Denoising of Images by using Wavelet Transformation

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Abstract: **In the modern age, Visual information can be transmitted over communication channel in the type of digital images is decent method, but after transmission corrupted image is found with noise. Before it can be used in applications, we need to remove noise and reconstruct the image. Image denoising is the method to manipulate the image data and generate a high quality visual image. In this thesis, we described image denoising using wavelet transform and various existing algorithms using different technique. The process of removing noise from an image is called as noise reduction or denoising. So, we can introduce some significant wavelet transforms for image denoising such as VisuShrink, Bayes Shrink and Bilateral thresholding and Proposed Spatial Adaptive thresholding techniques. The proposed method has been applied on original gray scale image such as Lena at distinct noise levels (standard deviation). Performance of noise reduction using proposed method is compared with several existing methods such as VisuShrink, BayesShrink and Bilateral thresholding. It is measure on the basis of error metric such as Peak Signal to Noise Ratio (PSNR), Mean Squared Error (MSE) and in terms of visible quality of images. This technique is combination of thresholding technique and wavelet dependencies, it is also less complex in comparison other techniques. The advantages of Spatial Adaptive thresholding technique is that it is better performs compared with other thresholding methods having higher PSNR and lower MSE values for different noise levels and gives better visual image quality. By using proposed technique, the PSNR and MSE in the image denoising are and as compared to the other techniques.**

INTRODUCTION

The vision is the most advanced of the human senses, so it is not surprising that images play the single most important role in our perception. However, unlike humans, who are confined to the visual spectrum band of the electromagnetic (EM) imaging machines cover most of the EM spectrum, ranging from gamma to radio waves. They can operate in images generated by human sources that are not accustomed to associate with images. These include ultrasonic, electron microscopy and computer-generated images. And digital image processing covers a wide range and variety of applications.

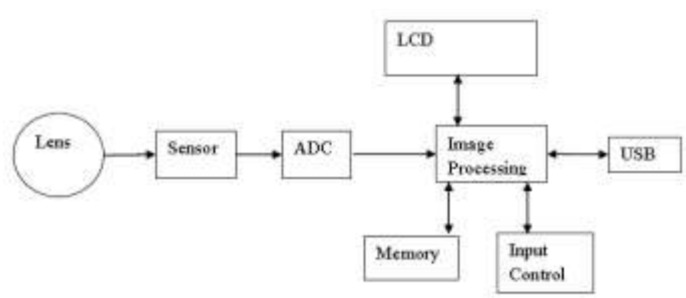
Active research in image processing is noise. If we think of the damaged images, then the analysis is corrupted by random variations in intensity values, which is the noise. It is due to the data acquisition process. The main objective of the methods of image noise removal is to recover the original image or fetch the best image quality after reducing a noisy one, in order to perform, in an easier way and a more semantics to a task that is part of image processing and image segmentation.

In this context, several studies apply to your work in this direction. Adaptive directional elevation (ADL) is one of the image compressions due to the characteristics representing the edges and textures in images efficiently [1-2]. Research has shown that the application of image noise elimination can also benefit from this technique [3-4].

Because of this, it can effectively decorrelate dependencies discontinuities found more compact image and high-frequency components induced by characteristics of the image at the lowest or low level band pass. If we think of the wavelet transform, then it can be effectively capture singular points to two dimensions means that includes a dimension, but it is wrong in representing the main features such as edge, colour, contour and so on. There are several directional and non-directional transformations redundant explored in various research projects, including curvelet, contourlet, wedgelet, and the airship bandlet wavelet [5-8].

NOISE SOURCES

The block diagram of a digital camera is shown in Figure. A lens focuses light from the regions of interest in a sensor. The sensor measures the colour and intensity of light. An analog to digital converter (ADC) converts the image to digital signal. A block of image processing improves the image and compensates some of the shortcomings of the other blocks of the camera. This memory is to store the image, while a screen can be used to preview. There are some blocks for the purpose of user control. The noise is added to the image in the lens, sensor, and ADC and the own block image processing.



Blocks of a Digital Camera and Sources of Noise

The sensor is made of millions of tiny light-sensitive components. They differ in their physical, electrical and optical properties, which adds a separate noise signal (referred to as the dark current shot noise) to the acquired image. Another shot noise component is the photon shot noise. This is because the number of photons detected varies across different parts of the sensor. The amplified sensor signal adds noise amplification, which is Gaussian in nature. The ADC adds thermal noise and quantization in the scanning process.

IMAGE DENOISING OVERVIEW

Efficient noise suppression in an image is a very important issue. De-noising finds wide applications in many fields of image processing. Image De-noising is an important task of pre-processing prior to further processing such as image segmentation, feature extraction, texture analysis etc. The purpose of De-noising is remove noise while retaining the edges and other features detailed much as possible. Conventional techniques of image de-noising using linear and nonlinear techniques have already been studied and analyzed for efficient scheme-de noising.

