An Efficient Methodology for Removal of Image Noise using Fusion of RCENN, RBFN & Wavelet Transform

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Abstract: Removal of noise from digital image is still a crucial part of image preprocessing. Image data sets collected by image sensors are generally contaminated by noise. Imperfect instruments like digital cameras, scanners and other image capturing devices may create problems with the data acquisition process. Furthermore, noise can be introduced by transmission errors and compression. Thus, noise removal is often a necessary and the first step to be taken before the images data is analyzed. Some application areas of noise removal process are satellite image data and also in television broadcasting. In this paper we are proposing a novel methodology for removal of image noise. Proposed method based on fusion of reduced coloumb energy network, radial basis function neural network wavelet transform and also used model of soft thresholding. Firstly Image decomposed by wavelet transform in to numerous layers, then decomposed layer distinguishes by diagonal, vertical and horizontal. Experimental results on quite a lot of test images are compared with conventional noise removal techniques, Experiments were also complete with different types of image data sets. Experimental results demonstrate that our proposed method removes noise more noteworthy.

Keywords- wavelet transform, soft thresholding, PSNR, noise.

I. INTRODUCTION

Image noise removal is an essential image processing task, both as a process itself, and as a component in other processes. Digital Imaging plays very important role in day to day's activities. So that, today's era, in every field application of an image is considerable and is very important. These are used by the scientists and by the researchers in various fields like in medical field for diagnoses, in remote sensing, vehicle detection, automatic surveillance, and technical diagnosis. These images are captured by camera which uses CCD or C-MOS. This sensor introduces the noise caused by poor luminance. These sensors measure the charge induced by incident photons on the mesh of electro-optical elements. Noise is unwanted signal. This unwanted signal degrades the quality of an image. This may loss some information such as intensity of pixel, curves present in an image, sharpness and curves in an image. The noise introduced in homogenous regions is evaluated. This region containing amount of only random noise patterns and by examining the statistics of resulting fused signal. Relevant statistics in this case, are the variance, the mean value and Probability Density Functions (PDF). Common PDFs found in an image processing applications are Rayleigh noise, Gaussian noise, Gamma noise, Impulse noise, Exponential noise, Uniform noise. These noises are explained in this chapter. The introduced noise in an image may be in additive model or in multiplicative model.

Generally images are affected by the Gaussian noise, which is random in nature. The characteristics of Gaussian noise and Noise models are also explaining here that specify Gaussian additive white noise and Gaussian Multiplicative noise.

Many ways to remove noise or set of data to process on image noise already exists. The main properties of a good image noise removal model are that it will remove noise while preserving edges. In the last few decades, numerous noise reduction techniques have been developed for removing noise in digital images. Most of the standard algorithms use a defined filter window to estimate the local noise variance of a noise image and perform the individual unique filtering process. The primary goal of noise reduction is to remove the noise without losing much detail contained in an image. To achieve this goal, we make use of a 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 according to the local statistics within the bands. The main advantage of the wavelet transform is that the image fidelity after reconstruction is visually lossless.

II. IMAGE NOISE

Image noise is an undesirable result of image capture that adds forged and inappropriate information. The real meaning of noise was and remains 'unwanted signals'. Noise is undesired information that pollutes the image. In the image noise removal process, information regarding the type of noise present in the unique image plays a important role. Typical images are ruined with noise modeled with whichever a Gaussian, uniform, otherwise salt or pepper distribution. A further typical noise is a speckle noise, which is multiplicative in nature. Noise is present in an image either in an additive or multiplicative form. Some variants of noise also describing here.

(a) Gaussian Noise

Gaussian noise is consistently distributed over the signal. This indicates that every pixel in the noisy image is the amount of the true pixel value in addition to a random Gaussian distributed noise value. This type of noise has a Gaussian distribution, which has probability distribution function given by, a bell fashioned

$$F(g)=\frac{1}{\sqrt{2\pi\sigma^2}}e^{-(g-m)^2/2\sigma^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where g stands for the gray level, m is the average of the function and σ is the usual deviation of the noise. Graphically, it is symbolized as shown in Figure 2.1 When set up into an image, Gaussian noise by means of zero mean and variance as 0.05 would seem as in Image 2.2(a). Image 2.2(b) demonstrate the Gaussian noise through mean (variance) as 1.5 (10) over a base image with a constant pixel value of 100.

