E-ISSN: 2321–9637
Volume 2, Issue 1, January 2014
International Journal of Research in Advent Technology
Available Online at: http://www.ijrat.org

ANALYSIS OF IMAGE DENOISING TECHNIQUE BASED ON WAVELET THRESHOLDING ALONG WITH PRESERVING EDGE INFORMATION

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ABSTARCT:
Noise is undesired information that contaminates the image. In digital image processing, an image is a two dimensional function represented as F(x,y),it can be defined as an artifact that depicts or records visual perception for example two dimensional picture that has a similar appearance to some objects. All digital images contain some degree of noise. Often we suffered with noise in image that is occurred due to the sensor and circuitry of a scanner or digital camera during image acquisition and/ or transmission. Whenever we are going to denoise an image, most of the method used to denoise often does not preserve the features of the image like edges of the image. In this paper we study about Wavelet Thresholding Algorithm for denoising an image. Also we study the edge detection algorithm in order to preserve the edge information of the image.

Keywords: *Image Denoising, Wavelet Thresholding, Edge detection*

1. INTRODUCTION

Digital images are prone to a variety of types of noise. In Image Processing, noise reduction plays a very vital role. Many enormous amounts of researches in the field of image and video processing came into existence in recent days such as compression, noise removal techniques, and other preprocessing functions for noise removal. Image Denoising plays very essential role in image restoration. There are various kinds of noise that may present in the image. The figure below describes the denoising concept.

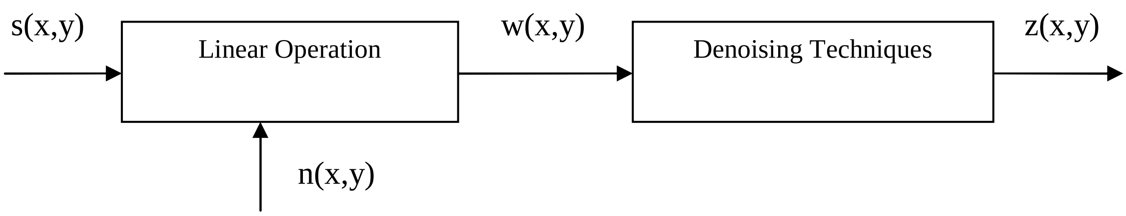

Figure 1. Denoising Concept

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Figure1 describes that the image s(x, y) is blurred by a linear operation and noise n(x,y) is added to form the degraded image w(x, y). This is convolved with the restoration procedure g(x,y) to produce the restored image z(x, y).
The "Linear operation" shown in above figure is the addition or multiplication of the noise $n(x,y)$ to the signal $s(x,y)$. Once the corrupted image $w(x, y)$ is obtained, it is subjected to the denoising technique to get the denoised image $z(x, y)$. Currently there are some of the image denoising methods but will cause a loss of image information like edges etc at the time of denoising process. Thus here we proposed a denoising technique which will not only denoise but also preserve image information .

The section II describes the related work, the section III is about the proposed work and the section IV gives conclusion.

2. RELATED WORK

*2.1. **A Stationary Edge Detection Algorithm for noisy Images.***

Classical edge detection is a combination of a smoothing filter and a gradient operator. In contrast, S.Nashat & A. Abdullah uses stationary wavelet edge detection. Wavelet based denoising provides multi-scale treatment of noise, down sampling of sub-band images during decomposition and the thresholding of wavelet coefficients may cause edge distortion and artifacts in the reconstructed images. To improve this limitation of the traditional wavelet transform, a multi-layer stationary wavelet transform is adopted.

We can summarize the paper as follows.

1. Provides differentiation between false and real edges using stationary wavelet edge detection. .
2. Provides an improved image-to-noise ratio.
3. Provides comparison between various edge detection techniques

***2.2 Edge-preserving wavelet thresholding for image denoising*.**

In this paper, it provides a general setting for wavelet based image denoising methods. The denoised image f is obtained by minimizing a functional, which is the sum of a data fidelity term and a regularization term that enforces a roughness penalty on the solution. The latter is usually defined as a sum of potentials, which are functions of a derivative of the image. It considers new potential functions, which allows preserving and restoring important image features, such as edges and smooth regions, during the wavelet denoising process.

Since important edges are characterized by high gradient magnitude, an efficient edge preserving denoising method must reduce shrinkage at points where the magnitude of the gradients exceeds certain thresholds, while shrinking coefficients corresponding to small values of the gradient, that are probably due to noise. On the other hand, the dyadic wavelet transform of an image allows us to simply evaluate, at each scale, the magnitude of the gradient of the original image smoothed at that scale. The purpose of this work is to develop new wavelet denoising methods that exploit the interplay between non-linear diffusion filtering and variational methods in the wavelet domain.

