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Analysis of Image Noise Reduction Using Neural Network

Abstract Noise adding methods (impulse and Gaussian) are using in this work, adding this type of noise employ to mensuration the image quality as result, therefore transform of (RGB) colors to another type of color impersonation that easy to deal with it, also sensitivity of human eyes to detect the colors. Applying Noise reduction (mean method, mode method, median method) ,By using a test image, we demonstrate that the filtering structure yields an output image which is significantly better than those of median, weighted median .The program of this work is written with Delphi Language, which have some flexibility to deal with image that's not found in other language. The great feature of this language and the ability to process the image in memory (so the processing will be faster and easier), easy to access the parameters through the subroutines (however the size of it), showing the stored images that in memory to the displayer through one instruction.

Keywords: *Noise Reduction, Gaussian Noise, Signal to Noise Raito, Noise adding Algorithms, noisy image*

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1. Introduction

Images are predominating low through many noises. Noise may be happen and gained at taking image, and many other factor. Noise reductions are useful functions in image processing. Broadly the quality of image processing are very affective during results of the noise removal have a strong influence on the quality of the image processing [1]. At this work use 2-D function of f(x, y) adding as a new input image, where x and y are best image coordinate, and the amplitude of the two- dimensions represented by (f) functions at any pair of coordinates (x, y) which is called the gray level of the image at the exact selected point where the image noise reduction technology reduces radiation [2,3]. However this paper study about the image smoothing for noise reduction for color images, starting with the noise adding, then traditional methods for noise reduction, a proposed method are approached using a neural network with multiple filters mask, and quality measure to know the efficiency for each method. This paper study about the image smoothing for noise reduction for color images, starting with the noise adding, then traditional methods for noise reduction, a proposed method are approached using a neural network with multiple filters mask, and quality measure to know the efficiency for each method.

2. Theoretical Background

I. Digital Image Processing

We can explain digital image processing base by depending on computer algorithms which used to make image processing on digital images. The term *spatial domain* leads to the needed pixel unit which makes an image in addition to that spatial domain means instructions used directly on these pixels and its operations will be known by this term.

$$G(x,y) = T[f(x,y)] \quad (1)$$

The input image to process in Figure explain f(x,y) and the processed image is g(x,y) and T is an operator on f, `defined over some neighborhood of (x, y) In addition, T can operate on a set of input images, such as performing the pixel-by-pixel and the principal approach in defining a neighborhood about a point (x, y) is to use a square or rectangular sub image area centered at (x, y) [[4], shown in Figure 1.

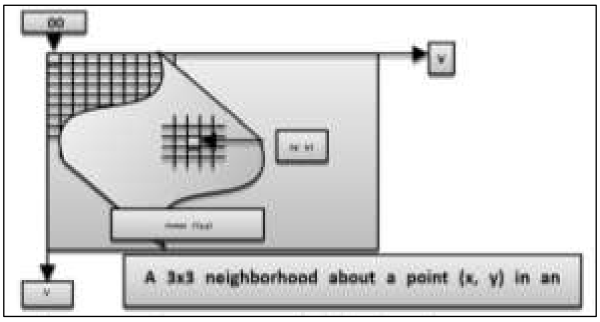

Figure 1: A point (3, 3) neighborhoods

This operation uses only the pixels in the area of the image expanded by the neighborhood in spite of other neighborhood shapes , precisely a circle

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sometimes are used square and rectangular arrays which is more popular because of their ease of implementation and the simplest form where T is when the neighborhood is of size 1x1 (that is, a single pixel) In this case, g depends only on the value of f at (x, y), and T becomes a gray-level in transformation function of the form [5]:

$$s = T(r) \quad (2)$$

Where, for simplicity in notation, r and s are variables denoting, respectively, the gray level of f(x, y) and g(x, y) at any point (x, y) for example, if T(r) has the form shown in Fig.2 (a, b) Gray level transformation functions for contrast enhancement when the results Describes and explains Gray level transformation functions [6].

II. Type of Noise

In Image processing, noise may be considered randomly as meaningless data; which is adding to the image but offered as an unwanted data cause of product of other activities. Though, noise remained to be data in image. Thus, loud activity may be referred to as noisy [1, 4].

1) Adaptive Gaussian Noise.
2) Adaptive Salt and Pepper Noise.
3) Adaptive Speckle Noise.
4) Adaptive Impulse noise.

III. Neural Network

A neural network consists of a group of processing units, whereas one subdivision makes its independents computations and transfers them to a second one [7].
Each subdivision may organize its independent computations and transfer its results to another subdivision. At last, subdivision of one or more processing units specifies the output from the network [8].
Between the (inputs and outputs) layer see the additional layer in Figure 3 called hidden layers and the process units considered as wilts which is like the neurons in human brain, so they called cells, neuromas, or artificial neurons. Figure 3 is a typical neural network and the level of layer from input to hidden as process and state the result in the output. The circular nodes represent neurons [9].
The neural network learning of selecting weighting values is clone so that a network performs well-defined tasks, translating input values to output values, is called training. There are three kinds of Neural Network to topography: feed forward, feedback and self-organizing feature map. Back propagation model is common in feedback network. To achieve training, is necessary with back propagation of error, in the current neural network field. With input signals applied and arbitrary initial weight settings, the resulting output signals are compared with the desired output signals for that relationship. The error between them is measured and used to adjust automatically the weight setting so that mean squared error function is minimized [7], as shown in Figure 4.

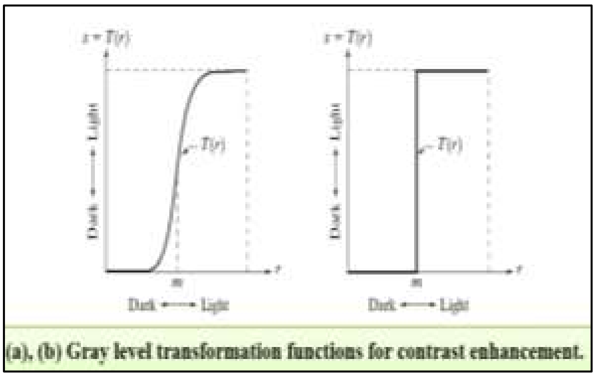


Figure 2: Gray level transformation functions

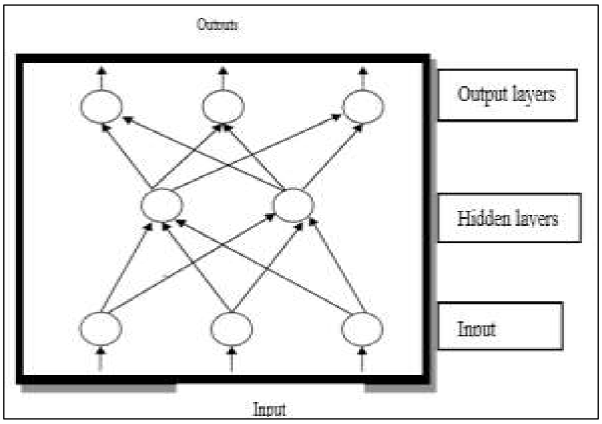
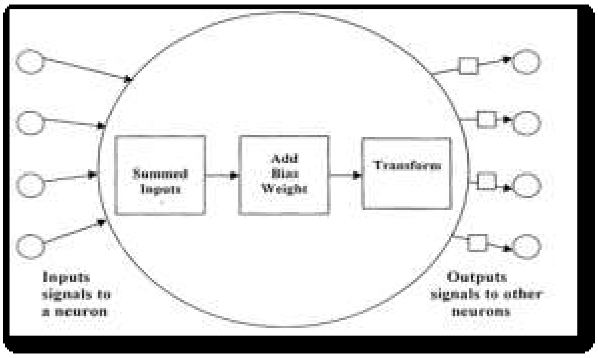


