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A New Improved Statistical Algorithm for Image Noise reduction

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Abstract: Many filtering algorithms have good noise reduction methods regardless the time complexity. This paper proposed a statistical algorithm which use correlation of the image to develop the filtering function. The correlating function applies filtering mask over the image to reduce the degradation. It can calculative resize the mask according to noise levels of the mask. The statistical histogram method is also introduced in the searching process of the median value. Experimental results show that the algorithm reduces the noise a much as possible and retains the detailed pixel value of the image. The complexity of the algorithm is decreased and efficiency of filtering function has been improved.

Introduction:1.Digital image is affected by noise resulting for image sensors or transmission of images.Image denoising is performed to remove the noise from the images..2.Linear and non linear filters are proposed for image denoising.3.Although non linear filters are more complex than linear filters they are more commonly used for image denoising because the reduce smoothing and edges are preserved.4.2-D spatial median filter is most commonly used non linear filter for image denoising.5.It is a non linear sorting based filter, it sorts the pixels in the given window 3×3 determining the median filter and replaces the pixel in the centre of given window with The noise is usually divided into Gaussian noise, the balanced noise and the impulse noise. The arisen impulse noises display as light and dark noise pixels under random distribution on the image. Basically they are also known as white and black pepper noise. This not only disturbs original value of the image, but also seriously corrupts the visual effects of the image. Therefore, the reduction of impulse noises has important significance to image processing and computer vision analysis. For an image corrupted by noises, we can use linear or nonlinear filter methods to reduce noises. In the frequency domain, the details are high-frequency components of the image, which easily confused with high-frequency noises. Therefore, how to keep the image details as usual effectively filter random noises is the key to image filtering processing. The median statistical filter is a nonlinear filter and it has widely used in digital image processing because of its good edge restoring characteristics and reducing impulse noise ability. The median filter is a rank-order filter. Its noise-reducing effects depend on the size and shape of the filtering mask which runs over the original image and its algorithm complexity mainly depends on how to get the median value. In order to improve the noise-reducing performance of the median filter, scholars proposed many improved methods to the conventional median filter [1-3].To improve the searching speed of the median value, people proposed some fast algorithms based on the dividing-conquering strategy, and simplified the algorithm complexity of the conventional median filter from O (N2) to O (n logn n) in

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references [4] and [5]. The subsequent work [6] of the paper further simplified complexity to O (n(1+logn n) /2). Based on the calculations study, this paper proposed two improvements to the median filtering algorithm:

(i) To improve the noise-reducing performance, the mask may be adaptively resized according to noise levels of the mask;

(ii) According to the median filtering theory, we only require quickly find the median value of the filtering mask, and not to rank all the pixels of the filtering mask. Therefore, the statistical histogram is introduced in the searching process of the median value to speed up the searching process.

Median Filtering Theory: It is totally based on statistics. It is non linear method used in signal processing as well as Image processing. here the noisy value of the digitized image is replaced by the median value of neighborhood pixels. The pixels of the image are ranked according to their gray levels and the median value og the group pixels is stored and replaced in place of noise value.the median filtering output is g(x,y)=med{f(x-I,y-j),i,jÍ€ W},where f(x,y),g(x,y) are the original image and output image respectively.W is the 2-dimensional mask, the mask size is m×m order and m is commonly odd like 3×3 and 5×5 etc, the mask shape may be linear, square, circular etc.

The Noise reducing performance of the median filter: as it is a non linear filter its mathematical analysis is relatively complex for the image with random noise.For an image with zero mean noise under normal distribution, the noise variance of the median filtering is approximately.

$$\sigma^2_{med}=1/4nf^2(n)= (\sigma_i^2/n+\pi /2-1).\ \pi/2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where σ_i^2 is the input noise power (the variance), n is the size of median filtering mask, f(n) is the function of noise densityand the noise variance of average filtering is $\sigma^2_0 = 1/n\ \sigma_i^2$ ………………………….(2)

Comparing (1) and (2) the statistical filtering method depends on two things; the size of the mask and the distribution of the image.The median filtering performance of random noise reduction is better than the average filterimh performance, but to the impulse noise especially narrow pixels are farther apart and the width is less than n/2, the mdian filter is very effective.the median filtering performance should be improved if median filtering is attached with average filtering or double derivative filtering algorithm, can resize the mask according to the noise density.Based on this an improved denoising algorithm(median filtering technique) is proposed.

