Optimization of Diversified Images by Using Discrete Wavelet Transform

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***Abstract*: In the following paper the author has proposed an algorithm based on Discrete Wavelet Transform to enhance the low contrast image. This algorithm is based on thresholding, mean, minimum, maximum and standard deviation only. In this noise is added repeatedly, and also utilize the well known histogram technique of image processing. Easy to implement in any generalized image is an advantage of this proposed algorithm. To verify the utility of this algorithm, this is applied to low contrast standard Lena image and other real life images.**

Introduction

The field of image processing has made significant progress in the quantitative analysis of biomedical images over the last 20 years. In certain domains, such as brain imaging, scientific papers that test clinical hypotheses using sophisticated image filtering and segmentation algorithms are not uncommon. Compared to the vast amount of research in medical Imaging modalities such as MRI and CT, the number of scientific papers on electron microscopy applications in the image processing community has been very limited. Tasdizen proposed an automatic method for estimating the illumination field using only image intensity gradients [1]. The computational analysis of neurons entails their segmentation and reconstruction from TEM images but is challenged by the heavily textured nature of cellular TEM images and typically low signal-to-noise ratios. Tasdizen proposed a new partial differential equation for enhancing the contrast and continuity of cell membranes in TEM images [2].

A microscopy image gets corrupted by noise, which may arise in the process of acquiring the image, or during its transmission, or even during reproduction of the image. Analysis and comparison of various filters were made on TEM image for denoising and was found that the performance of the Wiener Filter after de-noising for all Salt & Pepper, Poisson and Gaussian noise is better than Mean filter and Median filter. Also, the performance of the Median filter after de-noising for all Salt & Pepper noise is better than Mean filter and Wiener filter [3].

In recent time the surveillance systems are in demand for security and safety. The problems of remote surveillance have received growing attention, especially in the context of public infrastructure and monitoring. For surveillance application, in the night time at the line of control, discrete wavelet transform is useful to enhance very low contrast images. Discrete wavelet transform based contrast enhancement has two advantages over the other enhancement techniques. Firstly, it is able to enhance very low contrast images. This is because; in this approach Gaussian random noise is added to all pixels of very low contrast image and then threshold the noisy image.

Since the added noise is random, so, the threshold image for individual random noise is different. Now, multiple noisy threshold images are averaged, which is basically non-linear averaging. The error generated due to non-linearity (threshold) (in one noisy image) is minimized by averaging of different threshold noisy images. So, it enhances specially those regions where pixels information is very-very less. Secondly, there is no blocking or spot kind of artifacts introduced in DWT enhanced image. This is due to averaging operation or linearity operation of multiple threshold images.

In this chapter a novel enhancement techniques are investigated. Both these techniques are based on conventional DWT phenomenon. Gaussian noise is used in DWT phenomenon for image enhancement. The density of low intensity noise samples in Gaussian noise is greater than density of high intensity noise samples. Due to this the higher intensity values in the low contrast image becomes one and the lower intensity values becomes zero after addition of Gaussian noise and thresholding. This gives better contrast in the low level image so the dynamic range of the image increases.

Secondly, averaging number of noisy frames reduces noise present in the image and so quality of enhanced image increases.

To extract information from low contrast image, a new Wavelet transformation based enhancement algorithm is proposed. The new method is based on goodness of the noisy low contrast image which is a statistical approach. This approach focuses on finding the overall goodness of noisy image which describes the optimal noise standard deviation for enhancement of very low contrast images.

In image processing applications, linear filters tend to blur the edges and do not remove Gaussian and mixed Gaussian impulse noise effectively. Previously, a number of schemes have been proposed for Gaussian mitigation. Inherently noise removal from image introduces blurring in many cases. The ideal approach is to apply the filtering technique only to noisy pixels, without changing the uncorrupted pixel values. Non-linear filters such as Adaptive Median Filter (AMF), decision–based or switching median filters can be used for discriminating corrupted and uncorrupted pixels, and then apply the filtering technique. The performance of hybrid median filter is better than that of Lee, Kuan, Frost, Median, Truncated median filters. Hybrid Max Filter performs significantly better than many other existing techniques and it gives the best results after successive iterations. Madu S. Nair applied median filter to R-, G-, and B-planes individually, and then combined to form the restored color image and the result proved much better than SMF, AMF and decision based median filters. Median Filter performed satisfactorily on different medical images like MRI, Cancer, X-ray and Brain.

DWT Based Image Enhancement Technique

This section discusses the first new proposed technique for enhancement of images. From transformation technique, it is well known that any random signal can be represented as sum of sinusoidal components of different frequency, amplitude and phase. Same is true for images also. When a Gaussian noise of standard deviation σ is added to the image and the noise added image is thresholded the SNR of output signal is given by equation which is of the form

$$SNR = \frac{P_s(f)}{P_n(f)} = \frac{2f_0\Delta_0^2}{\sqrt{3}\sigma^4}\sum_{i=1}^{N}[B_i^2]exp\left(-\frac{\Delta_0^2}{2\sigma^2}\right).$$

Where *Bi* is the amplitude of i th sinusoidal component of input signal.

