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Removing Gaussian Noise Using Mean Filter and Fuzzy Filter

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Abstract - *Image filtering is employed to get rid of noise from a picture. Image filtering helps to retrieve the original image from image that is corrupted with noise throughout acquisition and transmission. Noise is associate unwanted signal that is random in nature. So, image filtering aims to get rid of different kinds of noises from a picture. Image filtering also enables us to enhance the images. Mean filter is a linear filter that uses mask over each pixel in a window of an image. It averages all the components within the window and replaces the central pixel with the obtained average value. Hence, the Mean filter is additionally referred to as averaging filter. Fuzzy filter for removing noise from an image is based on fuzzy set theory. It exploits fuzzy rules to determine the gray level of a pixel in a window. This paper presents Image filtering using Mean and fuzzy filters to get rid of Gaussian noise from an image. Further performance can be measured using mean square error and peak signal to noise ratio.*

1. INTRODUCTION

Image process [2] aims to enhance the image knowledge to suppress the unwanted distortions and to enhance some features of the input image. The output of image process could also be either an image or, a set of characteristics or parameters related to the image. A linear filter is one that can be done with a convolution, which is just the linear sum of values in a sliding window. Linear filters usually blur edges, destroy lines and different fine details present in the image. so to overcome these issues non-linear filters are used. These non-linear filtering techniques [1] preserve signal structure. The mean filter is a linear filter and a fuzzy filter is a non-linear filter. Fuzzy filters will manage the image exactness and ambiguity in several image processing applications efficiently.

The rest of the paper is organized as follows:-

- In the second section, we described types of noise.
- In the third section, we present the method of mean filter.
- In the fourth section, we described the fuzzy filter.
- In the fifth part, simulation results are discussed.
- We conclude and future work in the sixth and seventh part.

2. IMAGE NOISE

Image noise [3] is that the random variation of brightness or color data in images created by device and electronic equipment of scanner or camera.

Types of noise are the following:

- Gaussian noise
- Salt-and-pepper noise
- Speckle noise
- Quantization noise
- Film grain
- Non-isotropic noise

2.1 Gaussian Noise

The Gaussian noise is an image is introduced throughout the acquisition of digital pictures. It is an analytical noise where the probability density function is equal to Gaussian distribution. This noise can be modeled by adding random values to an image Gaussian noise.

2.2 Salt-and-Pepper Noise

It is additionally referred to as spike noise. This noise happens once there exists dark pixels in bright region and vice versa. This further indicates that abrupt disturbance in image signals give rise to salt and pepper noise.

2.3 Speckle Noise

Speckle noise may be a crude noise that corrupts the components of medical images in general. This noise occurs due to the modeling of the reflectivity function.

3. MEAN FILTER

The idea of mean filter [4] is simply to replace each pixel value in an image with the mean (average) value of its neighbors, including itself. This has the impact of eliminating pixel values that are unrepresentative of their surroundings. Mean filtering is usually thought of as a convolution filter. Like other convolution, it is based on kernel, which represents the shape and size of the neighborhood to be sampled when calculating mean.

The mean filter is defined by:

$$Mean\ filter(x_1, x_{2,\ldots\ldots\ldots} x_n) = \frac{1}{N}\sum_{i=1}^{n} x_i$$

4. FUZZY FILTER

Fuzzy filter [5] is based on a fuzzy set theory to reduce image noise and the contrast is a type of enhancement technique. It uses fuzzy rules. Fuzzy set theory was introduced by L.A.ZADEH. Fuzzy filter maps the gray levels into a fuzzy plane using membership function. An image of size M×N associated L gray levels can be considered as an array of fuzzy singletons, each having a value of membership denoting the degree of brightness or grade of membership.

Z = $\{set\ of\ elements\}$ with generic elements z.

Z = $\{z\}$ universe of discourse

A is used to denote a fuzzy set in Z.

$\mu_A(z)$ is the membership that associates with every value Z in interval [0,1] and it gives a grade of membership.

If $\mu_A(z) \approx 1$ then higher the membership grade of z in A.

z's for $\mu_A(z) = 1$ are full members of the set.

z's for $\mu_A(z) = 0$ are not a member of the set.

z's for $\mu_A(z) \leq 1$ are partial members of the set.

A fuzzy set 'A' can be usually represented as,

$$A = \{z, \mu_A(z) | z \in Z\}$$

Where z is generic element and

$\mu_A(z)$ is grade of membership.

