Image Denoiseing Using New Double 2-D Based Median Filter

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Abstract : *Noise is a major issue while transferring images through all kinds of electronic communication. Noise are of different types like, Gaussian noise, salt and pepper noise shot noise, film grain. Salt and Pepper noise is also known as Impulsive noise causes dark pixel in bright region and bright pixel in dark region. Salt-and-pepper noise is generated by errors during analog to digital conversion or data transfer. In this paper, we will give a new method that will help to remove the high density salt and pepper noise up to 55% efficiently. We will also study existing method of impulsive noise removal and compare with our suggested method using MATLAB. A comparison table is prepared with our new method and other methods like Median filter to find result in terms of Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE) for Lena Image and Cat Image.*

***IndexTerms* - PSNR, MSE, impulsive noise, median filter.**

I. INTRODUCTION

Noise is a disturbance in pixel values. There are several types of noise existing in images and these noises categorized based on the criteria of distribution, correlation, nature and sources. In this paper we concentrated on Salt and Paper noise which is generally caused by sensor and memory problem due to which pixel are assigned incorrect maximum values [1]. The salt and pepper noise pixels can take the maximum and minimum values in the dynamic range (0, 255) if a pixel value is with 255 then regarded as “Salt” and if pixel value is 0 regarded as “Pepper” combining the Salt-and-Pepper noise means it represents randomly occurring white and black pixels in an image. An Image can be corrupted by Impulse Noise during transmission or reception [2]. The goal of proposed method is to discover an efficient method of impulsive noise removal with high density and it should be more efficient than existing methods. There are several methods to remove salt and pepper noise in the image. Among all those methods Standard Median Filter has been established a reliable method. However, the major drawback of standard Median Filter (MF) is that the filter is good only at low noise densities. When the noise level is over 50% the edge details of the original image will not be preserved by standard median filter. Adaptive Median Filter (AMF) performs well at low noise densities. But at high noise densities the window size has to be increased which may lead to blurring the image [3]. Three algorithms, adaptive filtering techniques, simple 2-D median filter and central weighted filtering Techniques, have been explained in detail while other algorithms have been used for simulation purpose.

A median filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighboring pixel values, it replaces it with the median of those values. The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value. If the neighborhood under consideration contains an even number of pixels, the average of the two middle pixel values is used.

A 2D Median filter

The 2D median filter is a sliding-window spatial filter, it replaces the central value in the window with the median of all the pixel values lying in the window. An example of median filtering of a single 3x3 window of values is shown below.

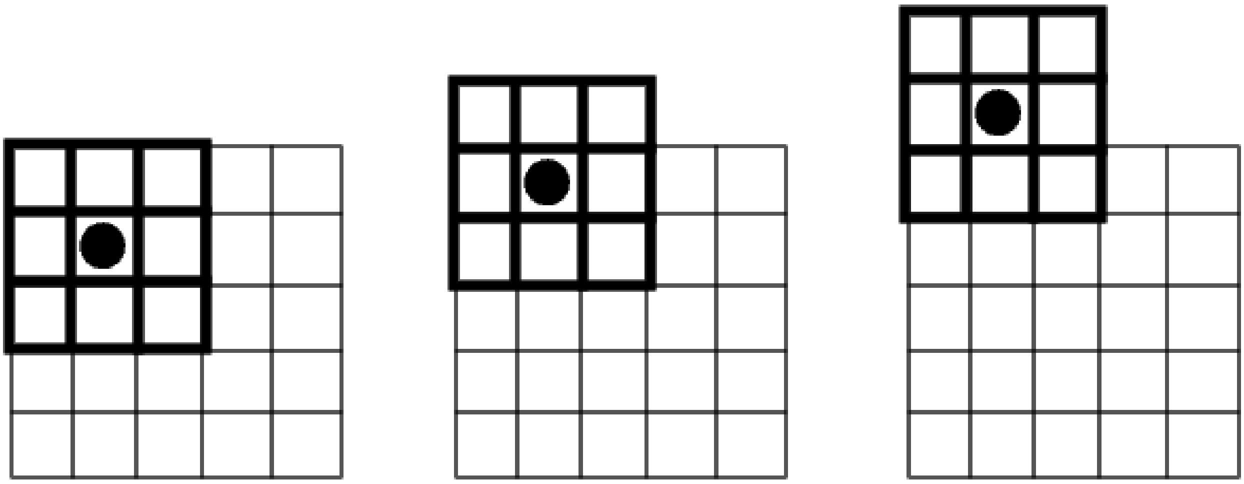
unfiltered values		
7	3	0
4	33	5
20	4	11

