Filtering The Corrupted Image By Different Rate Of Gaussian Noise

Suha H. Ibrahiem
AL-Mustansiriya, College of Basic Education
Baidaa K. Hamed & Haidar Jawad M. Al-Taa'y
Dr.Ali Abid D. Al –Zuky
AL-Mustansiriya, College of Science, Physics Dept.

Abstract

There are many reports that deal with removing noises from degraded images. The common noises reduction techniques are based on the assumption that the noise corrupts the image is signal independent, and adopte local statistics, computed in fixed neighborhood to recover the image signal.

In this paper we have generating Gaussian noise ($\mu_n = 0$ and $\sigma_n = 10$) with different rates (20, 40, 60, 80,100) % and we study additive Lee's filters for reducing additive Gaussian noise with a square and circular shape window. The resulting images and fidelity criteria showed that the circular smoothing window exhibit the best results in image noise reduction.

الخلاصة:-

هناك العديد من الدراسات تتعلق بازالة الضوضاء من الصور المشوبة . تقنيات تقليل الضوضاء المتعارف عليها تعتمد على فرضـــية ان الضوضـــاء المشوبه للصوره هي ضوضاء غير معتمدة على الاشارة، وتتبنى احصـــائيات موقعية، حيث يمكن تحسين عنصر الصورة بالاعتماد على العناصر المجاورة له .

في هذا البحث ولدنا الضوضاء الكاوسية $(\mu_n = 0$ and $\sigma_n = 10)$ بنسب مختلفة (20, 40, 60, 80,100) % ودرسنا مرشح ليي الجمعي لتقليـــل الضوضـــاء الكاوسيه الجمعية بنافذه مربعة ودائرية . الصور الناتجة والمعايير المعتمـــدة اثبتت ان النافذة الدائرية للتنعيم اعطت نتائج جيدة لتقليل ضوضاء الصورة .

1. Introduction

Real world signals usually contain departures from the ideal signal that would be produced by our model of the signal production process. Such departures are referred to as *noise*. Noise arises as a result of unmodelled or unmodellable processes going on in the production and capture of the real signal. It is not part of the ideal signal and may be caused by a wide range of sources, *e.g.* variations in the detector sensitivity, environmental variations, the discrete nature of radiation, transmission or quantization errors, *etc.* It is also possible to treat irrelevant scene details as if they are image noise (*e.g.* surface reflectance textures). The characteristics of noise depend on its source, as does the operator which best reduces its effects.

Additive noise, probably the most common type, can be expressed as [1,2]:

$$I(x, y) = R(x, y) + n(x, y) \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where I(x,y) Resulted noisy data, R(x,y) is the original signal (without noise), and n(x, y) represent the noise that corrupted the signal may be causes from environment and other sources of interference.

Many image processing packages contain operators to artificially add noise to an image. Deliberately corrupting an image with noise allows us to test the resistance of an image processing operator to noise and assess the performance of various noise filters[3].

in this paper we have generating Gaussian noise ($\mu_n = 0$ and $\sigma_n = 10$) with different rates (20,40,60,80,100)% and we study additive Lee's filter for reducing additive Gaussian noise, and adopting circular filter mask shape.

2. Additive Gaussian Noise

In Gaussian noise models, the noise density follows a Gaussian normal distribution G(μ_n , σ_n) defined by the mean μ_n , and standard deviation σ_n .

The Gaussian distribution in 1-D has the form [4,5]:

$$G(n) = \frac{1}{\sqrt{2\pi\sigma_n^2}} e^{\frac{-(n-\mu_n)^2}{2\sigma_n^2}} \quad \text{.............(2)}$$

Where n is the represent the random variable of mean $\mu_n = 0$, and standard deviation σ_n. This distribution. of zero mean (i.e. it is centered on the line $\mu_n = 0$). The distribution is illustrated in Figure 1.