Figure 3: Typical Neural Network

3. The Proposed Method for Image Enhancement

There are many different methods to process the images to lessen noise in the noisy selected image and different noise type appearing on the images. In this work a modified method for noise removal has been introduced, one of the AI techniques, Neural Networks, is suggested in this work to build a basic tool for noise removal. The idea behind this tool is to depend on the good part of each noisy image to remove the noise which may be found on its neighbors. One of the most important steps is to determine which part or group of pixels can be classified as a good reference and how it can be done. The important step of this work tries to classify the image into good part and noisy part by taking a threshold for all pixels that have a large difference between its neighbors. This work uses a BMP image as

Input image (it will be an original image) and applies different algorithms to it. These algorithms include noise adding, noise reduction,



and then compute the quality of the result imageafter reductions of the noise by comparing the image with the original image [7,10].

Figure 4: Processing steps inside a neuron

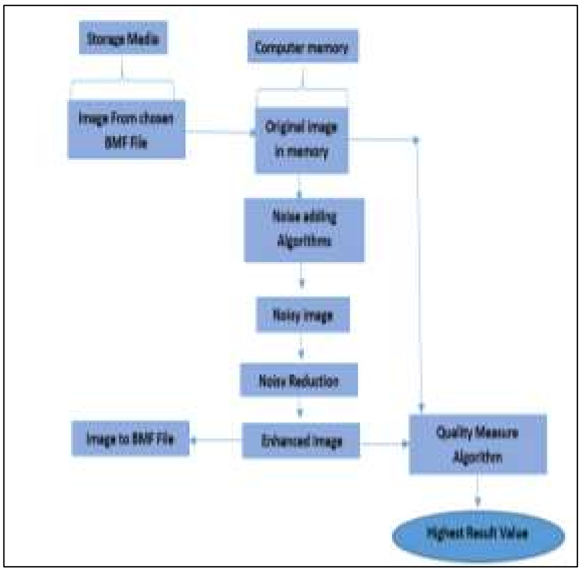
So, these algorithms can be classified into three different levels:

1) Noise Adding: with typical kinds of noise.
2) Noise Reduction: using the proposed methods and other traditional methods.
3) Quality Measure: using signal to ratio to compare the results.

Therefore Figure 5 show the diagram:

I. Noise Adding

Since the image taken from BMP file, it should be stored in memory, and another image is created after processing or applying different algorithms. This image is two dimensional colored images which has a different width and length pixel depending on BMP file [11].
Noise adding is process to the input image to get a noisy image as a result; the translation from the input image to the output image is pixel by pixel method, and the noise adding to the pixel through this translation (Figure 6) [12].



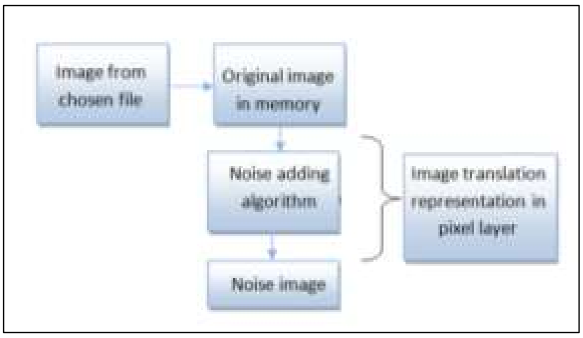


Figure 5: System work diagram
Figure 6: General Noise adding diagram

II. Noise Reduction

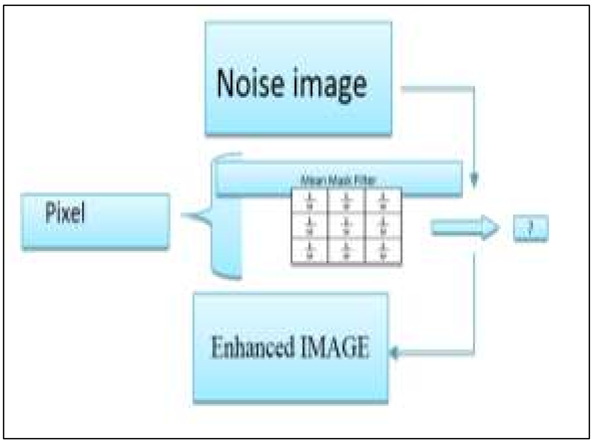
In this work all color images will be converted to mono image. That takes the summation of 0.587 of GREEN, 0.299 of RED, and 0.114 of BLUE. By this kind of conversion all color and mono images are processed in the same way. So it's like human eye detection the colors, the human eye can recognize the green color in the image better than the red color and it can recognize the red color better than the blue color [13].

1. The Mean method

The candidate is considered a spatial linear average of the object pixels next to the canal act, be the point of wearing the filters are clear, although the replacement value of each pixel in the image to the level of gray that is determined by a channel filter and process the image with less transmission in the level of gray [1, 5] as shown in Figure 7**.**

2. The Mode Method

This method replaces the noisy pixel with the high frequency of noisy pixel neighbors, and the neighbors depend on the sub window that was taken. If the sub window is 3x3 sizes, then the neighbors will be 8pixels, and the most similar pixel is selected to replace the middle pixel [1, 5] (Figure 8).