2.3 Feature-Based Wavelet Shrinkage Algorithm for Image Denoising.

For applying the wavelet shrinkage on images, according to Eric J Balster & Yuan F Zheng, because the wavelet shrinkage method is based upon the reduction in the magnitude of the coefficient value of corrupted images by a parameter c, between 0 and 1, the modified wavelet coefficient value is calculated by

L., k[x, y] =c[x, y] λ‟. k[x, y]
Where L., k[x, y] is the modified wavelet coefficient of scale k and spatial location (x, y),. € {lh,hh,hl}and λ‟. K[x, y] is the wavelet coefficient of the corrupted image.
In the wavelet transform, estimate the threshold value, and remove the coefficient value lesser than threshold and then apply inverse transform.
The wavelet shrinkage approach can be summarized as follows:

1. Apply the wavelet transform to the signal.
2. Estimate a threshold value.
3. Remove (zero out) the coefficients that are smaller than the threshold.

2.3 Wavelet Shrinkage and Denoising.
This paper gives wavelet shrinking algorithm for image denoising. The working of the wavelet shrinking is described. We can use the mean squared error to determine if the shrinkage method does a good job of denoising the given signal. It determines the threshold value that minimizes the mean square error. It gives two methods for wavelet shrinking:

1. Visu shrink: It is used for images which are sparse in nature.
2. Sure shrink: It is used for images which are not sparse.

2.4 Denoising through Wavelet Shrinkage: An Empirical Study

This paper evaluates several denoising methods like spatial filter etc on test images corrupted with white Gaussian noise. it provides conclusion that Sure shrink and Bayes shrink are the best wavelet based denoising methods for the type of images corrupted by Gaussian noise. It achieves the lower error rate as measured by mean square error.

In this pare the investigate wavelet based techniques for denoising, focusing on shrinkage methods. The basic idea behind these techniques is to use wavelets to transform the data into a different basis, where large coefficients corresponds to the signal, while small ones represent mostly noise. The wavelet coefficients are suitably modified and the denoised data is obtained by an inverse wavelet transform of the modified coefficients.

With the simplicity of implementation along with the denoising performance, it is found that Bayes shrink to be the best procedure. Spatial filters are very simple to implement and are computationally faster than wavelet based methods as they require far less computation in many cases. However, a comparison of the images indicates that spatial filters often result in grainier than the ones obtained from wavelet techniques. Unless special care is taken near the edges, they also tend to smooth the edges in the image.

3. PROPOSED WORK

As per analysis we proposed a methodology which improves image quality. The proposed methodology also considers the image features like edges at the time of denoising . thus we propose a methodoly which first detect the edges from noisy image and then apply the wavelet thresholding for image denoising. Here we have chosen Canny Edge detection algorithm for edge detection since it provide the low error rate & better edge localization.

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3.1 Canny Edge Detection

Edge Detection has been used extensively in the fields of image and signal processing. However many classical edge detection algorithms are there, some of them perform exceptionally well also but classical edge detectors usually fail to handle images with dull object outline or in the presence of strong noise. One of the important requirements for efficient edge detector is that the edge must be accurately detected and the noise is removed as much as possible from the scene.

There are three fundamental steps performed in edge detection.

1. Image smoothing for noise reduction n: The first step is to smooth the image using filters.
2. Detection of edge points: This is a local operation that extracts from an image all points that are potential candidates to become edge points.
3. Edge Localization: The objective of this step is to select from the candidate edge points only the points that are true members of the set of points comprising an edge.

Canny Edge Detection Provides low error rate, better edge localization and single edge point response. Single edge point response means that the detector should not identify multiple edge pixels where only a single edge point exists.

3.2 Wavelet Shrinking Algorithm:

Wavelet shrinkage is a signal denoising technique based on the idea of thresholding the wavelet coefficients. Denoising is the process of removing noise from a signal. Wavelet coefficients having small absolute values are considered to encode very fine details of the signal.

Wavelet shrinkage denoising should not be confused with smoothing, whereas smoothing removes high frequencies and retains low ones, denoising attempts to remove whatever noise is present and retain whatever signal is present regardless of the signal‟s frequency content.

3.2.1 Procedure for Wavelet Shrinkage.

The wavelet shrinkage method involves the following steps:
1. Apply wavelet transform to the signal.
2. Obtain a threshold Value that minimizes the Mean Square Error. Then using the Soft threshold function we remove (zero out) the coefficients that are smaller than the threshold.
3. Reconstruct the signal (apply the inverse of the Wavelet transform).

3.2.2 Two methods of wavelet shrinkage:

To determine a threshold (or tolerence) value λ that minimizes MSE (mean squared Error). There are two methods that we will discuss for choosing λthat is the visushrinkand sureshrink.

If the image is sparse we use visushrink method to select otherwise we use sureshrink

a. *Visu Shrink*: Visu Shrink was introduced by Donoho. It uses a threshold value t that is proportional to the standard deviation of the noise. It follows the hard threshold rule. It can be viewed as general-purpose threshold selectors that exhibit near optimal minmax error properties and ensures with high probability that the estimates are as smooth as the true underlying functions. However, Visu Shrink is known to yield recovered images that are overly smoothed. This is because Visu Shrink removes too many coefficients.

