Enhancement and De-Noising Techniques for Gray Scale Images using Spatial Domain Filtering

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Abstract: ***The field of Digital Image Processing refers to processing digital images by means of digital computer. One of the main application areas in Digital Image processing methods is to improve the pictorial information for human interpretation. Most of the digital images contain noise. This can be removed by many enhancement techniques. Filtering is one of the enhancement techniques which is used to remove unwanted information (noise) from the image. Image enhancement plays a vital role in every field where images have to be understood and analyzed. Many images like medical images, satellite images, microscopy images, aerial images and even real life photographs suffer from poor contrast and noise. It is also used for image sharpening and smoothening. This paper focuses on different image enhancement techniques for grayscale images in spatial domain and gives better approach for future research.***

Keywords: Noise, Spatial Domain Filtering, Filters, Image enhancement etc.

1. Introduction

When an image is acquired by a camera or other imaging system, often the vision system for which it is intended is unable to use it directly. The image may be corrupted by random variations in intensity, variations in illumination, or poor contrast that must be dealt with in the early stages of image processing. The fundamental steps in Digital Image processing are image acquisition, image enhancement, image analysis, image reconstruction, image restoration, image compression, image segmentation, image recognition, and visualization of image. The main sources of noise in digital image processing come under image acquisition and image transmission. To provide the better result and overcome these problems various non-linear filters are developed. To detect and reduce the noise from digital images used for real time applications is a demandable area and required a non-linear filter for reducing noise. So in this paper we introduced a spatial domain filter which is used to detect and reduce the noise from the images which are used for real time applications.

The core spatial-domain filtering activities are:

1. Read the image
2. Introduced noise
3. Apply various filters for reduction of noise

2. Types of Noise

Noise in an image is a very common problem. An image gets corrupted with different types of noise during he processes of acquisition, transmission/ reception, and storage/ retrieval. Noise may be classified as substitutive noise (impulsive noise: e.g., salt & pepper noise, random-valued impulse noise, etc.) and additive noise (e.g., additive white Gaussian noise). Each Region at 100% Zoom.

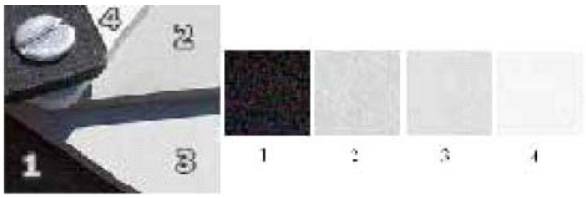

Figure 1: Image suppression due to different noises

a. Salt & Peepers noise

Salt and pepper noise is a form of noise typically seen on images. It represents itself as randomly occurring white and black pixels. An effective noise reduction method for this type of noise involves the usage of a median filter or a contra harmonic mean filter. Salt and pepper noise creeps into images in situations where quick transients, such as faulty switching, take place [17].

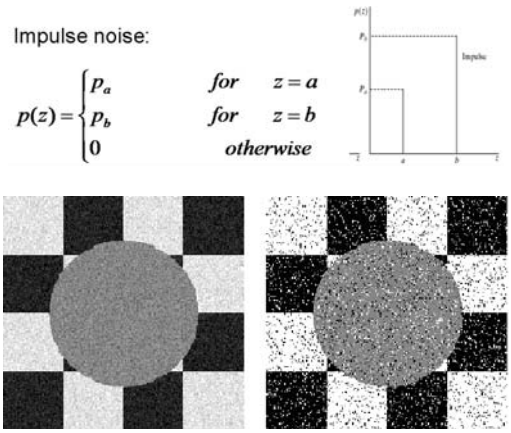

Figure 2: Salt and Pepper Noise

b. Gaussian Noise

Gaussian noise is statistical noise that has its probability density function equal to that of the normal distribution, which is also known as the Gaussian distribution. In other words, the values that the noise can take on are Gaussian-distributed. A special case is white Gaussian noise, in

which the values at any pairs of times are statistically independent (and uncorrelated). In applications, Gaussian noise is most commonly used as additive white noise to yield additive white Gaussian noise.