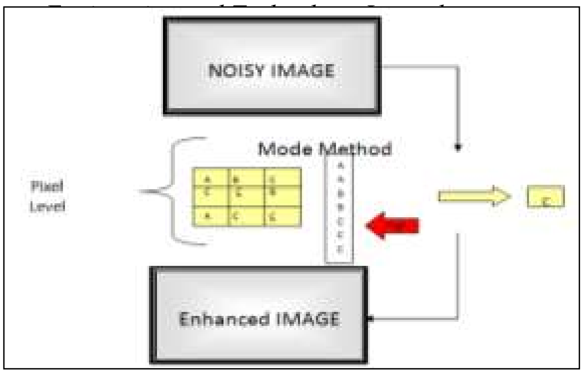
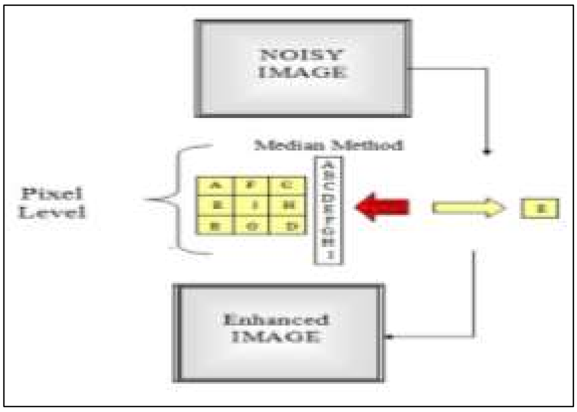


Figure 8: Noise Reduction mode method Diagram

Figure 9: Noise Reduction median method Diagram

3. The Median Method

This method replaces the noisy pixel with the middle pixel of neighbors after sorting them. And the neighbors depend on the sub window that is taken. If the sub window is 3x3 sizes, then the neighbors will be 8 pixels, and the 8 pixels are sorted as ascending or descending, then the middle pixel of this list is taken to replace the noisy pixel [1, 5], as shown in Figure 9**.**



III. The Proposed Method

In this work this is the suggested method to reduce (Impulse and Gaussian) of noisy image.

This method has 3 basic steps to do the redundancy

1. Detecting the noise: Since the good part of image is separated from (noisy) part of the image only; and a bitmap of this detection is made. This step depends on thresholding for this detection.

2. Applying multiple mask filters: Multiple 3x3 mask filters are used to solve many noise cases in 3x3 boxes. 30 different kinds of masks approach are used in this work.

3.Using the Neural network to reduce the noise: Since there are many solutions after approaching multiple mask filter, and one of the results of these masks is closer to the origin, therefore the Neural3.network is the helper to choose the best mask of that masks.

Figure 7: Mean Method Diagram

IV. Data Flow Diagram

Figure 10. The proposed method diagram

The diagram of the proposed methods can be drawn [14], as shown in the Figure 10:

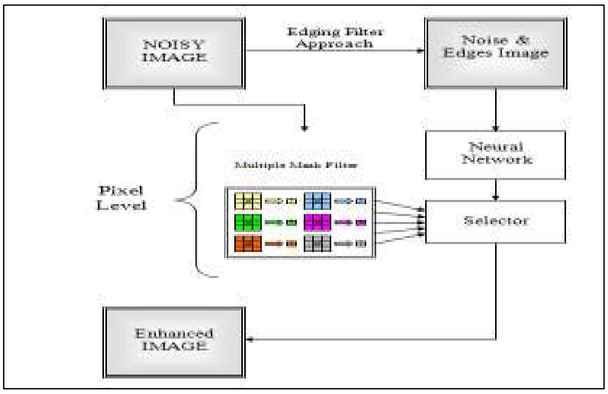


Figure 10: The proposed method diagram

4-Experiential Result

I. Quality measure

Quality is measured in this work by using SNR (Signal to Noise Raito), i.e. by comparing the Original Input Image with the Output Image after processing, from this Comparison a digital value can be obtained [15,16]. For each method of noise redundancy there is a SNR value to compare between the different kinds of them.

$$SNR = 10\log_{10}\left(\frac{\sigma^2}{e_{rms}^2}\right)$$
(3)

$$e_{rms}^2 = \frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{N}[f(i,j) - g(i,j)]^2$$
(4)

Threshold (Histogram shape) for detective proper threshold is to detective both of the modes (lower & upper) between them. However this method very easy [17], major problem with it: Histogram can be noisy, that because many local lower & upper. To get around this, the histogram smoothed before trying to find separate modes, in this work find the threshold value by using histogram shape.

II. The result and analysis

The program interface consist of three forms, first for the imaging operation, one for image analysis, and last one for testing SNR for the Neural network method.

The first form consists of:

1. Three Images (one for the Input Image, one for Process Image, and one for the Output Image)

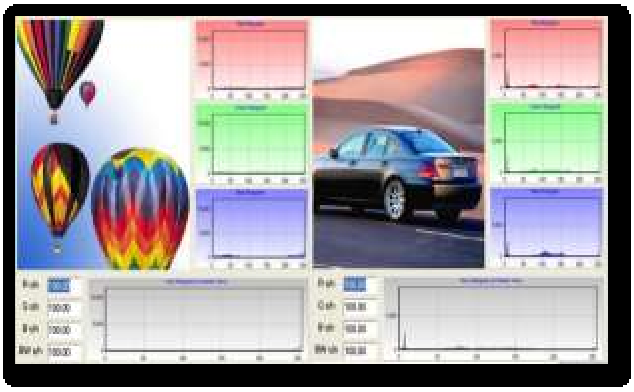


Figure 11: Image Analysis

2. Four fields, each field have many bottoms, each one have a function to do.
3. Additional bottoms for testing and exit from the program.
4. Some information about the image and gauge showing process rate.

Taken 2 different color images with in (128x128) size to approach noise adding and noise reduction methods. These images will be analyst to its Histogram. As shown in Figure 11 image analysis Shown:

A.BALLOON.BMP Testing

An Original Image for BALLOON.BMP (Figure 12). Applying Impulse Noise adding algorithm on the original image in Figure 12, and stop noise adding until SNR=5.52 for Gray-Level to get a Noisy Image (Figure 13) applying Mean Filter on the Noisy Image (Figure 13) to get an enhanced Image as shown in (Figure 14) with SNR=8.40 for Gray-Level .Applying Mode Method Algorithm on the Noisy Image in Figure 13 to get an Enhancement Image as shown in Figure 15 with SNR=4.14 for Gray-Level. Applying Median Method Algorithm on the Noisy Image in (Figure 13) to get an Enhancement Image (Figure 16) with SNR=14.15 for Gray-Level. Applying Input Compare on the Noisy Image in (Figure 13) to get the maximum Enhancement for the Image using Multiple Filter Masks and Traditional Enhancement Methods as shown in (Figure 17) which SNR=57.72 for Gray-Level. Applying Edge Test Algorithm on the Noisy Image in (Figure 13) to get the best threshold value for enhancement with the Proposed Method (Figure 18) Applying by Proposed Method Algorithm on the Noisy Image in Figure 13 to get an Enhancement (Figure 19) with SNR=14.23 for Gray-Level. Applying Gaussian Noise adding algorithm on the original image in Figure 19, and stop noise adding until SNR=7.27 for Gray-Level to get a Noisy Image as shown in Figure 20. Applying Mean Filter on the Noisy Image in Figure 20 to get an Enhancement Image as shown in Figure 21 with SNR=9.20 for Gray-Level. Applying Mode Method Algorithm on the Noisy Image in Figure 20 to get an Enhancement Image as shown in Figure 22 with SNR=3.01 for Gray-Level. Applying Median Method Algorithm on the Noisy Image in Figure 20 to get an Enhancement Image as shown in Figure 23 with SNR=10.75 for Gray-Level. Applying Edge Test Algorithm on the Noisy Image in Figure 20 to get the best threshold value for enhancement with the Proposed Method as shown in Figure 24, and the threshold value 33 is chosen. Applying the Proposed Method Algorithm on the Noisy Image in Figure 20 to get an Enhancement Image as shown in Figure 25 with SNR=9.81 for Gray-Level. Applying Edge Test Algorithm once again as feed backing on the first Enhanced Image with proposed method in Figure 25 to get the best threshold value for enhancement with the Proposed Method as shown in Figure 26, and the threshold value 15 is chosen. Applying the Proposed Method Algorithm once again as feed backing on the first Enhanced Image with proposed method in Figure 25 to get an Enhancement Image as shown in Figure 27 with SNR=9.96 for Gray-Level. With these results, the table 1 can be built as:

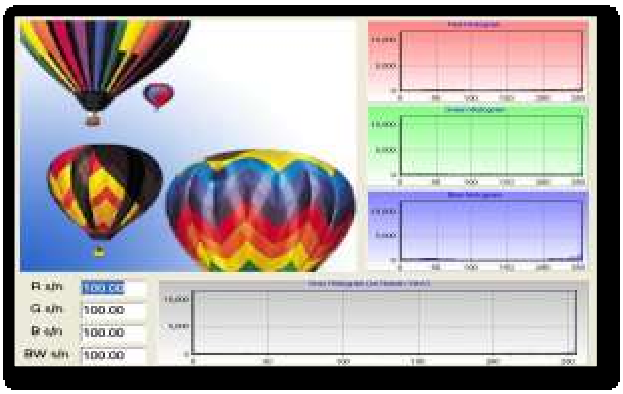


Figure 12: Balloon.bmp Original Image

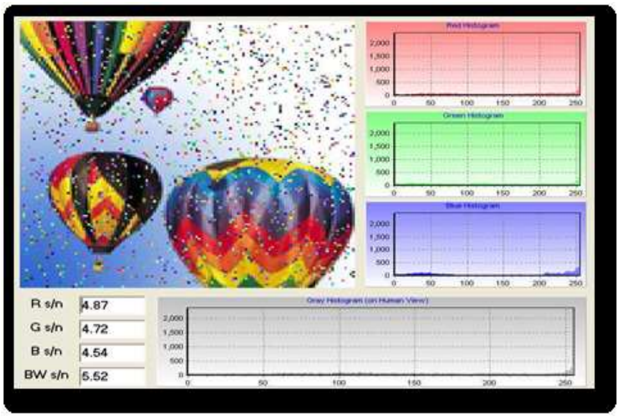


Figure 13: Impulse Noise adding

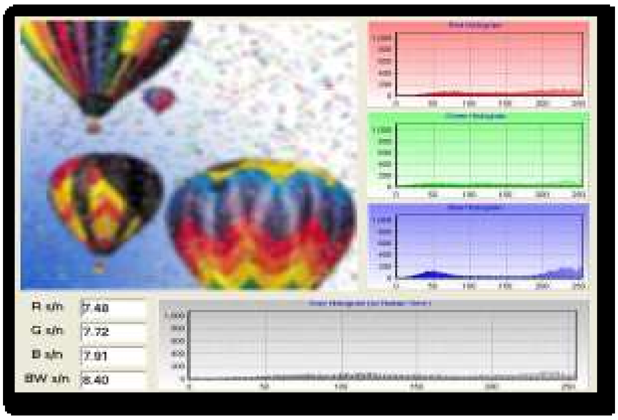


Figure 14: Mean Method (noise reduction)

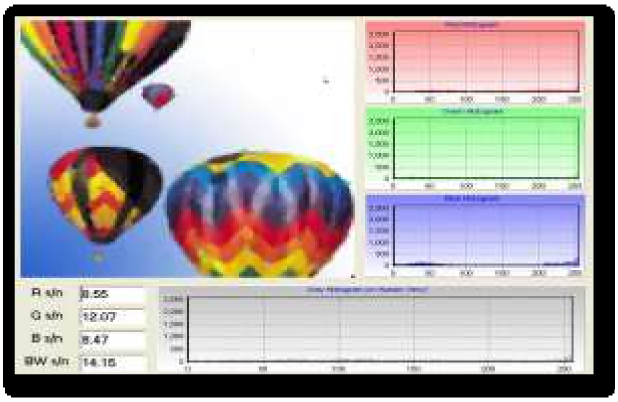


Figure 15: Mode Method (noise reduction)

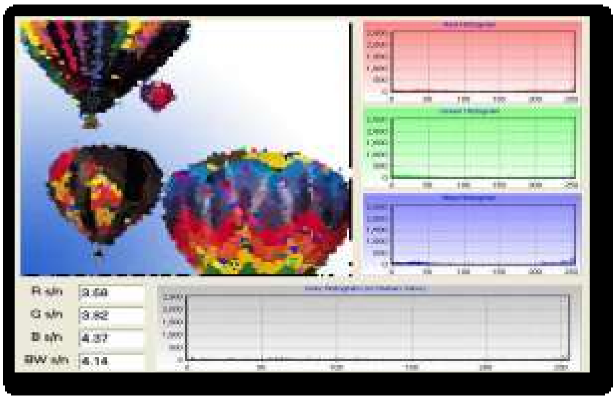


Figure 16: Median Method (noise reduction)