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b. *Sure Shrink:* A threshold choosen based on Stein's Unbiased Risk Estimator (SURE) was proposed by Donoho and Johnstone and is called as Sure Shrink. It is a combination of the universal threshold and the SURE threshold. This method specifies a threshold value tj for each resolution level j in the wavelet transform which is referred to as level dependent threshold. The goal of Sure Shrink is to minimize the mean squared error.

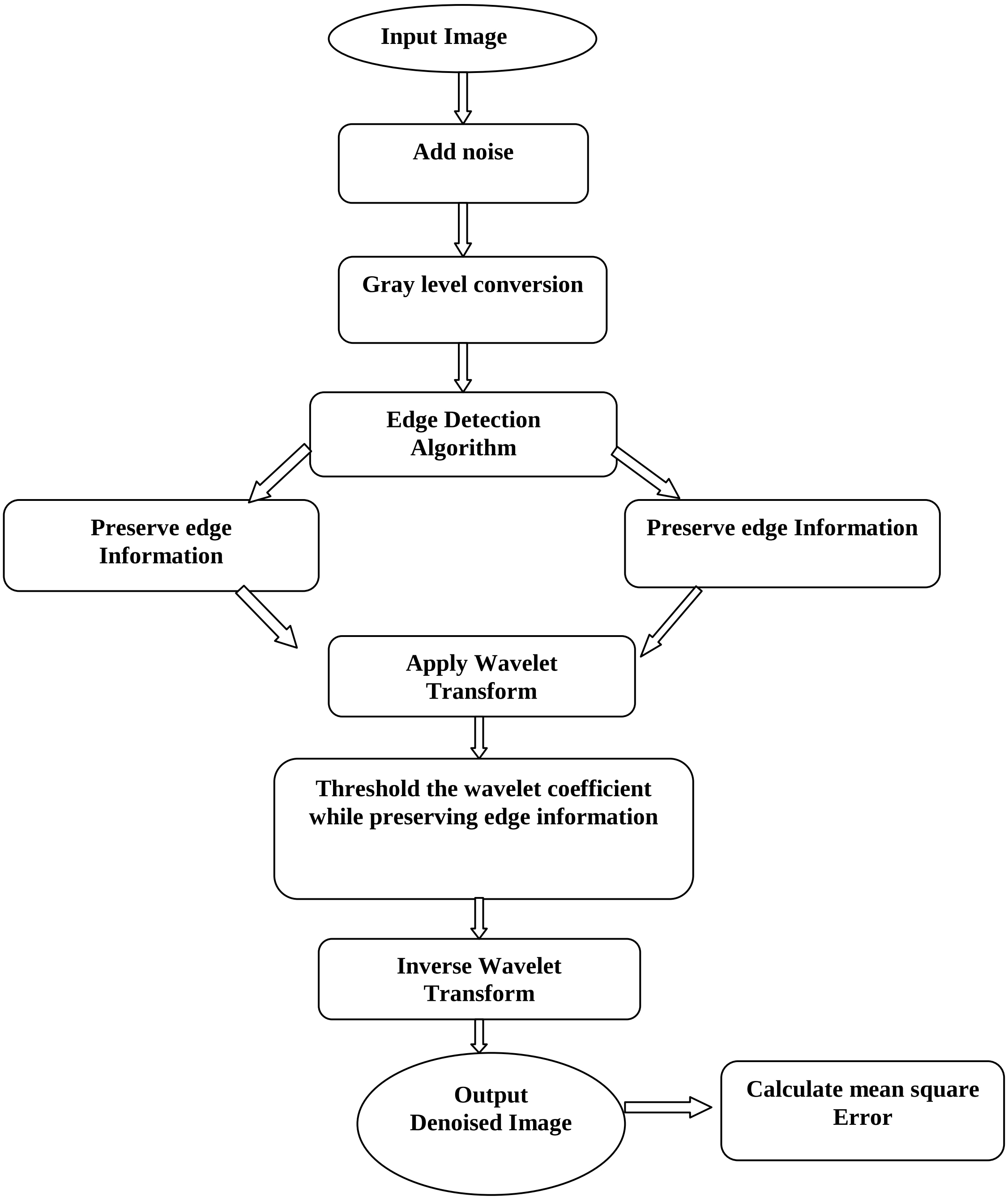

Figure 2 Flow chart for Image denoising along with edges

Figure 2 describes the flow chart of the proposed methodology.

4. CONCLUSION

The goal of image de-noising method is to recover the original image from a noisy measurement. This paper has presented the image denoising concept along with edge preservation. The edges are also used to find the object in image thus edge detection is the important identification & classification tool. By using the wavelet shrinking algorithm along with edge detection we can denoise the image form a noisy environment. At the same time it provides preserving the edges of the image, which is not provided by most of the methods at the time of denoising process.

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