After sorting - 0, 3, 4, 4, 5, 7, 11, 20, 33

After applying the median filter only '5' is preserved		
*	*	*
*	5	*
*	*	*

Center value (previously 33) is replaced by the median of all nine values (5). The median filter is also widely claimed to be 'edge-preserving' since it theoretically preserves step edges without blurring. However, in the presence of noise it does blur edges in images slightly.

How 2d median filter is applied on an Image Matrix, through a sliding window approach. Due to 2nd & 3rd condition we need to pad the edges.



The computational molecule overlaps only pixels that are in the original image. The result is included in the output matrix, regardless of the shape parameter.

The computational molecule overlaps pixels outside the original image, but the center pixel overlaps a pixel in the image. The result is included in the output matrix if the shape parameter is same or full.

The computational molecule overlaps pixels at the edges only. The center pixel is outside the image. The result is included in the output matrix if the shape parameter is full.

(Image illustration Courtesy, CUVT Prague)

By the above illustrations, it might be clear till now how the central element of the median filter is calculated & how the sliding window approach helps to decide & replace the original valued pixel.

The next type of median filtering is the center weighted median filtering technique. This is similar to the standard median filtering technique except that the center pixel in the window to be filtered is assigned a certain weight, i.e. the center pixel is repeated for some number of times which is defined as the weight. Since the center pixel in the window to be filtered is repeated for some number of times, this technique is called the center weighted median filter. Let, I_{ij} be the center pixel of the window W, then the output (filtered) pixel of the center weighted median filter as given by [4] is:

I_{ij} = median I[i s j t− −,w $I^{\cdot\cdot}_{ij}$ |(s ,t) ∈W,(,)s t ≠ (0,0)] [4]

Where, W is the window, w is the weight of the center pixel, w I¨ ij denotes that Iij is repeated w times in calculating the median.

Adaptive Median Filter

Therefore the adaptive median filtering has been applied widely as an advanced method compared with standard median filtering. The Adaptive Median Filter performs spatial processing to determine which pixels in an image have been affected by impulse noise. The Adaptive Median Filter classifies pixels as noise by comparing each pixel in the image to its surrounding neighbour pixels. The size of the neighbourhood is adjustable, as well as the threshold for the comparison. A pixel that is different from a majority of its neighbours, as well as being not structurally aligned with those pixels to which it is similar, is labelled as impulse noise. These noise pixels are then replaced by the median pixel value of the pixels in the neighbourhood that have passed the noise labelling test.

Peak Signal to Noise Ratio

Peak Signal to Noise Ration Often abbreviated PSNR is used to measure the quality of reconstruction of noise. It is a term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale [5]. The PSNR (in dB) is defined as:

$$PSNR = 20 \cdot \log_{10}\left(MAX_I\right) - 10 \cdot \log_{10}\left(MSE\right) \qquad [5]$$