Approximate Gaussian filtering of equidistant data can be obtained by regularizing the data with Tikhonov's second order stabilizing functionals. The correspondence between the resulting cubic spline functions and Gaussian functions was first shown by Poggio. The impulse response arising from cubic spline approximation is however not positive everywhere. As an alternative, approximating cubic splines under tension was considered in 1989 by Johannes and a fast implementation was proposed that requires the same amount of calculations for all values of the spread. The equivalence of minimum-norm least-squares solutions of systems of linear equations and standard iterative methods of solution is well established. On the other hand, while it is generally understood that truncated iteration is a form of regularization, comparatively few papers have formalized the relationship between direct methods of regularization and truncated iteration. A brief review of such papers was presented. It was proved that solutions by direct regularization are in fact identical to solutions of a certain type of truncated-iterative method, and conversely. This equivalence is proved by construction for a very general form of regularization method in which the coefficient matrix has full rank and is rectangular.

Proposed Methodology

To implement the above stated algorithm, one has to follow the following steps: The proposed new DWT based image enhancement techniques are given below.

- **Step-1** Very low contrast image img(*x; y*) is taken as an input image. Set $\sigma = \frac{M}{2}$ where M is average image intensity value.
- **Step-2** First plots the histogram of low contrast input image. Decide its threshold using histogram concept. Let it be T_1
- **Step-3** Using this threshold concept the given image is divided into two parts. Let us assume it may be I_1 and I_2.
- **Step-4** Take mean of the values of I_1 and I_2. Imin and Imax are the value of mean of each part of input image.
- **Step-5** Now calculates another threshold for calculating range of standard deviation. This can be taken as square root of variance of image. Let this threshold be T_2
- **Step-6** Now Calculate the range of Standard deviation using value Imax and Imin as given below.

Governing Equation of Enhanced Image

Smin = T_2

Smax = sqrt ((T_2+Imax)*(Imin+Imax+2* T_1))/2

Here Imax and Imin representing the highest and lowest luminance of image.

1. Decide the no of Frames, it is randomly chosen. In this thesis it is taken as 100.
2. Starting from Smin to Smax obtain one image corresponding to every increment. The increment is decide by the computation availability and quality of image enhancement in each step
3. To obtain output images. Optimized image is decided based on varies parameter

   For every frame
   Img (x, y)=img (x, y)+noise(I, mean)
   I belongs [Smin Smax]

For Calculating the Variance of this Noise image.

Take square root. Let it be Tn

Now make comparison of image intensity with

This Tn and add 255 if greater else add zero.

Divide this sum up array with No. of frames.

Result and Discussion

Enhanced and informative image is necessary requirement of many real life applications. For the verification of efficiency of this proposed algorithm, works start with standard Lena image. First take low contrast Lena image of size 512x512 and applied proposed mention algorithm. The output image is well enhanced in visualization. Here in DWT behavior is opposite to general believes about it. Traditionally believe that noise is destructive and presence of this can make system worse. Figures show the algorithm performance on Lena image. Also plot the PSNR value with number of frame of noise. It is found that increase with increasing the number of noise frame, optimal value of PSNR reach. After optimal value PSNR start decreasing with increasing the number of frame and constant with it after a certain values. The plot between PSNR with number of frames is given below. PSNR values are calculated using the following formula.

$$\mathrm{PSNR} = 10\log_{10}\frac{255^2}{\mathrm{MSE}}$$

The mean square error (MSE) is is calculated using this equation.

$$\mathrm{MSE} = \frac{1}{M \times N}\sum_{i=1}^{M}\sum_{j=1}^{N}(y(i,j) - x(i,j))^2,$$

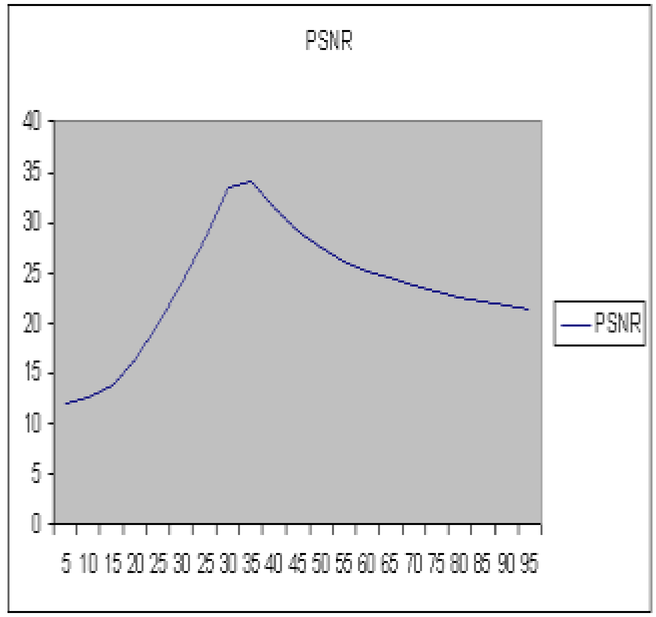
Here M and N are the number of rows and columns of input low contrast image.

Test Low Contrast Lena image

Optimal Lena image

S_{min} Lena image

S_{max} Lena image



The value of PSNR remains same for certain range of value. This value is dependent on property of image.

After get enhanced image with proposed algorithm, applied this algorithm to the other images of different size. Take low contrast cartoon image of size 256x256 and applied proposed algorithm. The enhanced image is given in figure.

Low contrast cartoon image

Enhanced cartoon image

Enhancement of cartoon image along Lena image clearly indicate that this algorithm can be apply of useful images like thumb impression, biomedical images and other low contrast images. It can also be applied for color images also.

Conclusion

Wavelet based algorithm enhanced the low contrast image by using thresholding. Easy to implement is an advantage of this algorithm. Here noise plays a constructive role in place of degrade the system perforations. Image is getting Enhanced according to the property of original image hence in the obtained results no spot are seen which make this method more acceptable.

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