3. Improved Median Filtering Algorithm

A. Improvement of the filtering mask The filtering mask is mainly on square mask or cross mask. Considering of the symmetry of the mask, n is commonly odd. The smaller the mask is, the better the image details are retained, the weaker the noise reduction performance is; the larger the mask is, the less the image details are retained, then stronger will be the noise reduction performance . To solve the contradiction, we introduce the adaptive filtering algorithm. In the filtering process, it can adaptively resize the mask according to noise levels of the mask. In the mask, max is the maximum value of gray levels, min is the minimum value of gray levels, average is the average value of gray levels, med is the median value of gray levels, jif),(is the central value of the mask, n is the size of the mask. The adaptive filtering requires two steps: Step 1: adaptively resizing the mask (1) Initialization: let n 3 ; (2) Computation: 1 medA min, 2 medA max (3) Judgment: if A ! 01 and A 02 , then turn to the step 2; if not, then enlarge the size of the mask, let n×n2 and turn to (2). Step 2: median filtering. B. Improvements of the median algorithm Because the average filter has better performance for filtering random noises, we combine the median filter with the average filter to certain size of the filtering mask. The improved method

Improved method:

For the natural image, neighboring pixels has strong correlation. The gray value of each pixel is quite close to neighboring pixels, and the edge pixels have the same property also. If the value of a pixel is greater or less than the value in the neighborhood, the pixel is contaminated by the noise; otherwise, the pixel is an available pixel. In the reducing-noise process, we sequentially check each pixel, if the value of a pixel is greater than the average value in the mask, then we judge that the pixel is contaminated by then noise and replace it with the median value of the mask; otherwise, we retain the original value of the pixel unchanged. This method not only reduces the computation time, but also retains the details of the image as far as possible. The original value of the pixel is replaced with the median value in the mask, and the next process of computation the average value may make full use of the new value of the pixel. This forms alternative process; it not only decreases the time complexity but improves noise reducing effect much better way.

e.g:reducing noise of the pixel(i,j) where moving window size is 3×3.

If f-average>0 then the median valueisf'(i,j).

If f'(i,j) <f(i,j),then f'(i,j) is the noise.By the conventional algorithm , the average and median value of pixel)I,j+1) arerespectively.

Average={f(i-1,j)+…f(i,j)+f(i,j+1)+…+f(i+1,j+2)}/9

Median={f(i-1,,j)+….+f'(I,j)+f(I,j+1)+…+f(i+1,j+2)}.

If f(I,j) is replaced by the factor of improved algorithm f(I,j) the average and median value are respectively.

Average=f(i-1,j)+…+f'(i,j)+f(i,j+1)…+f(i+1,j+2)}.

According to f'(I,j),f(I,j) average is less than average value.Thus the spatial extent of the noise reduction is increase and the time complexity of improved algorithm is less than conventional algorithm.Steps of improved algorithm are shown below.

1.The mask slides over the image , overlaps centre of the mask with the pixel on the image to serch the centre element f(i,j).

2.To read the values of the corresponding pixels of the mask.

3.To compute the average value of the mask.

4.to compare the value of the pixel with average, if value of each pixel is greater than average then searching median value and let f(i,j)=median value; otherwise original value of the pixel unchanged.

5.Repating step4 until i=j=n.

Fast computation of median value The complexity of the algorithm is mainly divided by the calculation of median value on above steps.This paper introduces histogram to improve searching speed of the median value.the method requires steps below.

1.To compute the gray histogram hist[i] (0<i<G where G=range of gray of n×n,find the median value med and record less than median value(ltmed) .Consider the pixel value which is less than median value.

2.To let the left row shift out of the histogram if value of shifting out pixels is less than median then ltmed-1.

3.To let the right now shift the histogram if the value of shifting out pixels is more than median then ltmed+1.

4.If ltmed<,N/2 then repeat med+1, ltmed+hist[ltmed] until ltmed=N/2.

(5) If ltmed>N/2,then repeat med-1,ltmed-hist[ltmed] until ltmed=N/2.

6.To return the median value.

The improved algorithm has two improvements compared to the conventional median filtering

algorithm. One is to make the number of the compared pixels equal to N by using the historical

information of the sliding mask and value of each pixel compares with original median value of mask.Another is to decrease the complexity of median algorithm.

C.Analysis of Complexity of Algorithm:

Suppose X = {Xi} (i=1, 2, ... , N) is the array to solve the median value, where 0 Mxi dd and i x is

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integer. By using the statistical histogram method to find the median value, the required maximum numberis N, and the complexity of the algorithm is approximately O (N).

Table 1. Comparison of the complexity of three algorithms:

Size Of Mask	The standard median filtering algorithmN lnN	The fast median filtering alg based on average N(1+ln N)/2	The improved algorithm in the paper
3×3	20	7	7
5×5	84	50	26
7×7	192	129	48
9×9	356	221	80
11×11	577	351	120

According to TABLE I, the computation complexity of the improved algorithm is obviously

4. Simulation Experiments

Experiment 1: comparative experiment among the standard median filtering algorithm, the fast medianfiltering algorithm based on average and the improved algorithm in the paper.10%, 35%, and 45% density impulse noises are respectively added to the original image of Lena. WithVC++6.0, results of the comparative experiment as shown in fig-1.