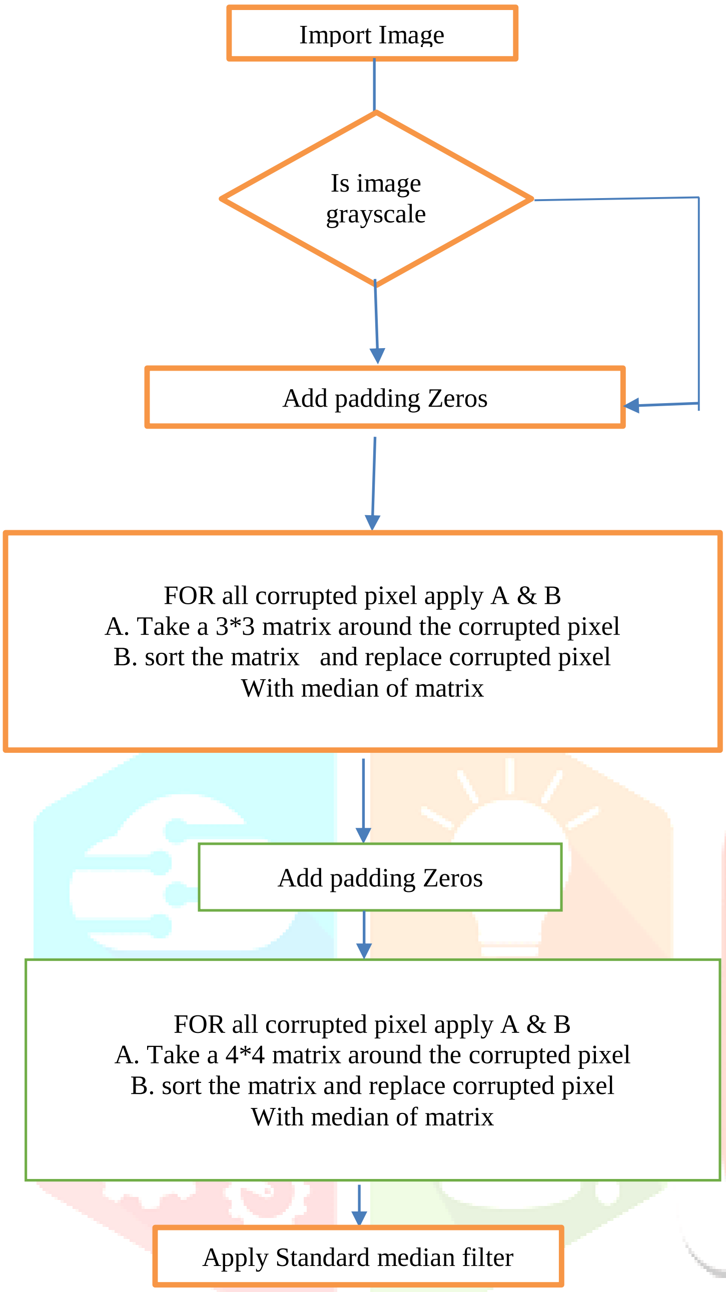
PSNR is most easily defined via the mean squared error (MSE). Given a noise-free m×n monochrome image I and its noisy approximation K, MSE is defined as:

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2 \qquad [6]$$

Where I and K being the original image and de-noised image respectively.

II PROPOSED METHODOLOGY

A new algorithm (DOUBLE 2-D BASED MEDIAN FILTER) is explained above with the help of flow chart, in this method we are going to apply 2D median filter and then output image Matrix is again passed through 2D median filtering with the enhanced matrix size so that first output result can be again improved. After applying these 2 steps, we are going to apply standard median filter. After this last step, final image is generated that is gone through comparisons with already existing image de-noising methods. PSNR values comparisons are mentioned in results and simulation field.



The proposed method processes the image with greater noise density as follows:

Step-1 we are adding padding with zero across the matrix of image.
Step-2 Take 3*3 matrix for each pixel.
Step-3 sort the matrix in non-decreasing order.
Step-4 replace the pixel value with new median value of matrix.
Step-5 again add padding with zero value.
Step-6 Take 4*4 matrix for each pixel.
Step-7 sort the matrix in non-decreasing order.
Step-8 replace the pixel value with new median value of matrix.
Step-9 Apply Standard median filter.

