# IMAGE ENHANCEMENT USING A NON-LINEAR NOISE FILTERING

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**ABSTRACT**

*Two applications of great importance in the area of image processing are noise filtering and image enhancement. The aim of noise filtering is to eliminate noise and effects on the original image, while corrupting the image as little as possible. Poisson, Gaussian and Salt and Pepper noises exist in many practical applications and can be generated by various sources, including the number of man made phenomena, a noisy sensor. This system provides these three methods of noise. Use can test these noises and then implemented the two filtering methods of medium and bilateral filters. The medium filtering and bilateral filtering are in order to perform the noise filtering as well as to achieve the enhancement of the image.*

## 1. INTRODUCTION

Nowadays, image processing techniques have been developed together with the artificial intelligent techniques. Such systems include computerized document analysis, character recognition, pattern matching, machine vision, object finding, etc. Image pre-processing as well as image processing steps have to be carried out during the development of those systems.

Upon the pre-processed image, necessary AI techniques are carried out. The performance of the system is mainly concerned with the quality of the image. The system is failure for the degraded image. Various methods have been proposed to increase the accuracy of the image. Noise restriction as well as denoising methods have also been proposed. Nonlinear partial equations are used extensively for various image processing applications. That led to a large number of iterations required for convergence to the desired solution.

Digital image processing is a major important subject of today's world. Before certain image processing, character recognition, pattern matching, machine vision, is performed, it is often necessary to enhance the quality of the image to fit for such image processing methods. Therefore, image enhancement becomes a major image preprocessing stage.

Therefore, this system tries to develop an image enhancement system using non-linear noise filtering techniques. Such non-linear noise filtering techniques of this system contains medium filtering, bilateral filtering. And then, system will be displayed the bar chart the comparison of these two methods by using mean square error measure value.

## 2. FILTERING METHODS

This system used noise filtering is to eliminate noise and effects on the original image. The Median Filter is a cornerstone of modern image processing and it is used extensively in smoothing and de-noising applications [1].The median filtering considers each pixel in the image in turn and looks at its nearby neighbors.

And then, decide whether or not it is representative of its surroundings. It does not replace the pixel value with the mean of neighboring pixel values and replaces it with the median of those values. The median is calculated by first sorting all the pixel values from the neighborhood into numerical order and then replace the pixel being considered with the middle pixel value [2]. The average of the two middle pixel values is used the basic drawback of the median filter and is the blurring of the image in process. This filter is applied uniformly across an image modifying pixels that are not contaminated by noise.

The Bilateral Filter is a non-iterative means of smoothing images and retains edge detail. It involves a weighted convolution. The weight for each pixel depends not only on its distance from the center pixel but also its relative intensity [1].

## 2. OVERVIEW OF THE SYSTEM

The image to be tested is acquired by means of a digital imaging device, such as, a digital scanner or a digital camera. The acquired image is stored in the bitmap file format. This is a color image, in which, each pixel conveying different red, green and blue (RGB) intensities.

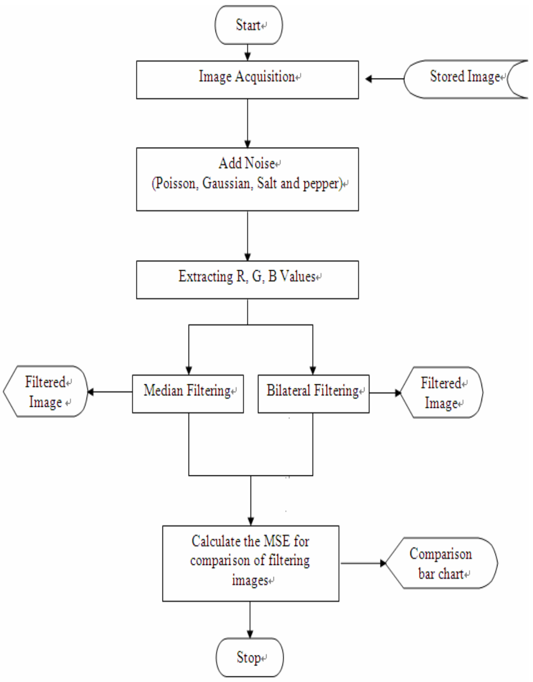


**Figure 1.** System block diagram representation

These RGB values are extracted individually in order to perform image enhancements. In this system, image enhancements are performed by non-linear noise filtering techniques. Such non-linear noise filtering techniques of this system contains medium filtering, bilateral filtering methods and so on. In this system used medium filtering and bilateral filtering methods. The filtered images of various filtering are compared to find out the best result filtered image.

