Image Enhancement Technique Using Symlet and Daubechies Wavelets

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Abstract: ***Images are used in a variety of fields for image analysis and image understanding. Digital images are usually degraded by various types of noise due to sensor problems, weather problems and so on. In this paper, we represent a new technique for removing noise from images. This technique integrates Symlet and Daubechies discrete wavelet family members, thresholding and fast fourier thresholding and neural network. This proposed method is tested on a set of images. The proposed method gives good results in terms of PSNR and MSE values***

Keywords: Symlet and Daubechies Discrete Wavelet Families, Thresholding Rule, Fast Fourier Thresholding, Neural Network, Gaussian Noise, Peak Signal to Noise Ratio(PSNR), Mean Square Error(MSE).

1. Introduction

Image enhancement is the process of adjusting digital images so that results are more suitable for further image analysis and image understanding. Image enhancement refers to the sharpening of image features so that it appears more pleasing to an observer for a specific task. The word specific is important because may be given method is useful for one application, but not suitable for another application It does not increase any inherent information content in digital images. Main objectives of image enhancement are gray level manipulation, noise reduction, filtering, resolution enhancement, segmentation and so on. In this process some improvement of digital images is done so that image quality increases without knowing the causes of degradation. In our method different levels of Gaussian noise are added in the original images. Different wavelet families are applied to noisy images. For further processing, thresholding and fast fourier thresholding is applied to processed image pixel values. At the end, image is recovered with the help of neural network.

2. Literature Survey

A lot of research work has been done by different researchers and scholars in the image enhancement field. There are varieties of techniques for image enhancement. There is a concept of combining adaptive filters with neural networks so that it may be able to collect high level information about the image contents. These types of filters have no need of specific knowledge and can be applied on broad categories of images [1]. A new method for fingerprint matching is based on the features extracted by using a new multiresolution analysis tool called digital curvelet transform is proposed [2]. This method is applied on a small set of database. It also compares different wavelets results with curvelet transforms that are applied on given set of database. It also suggests for modifying given method to work for larger databases and to attain even lower computational complexity [2]. For overcoming the problem of failing of histogram equalization on discrete images, a local-mean based method is proposed. Experiment results prove that enhancement performance is approved and speed of obtaining enhancement results is also improved [3].

Another hybrid filter for denoising and enhancing digital images is presented in this paper [4]. This method works where image is degraded with salt and pepper noise. This hybrid filter is a combination of nonlinear switching median filter and neuro-fuzzy network. This filter is not only quite effective in removing impulse noise, but also preserves image features. This filter is suitable for real time implementation.

Patil Pradeep M. et. al studies different image resolution enhancement techniques by using wavelet transforms. Basic functions of wavelet transforms are obtained using the scaling and translation of a the scaling function. Wavelet transforms are located in both time and frequency domain. Different enhancement techniques are compared such as Wavelet Zero Padding (WZP), Cycle Spanning (CS), Dual-Tree Complex Wavelet Transform (DT-CWT), Discrete Wavelet Transform (DWT), Stationary Wavelet Transform (SWT). Combination of DWT-SWT gives better results as compared to other methods [5].

Yashu Rajput et. al. presents a method for medical image enhancement, which is based on non-linear technique. This technique is a combination of histogram equalization and the discrete wavelet transforms. Experiment results prove that DWT removes noise from given images, enhances image contrast and preserves the original image quality [6]. This paper focuses on another enhancement technique with respect to spatial resolution. In this technique, stationary wavelet transform and Integer wavelet Transform divides the given input image into different sub bands having different frequency coefficients. Then the low resolution input image and high frequency sub band images are interpolated using bi cubic interpolation. Then inverse discrete wavelet transform has been used to combine all these sub images. The proposed technique is tested on different test images [7].

In our method we have used a combination of Symlet and Daubechies discrete wavelet families, average thresholding rule to compare image pixel values, fast fourier thresholding is applied for getting better results and then neural network is used for recovering back the original images.

3. Proposed Work

The proposed work is divided into different modules, as shown in Fig.1

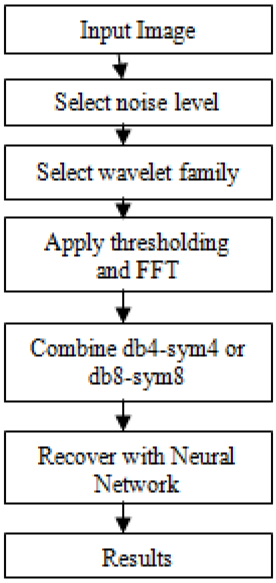

Figure 1: Module diagram

3.1 Image Acquisition

Firstly step is image acquisition and capturing of image is done through Samsung Phone based camera of 5 Mega Pixel. Captured image size is less than 300 KB.

