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Hybrid Approach for Denoising Real Time Images

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ABSTRACT

Images play an important role in day to day applications in various medias such as video conferencing, face book, mobile communication and also in medical imaging, satellite imaging and forensic to name a few. Noise present in the images makes unpleasant look and degrades the quality of the images, which in turn leads to poor interpretation by the human eyes. Noise Removal is an important pre-processing technique in the image processing field and is very much required for performing further process on the images, since all the post processing operations such as image compression and segmentation on the images are very much depend on the progress of pre-processing technique in order to achieve better view and interpretation by the human beings. This paper focuses to propose a hybrid approach to denoise impulse and Gaussian noise collectively from many real time images, by cascading Weiner filter of second order and Median filter. Firstly, Weiner filter of second order is performed and in the second stage median filter, which is well known for non linear process is performed. The median filter is used for impulse noise removal and exhibits better edge preservation and the wiener filter is implemented for Gaussian noise removal. This combined approach has got good performance results in terms of quantitative metrics such as Peak Signal Noise Ratio(PSNR), Mean Absolute Error(MAE), Normal Cross Correlation(NCC), and Normal Absolute Error(NAE) when compared to the existing filters such as Standard Median Filter(SMF), Adaptive Median Filter(AMF), Progressive Switching Median Filter(PSMF), and Weighted Median Filter(WMF) etc.

INTRODUCTION

The impulse and Gaussian noise could occur mainly during acquisition stage or poor focus of camera or during image storage or bit change in transmission etc., makes tough interpretation. This paper aims to remove impulse and Gaussian noise (Velayudham,2014) by combining wiener and median filter effectively (Rajamani,2011) to denoise real time and test images.Impulse noise is characterized by the pixel values in an imageas noise when there is a large or abrupt difference in values between the neighbor pixels. This abrupt change in pixel values constitutes the salt (pixel value 255) and pepper (pixel value 0) noise. It is viewed as black and white dots in an image. There are many algorithms to remove the noises, but all try to know whether the actual differences in pixel values constitute noise(PandiSelvi,2016) or wanted real photographic detail etc. However, no algorithm can take this decision perfectly(Sureshbabu,2016),because there is usually a tradeoff exists between noise removal and retain of fine, less-contrast information that might have similar characteristic of noise (Premkumar,2016).

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Wiener filtering:

The wiener filtering is optimal in terms of the mean square error,since it minimizes the overall mean square error in the process of inverse filtering and noise smoothing (Cannistraci, 2015). The wiener filter approach is based on a stochastic framework and onthe linear estimation of the original image. The orthogonality principle implies that the behavior of wiener filter in Fourier domain can be expressed to find where the power spectra of the original image and the additive noise follow, and the effect of blurring. The wiener filter has two separate parts as inverse filtering and noise smoothing part. It performs not only the deconvolution by inverse filtering (high pass filtering), but also removes the noise with a compression operation (low pass filtering). In order to implement the wiener filter in practice,it is necessary to estimate the power spectra of the original image and the additive noise. For white additive noise the power spectrum is equal to the variance of the noise. To estimate the power spectrum (Jeya Ramya,2016) of the original image many methods can be used. A direct estimate is the periodgram estimate of the power spectrum computed from the observation. The merit of this estimate is that, it can be implemented very easily without bothering about the singularity of the inverse filtering. Another estimate which uses a cascade implementation of the inverse filtering, and the noise smoothing is a straightforward result of the fact that the power spectrum can be estimated directly from the observation using the period gram estimate. The disadvantage of this implementation is that, when the inverse filter is singular, then the generalized inverse filtering could be used.

Median filtering:

Median filtering is a non-linear filtering technique, useful for preserving the sharp edges (Abhishek, 2015) of an image, which is characterized by the high frequency components (Geoffrine, 2011) present in it, while filtering noise. It removes the salt and pepper noise from images without any blur. The traditional steps for performing median filtering is as follows

- Take an input array of N values (N represents the size of the window) in a window of size 3x3 or 5x5 etc
- The centre pixel $Cij$of a selected kernel is to be the processing pixel.
- Sort all the pixels in a selected window of the input array including centre pixel of a window in ascending order as ($\mathrm{P}i1j1 < Pi2j2 < Pi3j3 \dots \dots PiNjN$).
- Find the middle or median value and replace the noisy processing pixel Cij by the median value.
- Perform it for the entire image by sliding the window in both column and row wise

proposed algorithm:

Many real time images are taken from the PSG college hostel ground and their characteristic features are analyzed. Based on the observations inferred from the images, an efficient algorithm is being proposed for the noise removal since the acquired images are prone to salt and pepper noise. Thus, in order to remove the noise efficiently, a combined approach is developed. Fig.1 shows the block diagram of the proposed technique. First,the wienerfilter removes the Gaussian noise and secondly followed by the median filter.The main issue is the removal of blur in digital images (Mary Joan,2015) due to problem in the linear motion or unfocussed image acquisition, andthose limitations are solved by the Wiener filter. The Wiener Filter after de-noising Gaussian is applied to the Median filter for de-noising Salt & Pepper noise and finally produces a denoised image output as shown in Fig.1

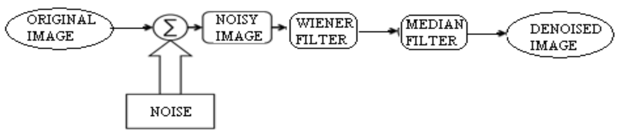

Fig.1: Block diagram of the proposed algorithm.

Thus, by combining both median (Esakkirajan,2011) and wiener filtering, both Gaussian, salt and pepper noise can be removed effectively from images. The great advantage of median filtering (Muni Sankar,2015) is that the edges of the image are preserved well, hence, makesthe interpretation better. That is why the combined approach is much better than the already existing algorithms.

Quantitative Analysis:

In order to determine the quantitative performance of the proposed noise removal algorithm the following parameters (Jayaraj.2010)are analyzed: PSNR, MAE, NCC, and NAE with the existing filters such as SMF, AMF, PSMF, and WMFetc (Latha Shanmugavadivu, 2015).

PSNR is ratio between the signal power and the noise power and is computed by the formulaas in equ.1

$$\mathrm{PSNR} = 20.\log_{10}\left(\frac{\mathrm{MAX_I}}{\sqrt{\mathrm{MSE}}}\right) \quad (1)$$

MAE is the sum of absolute difference between original image and the denoised image,and is computed by the formula as in equ.2

$$\mathrm{MAE} = \frac{1}{n}\sum_{i=1}^{n}|f_i - y_i| \quad (2)$$

It is the average of an absolute error, where f_i is the filtered image and y_i is the input image

NCC can be calculated by using equ.3

$$\mathrm{NCC} = \sum_{i=1}^{M}\sum_{j=1}^{N}[g(i,j).g'(i,j)] / \sum_{i=1}^{M}\sum_{j=1}^{N}\big(g(i,j)\big)2 \quad (3)$$

NAEcan be computed by using equ.4

$$\mathrm{NAE} = \sum_{i=1}^{M}\sum_{j=1}^{N}\big|[g(i,j).g'(i,j)]\big| / \sum_{i=1}^{M}\sum_{j=1}^{N} g(i,j) \quad (4)$$

Table 1: Results Of The Pa For The Real Time Images

Image	Noise (%)	PSNR	MAE	NCC	NAE
USA Coin	30	17	23.9055	1.0013	218.8354
	50	16	40.0351	1.0001	218.8570
	70	15	55.7810	0.9999	219.6179
	90	14	71.9667	1.0020	221.6071
PSG Tech Ground	30	25	23.7613	0.9997	121.9833
	50	21	40.0234	1.0003	123.0318
	70	19	55.9519	1.0030	126.2226
	90	17	71.7634	0.9999	131.4912
Tree	30	22	23.8501	1.0003	173.1503
	50	20	39.8137	1.0002	174.8985
	70	18	55.7638	0.9986	177.6095
	90	16	71.4277	0.9950	180.7375
Garden	30	20	23.8304	1.0007	137.2470
	50	18	40.0762	1.0011	139.2116
	70	17	55.7894	0.9990	142.4188
	90	15	71.9993	0.9982	147.8663
billiards game	30	25	23.9315	0.9981	103.1791
	50	21	39.8168	1.0007	104.4799
	70	19	55.9615	0.9952	107.9897
	90	17	71.4135	0.9986	114.9510
Bi cycle	30	20	23.8889	1.0004	129.7169
	50	18	39.7452	0.9986	131.0659
	70	17	55.6389	1.0017	135.0093
	90	15	71.5362	0.9950	139.9183
PSG Hostel path	30	19	24.0586	0.9995	140.1487
	50	18	39.8444	1.0011	141.9746
	70	16	56.0041	0.9981	144.7526
	90	15	71.7654	0.9979	149.6475
PSG Tech Hostel	30	21	23.9258	1.0000	169.8437
	50	19	39.8871	0.9994	170.1337
	70	17	55.6739	0.9980	171.1846
	90	16	71.7028	0.9985	173.8842
Hills	30	23	24.0143	0.9995	190.4525
	50	21	39.9196	0.9976	190.2774
	70	18	55.9268	1.0026	192.0293
	90	16	71.7732	0.9990	193.0766
Cochin boat	30	21	23.9261	1.0004	185.5019
	50	19	39.8300	1.0005	186.1555
	70	17	55.7603	1.0004	187.6942
	90	16	71.2205	0.9961	189.5629

