Review: Restoration of degraded Images by using various Denoised Methods

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ABSTRACT - Image Denoising as well as enhancing is basically one of the fundamental challenges in the field of image processing and computer vision for improving the interpretability or awareness of information in images for human being spectators and providing `better' input for other automated image processing techniques. The fast development of digital image processing leads to the development of feature extraction of images such as Image fusion techniques as PCA and Discrete Wavelet Transform to minimize structural distortions. Now, after fusion basic problem in image processing is to suppress the noise in corrupted image by using image resolution enhancement and denoising. Histogram equalization (HE) is simple technique for enhancing image quality. The method here adapts itself to various types of image noise as well as factor that are to be derived to estimate the noise-free coefficients. Edges play an important role in image representation, one effective means to enhance spatial resolution is to enhance the edges. Effectiveness of various methods is compared with all other techniques such as median, wiener, Bayes shrink and Normal shrink methods for removing noise. This paper presents a review of some significant work in the area of the denoising with Homomorphic filtering techniques and summarizes related research work in this area.

Keywords: DWT, Fusion, HE, Denoising, Homomorphic filters.

I. INTRODUCTION

Image denoising is a fundamental process in image processing, pattern recognition, and computer vision fields. The main goal of image denoising is to enhance or restore a noisy image and help the other system (or human) to understand it better. Image denoising is used to remove the noise while retaining as much as possible the important signal features. The purpose of image denoising is to estimate the original image form the noisy data. Image denoising is still remains the challenge for researchers because noise removal introduces artifacts and causes blurring of the images.

One of the fundamental challenges in the field of image processing and computer vision is image denoising, where the underlying goal is to estimate the original image by suppressing noise from a noise-contaminated version of the image. Image noise may be caused by different intrinsic (i.e., sensor) and extrinsic (i.e., environment) conditions which are often not possible to avoid in practical situations. Therefore, image denoising plays an important role in a wide range of applications such as image restoration, visual tracking, image registration, image segmentation, and image classification, where obtaining the original image content is crucial for strong performance. While many algorithms have been proposed for the purpose of image denoising, the problem of image noise suppression remains an open challenge, especially in situations where the images are acquired under poor conditions where the noise level is very high.

As we know **Image fusion** is the process of matching two images so that corresponding coordinate points in the two images correspond to the same physical region of the scene being imaged or Produce a single image from a set of input images. It aims to reduce amount of data, retain important information. So, various techniques of fusion are: High pass filtering technique, IHS transforms based image fusion, PCA based image fusion, Wavelet transforms image fusion, and Stationary Wavelet transforms image fusion.

The different fusion techniques are studied which are used to generate high resolution image that attempts to preserve the spectral characteristics of the original data. The selection of the fusion method for an application depends largely on the dataset. For image fusion methods, spatial enhancement and spectral preservation are all critical issues. In this paper, a new image fusion method is introduced and used which is the fusion outcome of SWT, DWT and PCA as it presents the best result for both visual and quantitative evaluations.

Image resolution enhancement is a technique that helps to obtained high-resolution images from low-resolution images. It is needed to achieve a good effect of vision, in an improved effective image resolution, required for a good quality of images where it is required to adjust in a better size of image. It is mainly used in practical applications, such as robot vision, medical system, police system, remote image and image disposal software [1]. Improved investigation of high resolution image won the breakthrough progress**.** There are many types of enhancement technique such as: Histogram Equalization (HE), Brightness Preserving Bi-Histogram Equalization (BBHE), Dualistic sub-Image Histogram Equalization (DSIHE), Minimum Mean Brightness Error Bi-Histogram Equalization (MMBEBHE), Recursive Mean Separate Histogram Equalization (RMSHE), Recursive Sub-Image Histogram Equalization (RSIHE), Recursively Separated and Weighted Histogram Equalization (RSWHE), Dynamic Histogram Equalization (DHE), Logarithmic Transformation, Powers-Law Transformations (Gamma Correction), Adaptive Gamma Correction and Weighting Distribution (AGCWD), etc.

