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Survey on Image Denoising Techniques

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Abstract: *Noise removal is a important task in image processing. Noise causes a barrier and it affects the performance by decreasing the resolution, image quality, image visuality and the object recognizing capability. There have been several published algorithms and each approach have its assumptions, advantages, and limitations .This paper presents a review of some significant works in the area of image denoising. The idea of this paper is to analyse different methods to produce the better result intermsof peak signal-to-noise ratio(PSNR),signal-to-noise ratio(SNR), structural similarity index(SSIM). Image denoising method combining Quardtree based nonlocal mean(QNLM) and locally adaptive principal component analysis is an efficient method it exploits nonlocal multiscaleself similarity better, by creating sub patches of different sizes using quardtree decomposition on each patch.The aim of this survey paper is to achieve very competitive denoising performance even obtaining better visual perception at high noise levels.*

Keywords: *Image denoising, nonlocal means (NLM),principal component analysis(PCA) ,Quardtree decomposition(QD).*

1. INTRODUCTION

Any form of signal processing having image as an input and output is called image processing. Image processing is a technique to enhance raw image received from camera or any other sensor,it contain some amount of noise. Noise is the disturbance or unwanted signal that is present in the image and is an unavoidable intrinsic characteristic of any image. If the images are corrupted by noise then the quality of images will be reduced. To retain the original image from the noise corrupted image denoising techniques are used.Denoising has been a critical and long-standing problem in the field of image processing.It is a challenging problem as the process of denoising causes blurring and introduces some anomalies in the image. Denoising means removal of unwanted information from an image. Image denoising model is used to remove the edges when preserving the edges. Image denoising method is used to improve the quality of image. Gaussian filter [1],Anisotropic filter [2],Total variation [3],and Bilateral filter [4] perform noise removal based on the information provided in local neighbourhood.

2. TYPES OF NOISE

The most common noise types found in the image are Gaussian Noise, Salt& Pepper Noise, Speckle Noise and Brownian Noise. The types of noise can be can be categorised into two models:

- Additive Noise Model (e.g. Gaussian and Impulse noise)
- Multiplicative Noise model(e.g. Speckle noise)

Additive noise is the signal that gets added to the original image to generate the resultant noisy image for example, Gaussian Noise & Impulse Noise. In the multiplicative model the noisy image is generated by multiplication of the original image and the noise signal forexample, Speckle Noise .

2.1. Gaussian Noise

Gaussian noise is evenly distributed over the image signal. That is, each pixel in the corrupted image is the sum of the true pixel values and a Gaussian distributed noise values. This type of noise has a Gaussian Distribution, it has a bell shaped probability distribution function given by,

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

Where in function *g* represents the gray level, *m* represent the mean of the function, and σ represent standard deviation of the noise.

2.2. Salt and Pepper Noise

The salt-and pepper noise is also called shot noise, impulse noise or spike noise. An image containing salt-and –pepper noise will have dark pixles in bright regions and bright pixels in dark regions.It can be caused by dead pixels, analogue-to-digital converter errors,and bit errors in transmission[5].Is has only two possible values, a high value and a low value. the probability of each is typically less than 0.1[6]

2.3. Speckle Noise

Speckle noise [Ga99] occurs in almost all coherent imaging systems such as laser, acoustics and SAR(Synthetic Aperture Radar) imagery. It is Multiplicative noise. The source of this noise is attributed to random interference between the coherent returns. Gamma distribution followed by Speckle noise is given as,

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

Where variance isα and$g$ is the gray level.

2.4. Brownian Noise

Brownian Noise[7] refer to a power density which decreases 6dB per octave with increasing frequency over a frequency range which does not include DC. It can be generated with temporal integration of white noise.

3. Literature survey

P.Perona and J.Malik [8] proposed "scale-space and edge detection using anisotropic diffusion". A new definition of scale-space is suggested,and a class of algorithms used to realize diffusion process is introduced . The diffusion coefficient is chosen tovary spatially in such a way to encourage intra region smoothing rather than inter region smoothing. It is shown that "no maxima should be generated at coarse scale" property of conventional scale space is preserved. As the region boundaries in the approach remain sharp, a high quality edge detector which successfully exploits global information is obtained the experimental result are shown on a number of images.Consider the anisotropic diffusion equation

$$I = div(c(x,y,t)\nabla t)$$
$$= c(x,y,t)\Delta I + \nabla c\,.\nabla I$$

D.D.Muresan and T.W.Park[9] proposed "Adaptive Principal Componets and Image Denoising "the image is corrupted by additive white gaussian noise. The large percentage of the image denoisingalgothims assume an orthogonal basic decomposition. The translation invariant denoising algorithm is achieved by shifting the signal multiple times. thedenoising results is compared with Gaussian niose of variance $\sigma = 50,25,15$

$$\hat{\sigma} = \frac{\text{Median}(H,H)}{0.6745}$$

Image	Noisy	HMM	Sp. A	SI-AShr	PC
Lena	24.60	31.66	33.05	33031	33.60
Boat	24.59	30.68	31.65	32.01	32.25
Barb	24.63	29.39	31.49	31.56	32.63
Ring	24.61	25.80	30.97	31.07	36.32

