**ISSN** 1746-7659, England, UK
**Journal of Information and Computing Science**
Vol. 8, No. 1, 2013, *pp*. 013-026

# Performance Evaluation of various Image De-noising Techniques

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(*Received July 10, 2012, accepted December 24, 2012*)

**Abstract.** The process of removing noise from the original image is still a demanding problem for researchers. There have been several algorithms and each has its assumptions, merits, and demerits. The prime focus of this paper is related to the pre processing of an image before it can be used in applications. The pre processing is done by de-noising of images. In order to achieve these de-noising algorithms, filtering approach and wavelet based approach are used and performs their comparative study. Different noises such as Gaussian noise, salt and pepper noise, speckle noise are used. The wavelet based approach has been proved to be the best in de-noising images corrupted with Gaussian noise, salt and pepper noise and speckle noise A quantitative measure of comparison is provided by the parameters like Peak signal to noise ratio, Root mean square error, Entropy and Correlation of the image.

**Keywords:** *Gaussian noise, Salt & Pepper noise, Speckle noise, Average filter, Wiener filter, Gaussian Filter, Median filter, Wavelet transform.*

## 1. Introduction

An image is a two dimensional function f(x, y), where x and y are plane coordinates, and the amplitude of f at any pair of coordinates (x, y) is called the gray level or intensity of the image at that point. Digital images consist of a finite number of elements where each element has a particular location and value. These elements are called picture elements, image elements and pixels. There are two types of images i.e. grayscale image and RGB image. Gray scale image has one channel and RGB image has three channels i.e. red, green and blue. Image noise is unwanted fluctuations.There are various types of image noises present in the image like gaussian noise, salt & pepper noise, speckle noise, shot noise, white noise[1]. There are various noise reduction techniques are used for removing the noise. Most of the standard algorithms use to de-noise the noisy image and perform the individual filtering process. The result is generally reduced the noise level. But the image is either blurred or over smoothed due to losses like edges or lines. Noise reduction is used to remove the noise without losing much detail contained in an image[2]. To achieve this goal, we use the mathematical function known as the wavelet transform to localize an image into different frequency components or useful sub-bands and effectively reduce the noise in the sub-bands.into different frequency components or useful sub-bands and effectively reduce the noise in the sub-bands.

### 1.1. Gaussian Filter

Gaussian filters are designed to give no overshoot to a step function input while minimizing the rise and fall time. This behavior of Gaussian filter causes minimum group delay. Mathematically, a Gaussian filter modifies the input signal by convolving with a Gaussian function; The Gaussian filter is usually used as a smoothing filter. The output of the Gaussian filter at the moment is the average of the input values [3].

### 1.2. Wiener Filter

It is used to reduce disturbance (noise) present in a signal by comparison with an estimation of the desired noiseless signal. The design of the Wiener filter is of different approach. The Wiener filtering is a linear

estimation of the original image [4]. The approach is based on a stochastic framework. Wiener filters are characterized by the following:

1. Assumption: signal and (additive) noise are stationary linear with known spectral characteristics
2. Requirement: the filter must be physically realizable or casual system.
3. Performance criterion: minimum MMSE[5]

## 1.3. Average Filter

Mean filter, or average filter is windowed filter of linear class, that smoothes signal (image). The filter works as low-pass one. The basic idea behind filter is for any element of the signal (image) take an average across its neighbourhood. To understand how that is made in practice, let us start with window idea.The Average (mean) filter smooths image data, thus eliminating noise [6]. This filter performs spatial filtering on each individual pixel in an image using the grey level values in a square or rectangular window surrounding each pixel[5].

For example:

a1 a2a3
a4 a5 a6 3x3 filter window
a7 a8 a9

The average filter computes the sum of all pixels in the filter window and then divides the sum by the number of pixels in the filter window:
Filtered pixel = (a1 + a2 + a3 + a4 ... + a9) / 9

## 1.4. Median Filter

A median filter belongs to the class of nonlinear filters unlike the Average filter. The median filter also follows the moving window principle similar to the Average filter. Median filtering is effective to remove 'salt and pepper' type noise. The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle (median) pixel value.

Table1: Concept of Median filtering

| | | | | |
|---|---|---|---|---|
| 123 | 125 | 126 | 130 | 140 |
| 122 | 124 | 126 | 127 | 135 |
| 118 | 120 | 150 | 125 | 134 |
| 119 | 115 | 119 | 123 | 133 |
| 111 | 116 | 110 | 120 | 130 |

Neighborhood values: 115,119,120,123,124,125,126,127,150
Median value: 124

The central pixel value of 150 in the 3×3 window shown in Table 1 is rather unrepresentative of the surrounding pixels and is replaced with the median value of 124. The median is more robust compared to the mean. Thus, a single very unrepresentative pixel in a neighborhood will not affect the median value significantly. Since the median value must actually be the value of one of the pixels in the neighborhood, the median filter does not create new unrealistic pixel values when the filter straddles an edge. For this reason the median filter is much better at preserving sharp edges than the mean filter. These advantages aid median filters in de-noising uniform noise as well from an image [19].

## 1.5. Image Noise