Different approaches are basically concerned denoise image data, such as average filter, median filter, and partial approach Gauss Differential Equations (PDE). If we analyze the properties of good pictures, then it will be with less noise and blur or minimize blur reduction is the important factor. PDE approach is much effective and is applied in several investigations as [12-13]. But it is more effective if applied fourth order partial differential equation. Applications of PDE models can be widely found in a wide range of image restoration tasks, such as removing noise and improves [14] color image processing [15-16] and resolution. This gives us the future or work with the fourth order partial differential equation with the same order in the direction of reducing blur vision.

Image Denoising play an important role in image processing task [17]. Eliminate noise when the edges are in the state to preserve the image is called noise removal. In the image processing task is an important and common problem. If we want a very high resolution image quality as the result then we must consider the parameters reducing noise parameters for better. The main purpose or objective of removing image noise is to recover the main image of the noisy image [18].

PROBLEM STATEMENT

The basic idea of this thesis is the estimation of the image non-corrupt of the distorted or noisy image, and is also called image "denoising". There are various methods to help restore an image of noisy distortions. The choice of method played a major role in the achievement of the desired image. The denoising methods tend to be a specific problem. For example, a method which is used for the satellite images denoise may not be suitable for denoising medical images. In this thesis, a study has been done on the various algorithms and each is denoising implemented in MATLAB13. Each method is compared and classified according to its effectiveness. In order to quantify the performance of various denoising algorithms, a high quality image is taken and some known noise is added. This would then be given as input to the denoising algorithm, which produces an image close to the original a high quality image. The performance of each algorithm is compared by calculating the signal-to-noise ratio (SNR) in addition to the visual interpretation.

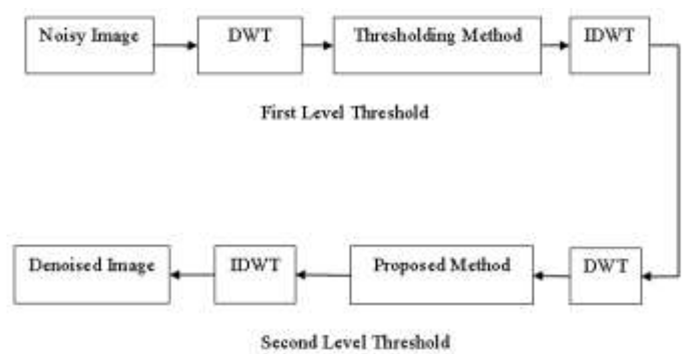
The ultimate goal of the image denoising and restoration techniques is to improve a degraded image in a sense.

- To develop a method for image data by denoising wavelet domain using the thresholding method using the VisuShrink modeling without using the settings of the sensor.
- To develop the segmentation method this improves the time complexity of the method denoising.

PROPOSED METHOD

SYSTEM MODEL

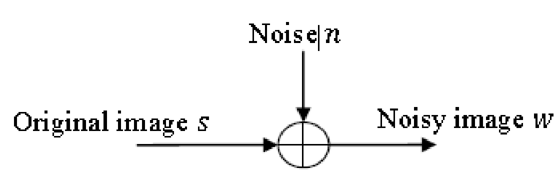
Block diagram of system model using proposed method has been seen in figure 4.1. Block diagram can be divided into two threshold level such as first level threshold and second level threshold. System model consists of various type of block such as noisy image, discrete wavelet transform (DWT), BayesShrink threshold, Inverse discrete wavelet transform (IDWT), Proposed Method and Denoised Image block. These blocks can be described in below.



Detailed Block Diagram of System Model Using Proposed Method

NOISY IMAGE

In this block, an image can be degraded by additive noise and it can produce noisy image. The degradation process model is shown in figure, the additive noise in term of , which can operate the original image and it produce a noisy image . After that noisy image is applied on the discrete wavelet transform.



Noise degradation

Discrete Wavelet Transform

The wavelets are mathematical relations that examine the data corresponding to the resolution or scale. They help in the study a signal at distinct resolutions in distinct windows. The discrete wavelet transform converts the noisy image into multi-resolution discrete functions.

These multi-resolution discrete functions are called as vanishing moments. After that these discrete function of noisy image is applied into the thresholding method.

Thresholding Method

The wavelets thresholding contribute a significant responsibility in the image denoising and image compression. The coefficients of wavelet calculated by the wavelet transform correspond to modify in the time series at a specific resolution. In studying the time series at different resolutions, then it is possible to filter the noise. Several types of thresholding methods are available such as VisuShrink, SureShrink and BayesShrink thresholding. VisuShrink is based on the hard thresholding approach, SureShrink and BayesShrink is based on the soft thresholding approach. These thresholding methods can be removed coefficients of noise and find optimal resolution.