Histogram Equalization (HE) is the best technique as an image is a graphical representation of the number of pixels in an image as a function of their intensity that uses the histogram. The histogram equalization technique is used to stretch the histogram of the given image. Greater is the histogram stretch greater is the contrast of the image.

II. LITERATURE SURVEY

C. G. Ravichandran and Magudeeswaran (2012) proposed mean brightness preserving Histogram Equalization based techniques for image enhancement that partition the histogram of the original image into sub histograms and then independently equalize each sub-histogram with Histogram Equalization. Results of this proposed techniques was done under low quality images which results in computationally effective that makes it easy to implement and use in real time systems. **Swati Khidse (2013)**, here author proposes various image enhancement techniques with image fusion techniques, which help out in various error analysis techniques. Image fusion techniques are assessed using the various metrics. **Ashishgoud Purushotham, at el.(2015),** result of fusion is a new image which is more suitable for human and machine perception. Pixel level image fusion using wavelets and principal component analysis have implemented and worked on different performance metrics with and without reference image which concluded that image fusion using wavelets with higher level of decomposition showed better performance in some metrics and in other metrics PCA showed better performance. DWT in all parameters performs better than the PCA fusion algorithm so finally we can conclude that DWT is performs better than PCA. **B Siva Kumar et al.** (2103) proposed an image resolution enhancement technique based on interpolation of the high frequency subband images obtained by discrete wavelet transform (DWT) and the input image. The edges are enhanced by introducing an intermediate stage by using stationary wavelet transform (SWT). DWT is applied in order to decompose an input image into different sub-bands. Then the high frequency sub-bands as well as the input image are interpolated. The estimated high frequency sub-bands are being modified by using high frequency sub-band obtained through SWT. Then all these sub-bands are combined to generate a new high resolution image by using inverse DWT (IDWT). The quantitative and visual results are showing the superiority of the proposed technique over the conventional and state-of-art image resolution enhancement techniques. **Kanagaraj Kannan et al. (2010)** introduced the fast development of digital image processing leads to the growth of feature extraction of images which leads to the development of Image fusion. The process of combining two different images into a new single image by retaining salient features from each image with extended information content is known as Image fusion. Two approaches to image fusion are Spatial Fusion and Transform fusion. Discrete Wavelet Transform plays a vital role in image fusion since it minimizes structural distortions among the various other transforms. Lack of shift invariance, poor directional selectivity and the absence of phase information are the drawbacks of Discrete Wavelet Transform. These drawbacks are overcome by Stationary Wavelet Transform and Dual Tree Complex Wavelet Transform. This paper describes the optimal decomposition level of Discrete, Stationary and Dual Tree Complex wavelet transform required for better pixel based fusion of multi focused images in terms of Root Mean Square Error, Peak Signal to Noise Ratio and Quality Index. **Biswa Ranjan Mohapatra (2014),** author presents here that Image restoration is an art to improve the quality of image via estimating the amount of noises and blur involved in the image. This paper gives a review of different image restoration techniques used. But primarily image restoration is done mostly using Weiner filter, Richardson-Lucy Blind Deconvolution algorithm, Inverse and Pseudo-inverse filter. **Sarabjeet Kaur (2014),** In this paper, author writes brief introduction of digital image processing related to image restoration, different types of noises are introduced and different methods which are used to remove noise are described with different parameters performed on medical images. Parameters like Contour plots, Histogram equalization, MSE, PSNR, max difference, average difference, normalized cross correlation, normalized absolute error, structure content are performed to be measured. Salt n pepper noise can be better removed by median filter. The performance of clahe and histogram filter is not better as compare to median, adaptive and linear filter. **Anamika Maurya,(2014),** here author describes about image restoration which estimate the original image from the degraded data by using Different types of image restoration techniques like wiener filter, inverse filter, regularized filter, Richardson –Lucy algorithm, neural network approach ,wavelet based approach, blind de-convolution are described and strength and weakness of each approach are identified. **Seema, Meenakshi Garg (2014),** here the concept of removing the noises by using the various types of filters and techniques are proposed. A new method based on discrete wavelet transforms using the Bayes-shrink method results were compared with median and wiener filter. In this, proposed technique work with two noises, namely Salt &Pepper and Gaussian noise, that were simultaneously reduced from a single image successfully and results were found to be better than wiener and median filters due to better PSNR ratio and Coc value. Results revealed that the proposed method was very efficiently able to remove noise from ultrasound gray scale images then others.