Figure:

Original lena image

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(a) (b)

Experiment 2: low signal to noise ratio experiment.60%, 70%, and 80% density impulse noises are respectively added to the original image of Lena.

Results of the improved algorithm in the paper are shown.

Performance estimation:

The effect of the image noise reduction may estimated by the subjective visual effect or the objectiveestimation method. The paper takes the peak signal to noise ratio (PSNR) and the signal to noise ratio (SNR)as the performance estimation standard.Suppose an original image is jif),(and its size is u NM , the processed image is jif),(OUT and its size is u NM , where ,...,2,1,,...,2,1 NjMi , then we have

MSE=(1/M×N) summation i=1 to m summation j=1 to n(fout-f(i,j)^2

PSNR= 10 log(a^{2}max/MSE)(dB)

SUM=summation i-1 to m summation j=1 to n=3 f(i,j)^2 /summation i=1 to m summation j=1 to n(fout(I,j)-f(I,j)^2

$$sum = \frac{\sum_{i=1}^{M} \sum_{j=1}^{N} f(i,j)^2}{\sum_{i=1}^{M} \sum_{j=1}^{N} (fout(i,j)-f(i,j)^2)}$$

snr =10 log (sum)(dB)

Where a $_{max}$=2^k-1, k denotes the number of pixel binary bit. If k=8 then a $_{max}$=255.The results of two experiments are shown below in table II.

Experimental results show that the performance of this algorithm is better than standard median filtering algorithm and fast median filtering algorithm is based on average.Specially with low SNR(signal to noise ratio) this improved algorithm has more advantages.

Table II: Comaparison of 3 algorithms.

Noise Density	The standard median filtering algorithm		The first median filtering algorithm based on average		The improved algorithm in the paper	
	PSNR(dB)	SNR(dB)			PSNR(dB)	SNR(dB)
10%	31.2439	25.5618	31.3804	25.6983	32.1180	26.1059
35%	28.7432	22.0611	28.8262	22.1441	31.8541	25.1720
45%	16.9419	11.2598	17.3371	11.6550	30.5521	23.8699
60%	----	__	__	__	28.5861	21.6371
70%	----	__	__	__	27.2651	20.3307
80%	----	__	__	__	26.1206	19.1103

5.Conclusion: The paper proposed an improved median filtering algorithm for image noise reduction. It can adaptively resize the mask according to noise levels of the mask. Combined the median filtering with the average filtering, the improved algorithm can reduce the noise and retain the image details better. The statistical histogram is introduced to improve the searching speed of the median value and the correlationof image has been fully used. Thus, the complexity of the improved algorithm is decreased to O (N).Experimental results show that the improved algorithm can well do with the relationship between the effect of the noise reduction and the time complexity of algorithm.Thats why it has a good application prospect in Digital Image processing as well as signal processing.

References.

[1].Guohong Liu, Wenming Guo, "Application of improved arthmetic of median filtering denoising, Computer Engineeringand Applications," 2010, vol.46, no.10, pp.187-189.

[2] Xiaokai Wang, Feng Li, "Improved adaptive median filtering," Computer Engineering and Applications, 2010, vol.46, no.3, pp. 175-176.

[3] Chao Wang, Zhongfu Ye, "Salt-and-pepper noise removal by adaptive median filter and TV inpainting," Journal of University of Science and Technology of China, 2008, vol.38, no. 3, pp. 282-287.

[4] Qinghua Huang, Heqin Zhou, Huanqing Feng, "A fast and effective algorithm of pulse noise filtering for imaging data,"Computer Engineering and Applications, 2002, no. 17, pp. 113- 114, 210.

[5] T S Huang, G T Tang, "A fast two- dimensional median filtering algorithm," IEEE Trans Acoustics, Speech, and SignalProcessing, 1979, vol.27, no. 1, pp. 13- 18.

[6] Chubin Wu, "The fast algorithm of medium filtering based on mean," Journal of Jiangsu Teachers University ofTechnology, 2006, vol.12, no.6, pp. 102-106.

[7] Tingbiao Chen, Liangzheng Xia, "Digital image processing," Beijing: Posts & Telecommunications Press, 1994.

[8] Ayman A Aly and Abdallah A. Alshnnaway “an Edge Detection and Filtering Mechanism of Two Dimensional Digital objects Based on Fuzzy inference, World Academy of Science Engineering and Technology 53,2009. .

[9]. Anil K. Jain. Fundamentals of Digital Image Processing, chapter 5.11, pages 163{174. Prentice Hall Inc., prentice hall international edition, 1989. [9].