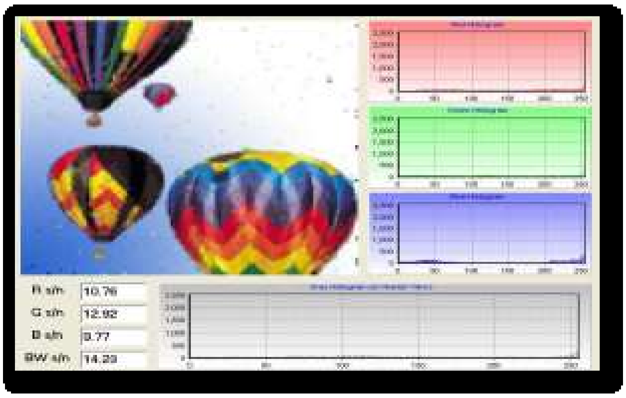


Figure 17: NSR over Threshold value

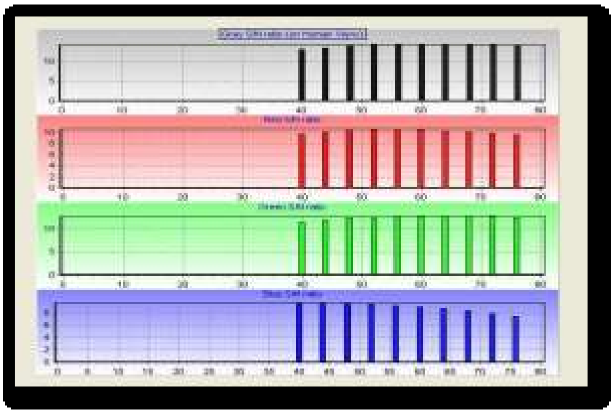


Figure 18: Proposed Method with threshold value 60

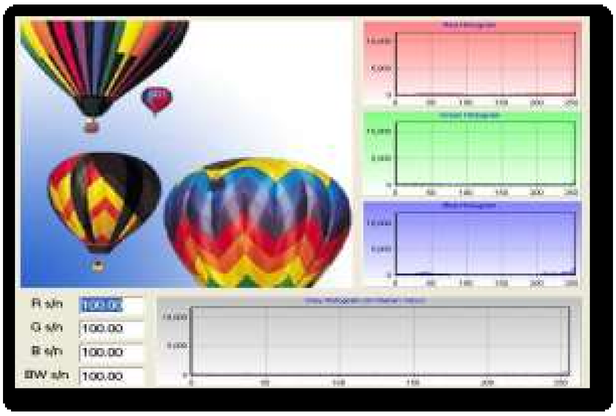


Figure 19: Original Image

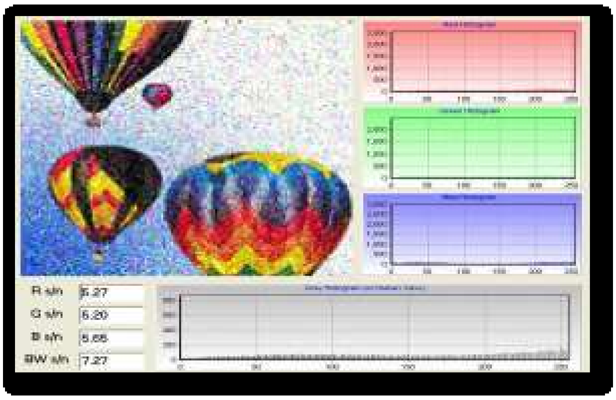


Figure 20: Gaussian Noise adding

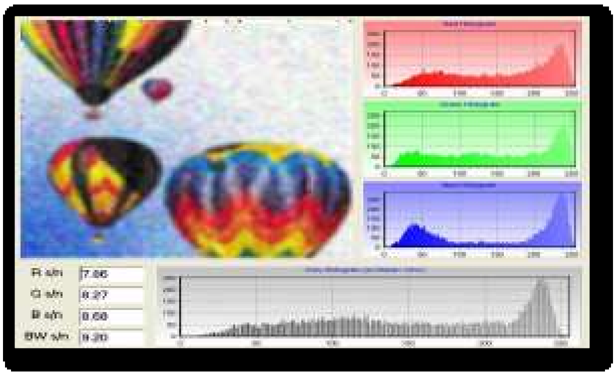


Figure 21: Mean Method (noise reduction)

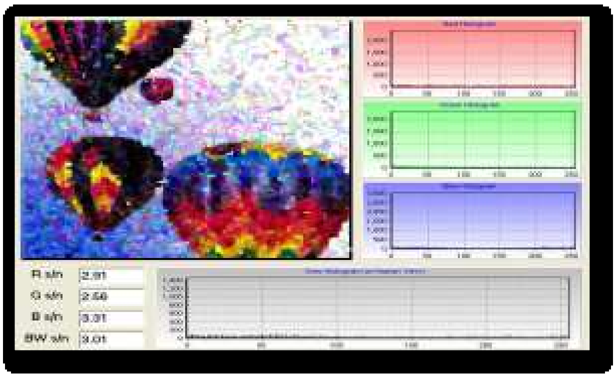


Figure 22: Mode Method (noise reduction)

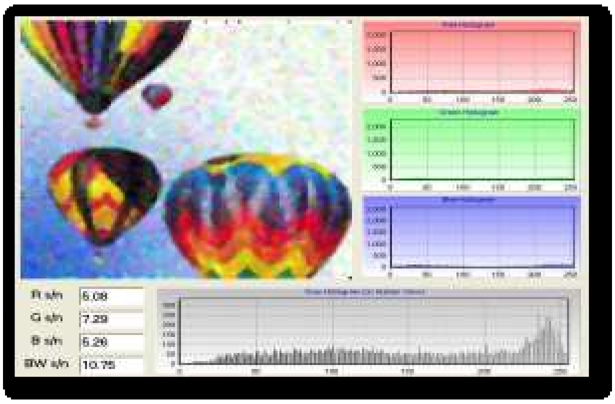


Figure 23: Median Method (noise reduction)