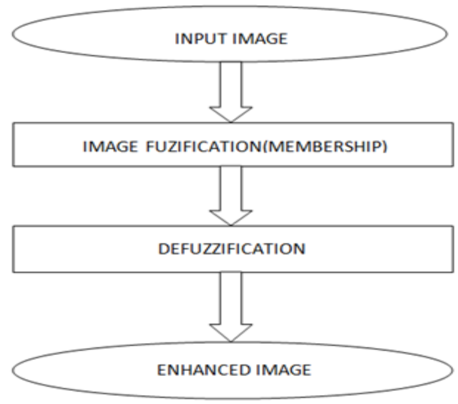

Fig.1 : proposed algorithm

The algorithm includes the following steps:

1. At first, the gray values of the neighborhood pixels (n × n window) are stored in an array a then sorted in ascending or descending order.
2. Then, the fuzzy membership value is assigned for each neighbor pixels:
   This step has the following characteristics:
   a. A ∏-shaped membership function is used.
   b. Membership value 1 is assigned to the mean value of the gray levels of the neighborhood pixels.
   c. Membership values are determined for all the pixels in the window.
3. Now, the gray value that has the highest membership value will be selected and placed output.

∏-shaped membership function is given by,

$$f(x;a,b,c,d) = \begin{cases} 0, & x \leq a \\ 2\left(\dfrac{x-a}{b-a}\right)^2, & a \leq x \leq \dfrac{a+b}{2} \\ 1-2\left(\dfrac{x-b}{b-a}\right)^2, & \dfrac{a+b}{2} \leq x \leq b \\ 1, & b \leq x \leq c \\ 1-2\left(\dfrac{x-c}{d-c}\right)^2, & c \leq x \leq \dfrac{c+d}{2} \\ 2\left(\dfrac{x-d}{d-c}\right)^2, & \dfrac{c+d}{2} \leq x \leq d \\ 0, & x \geq d \end{cases}$$

a, b, c, and d parameters. Membership values are computed for each input value in x.

For example consider a 3×3 window of pixels as follows,

81	121	148
87	126	152
99	132	158

Here,Mean value = 123

Median value = 126

Sorted order : 81, 87, 99, 121, 126, 132, 148, 152,158

Membership value (∏-shaped membership) : 0, 0.0408, 0.3673, 0.9955, 0.9853, 0.8678, 0.1633, 0.0588, 0

Selected value : 121

5. SIMULATION RESULTS

Experimental results which explored the characteristics of various filters are presented. The analysis has been presented on the basis of different variances of noise for the original image(256 × 256). The result is taken by comparing the performance of fuzzy filter and mean filter on basis of PSNR and MSE value.