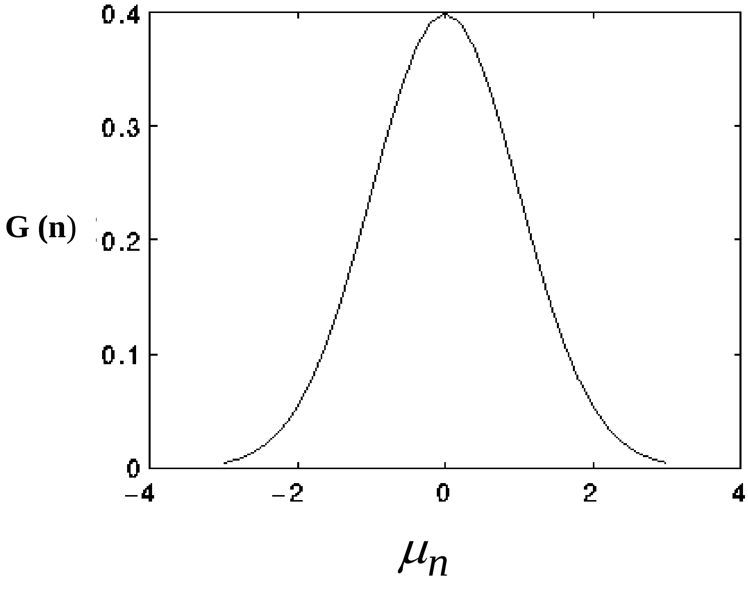


Figure 1: Gaussian distribution with $\mu_n = 0$ and $\sigma_n = 1$[4]

Gaussian Generation procedures

The computerize generation of Gaussian random variable, summarized in algorithm(1):

Algorithm(1) :Gaussian Random Variable Generation

Input: σ, **Sn**

Output : Oc(n)

i Input size of Gaussian data file(Sz) that we want to be generated.

ii Determine the Gaussian distribution G(n) using (n=-255, -254 ,…,254,255), from eq (2) then determine the occurrence of n (i.e O_C (n) in file of size Sn this by using:

Oc(n)= Round_ integer(G(n)* Sn)

iii Randomly distribute the value n of Oc(n) in file of size Sn.

3. Lee's Filter

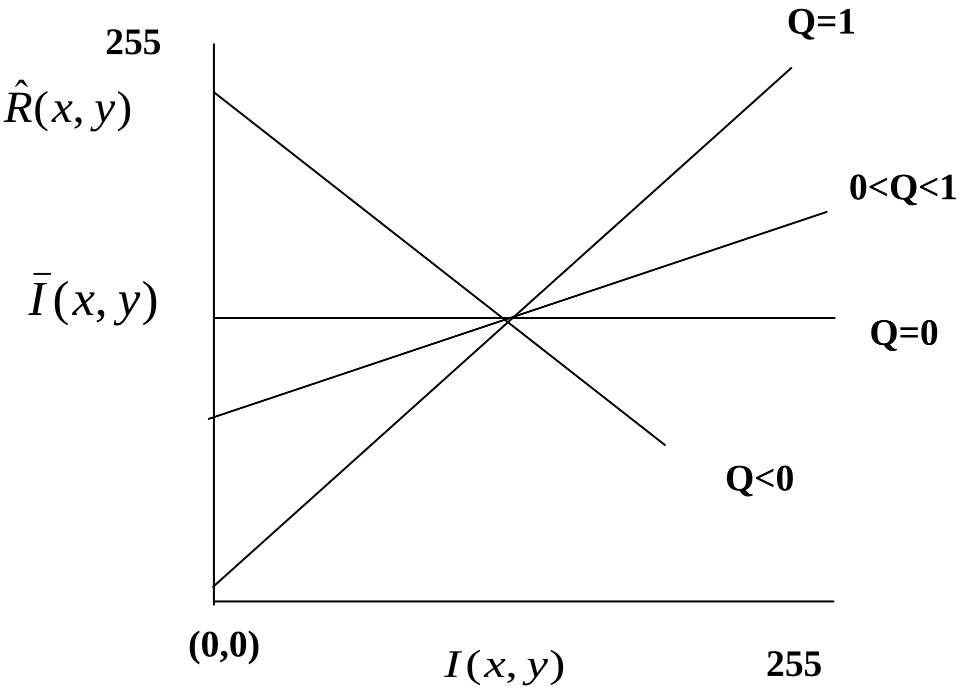
Lee [6], suggest adaptive smoothing filter (called local linear minimum mean square error (LMMSE)filter). Since it uses a linearization by Taylor expansion, around the mean, then applied Wiener filter. The LMMSE filter estimate the true signal $R(x,y)$, which we denoted by $\hat{R}(x,y)$, by using a linear relation between the estimator $\hat{R}(x,y)$, and the measured value $I(x,y)$, this relation given by:

$$\hat{R}(x,y) = \mu(x,y) + Q(x,y)\big(I(x,y) - \mu(x,y)\big) \quad \text{.............(3)}$$

and

$$Q(x,y) = 1 - \frac{\sigma_n^2}{\sigma_{I(X,Y)}^2} \quad \text{...............(4)}$$

Were $\mu(x,y)$ and $\sigma_{I(X,Y)}$ the local mean and standard deviation of observation $I(x,y)$, and σ_n is the noise standard deviation . The above relation shown in fig (2) below:



Caption of figure (2)

Lee assumes the noise is not correlated with the image signal. As for the variance of the noise σ_n^2. It is constant over the whole image if the noise signal independent. But, it varies if the noise signal dependent. So for the signal dependent noise must be locally estimate σ_n^2 with knowledge of the type of noise that corrupted the image [7].

4. Noise Filtering Procedure:

In this study has been applied Lee's filter to enhance corrupted image by additive Gaussian noise. The procedure of Lee's filter modified by using circular sliding window instead of square window, and computing local mean $\mu(x,y)$ and local variance σ_I^2. Then improve central pixel value in circular block by using eq.(3) and(4). The circular block detmine by its radius (R) this by using the following algorithm [8]:

Algorithm(2) :Circular shipe window given by

1. Determine array of circular block cbk(1000,2), where 1000 represent the maximum no. of pixels in the circular block, and 2 represent no. of axises in the plane(x and y).
2. Input radius length (L_R).And put L=1.
3. Put vbk (L,1) =0, and cbk(L,2)=0 (central pixel location in the window).
4. Put pr=0.00001(precision value).

(i). For R_1=1 To L_R Do
    Compute dθ=45/R_1
    Compute n_t= 360/ dθ (Represent no. Partitions of the circular)
Compute n_{t1}=n_t-1
(ii). For T=0 To n_{t1} Do
    Compute θ=T*d θ(represent the angle of the part T)
    Compute S=Sin (θ)
    Compute C= Cos (θ)
  IF $|S|$ t_r then put y=0 else put y=Round integer (R_1*S)
  IF $|C|$ t_r then put X=0 else put X=Round integer (R*C)
    Compute L=L+1
    Put cbk(L,1)=x
    Put cbk(L,2)=y
END (ii)
END (i)

5. Results and Discussions

One image have been adopt to demonstrate the smoothing effects, this is:

Lena image: have size (512X512) and grays ranged between 0 (dark) to 255 (bright). The generation Gaussian noise (mean =0 and $\sigma = 10$) with different rates of this image produced five images with noise ratio 20%, 40%,60%,80% and100% respectively.

Figure (3) represent, Lena images (i.e. the original, noisy (different noise rates), and the smoothed images) smoothed by Square window of size (5X5).and Circular window of radius(2)

To evaluate filtering efficiency, we extract 3- homogenous regions with different means, Then compute the mean ,standard deviation (STD), and signal to noise ratio(SNR)values in extracted regions for noisy , and filtered images. .

$$SNR = \frac{\mu}{\sigma} \qquad \text{...............(5)}$$

The results of these measures, demonstrated in fig (4), for noisy image, and filtered images (smoothed by square and circular blocks respectively). Where can be shown that the σ values increased in noisy image for increase rate of the noise and decreased for filter image. In fig (5) can be note that the SNR values are decreased in noisy image for increase rate of the noise and increased for filter image especially in circular window.

6. Conclusion

From the results ,above can be concluded that the σ .values are increased and the SNR decreased in noisy image for increase rate of the noise .Filtering processing that enhance the image quality ,i.e. improve SNR and damped the σ.