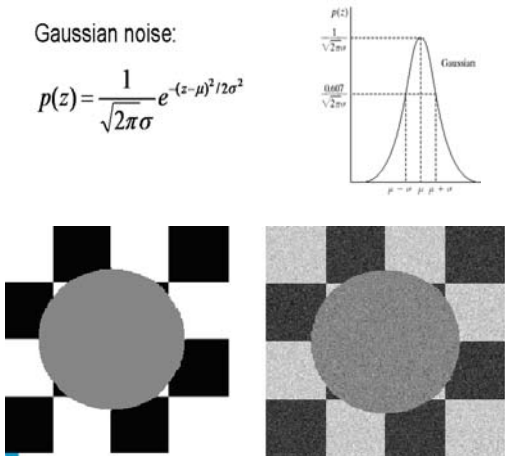

Figure 3: Gaussian Noise

3. Image De-Noising Filters

As discussed above there are two types of noise typically seen on images, Salt & Peepers noise and Gaussian noise. To remove these noises various filters are used. Selection of appropriate filter for de-noising is depends upon the type of noise. Various filtering techniques have been proposed for removing impulse noise in the past, and it is well known that linear filters could produce serious image blurring. As a result, nonlinear filters have been widely exploited due to their much improved filtering performance, in terms of impulse noise attenuation and edge details preservation. So here in the following section firstly we are going to discuss the three non linear filters which are widely used for image de-noising, than we present a proposed filter (Spatial domain filter) for removing noise from digital images used for real time applications.

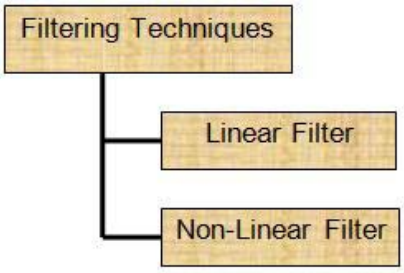

Figure 4: Filtering Techniques

Linear Filters:

Linear filters are used to remove certain type of noise. Gaussian or Averaging filters are suitable for this purpose. These filters also tend to blur the sharp edges, destroy the lines and other fine details of image, and perform badly in the presence of signal dependent noise [5].

Non-Linear Filters:

In recent years, a variety of non-linear median type filters such as rank conditioned, weighted median, relaxed median, rank selection have been developed to overcome the shortcoming of linear filter.

Mean Filter:

The mean filter is a simple spatial filter. It is a sliding-window filter that replaces the center value in the window. It replaces with the average mean of all the pixel values in the kernel or window. The window is usually square but it can be of any shape.

Advantage:

a. Easy to implement
b. Used to remove the impulse noise.

Disadvantage: It does not preserve details of image. Some details are removes of image with using the mean filter.

Median Filter:

Median [4] Filter is a simple and powerful non-linear filter which is based order statistics. It is easy to implement method of smoothing images. Median filter is used for reducing the amount of intensity variation between one pixel and the other pixel. In this filter, we do not replace the pixel value of image with the mean of all neighboring pixel values, we replaces it with the median value. Then the median is calculated by first sorting all the pixel values into ascending order and then replace the pixel being calculated with the middle pixel value. If the neighboring pixel of image which is to be considered containing an even numbers of pixels, than the average of the two middle pixel values is used to replace. The median filter gives best result when the impulse noise percentage is less than 0.1 %. When the quantity of impulse noise is increased the median filter not gives best result.

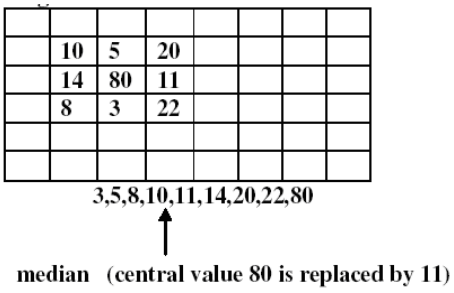

Figure 5: Method of Median Filter

Algorithm of Median Filter

The algorithm for the median filter is as follows:

Step 1. Select a two dimensional window W of size 3*3. Assume hat the pixel being processed is Cx,y.
Step 2. Compute Wmed the median of the pixel values in window W.
Step 3. Replace Cx,y by Wmed.
Step 4. Repeat steps 1 to 3 until all the pixels in the entire image are processed.

Advantage:

a. It is easy to implement.
b. Used for de-noising different types of noises.

Disadvantage:

a. Median Filter tends to remove image details while reducing noise such as thin lines and corners.
b. Median filtering performance is not satisfactory in case of signal dependant noise. To remove these difficulties different variations of median filters have been developed for the better results.

