Analysis of Different Image Denoising Techniques

Devang K. Vadher[1], D. U. Shah[2]

[1,2]Department of Electronics and Communication Engineering, School of Engineering, R. K. University, Rajkot, Gujarat, India

Abstract: ***Visual data transmitted in the form of digital images is becoming a main method of digital communication but the received image is to be processed before it can be used in applications. Image denoising involves administration, control, handing of the image data to produce a visually high quality image. So that Denoising is the first and last step to be taken before the images is used for any application. Noise is added due to data transmission reception, necessary to apply a suitable denoising method. This paper presents a brief introduction of some image denoising methods. Potential future trends in the area of denoising are also mentioned.***

Keywords: Image Denoising, Wavelet, PSNR (Peak Signal to Noise Ratio), SNR (Signal to Noise Ratio), MSE (Mean Square Error).

1. Introduction

Digital Image have many application such MRI images, satellite images, computer tomography, astronomy. Images collected by sensors are generally damaged by noise. Noise can be introduced by transmission, reception, compression, storage and acquisition. Images are corrupted due to noise. It is necessary to apply an appropriate denoising technique to recover for such noisy images. Image denoising is a challenging problem for researches. . Due to noise image can be blurred and some data can be lost. This paper makes introduction of some image denoising methods. Data capturing instruments data transmission by physical media data acquisition and image quantization. This paper describes different techniques for image denoising.

2. Image Denoising Research

Image Denoising has remained a basic problem in the field of image processing. Wavelets give a capital performance in image denoising due to properties such as sparsity and multiresolution structure. Wavelet Transform gaining popularity various techniques for denoising in wavelet domain were introduced. The focus was shifted from the Spatial and Fourier domain to the Wavelet transform domain.

3. Classification of Denoising Methods

There are two basic methods to image denoising, spatial filtering methods and transform domain filtering methods. In spatial filtering noise is removed by processing on image itself. Where in transform domain filtering image transferred into another domain and then applied denoising technique to the image for remove noise in the image.

3.1 Spatial Filtering

A traditional way to remove noise from image data is to employ spatial filters. Spatial filters can be further classified into non-linear and linear filters.

I. Non Linear Filtering

In non linear filtering the noise is removed without any attempts to externally identify it. Spatial filters apply a low pass filtering on groups of pixels by imagining that noise occupies the higher region of frequency spectrum. Generally spatial filters remove noise to a great extent but drawback of blurring images which in turn makes the edges in pictures invisible. Median 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 neighbouring pixel values, we replaces it with the median value.

II. Linear Filters

Linear filters too tend to blur sharp edges, destroy lines and other fine image details, and perform poorly in the presence of signal-dependent noise. A mean filter is the optimal linear filter for Gaussian noise in the sense of mean square error .The wiener filtering method requires the information about the spectra of the noise and the original image and it works well only if the underlying signal is smooth. Wiener filter method implements spatial smoothing and its model complexity control correspond to choosing the window size. To overcome the weakness of the Wiener filtering wavelet based denoising technique.

3.2 Transform Domain Filtering

The transform domain filtering methods can be classified according choice of the functions. The basic functions can be further classified as data adaptive and non-adaptive. Non-adaptive transforms are discussed first.

Spatial – Frequency Filtering

In frequency smoothing methods the removal of the noise is by designing a frequency domain filter. Spatial-frequency filtering refers use of low pass filters using Fast Fourier Transform (FFT). These methods are time consuming and depend on the cut-off frequency and the filter function behaviour. They may produce artificial frequencies in the processed image.

3.3 Wavelet Domain Filtering

Filtering operations in the wavelet domain can be classified into linear and nonlinear methods.

I. Linear Filters

Linear filters such as Wiener filter in the wavelet domain yield optimal results when the signal corruption can be expressed as a Gaussian process .The filtering operation successfully reduces the MSE. In a wavelet-domain spatially- adaptive FIR Wiener filtering for image denoising is proposed where wiener filtering is performed only within each scale and intrastate filtering is not allowed.