MSE is given

$$MSE = \frac{1}{MN}\sum_{x=1}^{M}\sum_{y=1}^{N}(f(x,y) - k(x,y))^2$$

PSNR is given by

$$PSNR = 20log_{10}\frac{255}{\sqrt{MSE}}\text{ dB}$$

Fig. 2: Original image

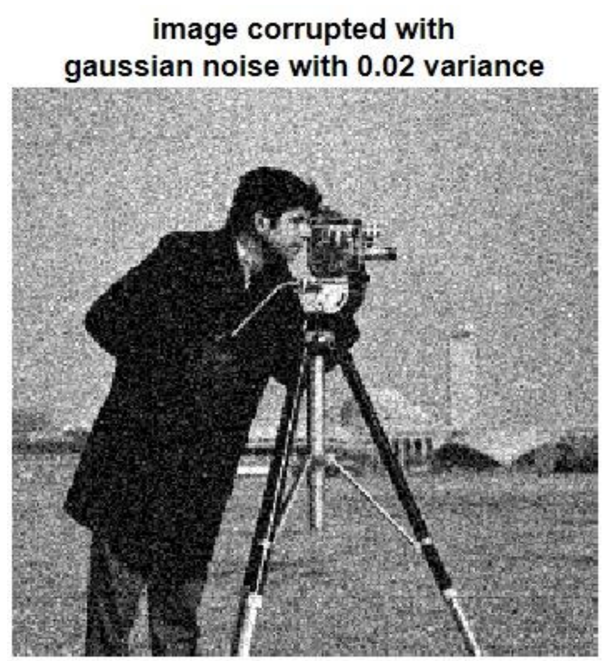

Fig. 3: Adding Gaussian noise with 0.02 variance

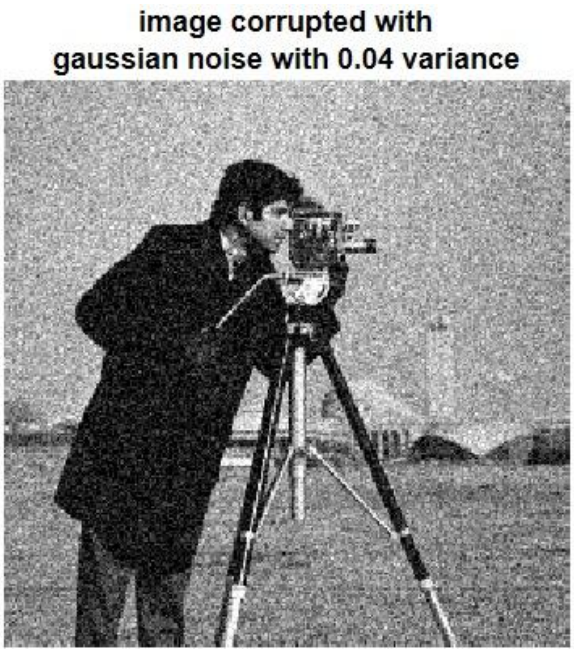

Fig. 4: Adding Gaussian noise with 0.04 variance

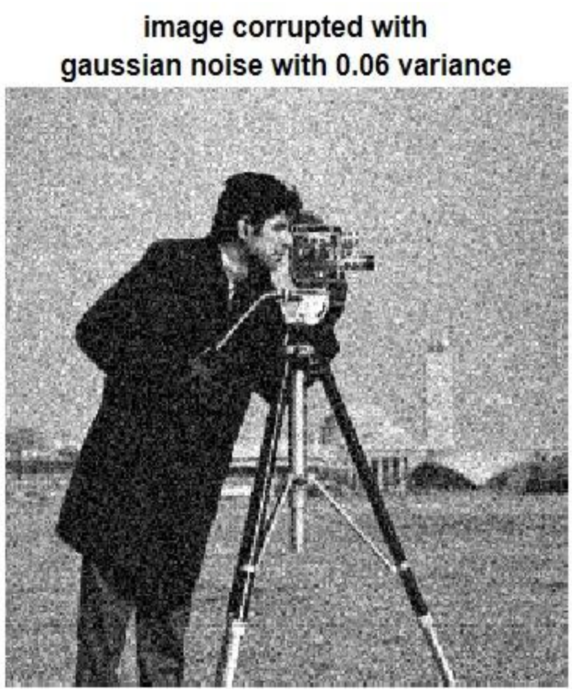

Fig. 5: Adding Gaussian noise with 0.06 variance

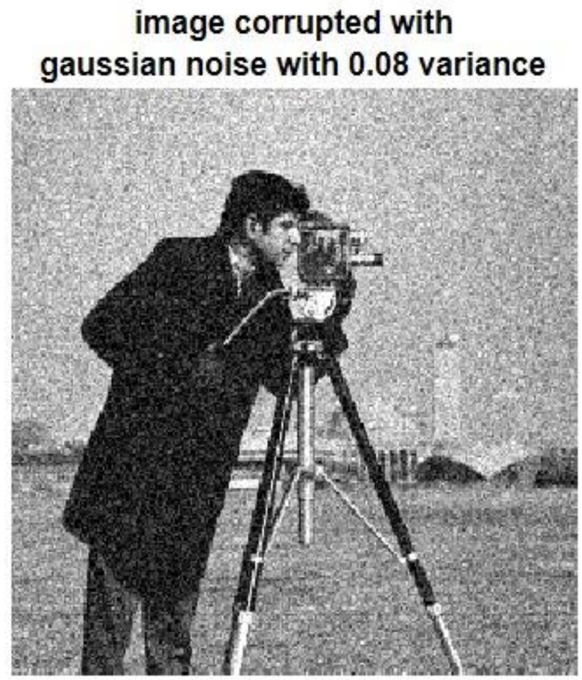

Fig. 6: Adding Gaussian noise with 0.08 variance

Fig. 7: De-noising by mean filter, variance=0.02

Fig. 8: De-noising by mean filter, variance=0.04

Fig. 9: De-noising by mean filter, variance=0.06

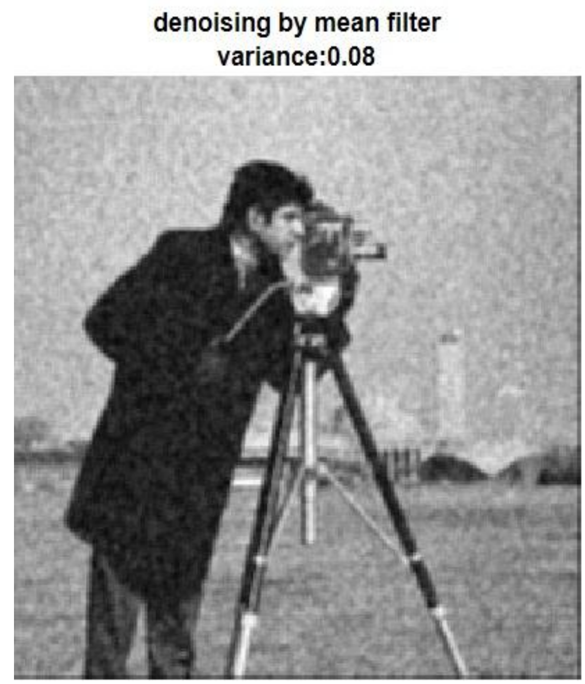

Fig. 10: De-noising by mean filter, variance=0.08

Fig. 11: De-noising by fuzzy filter, variance=0.02

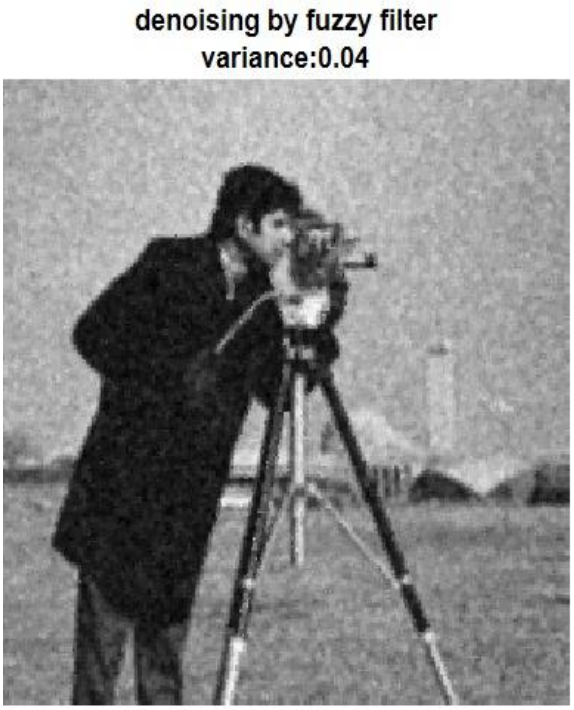

