = (\mathrm{q}, \mathrm{t}\,) - \mathrm{N} \leq \mathrm{q} \leq \mathrm{N}, -\mathrm{N} \leq \mathrm{q} \leq \mathrm{N} \quad 2.3$$

$$\mathrm{Y}(\mathrm{i}, \mathrm{j}) = \mathrm{MED}(\mathrm{X}(\mathrm{i} + \mathrm{q}, \mathrm{j} + \mathrm{q})(\mathrm{q}, \mathrm{t}) \in \mathrm{W} \quad 2.4$$

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

$$\mathrm{WM}(\mathrm{i}, \mathrm{j}) = \mathrm{MED}(\mathrm{X}(\mathrm{i} + \mathrm{q}, \mathrm{j} + \mathrm{q})(\mathrm{q}, \mathrm{t}) * \mathrm{W}(\mathrm{i} + \mathrm{q}, \mathrm{j} + \mathrm{q})(\mathrm{q}, \mathrm{t}) \in \mathrm{W} \quad 2.5$$

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.

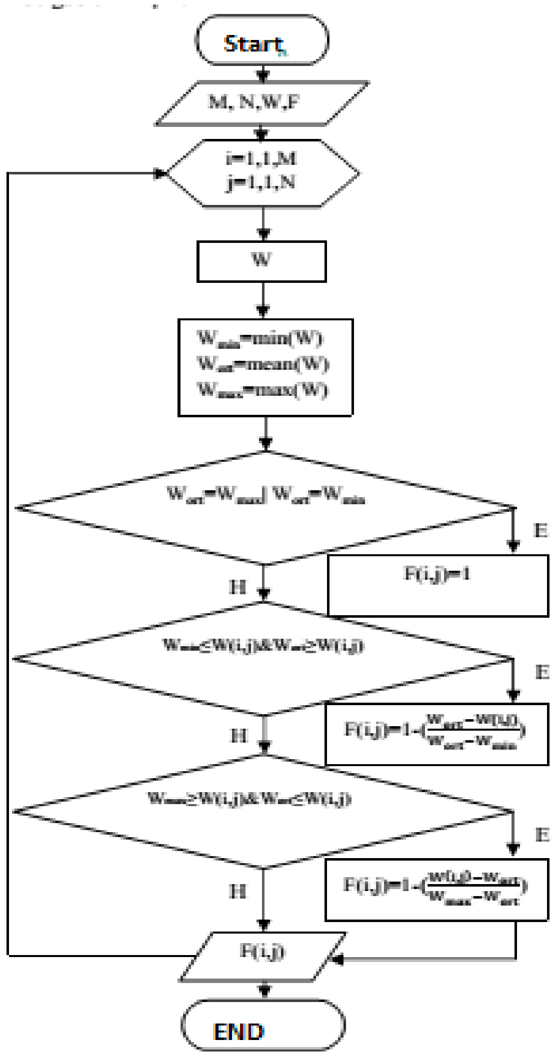

Figure 1: Adaptive fuzzy filter flow diagram.

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

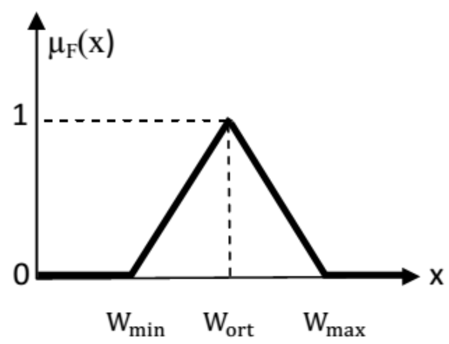

Figure 2: Fuzzy filter membership function

Noise detection step in the window noise amount has been detected. After this detection, every window, adaptively with the amount of noise in the window method with varying coefficients was applied. Thus, detail, edge and texture information of the image filtering process by protecting as much as possible After all these processes, ensuring an effective recovery is standard for the proposed method Provided support with median filter, second time filtering This method, on different images achieve effective results even at high noise levels