Original Image

Noisy Image20%

Lee's Filter
(Square window (5*5)

Lee's Filter
(Circular window of radius (2))

Noisy Image40%

Lee's Filter
(Square window (5*5)

Lee's Filter
(Circular window of radius (2))

Noisy Image60%

Lee's Filter
(Square window (5*5)

Lee's Filter
(Circular window of radius (2))

Noisy Image80%

Lee's Filter
(Square window (5*5)

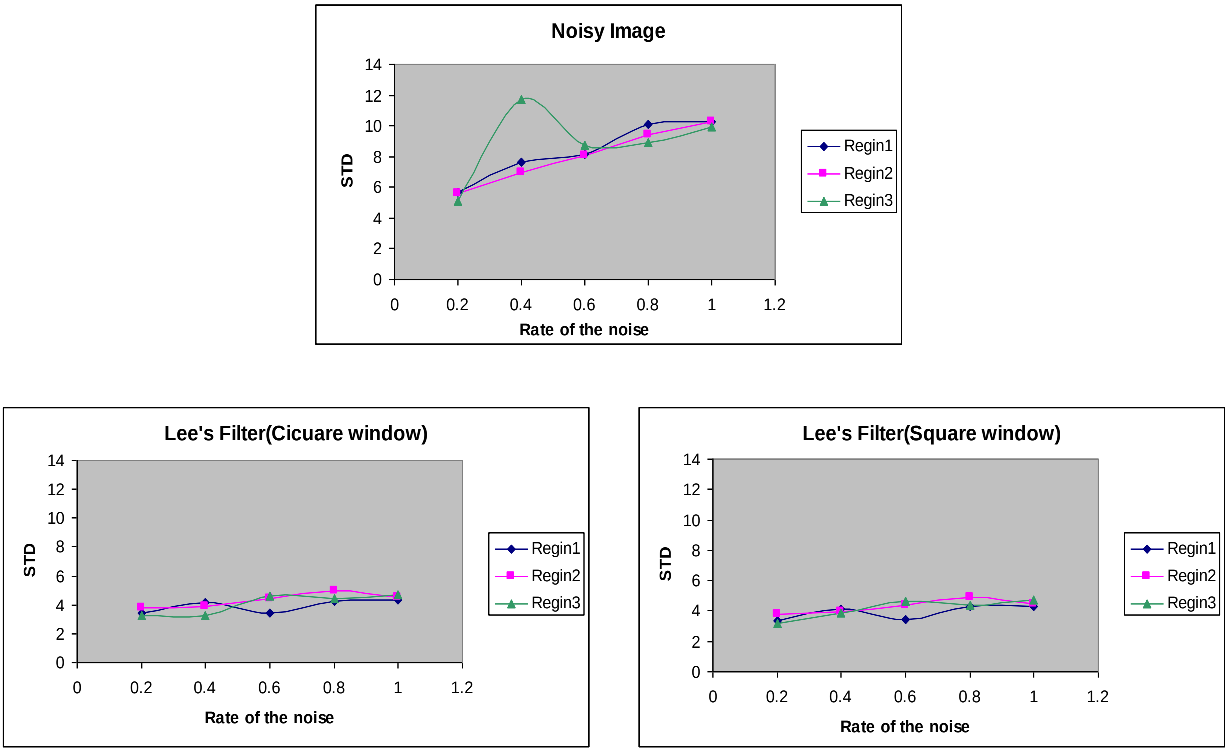
Lee's Filter
(Circular window of radius (2))

Noisy Image100%

Lee's Filter
(Square window (5*5)

Lee's Filter
(Circular window of radius (2))

Fig. (3) **Original, Noisy**(additive Gaussian noise $\sigma_n = 10$) **and smoothing images for Lena image**



Fig(4) The Rate of the Gaussian noise and STD$\left(\sigma_n\right)$ for 3-regions in