Fig. 12: De-noising by fuzzy filter, variance=0.04

Fig. 13: De-noising by fuzzy filter, variance=0.06

Fig. 14: De-noising by fuzzy filter, variance=0.08

Table - 1: Variance, Mse and Psnr Of Mean Filter And Fuzzy Filter

VARIANCE	MEAN FILER		FUZZY FILTER	
	MSE	PSNR	MSE	PSNR
0.02	27.8246	77.5661	27.028	77.856
0.04	18.0984	81.8671	16.941	82.527
0.06	13.2203	85.0077	12.010	85.967
0.08	10.5391	87.2743	9.0892	88.754

Also, various membership functions like triangular, trapezoidal membership functions can also be used to remove Gaussian noise.

A Triangular membership function is specified by three parameters {a, ,b, c} as follows :

$$f(x;a,b,c)=\begin{cases}0, & x\le a\\ \dfrac{x-a}{b-a}, & a\le x\le b\\ \dfrac{c-x}{c-b}, & b\le x\le c\\ 0, & c\le x\end{cases}$$

$$f(x;a,b,c,d)=\begin{cases}0, & x\le a\\ \dfrac{x-a}{b-a}, & a\le x\le b\\ 1, & b\le x\le c\\ \dfrac{d-x}{d-C}, & c\le x\le d\\ 0, & d\le x\end{cases}$$

