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Image Denoising Using Wavelet Transform,Median Filter and Soft Thresholding

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Abstract – The key point when we talk about image processing is the removal of noise. In the field of image denoing, there are several/numerous proposed methods and ways in which an image can be denoised .In This paper we propose a method that makes use of the wavelet transform on the input image which has been noised and uses Median Filter and Soft Thresholding on its components.

Key Words:Denoising, Thresholding, Median filter,Wavelet Transform,Image Processing **.**

1.INTRODUCTION

Images which gets effected with noises are very hard to manage and difficult to eradicate. Images and its usage are increasing in our daily lives, hence reduction/removal of noises gaining importance. For the purpose of reduction/removal of noises effecting image many techniques or methods exist, each of which comes with its own pros and cons. While there exist many methods the sole purpose of its existence being remove noise as well as preserving the essential information of the image. .Image de-noising can be broadly classified into Spatial Filtering and Transform Domain Filtering. Transform Domain Filtering is supervision of transformation fields and after the transformation the coefficients are processed. Then the noised is removed by inversing the transformation example of it is wavelet transform. In this discrete wavelet transform is used on the noised input image and the components thus received as the result of the transformation, on it we apply Median Filter on the Approximation coefficient and also we apply Soft Thresholding on the Detail coefficients .

2. LITERATURE REVIEW

Literature review of some selected methods based on wavelet transform in recent years

G.Y Chen[1],used digital complex ridgelet transform to denoise image. The Gaussian White Noise which was added to the image, it was good in removing it while it preserved sharp edges as well.

F. Xiaoa et al.[2] worked on wavelet based noise removal technique through Thresholding. Based on their result they came to the conclusion that BayesShrink and Feature-Adaptive Shrink are best fit for wavelet based methods.

V. Bruni et al.[3] came up with a method, technique which used WISDOW-Comp for the purpose of denoising and compression .In result, they came to the conclusion that it gives better result when compared to other state of the art compression and denoising in terms of rate and distortion .

A. Jaiswala et al.[4] came up with a method for removing Salt & Pepper noise. They used filtering methods ,Wavelet based technique using threshold, Hard Thresholding and Weiner filter in stages .They concluded that results were good in terms of PSNR & MSE.

H. Rabbani et. Al[5]came up with a method that captured heavy tailed nature of wavelet co-efficients & local parameters .They observed that in terms of PSRN and visually results were good.

3. Proposed Method

The method that we propose is shown in fig 1 Gaussian and Salt and Pepper noise is added to the image ,the resultant image is input to the proposed method.The proposed method aids in the reduction, removal of the noised image. The result of the method is evaluated in terms of SSIM, PSNR and MSE.

Methodologies:

1) **Input:** An Image is selected where later noise is added . Figiure 3

2) **Addition of noise:** When the selection of input image is over, either Gaussian noise or Salt & Pepper noise with variance 0.1 is added to the image.Fig 4

3) **Noised image:** Once we apply the noise on the input image we get the noised image on which we apply the proposed denoising method

4) **Discrete Wavelet transform:** The image received after noised is added, there we apply db4 Wavelet transformation. After the transformation of the noised image we get into 4 sub bands HH, HL, LH and LL sub bands fig-2.

5) **Filter and thresholding:** We apply Median Filter on the LL sub band and soft thresholding on the remaining sub bands that is HH,HL,LH.

6) **Inverse Wavelet Transform:** After the application of the median filter and soft thresholding on the sub bands ,inverse wavelet transformation is applied and observe the result and calculate its SSIM, PSNR and MSE .