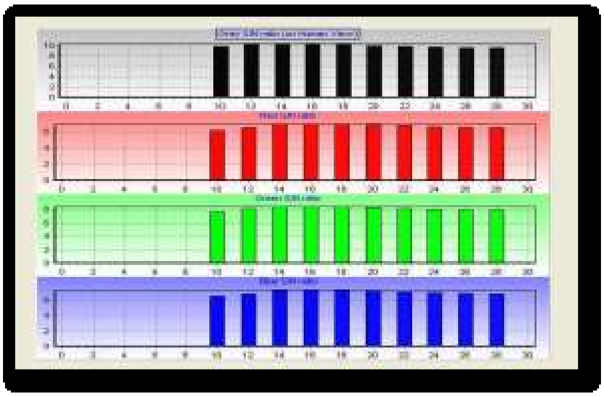


Figure 24: NSR over Threshold value

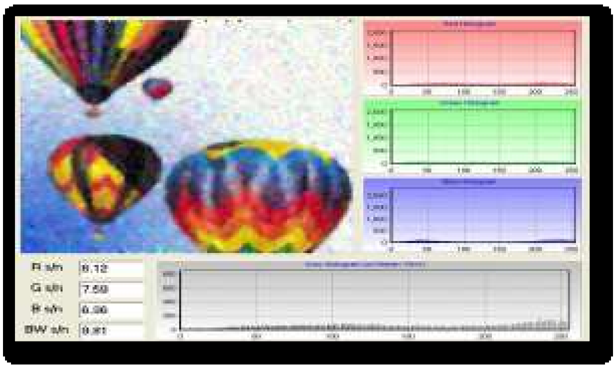


Figure 25: Proposed Method with threshold = 33

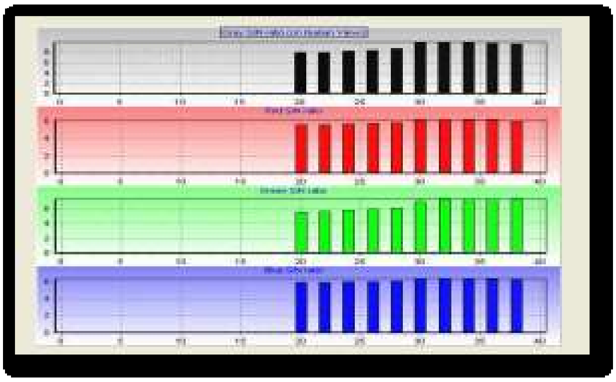


Figure 26: NSR over Threshold value

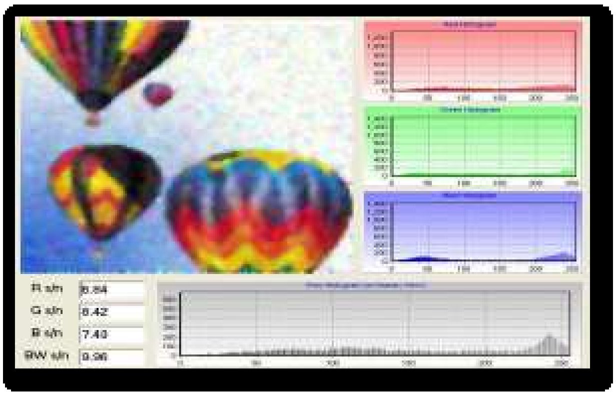


Figure 27: Balloon.bmp Proposed Method with threshold = 15

b.The image of CAR.BMP Testing

An Original Image (Figure 28). Applying Impulse Noise adding algorithm on the original image Figure 28, and stop noise adding until SNR=5.15 for Gray-Level to get a Noisy Image (Figure 29). Applying Mean Filter on the Noisy Image Figure 29 to get an Enhancement Image (Figure 30) with SNR=7.46 for Gray-Level. Applying Mode Method Algorithm on the Noisy Image (Figure 29) to get an Enhancement Image (Figure 31) with SNR=4.21 for Gray-Level. Applying Median Method Algorithm on the Noisy Image in Figure 29 to get an Enhancement Image (Figure 32) with SNR=11.31 for Gray-Level .Applying edge test algorithm on the noisy image (Figure 29) to get the best threshold value for enhancement with the proposed method

(Figure. 33) Applying Proposed method algorithm on the noisy image in Figure 30 to get an Enhancement Image (Figure 34).

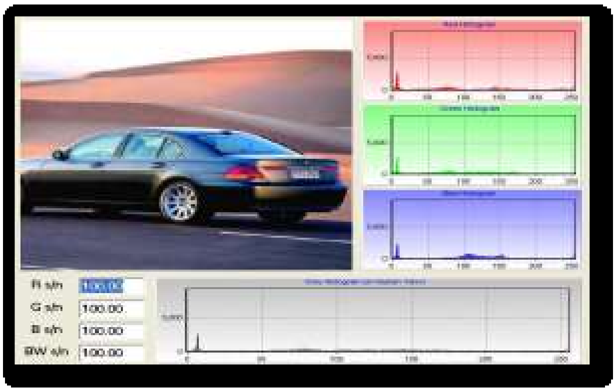


Figure 28: Car.bmp Original Image

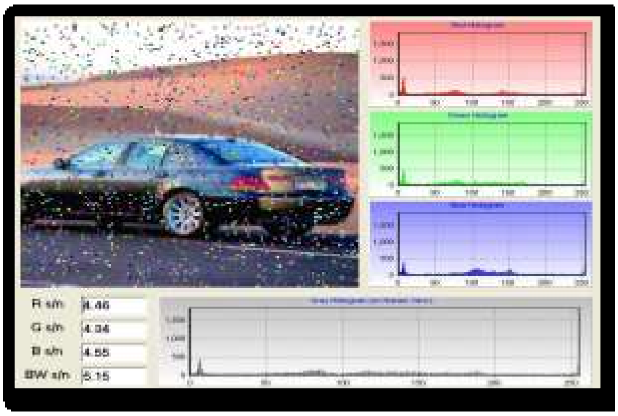


Figure 29: Impulse Noise adding

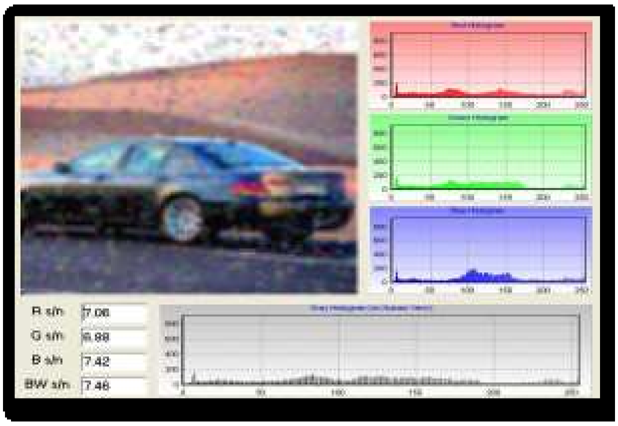


Figure 30: Mean Method (noise reduction)

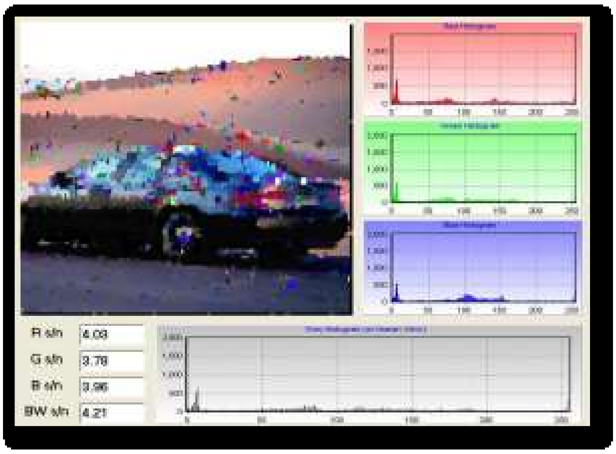


Figure 31: Mode Method (noise reduction)

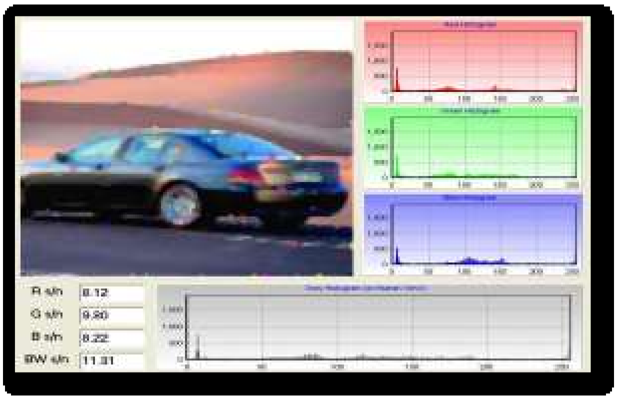


Figure 32: Median Method (noise reduction)