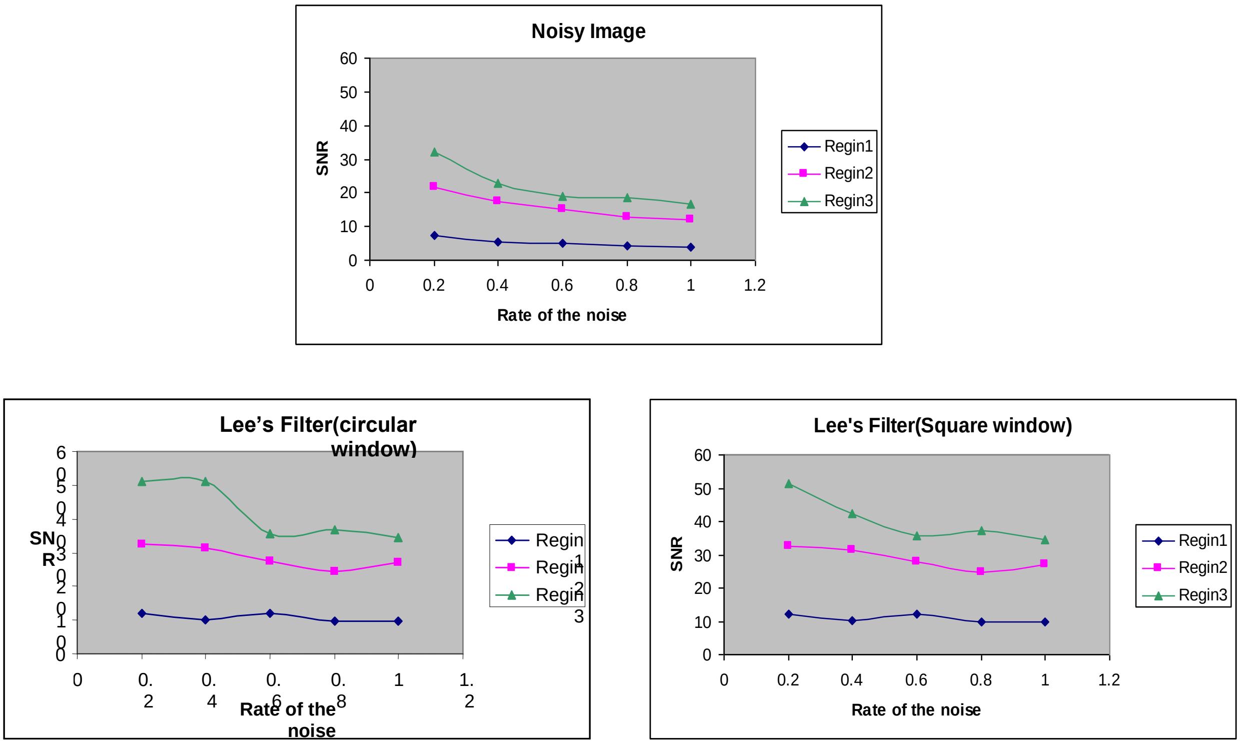


Fig (5) The Rate of the Gaussian noise and SNR for 3-regions in

7. References

1. Yasuyuki Matsushita and Stephen Lin, ``Radiometric Calibration from Noise Distributions'', In Pro-ceedings of IEEE Computer Vision and Pattern Recognition (CVPR), 2007.
2. Ali Abid Dawood AL-Zuky,"Quantitative analysis of synthetic aperture radar SAR images", Ph.D. thesis, Physics dept., College of Science, Baghdad Univ., 1998.
3. A. Buades, B. Coll, and J. Morel, "A non-local algorithm for image denosing", Proc. of IEEE Conf. Computer Vision and Pattern Recongnition, 2005.
4. A. Jain Fundamentals of Digital Image Processing, Prentice Hall, , pp 244 - 253, 273 - 275. 1989
5. E. Davies Machine Vision: Theory, Algorithms and Practicalities, Academic Press, pp 29 - 30, 40 - 47, 493. 1990
6 J.S.Lee,"Digital image enhancement and noise filtering by use of local statistics", IEEE, Trans. PAMI-2,n2,pp165-168,1980.
7. Ali Abid Dawood AL-Zuky," Modify Adaptive Lee's Filter by Using Circular Smoothing Window" Accepted to be published in J.of Collegeof Science, Al-Mustnsiriyah Univ. 2002.

8. Ali Abid Dawood AL-Zuky, "Speckle Reduction Using circular Frost's filter Window", Accepted to be published in J.of Collegeof Science, Al-Mustnsiriyah Univ. 2002.