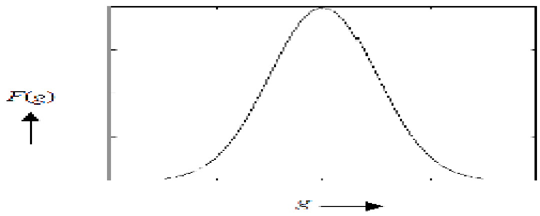

Figure 2.1: Gaussian distribution

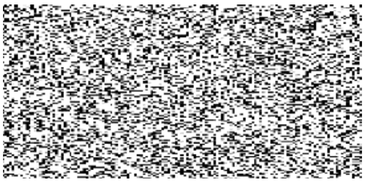

Figure 2.2: (a) Gaussian noise noise (mean=0 variance=0.05)

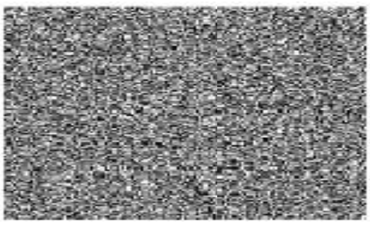

Figure 2.2: (b) Gaussian noise (mean=1.5 variance=10)

(a) Salt and Pepper Noise

Salt and pepper noise is an impulse kind of noise, which is too referred to as strength spikes. This is because of generally by reason of errors in data transmission. It has only two probable values, *a* and *b*. The probability of each is usually less than 0.1. The corrupted pixels are set instead to the smallest or to the highest value, giving the image a “salt and pepper” like look. Unaffected pixels stay unchanged. Intended for an 8-bit image, the classic value for pepper noise is 0 and in favor of salt noise 255. The salt and pepper noise is usually caused by malfunctioning of pixel essentials in the camera sensors, defective memory locations, or timing fault in the digitization procedure. The probability density function for this type of noise is demonstrated In Figure 2. 3. Salt and pepper noise through a variance of 0.05 is illustrated in Image 2.4.

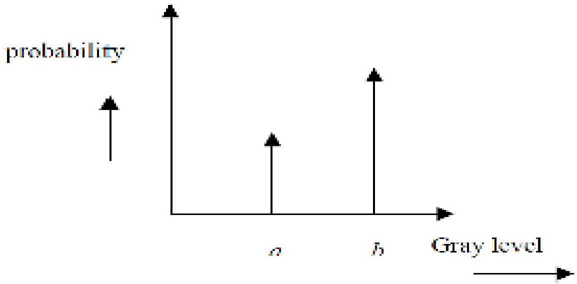

Figure 2.3: PDF for salt and pepper no

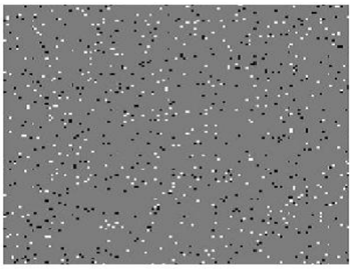

Figure 2.4: salt and pepper noise

(C) Speckle Noise

Speckle noise is a multiplicative noise. These kinds of noise happen in almost all coherent imaging systems for example laser, acoustics and Synthetic Aperture Radar (SAR) imagery. The foundation of this noise is accredited to random interfering among the coherent returns. Totally developed speckle noise have the attribute of multiplicative noise. Speckle Noise pursues a gamma distribution and is given as

$$F(g)=\frac{g^{\alpha-1}}{(\alpha-1)!a^{\alpha}}e^{-\frac{g}{a}}$$

Where variance is *a*2α in addition to *g* is the gray level. Lying on an image, speckle noise (through variance 0.05) looks as demonstrated in Image 2.6. The gamma distribution is given below in Figure 2.5.