Wiener Filter:

The purpose of the Wiener filter is to filter out the noise that has corrupted a signal. This filter is based on a statistical approach. Mostly all the filters are designed for a desired frequency response. Wiener filter deals with the filtering of an image from a different view. The goal of wiener filter is reduced the mean square error as much as possible. This filter is capable of reducing the noise and degrading function. One method that we assume we have knowledge of the spectral property of the noise and original signal. We used the Linear Time Invariant filter which gives output similar as to the original signal as much possible [4]. Characteristics of the wiener filter are [6]:

a. Assumption: signal and the additive noise are stationary linear-random processes with their known spectral characteristics.
b. Requirement: the wiener filter must be physically realizable, or it can be either causal
c. Performance Criteria: There is minimum mean-square [MSE] error.

Low pass Filters:

A low pass filter is the basis for most smoothing methods. An image is smoothed by decreasing the disparity between pixel values by averaging nearby pixels Using a low pass filter tends to retain the low frequency information within an image while reducing the high frequency information. The low-pass filtered image looks a lot blurrier. But the question is why we would want a blurrier image. Often images can be noisy, no matter how good the camera is, it always adds an amount of “snow” into the image. The statistical nature of light itself also contributes noise into the image. Noise always changes rapidly from pixel to pixel because each pixel generates its own independent noise. The image from the telescope isn't "uncorrelated" in this fashion because real images are spread over many pixels. So the low-pass filter affects the noise more than it does the image. By suppressing the noise, gradual changes can be seen that were invisible before. Therefore a low-pass filter can sometimes be used to bring out faint details that were smothered by noise.

High pass filters:

A high pass filter is the basis for most sharpening methods. An image is sharpened when contrast is enhanced between adjoining areas with little variation in brightness or darkness.

4. Results

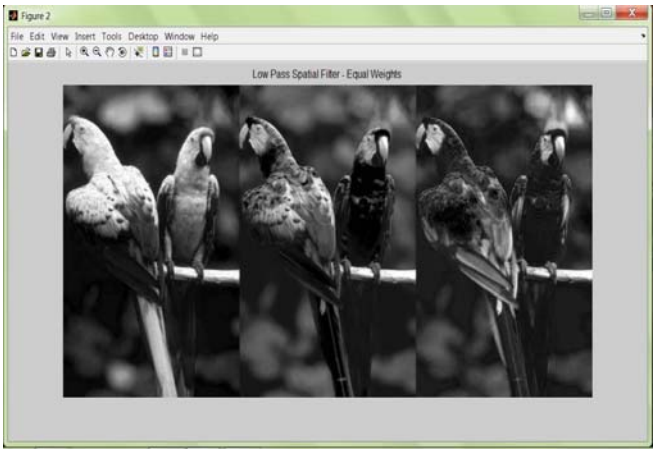

Figure 6: Illustrating the low pass filter removing the noise from the foreground

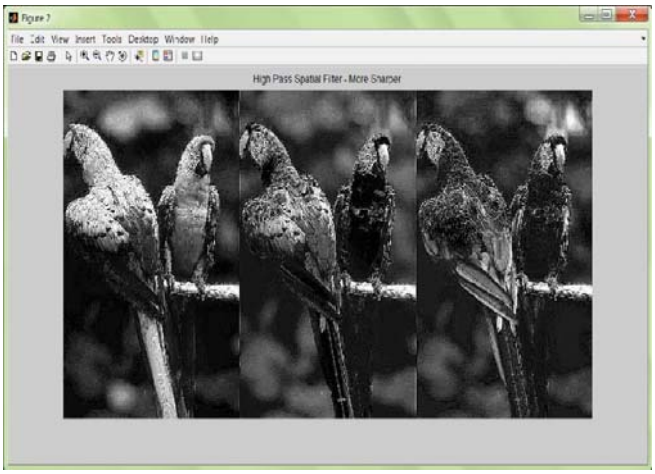

Figure 7: Illustrating the high pass filter intensifying the more contrast parts.

5. Conclusion and Future Work

The objective of the paper is to smooth and sharp the images by using various Filtering techniques, where Filtering techniques are one of the enhancement techniques in the Digital image processing and thus help the beginners of image processing to introduce to various filtering techniques. In this paper we had implemented few spatial domain filters and frequency domain filters to remove various types of noises. In this paper we performed operation on the Grey scale images and in the future we want to perform it on the colored images.

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