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

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

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

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

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

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

III. 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

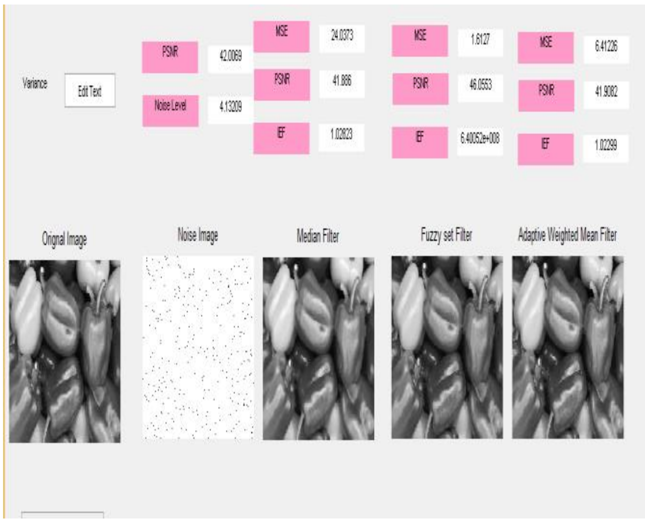

Figure 3 Comparison of Noise level & Median Filter ,Adaptive weighted filter and Adaptive Fuzzy Filter

. 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

Table 3. Comparisons of Adaptive Weighted Median Filter

Sr. no	Variance(%)	mse	psnr	ief
1	0.001	6.41	41.908	1.0299
2	0.002	7.71	41.907	1.024
3	0.003	7.609	41.907	1.019
4	0.004	6.9596	41.905	1.0237
5	0.005	7.063	41.907	1.0249

Table 4. Comparisons of Adaptive Fuzzy Filter

Sr. no	Variance(%)	mse	psnr	ief
1	0.001	1.9127	46.053	6.41E+08
2	0.002	2.89	43.6	3.56E+08
3	0.003	2.2436	44.6207	4.58E+08
4	0.004	2.3003	44.5129	4.48E+08
5	0.005	2.4822	44.18	4.17E+08

IV. 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. From the table we conclude that Adaptive filter show better result as compare the other two algotrithms.

REFERENCES

1. Lee, C. S., Hsu, C. Y. ve Guo, S. M., "An Intelligent Image Agent Based on Soft-Computing Techniques for Color Images Processing", Expert System withApplications, Vol. 28, .pp. 483-494, Apr. 2005.
2. Ibrahim, H. ve Toh, K. K. V., "Salt-and-Pepper Noise Detection and Reduction Using Fuzzy Switching Median Filter", IEEE Transaction on Consumer Electronics, vol. 54, no. 4, pp 1956-1961, Nov. 2008.4.
3. Tang, Q., Jin, W. ve Zhou, Y., "Adaptive Fuzzy Median Filter for Images Corrupted by Impulse Noise", 2008 Congress on Image and Signal Processing, Vol. 3, 2008.
4. Duan, F. ve Zhang, Y. J., "A Highly Effective Impulse Noise Detection Algorithm for Switching Median Filters," IEEE Signal Processing Letters, vol. 17, no. 7, pp. 647-650, Jul. 2010.
5. Ashourzadeh, M., Jampour, M., Ziari, M. ve Zadeh, R. E., "Impulse Noise Detection and Reduction Using Fuzzy Logic and Median Heuristic Filter", 2010 International Conference on Networking and Information Technology, 2010
6. Toh, K. K. V. ve Ashidi, N., "Noise Adaptive Fuzzy Switching Median Filter for Salt-and-Pepper Noise Reduction", IEEE Signal Processing Letters, vol. 17, no. 3, pp. 281-284, Mar. 2010.
7. Yüksel, M.E., "A HybridNeuro-Fuzzy Filter for Edge Preserving Restoration of Images Corrupted by Impulse Noise, IEEE Transactiıns on Image Processing, Vol.15, no:4, pp. 928-936, Apr. 2006.
8. Schulte S., Witte, V.D.Nachtegael, M., Weken, D. V. D. ve Kerre, E. E., "Fuzzyrandom impulse noisereduction method", Fuzzy Sets and System, Vol.158, pp. 270-283, Feb. 2007.J.

AUTHORS PROFILE

Deepa mandale, is pursuing MTech, in Electronics & Communication Engineering from Anjuman College of Engineering & Technology Nagpur, under the guidance of Ruhina Quazi. From Rashtrasant tukdoji maharaj Nagpur University She had done her Bacherlor in Engineering from J.D. College of Engineering & Technology with first class. Her current research topic in soft computing technique in Digital Image Processing.

Ruhina Quazi, is currently an Assistant Professor at Anjuman College of Engineering & Technology, Nagpur, Maharashtra, India. The author obtained her first degree in Electronics & Telecommunication Engineering from RTM Nagpur University in 2005 and completed her Master's in Technology in VLSI in the year 2007. She is a registered member of ISTE.Currently, She is pursuing her Phd in Electronics.Her Areas of Specialization include VLSI and Image Processing. She has about 13 years of working experience in academic environment. She is a regular participant of many Research Development Programs,Faculty Development Programs, STTPs and Teqip Programmes held at ISTE and National Level