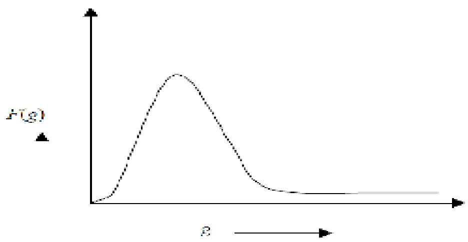

Figure 2.5: Gamma distribution

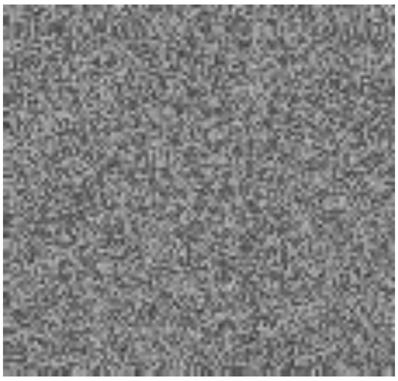

Figure 2.6: Speckle noise

(C) Brownian Noise

The Brownian noise comes under the class of fractal or 1/*f* noises. The numerical model for 1/*f* noise is fractional Brownian motion. Fractal Brownian motion is a non stationary stochastic procedure that follows a standard distribution. Brownian noise is a particular case of 1/*f* noise. It is attain by integrating white noise. It can be graphically symbolize as shown in Figure 2. 7. Lying on an image, Brownian noise would seem like Image 2.8 which is build up from Fraclab.

Figure 2.7: Brownian noise distribution

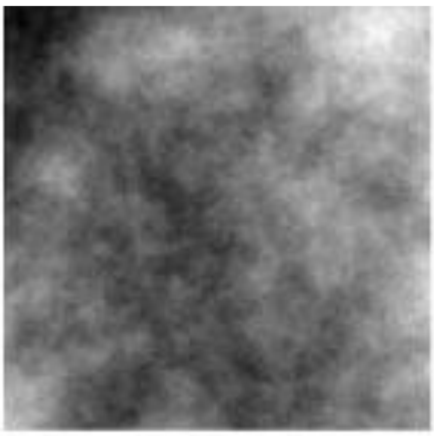

Figure 2.8: Brownian noise

III. CURRENT NOISE REMOVAL TECHNIQUES

Various noise removal techniques have been proposed so far and their application depends upon the type of image and noise present in the image. Image noise removal is classified in two categories:

Spatial domain filtering

This is the traditional way to remove the noise from the digital images to employ the spatial filters. Spatial domain filtering is further classified into linear filters and non-linear filters.

Linear Filters

A mean filter is the optimal linear for Gaussian noise in the sense of mean square error. Linear filters tend to blur sharp edges, destroy lines and other fine details of image. It includes Mean filter and Wiener filter.

a. Mean Filter

This filter acts on an image by smoothing it. It reduces the intensity variations between the adjacent pixels. Mean filter is nothing just a simple sliding window spatial filter that replaces the centre value of the window with the average values of its all neighboring pixels values including itself. It is implemented with the convolution mask, which provides the results that is weighted sum of vales of a pixel and its neighbors.

It is also called linear filter. The mask or kernel is square. Often 3×3 mask is used. If the coefficient of the mask sum is up to one, then the average brightness of the image is not changed. If the coefficient sum to zero, average brightness is lost, and it returns a dark image.

b. Weiner Filter

Weiner filtering method requires the information about the spectra of noise and original signal and it works well only if the underlying signal is smooth. Weiner method implements the spatial smoothing and its model complexity control corresponds to the choosing the window size. H(u,v) is the degradation function and H(u, v)* is its conjugate complex. G(u, v) is the degraded image. Functions Sf(u, v) and Sn(u, v) are power spectra of original image and the noise. Wiener Filter assumes noise and power spectra of object a priori.

$$f(u,v) = \left[\frac{H(u,v)^*}{H(u,v)^2 + \left[{Sn(u,v)}/{Sf(u,v)}\right]}\right] G(u,v)$$

Non- Linear

With the non-linear filter, noise is removed without any attempts to explicitly identify it. Spatial filters employ a low pass filtering on the group of pixels with the assumption that noise occupies the higher region of frequency spectrum. Generally spatial filters remove the noise to reasonable extent but at the cost of blurring the images which in turn makes the edges in the picture invisible.

a. Median Filter

Median filter follows the moving window principle and uses 3×3, 5×5 or 7×7 window. The median of window is calculated and the center pixel value of the window is replaced with that value.