III. SIMULATION RESULTS AND DISCUSSIONS

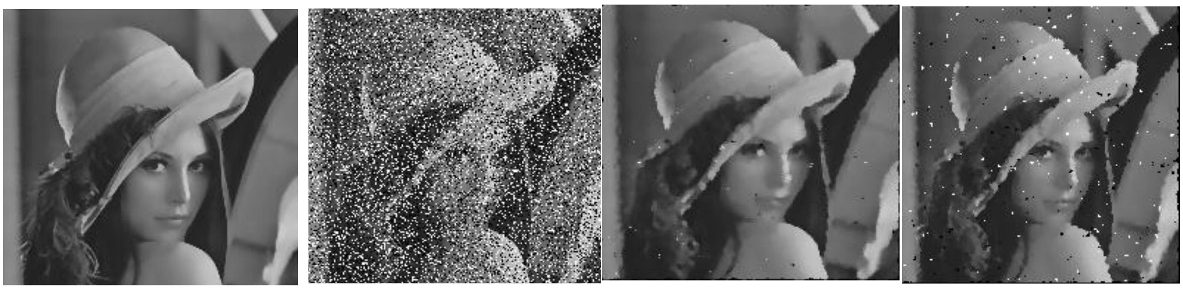
Proposed method is applied on to images Lena and cat image and other method (above mentioned) are also applied. A comparison Table 1 illustrate the result in terms PSNR values for Lena image and Table 2 shows the result for Cat images in terms of PSNR value. Graph 1 and Graph 2 shows the result in terms of PSNR and MSE at different noise level. The noise densities from 5% to 50% are added to the images and their MSE and PSNR are calculated. The MSE and PSNR are calculated from Equations 1 and 2 respectively. It is to be noted that greater the value of PSNR and lower the value of MSE, the filtering technique is better.

Table 1. PSNR values for Lena Image at different noise densities

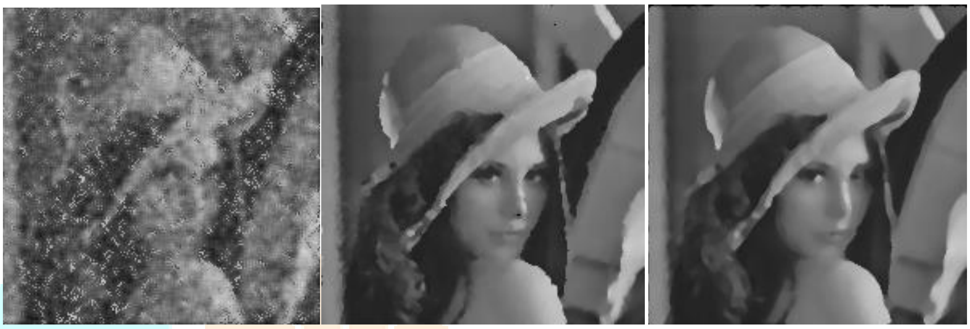
Noise Density	Proposed method	Median filter	Central weighted MF	2D median filter	Adaptive median filter
5	75.18	17.87	66.12	71.03	71.85
10	74.73	15.05	63.33	70.93	70.49
20	74.24	12.14	60.48	70.35	68.66
30	73.34	10.47	58.75	68.39	67.03
40	72.81	9.29	57.45	65.7	66.03
50	70.8	8.37	56.64	62.82	65.04

Table 2. PSNR values for Cat Image at different noise densities

Noise Density	Proposed method	Median filter	Central weighted MF	2D median filter	Adaptive median filter
5	73	17.55	65.93	72.35	70.88
10	72.8	14.95	63.17	72.25	69.59
20	72.75	11.97	60.28	71.48	67.81
30	72.67	10.28	58.5	69.29	66.51
40	72.34	9.09	57.31	65.98	65.21
50	71.38	8.18	56.4	62.77	64.12



(A) (B) (C) (D)