## 4. IMAGE FILTERING TECHNIQUES

In image processing techniques, character recognition, object extraction, machine vision, etc, before these techniques are applied, the image has to be prepared to fit with image processing techniques. These preparing image steps are known as image preprocessing steps. Among these image pre-processing steps, filtering techniques are the main ones. In this system, the two filtering techniques such as medium filtering and bilateral filtering are implemented to highlight the importance of the image preprocessing techniques. Before filtering, user can choose noise method such as “Poisson”, “Gaussian” and “Salt and Pepper”. And then, image filtering techniques makes the quality of the image higher and hence they are known as image enhancement techniques. The system will be displayed the bar chart for the comparison of these two methods.

### 4.1. Image Acquisition

In this system, the user can choose input image.

**Figure 2.** Input image of the system

### 4.2. Add Noise

In this step, user can choose the requirement type such as "Poisson", "Gaussian" and "Salt and Pepper". If the user selected one, the image will become distortion with noise.

**Figure 3(a).** Image with poisson noise

**Figure 3(b)**. Image with gaussian noise

**Figure 3(c).** Image with salt and pepper noise

If the user selects "Poisson" noise, the distortion image is as shown in Figure 3(a). If the user selects "Gaussian" noise, the distortion image is as shown in Figure 3(b). If the user selects "Salt and Pepper" noise, the distortion image is as shown in Figure 3(c).

### 4.3. Extracting R, G, B Values

In this process, the system will display the R, G, B values. In which each pixel is specified by three values, one each for the red, green, and blue components of the pixel's color. It is usually defined by the color response of the monitor.

### 4.4. Median Filtering

Median filters are quite popular nonlinear spatial filter, because they provide excellent noise-reduction capabilities, with considerably less blurring than linear smoothing filters of the same size. They are particularly effective in the presence of impulse noise (salt-and-pepper noise).

The value of a set values is such that half the values in the set are less than or equal to it, and half are greater than or equal to it.

**Figure 4.** Remove poisson noise image using median filtering

Median filtering is a cornerstone of modern image processing and is used extensively in smoothing and de-noising applications. Like the mean filter, the 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. Figure5 illustrates an example calculation [2].

The basic drawback of the application of the median filter is the blurring of the image in process. In the general case, the filter is applied uniformly across an image, modifying pixels that are not contaminated by noise. In this way, the effective elimination of impulse noise is often at the expense of an overall degradation of the image and blurred or distorted features [3].

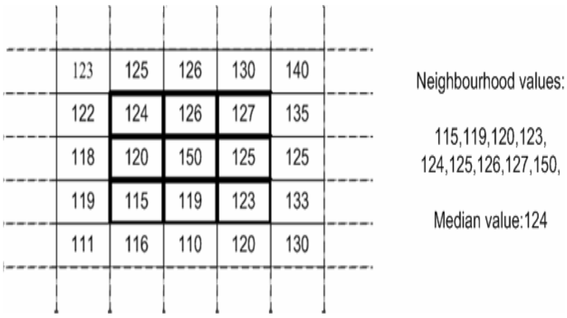


**Figure 5.**Calculating the median value of a pixel neighborhood.

As can be seen the central pixel value of 150 is rather unrepresentative of the surrounding pixels and is replaced with the median value: 124. A 3×3 square neighborhood is used in this system; larger neighborhoods will produce more severe smoothing [2].