C.Tamasi and R.Mandhuchi [10] proposed "Bilateral filtering for gray and color image " the Bilateral method is used for edge- preserving smoothing .bilateral filtering is analogous to that of traditional filtering called domain filtering. It combines gray level or colors based on both their geometric closeness and their photometric similarity and prefers near

values to distant values in both domain and range and operates on three bands of color image separately, abilateral filter can enforce the perceptual metric underlying the CIE-Lab color space, and smooth color and preserve edges in a way that is turned to human perception.$\sigma_r = 100, \sigma_d$=10

$$H(X) = k_d^{-1}(x)\iint_{-\infty}^{\infty} f(\xi)e(\xi,x)d\xi$$

Buades and B.Coll [11] proposed "A Nonlocal algorithm for image denoising" to evaluate the performance we first compute and analyze this method noise for a wide class of denoising algorithms namely the local smoothing filter, second a new algorithm the Non Local Mean(NL-Means) based on a non local averaging of all pixels in the image finally compared under three well defined criteria the method noise, the visual quality of the restored image and the mean square error the Euclidean difference between the restored and true image.

$$NL[u](i) = \sum_{j\epsilon I} W(i,j)v(j)$$

Image	GF	AF	TVF	YNF	NL
Lena	120	114	110	129	68
Baboon	507	418	365	381	292

The Non local denoising approach presented by Buades et.al[12] denoising results are obtained at high expense of computational cost here a new algorithm that reduces the computational cost for calculating the similarity of neighbourhood window is proposed after that we use an efficient summed square image scheme and fast fourier transform to accelerate the calculation of this measure, our algorithm is about fifty times faster than the original non local algorithm both theoretically and experimentally and produces comparable results in terms of mean squared error and perceptual image quality

$SSI(x_0, y_0) = \sum_{x\le x_0, y\le y_0} I^2(x,y)$

Image size	Original NL	FastNL algorithm	Ratio
512 *512	28.16secs	0.35secs	80.5
1024*768	85.45secs	1.44secs	58.6
2592*1944	551.1secs	9.55secs	57.7

A speed up technique for the Non Local Mean (NLM) image denoising algorithm based on Probabilistic Early Termination (PET) is proposed by R. Vignesh[13] NLM scheme is dedicated to the distortion calculation between pixel The proposed PET scheme adopts a probability model to achieve early termination specifically the distortion computation can be terminated and the corresponding contributing pixel can be rejected earlier if the expected distortion valve is too high to be of significance in weighted averaging the performance comparative with several fast NLM schemes is provided to demonstrate the effectiveness of the proposed algorithm

$\hat{X}(i) = \sum_{j\in I} W_{ij} Y(j)$

Denoised Lena image

Schemes	PSNR	SSIM
Standard NLM	28.68dB	0.821
Pre-selectionby mean	28.44dB	0.816
Clustering scheme	28.32dB	0.757
Proposed PET	28.54dB	0.814

Pankaj.H [14] proposed "Wavelet Thresholding Approach for Image Denoising" the noise is removed by using wavelet thresholding .threshold is driven in a Bayesian technique to use probabilistic model of the image wavelet coefficients dependent on the higher order moments of generalized Gaussian distribution and is typically with in 5%of the MSE of

the best soft thresholding benchmark with the image the parameter is based on the criterion derived from Rissanen's minimum description length(MDL) principle here compression &denoise method remove noise significantly, for large noise power

Image	σ	Hard shrink	Soft shrink	Proposed method
Lena	10	32.434	32.273	33.5793
	20	30.224	30.247	30.3582
	30	27.235	28.138	28.5722

4. Different denoising Algorithms in terms of PSNR

Sl. No	**Algorithm**	**Authors**	**Lena image**		**Barbara image**		**Remarks**
			σ=10	**σ=20**	**σ=10**	**σ=20**	
1	QNLM &LAPCA	Chenglinzuo	34.36/.883	31.58/.830	33.50/.911	30.47/.861	Better result when compared with BM3D-SAPCA
2	Adaptive Bayesian method	Wilfriedphilips	32.84	29.66	30.71	26.47	Better result compares to HMT and MRF models
3	FoGSM Algorithm	SiweiLyu	35.94	32.11	35.01	30.10	Consistent improvement in PSNR over the local GSM-based algorithm
4	EM Algorithm for the MPGSM model	Bare Goossens	35.74	32.80	35.12	31.50	Computational savings compared to GSM-BLS method
5	Stein's unbaised risk estimate(SURE)	Dimitri Van De Ville	35.1	30.7	33.2	28.1	It would be slightly suboptimal and also suffer from the bias in estimating σ
6	Fourier block processing and Wiener filtering	Naveen s	35.87	32.20	34.73	30.38	Produces sharper edges and clear tips compared with other methods such as PID and DDID
7	BM3D-SAPCA Algorithm	KostadinDabov	34.42	32.22	33.30	30.99	The matching cannot be done among the adaptive shape neighborhood with sufficient reability

5. Conclusion

In this paper, we explored some of the denoising techniques for image denoising. we present a literature review of some of the proposed denoising techniques that will be useful for the users by getting a brief introduction of these techniques .this method can provide better results in terms of image quality and similarity measures when compared with all other methods in terms of peak signal to noise ratio, SNR ,SSIM. future scope is to calculate the amount of noise added to the pixel, removal of noise .

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