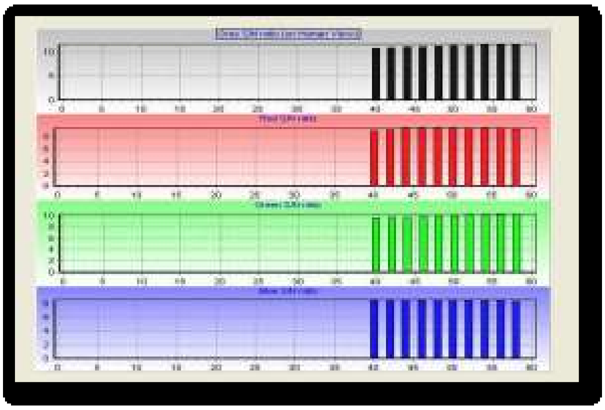


Figure 33: NSR over Threshold value

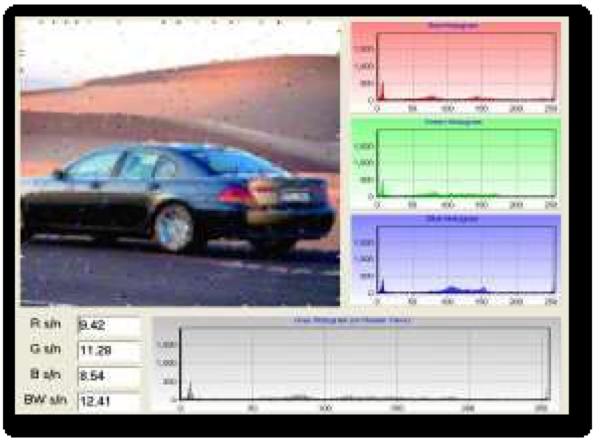


Figure 34: Proposed Method with threshold = 55

Original Image (Figure 35) ,Applying Gaussian Noise adding algorithm on the Figure 35, and stop noise adding until SNR=6.34 for Gray-Level to get a Noisy Image as shown in Figure 36.,Applying Mean Filter on the Noisy Image in Figure 35 to get an Enhancement Image as shown in Figure 36 with SNR=7.85 for Gray-Level. , Applying Mode Method Algorithm on the Noisy Image in Figure 35 to get an Enhancement Image as shown in Figure 37 with SNR=3.01 for Gray-Level. Applying Median Method Algorithm on the Noisy Image in Figure 35 to get an Enhancement Image as shown in Figure 38 with SNR=8.99 for Gray-Level, Applying Edge Test Algorithm on the Noisy Image in Figure 35 to get the best threshold value for enhancement with the Proposed Method can see in chart 39.Applying Proposed Method Algorithm on the Noisy Image in Figure 35 to get an Enhancement Image an see in chart 40 with SNR=8.48 for Gray-Level. , Applying Edge Test Algorithm once again as feed backing on the first Enhanced Image with proposed method in Figure 40 to get the best threshold value for enhancement with the Proposed Method can see in chart 41, Applying the Proposed Method Algorithm once again as feed backing on the first Enhanced Image with proposed method in Figure 40 to get an Enhancement Image can see in chart 42 with SNR=8.88 for Gray-Level. With these results, the table 2 can be builte as shown:

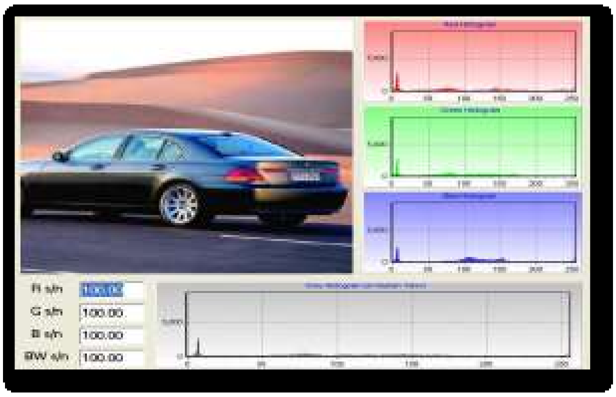


Figure 35: Original Image

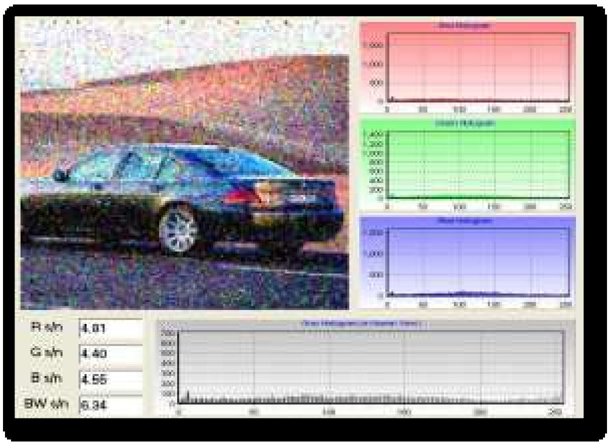


Figure 36: Impulse Noise adding

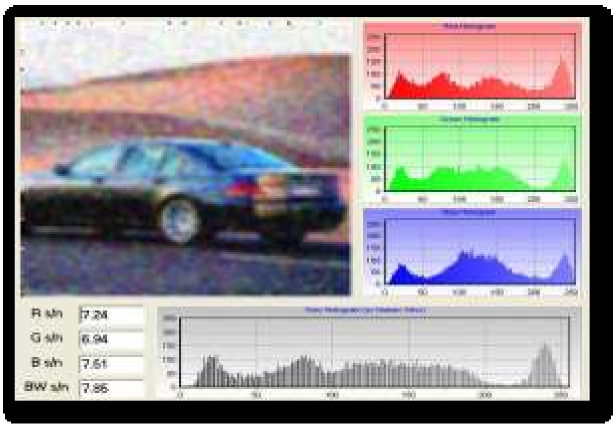


Figure 37: Mean Method (noise reduction)

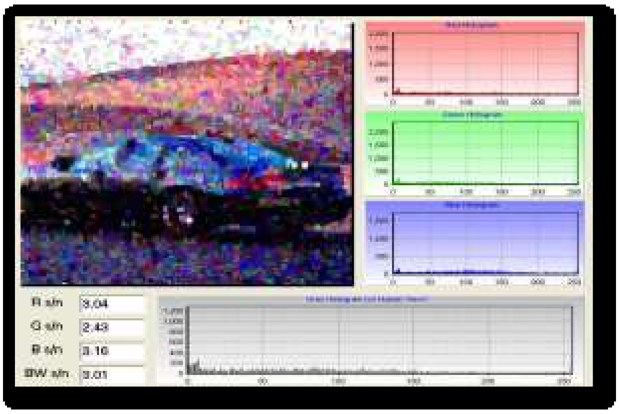


Figure 38: Mode Method (noise reduction)

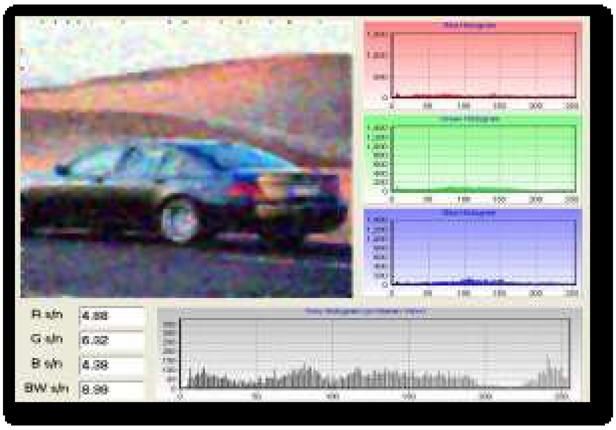


Figure 39: Median Method (noise reduction)