### 4.5. Bilateral Filtering

Euclidean Distance, given two points p = ($x_p$, $y_p$) and q = ($x_q$, $y_q$) the Euclidean distance value between p and q is given by It is easy to verify that $d_E$ satisfies the conditions to be a distance given in [4].

$$d_E(p,q) = \sqrt{(x_q - x_p)^2 + (y_q - y_p)^2}$$

A number of discrete distances have been defined on the square lattice. All move lengths are first set to unity, leading to the d4 distance, $d_8$ distance and $d_{knight}$ distance. The Bilateral filter was a non-iterative means of smoothing images while retaining edge detail. It involves a weighted convolution in which the weight for each pixel depends not only on its distance from the center pixel, but also its relative intensity [1].

The bilateral filter is a normalized convolution in which the weighting for each pixel *p* is determined by the spatial distance from the center pixel *s*, as well as its relative difference in intensity [1].These functions multiply together to produce the weighting for each pixel.

For input image *I*, output image *J* and window Ω, the bilateral is defined as follows:

$$J_s = \sum_{p\in\Omega} f(p-s) g(I_p - I_s) I_p \Big/ \sum_{p\in\Omega} f(p-s) g(I_p - I_s)$$

Where f (p-s) is the Euclidean distance value between p and q, g($I_p$-$I_s$) is the difference of center pixel s and neighbor pixel p within the window Ω.The above process within the window Ω is slide over the image and the center pixel is replaced with $J_s$.

**Figure 6.**Remove poisson noise image using bilateral filtering

### 4.6. Calculated the MSE for Comparison of Filtering Images

After finishing the filtering methods, the system will be displayed the image with noise median filtering and bilateral filtering image and then comparison chart for the resolution of these two methods. The mean square error (MSE) function is commonly used because mathematical structure that is easy to compute and it is deferential minimum can be sought [5]. For a discrete image signal y(m, n) and its estimate) ˜ y(m, n)where m, n =0, 1,...,N − 1 the MSE is defined as

$$MSE = \frac{1}{MN} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} (y(m,n) - \tilde{y}(m,n))^2$$

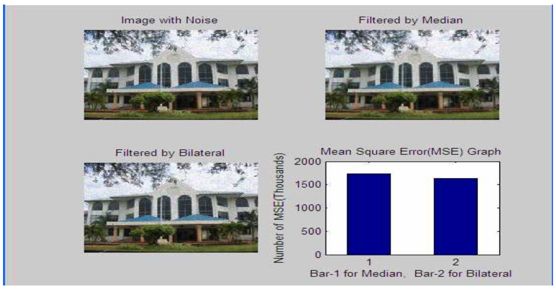


**Figure 7**. Comparison of images filtering poisson noise

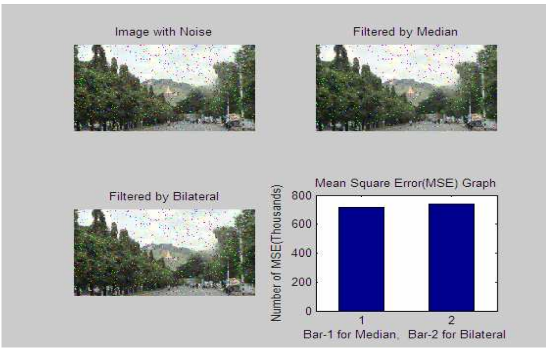


**Figure 8.** Comparison of images filtering salt and pepper

## 5. CONCLUSION

Many image processing techniques are developed to reduce noise. The median filter and bilateral are the best nonlinear filter but requires a priori knowledge of the noise-free image. So the size or scale of the domain constitutes the limit to this amount. Since many natural images can be described as a collection of grey value and oriented texture domains, a scale and orientation adaptive smoothing scheme provides a powerful noise reduction method.

When developing this system, it is found that the medium filtering techniques enhance the image by flattening the color variations in the image. Medium filtering flattens the color variation because the after the medium color of the current window is calculated, the resultant color is taken as the representative color of that window and is used to replace the color of the center pixel.

If the window size becomes lager, the color flattening may be certainly higher. With the bilateral image filtering technique, even though the whole image is enhanced, the small areas of color variations become dots or spots on the image. This fact is a major problem with bilateral filtering technique. Therefore, noise filtering stage should be carried out with bilateral filtering technique.

However, this paper in the removal of noises by using two methods, median filter is better. But it can also be found that bilateral filter is better in some situations, especially salt & pepper and poisson noises of line edge pictures in buildings.

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