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Table II: Results Of The Pa For The Test Images

Image	Noise (%)	PSNR	MAE	NCC	NAE
Cameraman	30	25	24.0018	1.0009	252.5867
	50	21	39.8764	1.0001	252.4119
	70	19	56.1500	1.0017	252.8567
	90	17	71.8148	0.9977	252.0016
Lena	30	24	23.9010	0.9991	127.5166
	50	21	39.7300	0.9990	128.8885
	70	18	55.7614	1.0028	132.5644
	90	16	71.8126	1.0041	137.9710

TableIII: Comparison Results Of Psnr For Lena Image

Noise (%)	SMF	AMF	PSMF	WMF	PA
30	15.30	22.1	23.52	21.66	24
50	11.82	20.04	19.13	14.22	21
70	10.72	16.10	11.84	9.49	18
90	8.25	8.002	6.57	6.56	16

Table IV: Comparison Results Of Mse For Lena Image

Noise (%)	SMF	AMF	PSMF	WMF	PA
30	117.50	83.53	43.40	179.56	23.9010
50	277.04	147.34	152.14	595.50	39.7300
70	441.07	466.56	589.23	824.05	55.7614
90	683.21	841.99	887.35	931.06	71.8126

Table V: Comparison Results Of Psnr For Cameraman Image

Noise (%)	SMF	AMF	PSMF	WMF	PA
30	17.67	19.37	20.58	21.66	25
50	14.31	17.58	18.66	19.19	21
70	13.46	14.93	15.47	16.49	19
90	9.47	10.45	11.01	14.33	17

Table VI: Comparison Results Of Mae For Cameraman Image

Noise (%)	SMF	AMF	PSMF	WMF	PA
30	200.50	103.53	99.40	88.56	24.0018
50	317.22	112.30	102.91	95.30	39.8764
70	413.03	346.23	249.25	114.02	56.1500
90	602.21	544.22	437.07	281.77	71.8148

IV Qualitative Analysis:

The proposed algorithm is tested qualitatively and results are shown as below.

Fig.2: Results of the PA for lena and cameraman for the noise densities 30%,50%,70% and 90% respectively and their corresponding denoised images

Fig.2 shows the qualitative results of the proposed algorithm for standard test images (lena and cameraman) for the noise densities 30%,50%,70% and 90% respectively and their corresponding denoised images

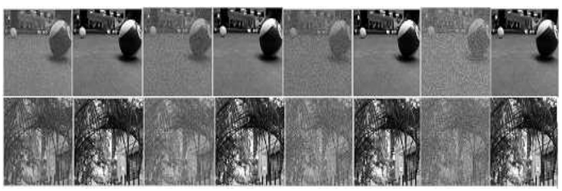

Fig.3: Results of PA for real time images for the noise densities 30%,50%,70% and 90% respectively and their corresponding denoised images

Fig.3 shows the qualitative results of the proposed algorithm for real time images (Foot ball and garden) for the noise densities 30%,50%,70% and 90% respectively and their corresponding denoised images

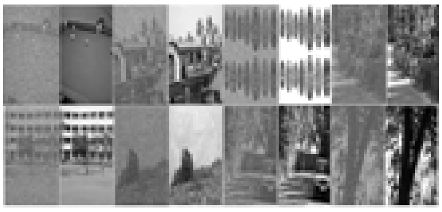

Fig.4: Results of the PA for various real time images for the noise density 70% and their corresponding denoised images

Fig.4 shows the qualitative results of the proposed algorithm for various real time images for the noise density 70% and their corresponding denoised images.

Since the wiener filter removes the Gaussian noise completely and the median filter removes salt & pepper noise,

The denoised results are compared with the performance metrics of other standard algorithms in order to evaluate the performance of each filter and the results are tabulated for comparison as in Table 1 to 6. The qualitative results are plotted and are shown in fig. 1 to fig. 4.

Conclusion:

An effective hybrid algorithm is proposed to remove salt and pepper noise and Gaussian noise from the real time and standard test images. Since median and wiener filter techniques combined, the proposed algorithm extracts the benefits of both techniques, and its performance is tested on both real time and standard test images for all noise densities ranging from 10% to 90%. From the qualitative and quantitative measures, it is clear the proposed algorithm shows better performance results than the other existing algorithms.

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