2. Transform domain filtering

The transform domain filtering can be subdivided into data adaptive and non-adaptive filters. Transform domain mainly includes wavelet based filtering techniques.

IV. PROPOSED METHOD

In this paper we proposed a novel methodology for image noise removal based on wavelet thresholding and radial biases neural network. Initially the discrete wavelet transform function is applied into input image. Now input image decomposed in to layer structure form. After that we calculate horizontal, vertical and diagonal coefficient of input image, after that we apply soft thresholding technique and generate trained pattern using RCE algorithm. In RBF network we used Gaussian based kernel function. The RCE algorithm generates a trained pattern for the removal of noise. In that process the variance factor of noise is increase and the target PSNR value is achieved. As known, the high-order statistical relationship does play an important part in image filtration technique area. So in order to take advantage of the high-order statistical relationship among variables, so we used RCE algorithm for training the network. Proposed

noise removal filter is a three-layer neural network with inputs derived from an NxN

neighborhood of the transformed image and appropriately selected neuron activation functions. As shown in Figure 6.6, the network takes Yp and ΔYk as the inputs, where Yp is the wavelet transform coefficient under consideration, which is the center of a N x N processing window, and ΔYk=Yk -Yp is the difference value between Yp and the coefficient Yk (k=0,1,…,N2-1, kΔp) of the other points in the N x N window.

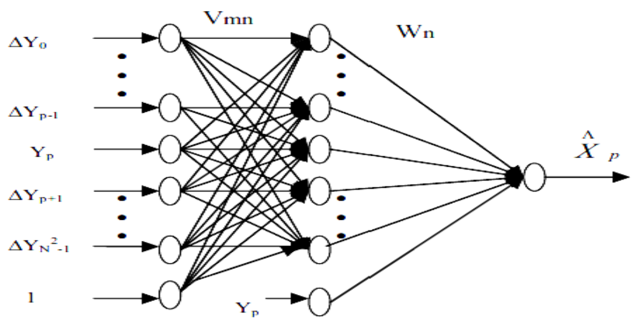

Figure 4.1: Neural network structure

The output of network is linear activation function.that activation function perform the targeted output of PSNR value.

Step for proposed methodology.

1. Start.
2. Input: image I.
3. Execute wavelet transform WT on image I.
4. Do decomposition, image I.
5. Locate horizontal, vertical and diagonal coefficient of wavelet.
6. Execute WT soft thresholding.
7. Verify value of coefficient of wavelet.
8. Fix on the dimension of vector input 3x3.
9. Perform training on network N.
10. Execute target value of activation function F.
11. Locate PSNR with difference.
12. Output: Noise free image D with result.