(E) **(F)** **(G)**

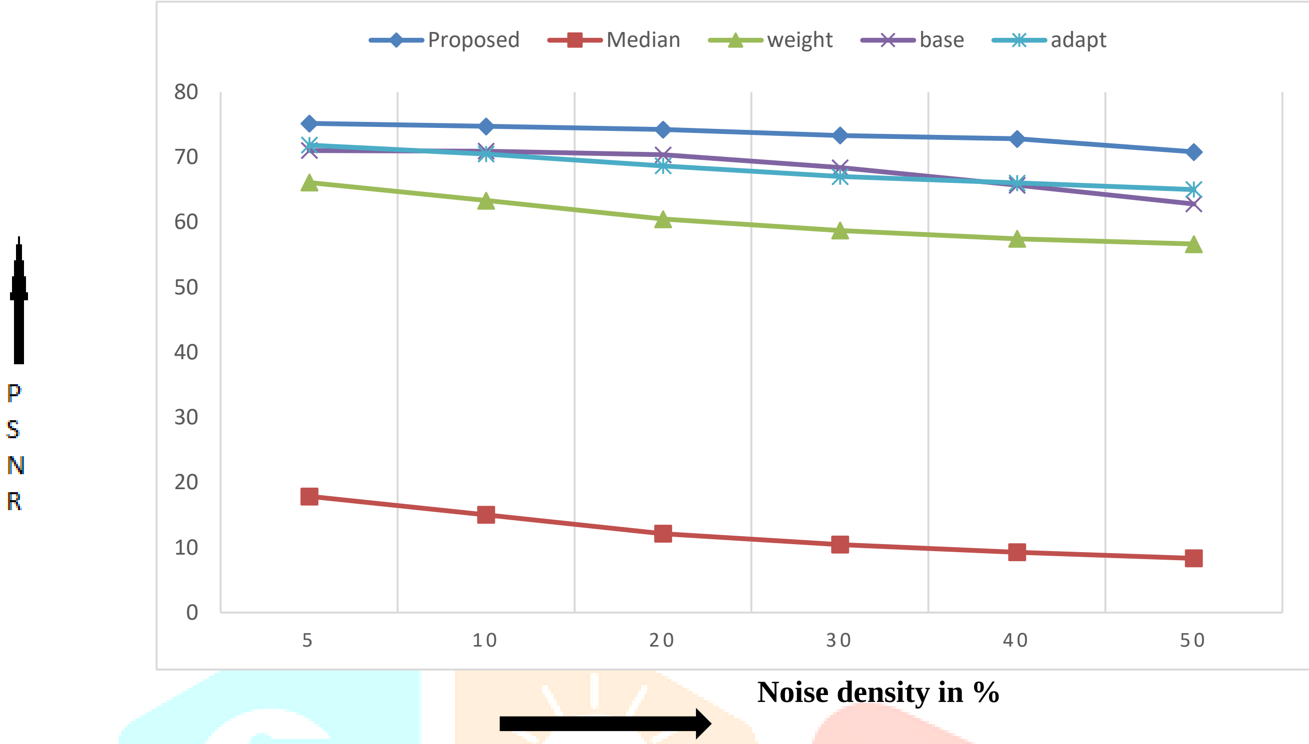
Figure 1. Simulation Results for Lena Image at 30% noise density (A) Original Image, (B) Noisy Image, (C) Standard Median Filtering, (D) 2D median filter (E) Adaptive median filter (F) Central weighted MF, (G) Proposed method