Inverse Discrete Wavelet Transform

After that the decomposition of the image or the data in the coefficients of wavelet, comparing the component of coefficients by a specified threshold value and shrink these coefficients nearby zero to get away the noise effect in the data. The image is restored from the changed coefficients. This process is called as the Inverse Discrete Wavelet Transform. The conversion is orthogonal and invertible; where the inverse transform consists a transpose matrix is the transform matrix. This transpose matrix reconstructs the multi-resolution discrete function into an image.

SIMULATION RESULTS

In this chapter, the proposed method has been applied on original gray scale image such as Lena at distinct noise levels (standard deviation). Performance of noise reduction using proposed method is compared with several existing methods such as VisuShrink, BayesShrink and Bilateral thresholding. It is measure on the basis of error metric such as Peak Signal to Noise Ratio (PSNR), Mean Squared Error (MSE) and in terms of visible quality of images. To measure the performance of proposed method and it is compare with the VisuShrink, BayesShrink and Bilateral thresholding using Peak Signal to Noise Ratio (PSNR) which is defined as the ratio between the square of maximum fluctuations in the input image (R) and Mean Squared Error (MSE), taking of base 10. In other words, the ratio between the maximum possible value (power) of an image signal and the power of infected noise image signal. The Peak Signal to Noise Ratio (PSNR) is generally defined in terms of logarithmic decibel scale. The PSNR is

$$\mathrm{PSNR} = 20\log_{10}\left(\frac{\mathrm{R}^2}{\mathrm{MSE}}\right)\ \mathrm{dB}$$

Where MSE is the Mean Squared Error between the denoised image and the original image and the maximum fluctuations in the input image is . The Mean Squared Error (MSE) is defined as the square of the average errors between the original image signal and noisy image signal. The Mean Squared Error is

$$\mathrm{MSE} = \frac{1}{\mathrm{MN}}\sum_{m=1}^{M}\sum_{n=1}^{N}\{\mathrm{x(m,n)} - \hat{\mathrm{x}}(\mathrm{m,n})\}^2$$

Where M is the width of image,N is the height of image, X(M,N) is the original image and x<(M,N) is the noisy image. Consider the Peak Signal to Noise Ratio has been obtained for Lena image of distinct noise level using proposed method and different existing methods. The higher value of PSNR means, the noisy image signal has been better recovered to compare the original image and better the using methods. This means Mean Squared Error would be minimum between the original image and noisy image. The proposed method determines the application in denoising images those are corrupted throughout the transmission which is generally random in nature. It is observed that the proposed method is better performs compared with other thresholding methods having higher PSNR and lower MSE values for different noise levels (standard deviation and 15).

Comparison of PSNR and MSE of different methods for noise level

Methods	PSNR (dB)	MSE
Noisy Image	28.049374513076387	101.8926622339166
VisuShrink	25.839886653117580	169.4695575312084
BayesShrink	27.679739023545512	89.45362329745875
Bilateral	28.049521730943240	101.8892083180217
Proposed method	28.958217255957077	82.653002623649170

Comparison of PSNR and MSE of different methods for noise level (standard deviation σ = 15)

Methods	PSNR	MSE
Noisy Image	24.707061769525605	219.9754343555744
VisuShrink	24.637127584852987	223.5463598597789
BayesShrink	25.854349286382782	124.6778920634702
Bilateral	24.707248161919410	219.9659935568439
Proposed method	27.892914095830868	105.6304065452395

(a) Original input image (b) Noisy image (c) VisuShrink thresholding (d) BayesShrink thresholding (e) Bilateral thresholding (f) Proposed Spatial Adaptive thresholding

Figure shows the image denoising using various thresholding methods From figure, the proposed spatial adaptive thresholding algorithm provides better performance compared with thresholding methods like VisuShrink, BayesShrink, and Bilateral threshold providing a better PSNR and MSE values.

CONCLUSION

In this thesis, we described image denoising using wavelet transform and various existing algorithms using different technique. The process of removing noise from an image is called as noise reduction or denoising. In this thesis, we have introduced some significant wavelet transforms for image denoising such as VisuShrink, BayesShrink and Bilateral thresholding techniques. After that we proposed Spatial Adaptive thresholding technique for image denoising. This technique is combination of thresholding technique and wavelet dependencies, it is also less complex in comparison other techniques. The advantages of Spatial Adaptive thresholding technique is that it is better performs compared with other thresholding methods having higher PSNR and lower MSE values for different noise levels and gives better visual image quality. By using proposed technique, the PSNR and MSE in the image denoising are 28.958 Db and 82.963 dB as compared to the other techniques.

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