Block Diagram of Proposed Method

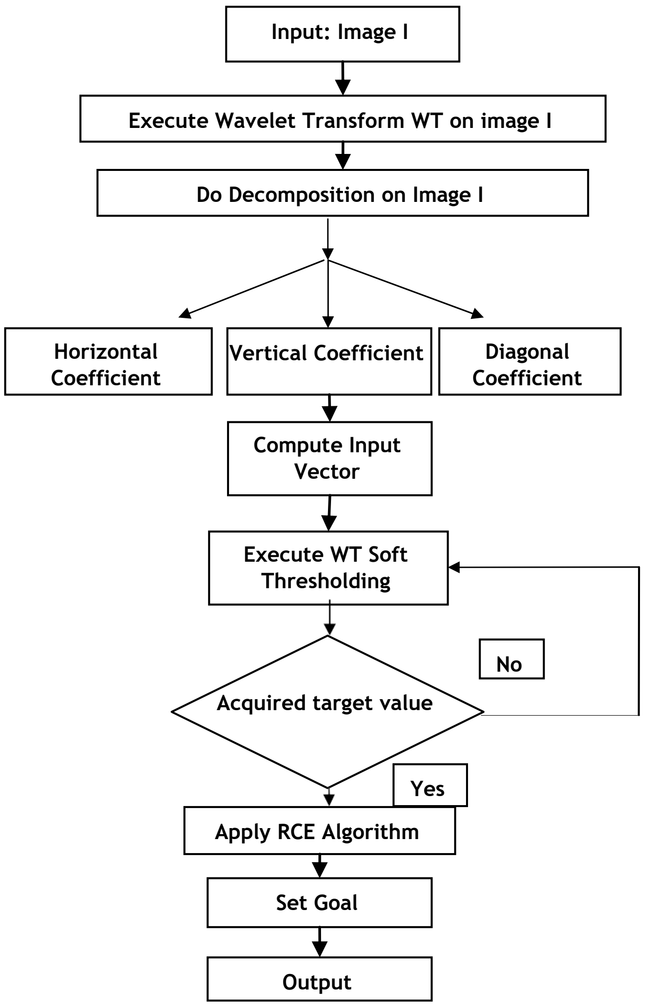

Figure 4.2: Absolute block diagram of proposed method

V. IMPLEMENTATION AND RESULTS

To examine the efficiency of the proposed technique for image noise removal and image filtration we execute various experimental job; all these jobs perform in matlab software and well-known image data set such as Lena, Barbara, and cameraman and x-ray image of finger. For experimental estimate of our proposed method for image noise removal we used very famous image such as Lena, Barbara, finger and cameraman. All images are gray scale and size of resolution is 512*512.

Result analysis

Here we are giving a image-wise tabular analysis of above explained methods as per achieved PSNR.

It is well known that higher PSNR (Peak-Signal-to-Noise-Ratio) will give better image quality. Following tables shows the different values of PSNR for old methods, base paper method and proposed method.

(a) For Lena image resolution 512* 512 and variance 0.006

Table 5.1: Shows the PSNR value of all method applied on Lena image

Noise removal method	PSNR(DB)
ANN	32.37
ANN + Edge Preserving	30.75
Winner Filter	33.30
Proposed Method	33.62

(b) For finger image resolution 512* 512 and variance 0.006

Table 5.2: Shows the PSNR value of all method applied on finger image

Noise removal method	PSNR(DB)
ANN	23.19
ANN + Edge Preserving	23.14
Winner Filter	23.73
Proposed Method	26.11

(c) For cameraman image resolution 512* 512 and variance 0.006

Table 5.3: Shows the PSNR value of all method applied on camera man image

Noise removal method	PSNR(DB)
ANN	25.76
ANN + Edge Preserving	25.89
Winner Filter	28.50
Proposed Method	29.47

(d) For Barbara image resolution 512* 512 and variance 0.006

Table 7.4: Shows the PSNR value of all method applied on Barbara image

Noise removal method	PSNR(DB)
ANN	22.76
ANN + Edge Preserving	23.03
Winner Filter	25.23
Proposed Method	25.68

Comparative Result Analysis

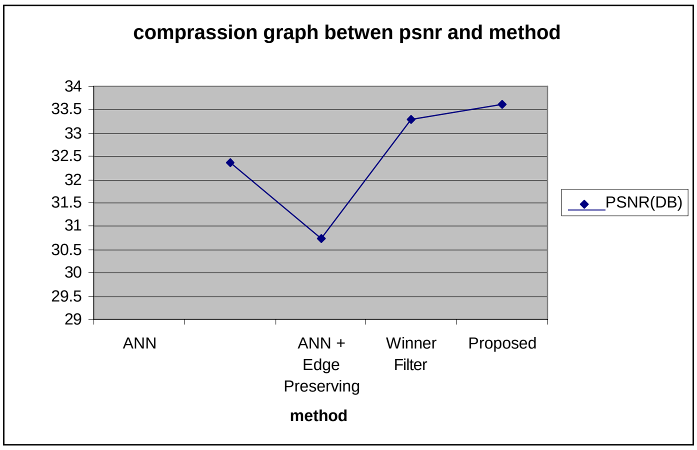

Figure 5.1**:** Shows that comparative PSNR value for image improvement for Lena image.