(A) **(B)** **(C)** **(D)**

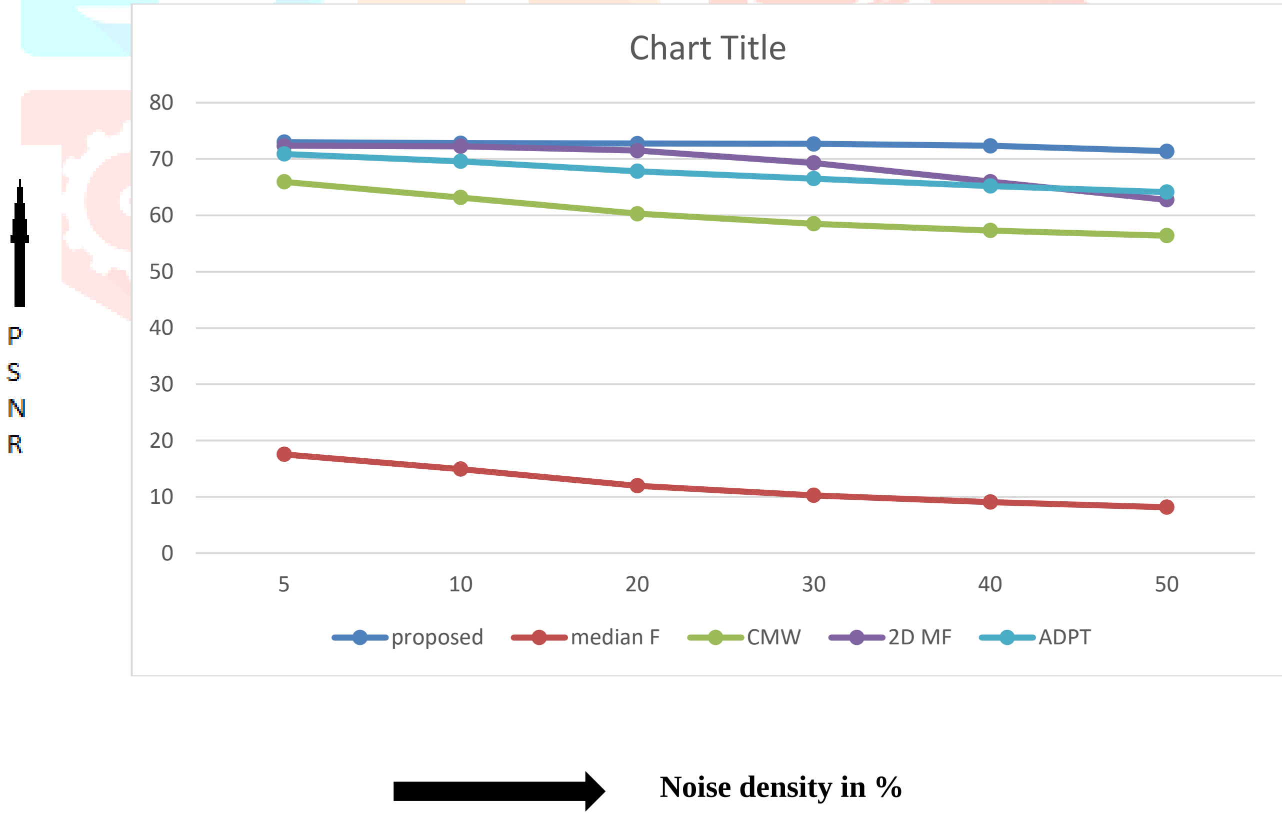
(E) **(F)** **(G)**

Figure 2. Simulation Results for cat Image at 30% noise density (A) Original Image, (B) Noisy Image, (C)Standard Median Filtering, (D) 2D median filter (E) Adaptive median filter (F) Central weighted MF, G) Proposed method

Graph 1. PSNR values for Lena Image at different noise density



Graph 2. PSNR values for Cat Image at different noise density



III CONCLUSION

Various techniques of image denoising are in discussions and have been discussed. A new more efficient Technique which generates much better results than the discussed algorithms is proposed here. The results portrayed above gives a clear view that the proposed method performs better than all of them in the fields of image Denoising of impulsive noise based on PSNR and visual clarity. For images with a very high density of noise, double 2D based median filtering can give us a better visualization of the image and better values of PSNR than all other discussed filtering.

REFERENCES

[1] Digital Image Processing by S.Sridhar, Second Edition ,Oxford University Press.

[2] A.Srinagesh, BRLKDheeraj, Dr.G.P.Saradhi Varma, "A New Method for Removal of Salt and Pepper Noise through Advanced Decision Based Unsymmetric Median Filter" International Journal of Computer Science and Information Technologies, Vol. 5 (6), 2014, 7130-7135

[3] S. Esakkirajan, T. Veerakumar, Adabala N. Subramanyam, and C. H. PremChand "Removal of High Density Salt and Pepper Noise through Modified Decision Based Unsymmetric Trimmed Median Filter" , IEEE Signal Processing Letters, Vol. 18, No. 5, May 2011.

[4] T. Chen, K. K. Ma, L.H. Chen, "Tri-State Median Filter for Image Denoising", IEEE Transactions on Image Processing, vol. 8, Issue 12, pp 1834-1838, 1999.

[5]. N.Rajesh Kumar, J.Uday Kumar "A Spatial Mean and Median Filter For Noise Removal in Digital Images "International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering(IJAREEIE) Vol. 4, Issue 1, January 2015

[6]. Suman Shresth "Image Denoising Using New Adaptive Based Median Filter" Signal & Image Processing: An International Journal (SIPIJ) Vol.5, No.4, August 2014

[7] Guangyong Chen1, Fengyuan Zhu1, and Pheng Ann Heng1"An Efficient Statistical Method for Image Noise Level Estimation", Chinese Academy of Sciences,2013.

[8].I. Pitas and A. N. Venetsanopoulos, "Nonlinear Digital Filters: Principles and Applications", Boston, MA: Kluwer, 1990.