II. Non-Linear Filters

The most researched domain in denoising using Wavelet Transform is the non-linear coefficient Thresolding based methods. The method in which small coefficients are removed while others are left untouched is called Hard Thresolding. But the procedure generates spurious blips, better known as artifacts, in the images as a result of unsuccessful attempts of removing moderately large noise coefficients. To overcome the drawback of hard Thresolding, wavelet transform using soft Thresolding was evaluated introduced. In this scheme, coefficients above the threshold are concentrating by the absolute value of the threshold itself. Similar to soft Thresolding, other techniques of applying thresholds are semi-soft Thresolding. Most of the wavelet shrinkage research is based on methods for choosing the favourable threshold which can be adaptive or non-adaptive to the image.

a. Non adaptive Thresolding

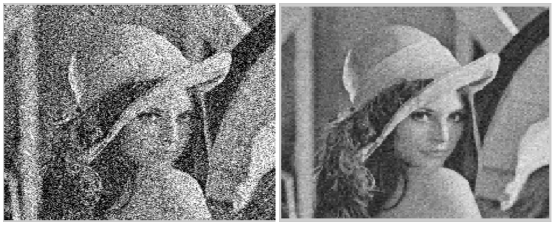
VISU Shrink is non-adaptive universal threshold, which suggest only on number of data points. It has asymptotic equivalence suggesting best performance in terms of MSE when the number of pixels reaches infinity. VISU Shrink is known to yield overly smoothed images because its threshold elect can be large due to its dependence on the number of pixels in the image.

b. Adaptive Thresolding

SURE Shrink uses a hybrid of the universal threshold and the SURE threshold and performs better than VISU Shrink. Bays' Shrink minimizes the Bays' Risk Estimator function dissonant Generalized Gaussian prior and thus yielding data adaptive threshold. Bays Shrink outperforms SURE Shrink most of the times. Cross Validation alter wavelet coefficient with the weighted average of neighbourhood coefficients to minimize generalized cross validation (GCV) function providing maximum threshold for every coefficient.

The assumption that one can classify noise from the signal purely based on coefficient magnitudes is violated when noise levels are higher than signal magnitudes. Under this high noise circumstance, the spatial configuration of neighbouring wavelet coefficients can play a large role in noise-signal Classifications. Signals tend to form meaningful features while noisy coefficients often scatter randomly.

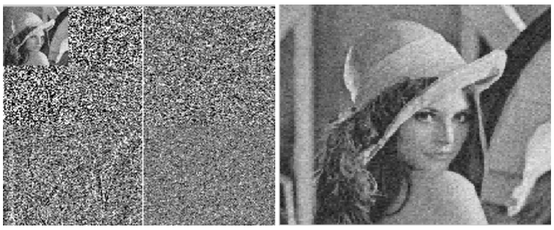
Original image Noisy image (Salt&papper)



Noisy image (Gaussian) Wiener filter

Median Filter Hard Thresolding

Soft Thresolding Bayes shrink



Decomposed structure Vishu shrink

4. Conclusion

Performance of denoising algorithms is measured using quantitative performance measures such as peak signal-to-noise ratio (PSNR), signal-to-noise ratio (SNR) and mean square error (MSE). An ideal denoising procedure requires *knowledge* of the noise. First step is obtaining knowledge of noise and denoising methods then apply suitable method to noisy image which will give good result of noise free image.

Generally they are two techniques spatial domain and transform domain for the image denoising. In spatial domain median filter gives best result when the salt & paper noise added into the image. Wavelet Transform is the best suited for performance because of its properties like sparsity, multiscale nature and multi resolution structure.

Table 1: PSNR values of different denoising technique for different noises are added

	Gaussian	*Salt and Pepper*	*Poisson*	*Speckle*
Wiener	25.514	25.0271	**32.3082**	27.2052
Median	20.5333	**33.4224**	31.7208	24.8384
Soft Thresolding	24.2507	19.1517	28.0704	26.0243
Hard Thresolding	24.3061	16.0549	26.3167	26.2491
Vishu Shrink	**29.8021**	29.6591	22.4397	26.5901
Baysian Shrink	24.713	16.0207	31.479	25.8238

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