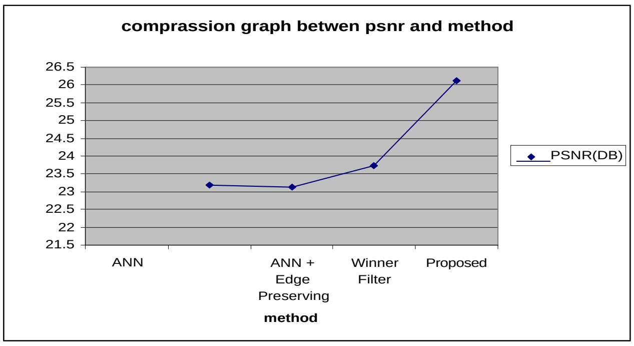

Figure 5.2: Shows that comparative PSNR value for image improvement for finger image.

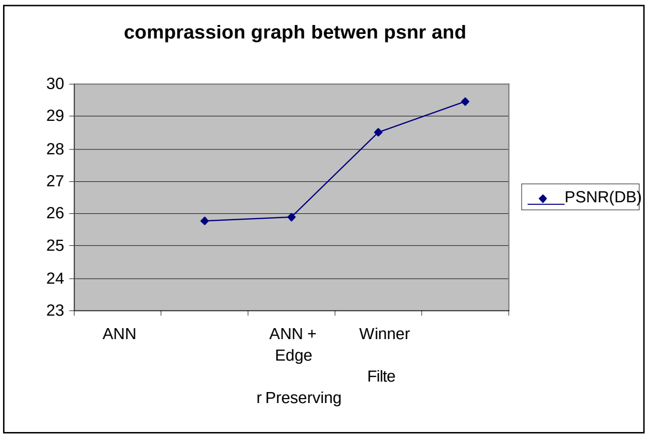

Figure 5.3: Shows that comparative PSNR value for image improvement for camera manimage.

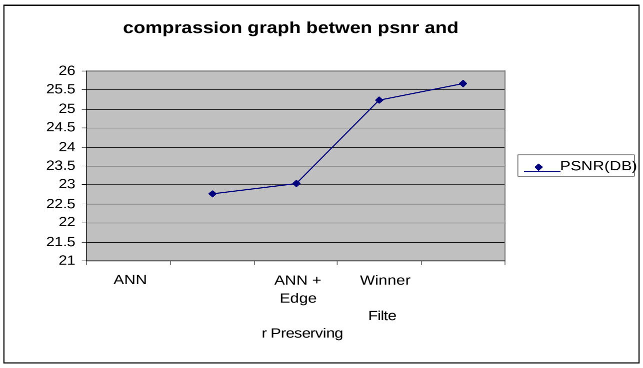

Figure 5.4: Shows that comparative PSNR value for image improvement for camera manimage.

VI. CONCLUSION

In this paper a fusion method based on wavelet transform and RBF neural networks is proposed. RBF were used to find correlation between noised and original wavelet coefficients and approximation. Also multiscale wavelet edge detection was used for achieving a better noise removal quality. Experimental results demonstrated capability of proposed method to remove noise in terms of PSNR and visual quality. Different architectures and different activation functions is considered. The experimental results show the mean with the traditional noise removal methods, the proposed threshold-based noise removal digital image noise removal algorithm for mixed digital image noise removal is relatively clear, especially in the more noise, more complex cases", can show its good performance.

The proposed method is also capable to remove noise of natural images and gives better results during neural network training as compared to results of neural network training of standard images.

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