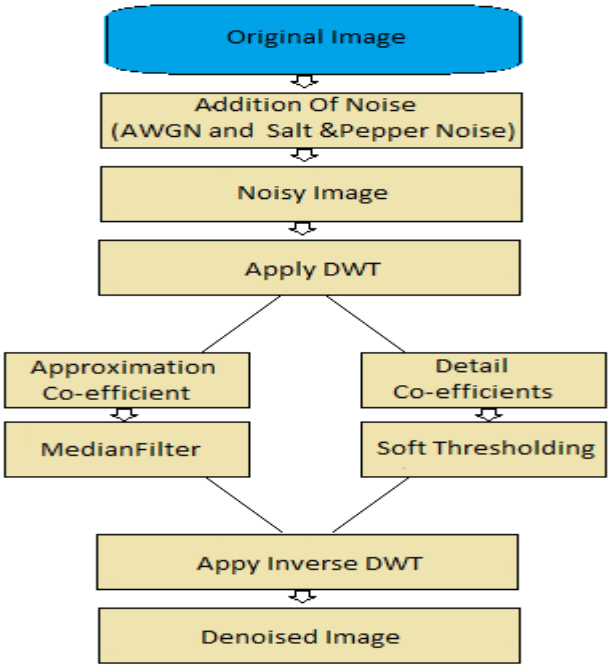


Fig -1: The Proposed Method

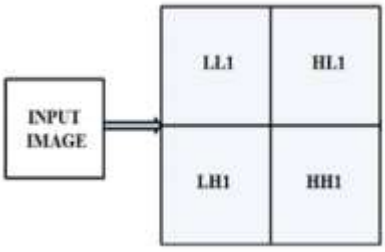


Fig -2: Image Decomposition

Fig -3: Selected original Lena Image

a) With Added AWGN

b) With Added Salt And Pepper noise

Fig -4: Noisy Lena Image with a)With AWGN variance0.1& b)With Salt&Pepper Noise variance 0.1

4. EXPERIMENTAL RESULT AND DISCUSSION

We make use of three parameters PSNR,MSE SSIM.

4.1 Mean Square Error(MSE)

The calculation of the MSE is given by the formula

$$Mean\ Square\ Error\ (MSE) = \sum_{i=j=0}^{N} \frac{[f(i,j) - F(i,j)]^2}{N^2}$$

f(i,j) represents the original image, F(i,j) represents the approximated version and N is the dimension.Lower the MSE better the denoising result.

4.2 Peak Signal To Noise Ratio(PSNR)

The calculation of PSNR is given by the formula

$$PSNR = 10log_{10}\left(\frac{MAX_I^2}{MSE}\right) = 20log_{10}\left(\frac{MAX}{MSE}\right)$$

It makes use of MSE given by

$$Mean\ Square\ Error\ (MSE) = \sum_{i=j=0}^{N} \frac{[f(i,j) - F(i,j)]^2}{N^2}$$

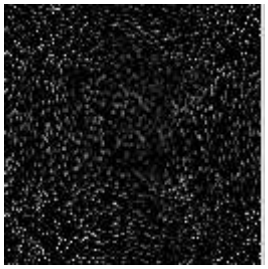
MAX_i is possibly the maximum value a pixel in the image can have.

4.3 Structural Similarity Index

The structural similarity (SSIM) index is a method for measuring the similarity between two images. It is given as

$$\mathrm{SSIM}(x,y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)}$$

a) LL Coefficient



b) HL Coefficient

c) LH Coefficient

d) HH Coefficient

Fig -5: After The decomposition of the image with Salt&Pepper Noise variance 0.1.

a) LL Coefficient

b) HL Coefficient

c) LH Coefficient

d) HH Coefficient

Fig -6: After The decomposition of the image with AGWN Noise with variance 0.1

Original Image

Noised Image

Denoised Image

Fig -6: Application of proposed method on AWGN added image with variance 0.1

Original Image

Noised Image

Fig- 7: Application of proposed method on Salt&Pepper Noise added image with variance 0.1

In table 1 we see the SSIM, MSE and PSRN of the noised images with AWGN and Salt&Pepper Noise and compare it with the Proposed Method's

Table -1: Results in terms of SSIM,MSE and PSNR

Variance=0.1	MSE	PSNR	SSIM
Noised image with AWGN	0.0196	17.0736	0.3499
After applying Proposed Method	0.0129	18.8934	0.6663
Noised Image with Salt&Pepper Noise	0.0312	15.0637	0.2440
After Applying Proposed Method	0.0009	30.6091	0.7743

3. CONCLUSIONS

In the paper, reviewing of certain papers related to image denoising was done and their results were analyzed.A new method which uses db4 wavelet transformation was suggested which makes use of Median filter on the Approximation coefficients and Soft Thresholding on the Detail coefficients. We observe Competitive performance in comparison to some other methods. The PSNR ,The SSIM and the MSE values of the method proves the effectiveness of the method.

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