III. VARIOUS TYPES OF NOISES

Types of noise are:

- Gaussian Noise
- Poisson Noise
- Salt and Pepper Noise
- Speckle Noise

IV. METHODS OF DENOISING

4.1 Discrete Wavelet Transform

Discrete Wavelet Transform (DWT) is introduced to overcome the redundancy problem of CWT. The approach is to scale and translate the wavelets in discrete steps.

$$\mathrm{DWT}(\tau_0, s_0) = \frac{1}{\sqrt{s_0^f}} \int_{-\infty}^{\infty} f(t)\, \psi\left(\frac{t - k\tau_0 s_0^f}{s_0^f}\right) dt \quad (4.1)$$

Where s_0^f is the scaling factor τ_0 is the translating factor, k and j are just integers.

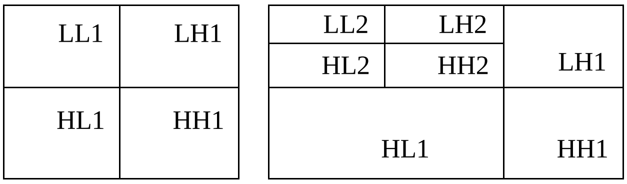
Subsequently, we can represent the mother wavelet in term of scaling and translation of a dyadic transform as

$$\psi_{j,k}(t) = 2^{-f/2}\psi\left(2^{-f}t - k\right) \quad (4.2)$$

Replacing eqn, the coefficients of DWT can be represented as

$$C_{f,k} = 2^{-f/2} \int_{-\infty}^{\infty} f(t)\psi(2^{-f}t - k)\, dx \qquad (4.3)$$

By applying DWT, the image is actually divided i.e., decomposed into four sub-bands and critically sub sampled as shown in fig 4.1(1):



(a) One-Level (b) Two-Level

Fig 4.1(1): Image Decomposition

4.2. Median Filter

This filter sorts the surrounding pixels value in the window to an orderly set and replaces the center pixel within the define window with the middle value in the set.

$$\hat{f}(x,y) = \underset{(s,t)\in S_{xy}}{\text{median}}\{g(s,t)\} \qquad (4.4)$$

4.3. Wiener Filter

Wiener2 low pass-filters an intensity image that has been degraded by constant power additive noise. Wiener2 uses a pixel wise adaptive Wiener method based on statistics estimated from a local neighborhood of each pixel.

J = wiener2 (I, [m n],noise) filters the image I using pixel wise adaptive Wiener filtering, using neighborhoods of size m-by-n to estimate the local image mean and standard deviation. If you omit the [m n] argument, m and n default to 3. The additive noise (Gaussian white noise) power is assumed to be noise.

[J, noise] = wiener2 (I, [m n]) also estimates the additive noise power before doing the filtering. Wiener2 returns this estimate in noise.

4.4 Bayes Shrink Thresholding Method

Bayes Shrink was proposed by Chang, Yu and Vetterli. The goal of this method is to minimize the Bayesian risk, and hence its name, Bayes Shrink The Bayes threshold, is
defined as:

$$t_B = \sigma^2 / \sigma_s \qquad (4.5)$$

The noise variance is estimated from the sub band HH by the median estimator. From the definition of additive noise we have w(x,y) = s(x,y)+n(x,y). Since the noise and the signal are independent of each other, it can be stated that can be computed as shown below.

With and the Bayes threshold is computed from

$$\sigma_w^2 = \sigma_s^2 + \sigma^2.$$

σ_w^2 can be computed as shown below:

$$\sigma_w^2 = \frac{1}{n^2}\sum_{x,y-1}^{n} w^2(x,y).$$

The variance of the signal, σ^2_s is computed as

$$\sigma_s = \sqrt{\max(\sigma_w^2 - \sigma^2, 0)}. \qquad (4.6)$$

Using this threshold, the wavelet coefficients are threshold at each band.