3.2 Select Noise Level

Gaussian Noise is added in the original image. It represents statistical noise having normal distribution. It arises during the image acquisition process for example sensor noise due to poor illumination, bad weather conditions and so on. In this different noise levels are added in original image such as 20%, 40%, 60% etc.

3.3 Select Wavelet Family

On noisy image, two wavelet families are applied i.e. Symlet and Daubechies. Daubechies wavelet has a high frequency coefficient spectrum than the Haar wavelet. Daubechies wavelet is used in solving problems such as fractal problems, signal discontinuities etc. Symlet wavelets are enhanced versions of daubechies wavelets. The operation for Daubechies and Symlet DWT is more effective than other wavelets of the wavelet family. It has been applied to images of multi resolution representation.

3.4 Apply Thresholding and Fast Fourier Thresholding

After applying different wavelet families on noisy image, it puts DWT into wave form. On image pixels thresholding value is applied so that any pixel value does not exceed from thresholding value. Thresholding value is calculated with the help of average thresholding rule.

$$\text{Average Thresholding rule} = \frac{\text{sum of all the pixels in the image}}{\text{No. of pixels in the image}}$$

3.5 Combine DB4-SYM4 DWT or DB8-SYM8 DWT

After applying thresholding and fast fourier thresholding on respective wavelets, outputs of respective family members are combined with each other for further processing, whether it is a combination of db4-sym4 or db8-sym8

3.6 Recover With Neural Network and Canny Edge Detector

For edge detection, output of the FFT is inputted to canny edge detector, also known as the optimal detector, as it offers minimum error rate, good localization and minimal responses per edge. To get back original image, neural network is applied as it gives better results.

4. Pseudo code implementation

```
i. Input image
ii. Select noise level

   for i = 1 : length(img)
   img_value = img_value + noise.val();
iii. Select a wavelet for the processing
       If(wav_val== db4)

   [bit-val, coefficient-val] = dwt(image-name, “db4”)
   Value-text = dwt(bit-val, “sym4”)
   Plot(value-next);
   Noisy-value = value-next + previous value;
   Else
   [bit-val, coefficient-val] = dwt(image-name, “db8”)
   Value-text = dwt(bit-val, “sym8”)
   Plot(value-next);
   Noisy-value = value-next + previous value;
iv. Apply threshold selection rule();
v. If(bit-value > avg.value)
        {bit-value = avg.value
        }
vi. Image reconstruct ();
vii. Calculate PSNR
```

5. Results and Discussions

The proposed method was implemented with Matlab 7.0 version. The proposed algorithm given in the above section is implemented in this section. The performance of the proposed algorithm tests under various noise conditions and applied to a different set of images where size of images is less than 150 KB. These images are collected from real scenes. The performance of given method and reconstructed image quality is measured using Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR). MSE and PSNR are two error metrices for comparing image quality.

A.PSNR

PSNR is defined as the ratio of the reference signal to the distortion signal. A higher PSNR value indicates higher quality of reconstructed images.

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

Where R indicates the maximum fluctuation in image data type.

B.MSE

MSE is defined as the average squared difference of the reference signal and distortion signal. Lower value of MSE indicates a lower error in the signals.

$$MSE = \frac{\sum_{M,N}[I_1(m,n) - I_2(m,n)]^2}{M * N}$$

Where m and n are the rows and columns of the input images.

Figure 1: Original image

Figure 2: Noisy image

Figure 3: Reconstructed image

The pictorial results are shown in above figure. This hybrid method gives good results, enhances performance, it is a good model for denoising noises from images.

Table 1: Evaluation metrics with gaussian noise 20% and 40%

Parameters	*PSNR(db)*	*MSE*
Proposed method with db4-sym4 dwt	71.125	0.01
	71.372	0.01

Table 2: Evaluation metrics with gaussian noise 20% and 40%

Parameters	*PSNR(db)*	*MSE*
Proposed method with db8-sym8 dwt	70.997	0.01
	71.091	0.01

6. Conclusion

In this paper, a hybrid technique is represented for image enhancement that integrates Symlet and Daubechies discrete wavelet family members, thresholding rule and fast Fourier thresholding and neural network. Gaussian noise is added in different images up to different levels. Experiments results prove that proposed method enhances image quality and also removes noise from images.

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