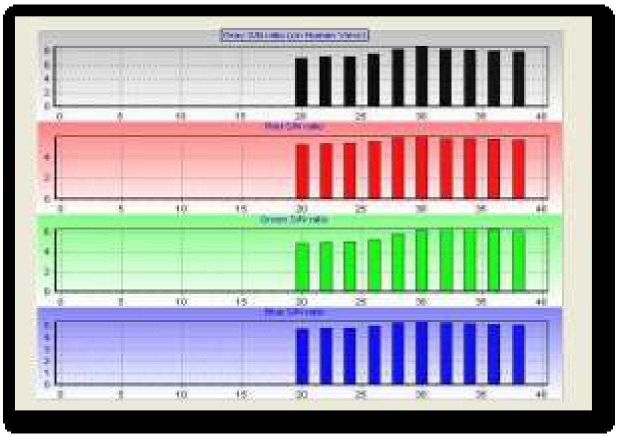


Figure 40: NSR over Threshold value

Figure 41: Proposed Method with threshold value 33

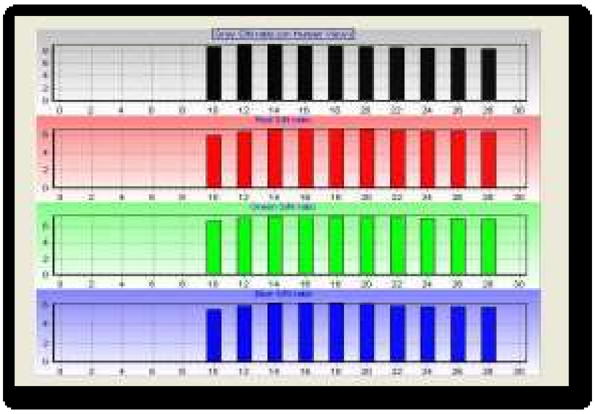


Figure 42: NSR over Threshold value

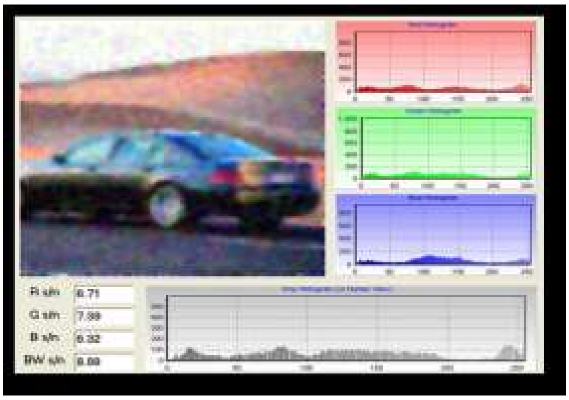


Figure 43: Proposed Method with threshold value 13

Figure 44: Input Image

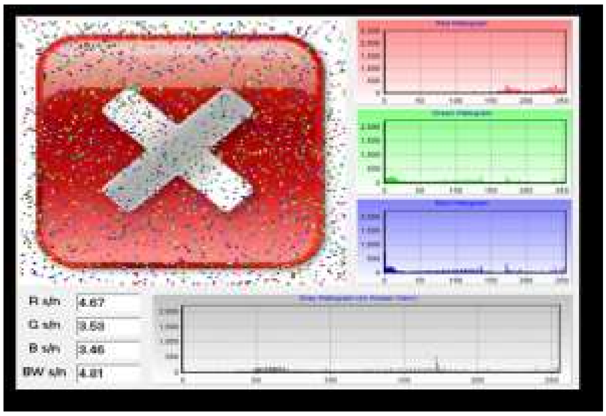


Figure 45: Image before Processing

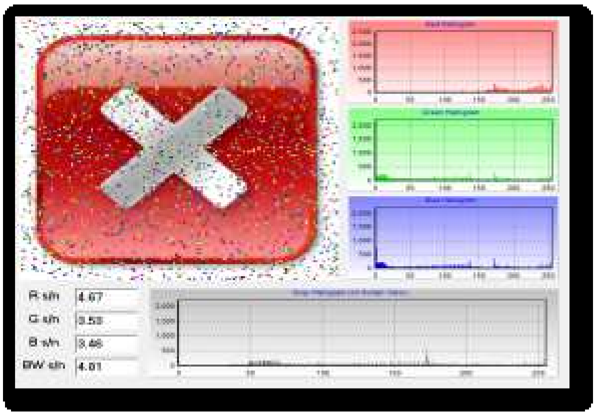


Figure 46: Output after Processing

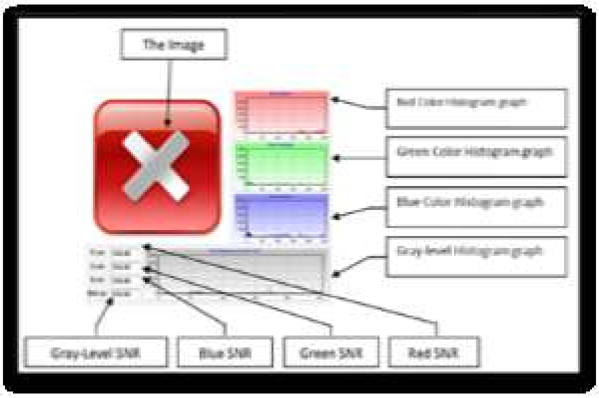


Figure 47: Image Information Form

c.Testing Results

From the previous tables and the rest of other Picture Files results, Table can be build according to those results, as shown in table 3:

Table 1: Noise reduction results

SNR/Image	Noise	Mean	Mode	Median	1st Threshold	1st Neural	2nd Threshold	2nd Neural
Balloon with Impulse Noise	5.52	8.4	4.14	14.15	60	14.23	-	-
Balloon with Gaussian Noise	7.27	9.2	3.01	10.75	33	9.81	15	9.96

SNR/Image	Noise	Mean	Mode	Median	1st Threshold	1st Neural	2nd Threshold	2nd Neural
CAR with Impulse Noise	5.15	7.46	4.21	11.31	55	12.41	-	-
CAR with Gaussian Noise	6.34	7.85	3.01	8.99	30	8.48	13	8.88

Table 2: Noise reduction results

Table 3: The picture file Noise

Impulse Noise								
SNR/Image	Noise	Mean	Mode	Median	1st Threshold	1st Neural	2nd Threshold	2nd Neural
CAR	5.15	7.46	4.21	11.31	55	12.41	-	-
Balloon	5.52	8.4	4.14	14.15	60	14.23	-	-
Gaussian Noise								
CAR	6.34	7.85	3.01	8.99	30	8.48	13	8.88
Balloon	7.27	9.2	3.01	10.75	33	9.81	15	9.96

3. *Conclusions*

From this paper many conclusions can be drawn:

1) Enhancement
2) Depends on threshold value, this value is very important to be chosen, and is effective on the result.
3) In feedback the threshold value should be less than previous value that was chosen.

If a part on an image was missing, the proposed method will try to recover this part, but it takes a many times of feed backing and a long time doe's recover.

4) The neural network depends on the eight pixel neighbors if the slide window is (3x3) and 24 neighbors if the slide window is (5x5).
5) Multiple masks are helpful to take most cases of noise in the slide window, so if this mask increases it gives a better recovery.

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