4.5 Normal Shrink Thresholding Method

Normal Shrink is an adaptive threshold estimation method for image denoising in the wavelet domain based on the generalized Gaussian distribution (GGD) modeling of sub-band coefficients. It is computationally more efficient and adaptive because the parameters required for estimating the threshold depend on sub-band data.

The steps of Normal Shrink for image denoising are as follows:

1) Take the logarithmic transform of the speckled image.
2) Perform multi-scaled decomposition of the image corrupted by Gaussian noise using wavelet transform.
3) Estimate the noise variance σ^2 from subband HH1 using formula:

$$\hat{\sigma}^2 = \left[\frac{median(|Y_{ij}|)}{0.6745}\right]^2, \qquad Y_{ij} \in subband\ HH_1 \qquad (4.7)$$

4) For each level, compute the scale parameter β using the equation:

$$\beta = \sqrt{\log\left(\frac{L_k}{J}\right)} \qquad (4.8)$$

5) For each sub-band (except the low pass residual) :

a) Compute the standard deviation σ_y.

b) Compute threshold T_N using equation

$$T_N = \frac{\beta \hat{\sigma}^2}{\hat{\sigma}_y} \quad (4.9)$$

c) Apply soft thresholding to the noisy coefficients.

6) Invert the multiscaled decomposition to reconstruct denoise image $\hat{f}$.

7) Take the exponential of the reconstructed image obtained from step 6[3].

V. PROBLEM DEFINITION

After studying work of various researchers in the field of image denoising, fusion and enhancement of digital images, it was found that Histogram equalization is an effective image enhancement technique as the brightness of an image can be changed after the histogram equalization, which is mainly due to the flattening property of the histogram equalization using gray scale images. So a method should be generated that can enhance image contrast as well as preserve image brightness and having low computational complexity and having results better than existing techniques. There are several reasons for an image to have poor contrast:

- The poor quality of the used imaging device.
- Lack of expertise of the operator.
- The adverse external conditions at the time of acquisition.

Image restoration is an important issue in high level image processing which deals with recovering of anoriginal and sharp image using a **degradation** and restoration model. During image acquisition process degradation occurs. Image restoration is used to estimate the original image from the degraded data. An image is often **corrupted by noise** during its acquisition and transmission.With the passage of time, image gets **degraded due to different atmospheric and environmental conditions**, so it is required to restore the original image using different image processing algorithms. A tradeoff between noise reduction and the preservation of actual image features (without noise) has to be made in a way that enhances the diagnostically relevant image content.Image denoising is used to remove the additive Gaussian noise while retaining important maximum possible image features. The problem is to recover the original signal from the noisy data. We want the recovered signal to be as close as possible to the original signal, retaining most of its important properties (e.g. smoothness). Recently, nonlinear methods, especially those based on wavelets have become increasingly popular.

VI. CONCLUSION & FUTURE WORK

In a summary, the different enhancement techniques are studied to enhance the brightness of the digital images in any field with the speed of execution of the program also an important factor. As in this Paper, we concluded to hybrid fusion techniques to perform better result as compared to the existing as single techniques which are used to generate high resolution image that attempts to preserve the spectral characteristics of the original data. DWT fusion method presents the best result for both visual and quantitative evaluations with PCA fusion technique as to preserves more spectral information as compared with multiplicative. Also this paper presents a various methods for denoising images, as we know that thresholding methods is used to restore images with different noise levels. As seen from the above discussion that wavelet thresholding is an effective method of denoising noisy signals. We first tested hard and soft thresholding on noisy versions of the standard 2-D images. Thus we can implement Bayes thresholding to remove noise from images. These also show good results. We can work on wavelet thresholding and Bayes thresholding, for further enhanced of having better noise removal efficiency by adding more restoration techniques like Normal Shrink, Stationary Wavelet Transform (SWT) etc. Also, more wavelet decomposition levels can be used for better parameter performance values. Then last but not least various denoising techniques for enhancement or removal of unwanted noise from fused images will be worked out for comparing best results with all above technique as discussed.

Future scope is here that we can combine the fusion techniques to get out good contrast and high resolution images with enhancement techniques. Then hybrid the denoising techniques to overcome all the problems as discussed.

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