The Trapezoidal membership is given by,

Table – 2: comparison of mean filter and fuzzy filter

variance	Mean Filter		Fuzzy Filter					
			Triangular MF		Pi-shaped MF		Trapezoidal MF	
	MSE	PSNR	MSE	PSNR	MSE	PSNR	MSE	PSNR
0.02	27.5851	77.6525	25.8599	78.2984	27.2160	77.7872	27.1653	77.8059
0.04	18.4820	81.6573	16.5116	82.7846	17.5239	82.1896	17.5308	82.1857
0.06	13.3547	84.9066	11.1072	86.7493	11.8730	86.0826	11.8686	86.0863
0.08	10.6485	87.1710	8.3767	89.5707	8.9367	88.9236	8.8687	89.0000

6. CONCLUSION

This paper tells that fuzzy filter is better than mean filter according to PSNR and MSE values for different variances. PSNR high means good quality and low means bad quality. This PSNR depends on MSE. So, low the error, high will be the PSNR. The performance of mean filter and the fuzzy filter is shown in Table - 1. From table – 2, we can observe that the fuzzy filter (with any membership function) will give better performance when compared to mean filter.

7. SCOPE FOR FUTURE WORK

Some new filters can be used for comparison of different types of noises and different types of images which have different pixel value. It also include use new concepts to modification of membership value without affecting the performance of result in Fuzzy filtering.

REFERENCES

[1] International Journal of Computer Science and T. K. Thivakaran, Dr. R. M. Chandrasekaran, “Nonlinear Filter Based Image Denoising Using AMF Approach”, Information Security, Vol. 7, No. 2, 2010.
[2] Charu Khare, Kapil Kumar Nagwanshi, “Image Restoration Technique with Non Linear Filter”, International Journal of Advanced Science and Technology, Vol. 39, February, 2012.
[3] R.C. Gonzalez and R.E. Woods, Digital Image Processing, Prentice Hall, 2008.

[4] Mukesh C. Motwani, Mukesh C. Gadiya, Rakhi C.Motwani, Frederick C. Harris, Jr, (2004), "Survey of ImageDenoising Techniques," Proc. of GSPx, 2004, Santa Clara Convention Center, Santa Clara, CA, pp. 27- 30.

[5] M. Mozammel Hoque Chowdhury, Md. Ezharul Islam,Nasima Begum and Md. Al-Amin Bhuiyan "Digital Image Enhancement with Fuzzy Rule-Based Filtering", IEEE, 1-4244-1551-9/07, 2007.

[6] Charles Boncelet (2005)."Image Noise Models" in Alan C. Bovik. Handbook of Image and Video Processing.

[7] S. A. Mahmood, "Fuzzy Enhancement for Color Image Processing," 2009 International Conference on Computer Technology and Development, Kota Kinabalu, 2009, pp. 340-344. doi: 10.1109/ICCTD.2009.229.

[8] A. S. Parihar, O. P. Verma and S. Tyagi, "An optimal fuzzy filter for Gaussian noise in color images using bacterial foraging algorithm," 2013 Annual International Conferenceon Emerging Research Areas and 2013 InternationalConference on Microelectronics, Communications andRenewable Energy, Kanjirapally, 2013, pp. 1-6.doi: 10.1109/AICERAICMiCR.2013.6576022.

[9] P. Dwivedy, A. Potnis, S. Soofi and P. Giri, "Performance comparison of various filters for removing different image noises", 2017 International Conference on Recent Innovations in Signal processing and Embedded Systems (RISE), Bhopal, 2017, pp. 181-186. doi: 10.1109/RISE.2017.8378150.

[10] S. Chankhachon and S. Intajag, "Resourceful method to remove mixed Gaussian-Impulse noise in colorimages," 2015 12th International Joint Conference onComputer Science and Software Engineering (JCSSE),Songkhla, 2015, pp. 18-23 doi: 10.1109/JCSSE.201.7219763.

[11] YoungSik Choi and R. Krishnapuram, "Image enhancementbased on fuzzy logic,Proceedings" International Conference on Image Processing, Washington, DC, USA, 1995, pp.167-170 vol.1.doi: 10.1109/ICIP.1995.529066.

[12] F. Russo, "A technique for image restoration based on recursive processing and error correction", Proceedings ofthe 17th IEEE Instrumentation and MeasurementTechnology Conference [Cat. No. 00CH37066], Baltimore,MD, USA, 2000, pp. 1232-1236 vol.3 doi:10.1109/IMTC.2000.848674.