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Wavelet Based Edge Preservation And Noise Reduction In OCR Images

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Abstract- The search for efficient image denoising methods is a challenging task for various unfussy analysis. This problem become much crucial in case of boundary specific applications like optical character recognition (OCR), bar code reader (BRC) etc. in such application all the information contained in edges, hence after denoising the output image should contain all the boundary information same as input image before denoising, most algorithms have not yet attained a desirable level of pertinency. This paper deals with OCR image de-noising by using the wavelet transform based on various thresholding techniques. The comparative study has been carried out based on the three different parameters like Mean Square Error, Peak Signal to Noise Ratio and Edge Preserving Index.

Keywords-Noise; Denoising; Transform; Wavelets; MSE; PSNR; EPI.

Introduction

The wavelet transform is a time-frequency analysis tool developed, which has been successfully applied in the image processing domain after [1] presented the fast decomposition algorithm. Various enhancement methods based on wavelet transform such as [2][3][4][5] and [6][7],this paper presents a comparative study of OCR image denoising using wavelet analysis. Image denoising performs the preprocessing step in the field of photography, research, medical science and technology, where somehow image has been degraded and wants to be restored before additional processing. Different denoising techniques have been planned so far and their application depends upon the type of image and noise here in the image. These are the meticulous functions that distribute data into different frequency components with a resolution matched to its scale. It has head over traditional methods in examining physical situations where the signal contains discontinuities and honed spikes

A. Image Noise Types

Gaussian noise-. It is evenly distributed over the signal. Every pixel in noisy image is the summation of true pixel value and a random Gaussian distributed noise value

$$= \frac{1}{\sqrt{2\pi\delta}} e^{\frac{-(g-\mu)^2}{2\delta^2}} \qquad (3)$$

Where g = gray level, μ = mean and δ = Standard deviation .Amplifier noise is a most important component of the "read noise" of an image sensor [8].

Salt-and-pepper noise - It is an urge type of noise and is also referred to as strength spikes. It is commonly caused due to missile in communication. It has only two possible values, a high and a low. The

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prospect of each one is typically less than 0.1. The alter pixels are set alternatively to minimum or to maximum values giving the resemblance of Salt and Pepper appearance. The unaffected pixels remain unmarked.

Poisson noise- It is a basic form of variability associated with the measurement of light, the self-sufficient of photon detections and intrinsic to the quantized nature of light. It anticipation immensity is signal dependent and initiate the dominant source of image noise kept out in low-light conditions. Individual photon detections can be treated as independent actions that follow a random temporal distribution. Since a result, photon counting is a classic Poisson procedure and the number of photons N measured by a given sensor component over a time interval t is described by the discrete probability distribution.

$$\frac{e^{-\lambda t}(\lambda t)^k}{k!}$$

Where λ is the estimated number of photons per unit time interval, which is proportional to the incident picture irradiance. It is a standard Poisson distribution with a rate parameter λt that corresponds to the expected incident photon calculates. The uncertainty described by this distribution is identified as Poisson noise.

Speckle Noise- It is multiplicative noise. This type of noise [9] occurs in almost all coherent systems such as Ultrasound images, SAR images etc. The resource of this noise is uneven interference between the coherent returns. Speckle noise has the characteristic of multiplicative noise and it obey distribution given as

$$F(g)=\{ g^{\alpha-1}/(\alpha-1)!\ \alpha^{\alpha} \}\ e^{-g/a} \quad (5)$$

WAVELET TRANSFORM

A wavelet is a waveform of an effectively limited duration that has an average value to zero. The transform is the essential transform for time-frequency description of analyzed signal as mentioned in the introduction. It can be used in different signal processing applications, e.g. signal compression, feature extraction, and noise suppression [10]. It gives details regarding the frequency content of a signal. It is the solution to the multi resolution problem. It has the important property of not having a set width sampling window. The transform can be broadly classified into continous wavelet transform, and discrete wavelet transform. The theory of wavelet transform is explained in many publications, a more detailed description of the wavelet transform and its properties can be found, for example, in [11].

Thresholding Techniques

In wavelet domain[12], the largest coefficients correspond to the signal, and small ones represent mostly noise. The usual thresholding of wavelet coefficients is governed mainly by either 'hard' or 'soft' thresholding function. When the hard thresholding is used the wavelet coefficients below the threshold λ are made zero and coefficients above threshold are not changed. If x,y

$$\Pr(N = k) = \quad (4)$$

denote the input and the output then the hard threshold $T_h(y, \lambda)$ is given by

$$= \quad = \begin{cases} y, & \text{if } |y| \geq, \lambda) \\ 0, & \text{otherwise} \end{cases} \qquad (5) \qquad \hat{X} \quad T_h\,(y,\lambda)$$

Generally, soft thresholding tends to have a bigger cross due to the threshold of large coefficients,[13]. But different thresholding techniques can be applied to obtain a compromise between these two drawbacks.

$$= T_h\,(y,\lambda) = \qquad (6) \qquad \hat{X}$$

Thresholding Estimation

The most important part of the algorithm is the estimation of the optimal threshold value. When the threshold value is low, then noise reduction is inefficient when it is high, then detailed image information can be lost. In this work, we consider one of the most frequently used estimation algorithms, the so-called *global threshold* [14].

$$\begin{cases} y - \lambda, & \text{if } |y| \geq \lambda \\ y + \lambda, & \text{if } |y| \leq -\lambda \\ 0, & \text{otherwise} \end{cases} \qquad (7)$$

where N is the number of input image pixels, σest represents the standard deviation of noise, which can be estimated by the Donoho and Johnstone theorem [15]

$$T = \sigma_{est} \cdot \sqrt{2 \cdot \log(N)},$$

Through the inverse wavelet transform the enhanced image was generated.

METHODOLOGY

The wavelet denoising is accomplished in the following three steps namely Wavelet Decomposition, Threshold Detail Coefficients, Wavelet Reconstruction. In this paper, wavelet transform is used for decomposition. The input image is decomposed at two levels. After decomposition the given image is realized by one approximation coefficient and 6 detail coefficients.. In OCR images many wavelets like db, sym, coif, etc can be used for denoising at certain level of soft and hard threshold and then decomposed and reconstructed the denoised image. MSE, PSNR and EPI values are calculated for comparing these wavelets.

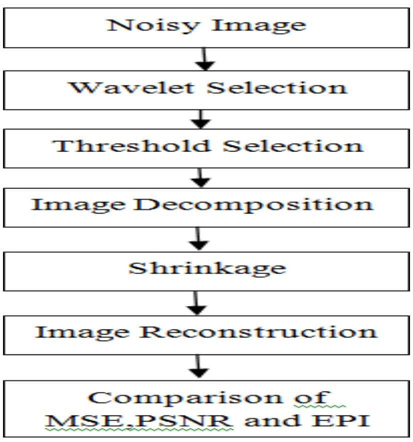

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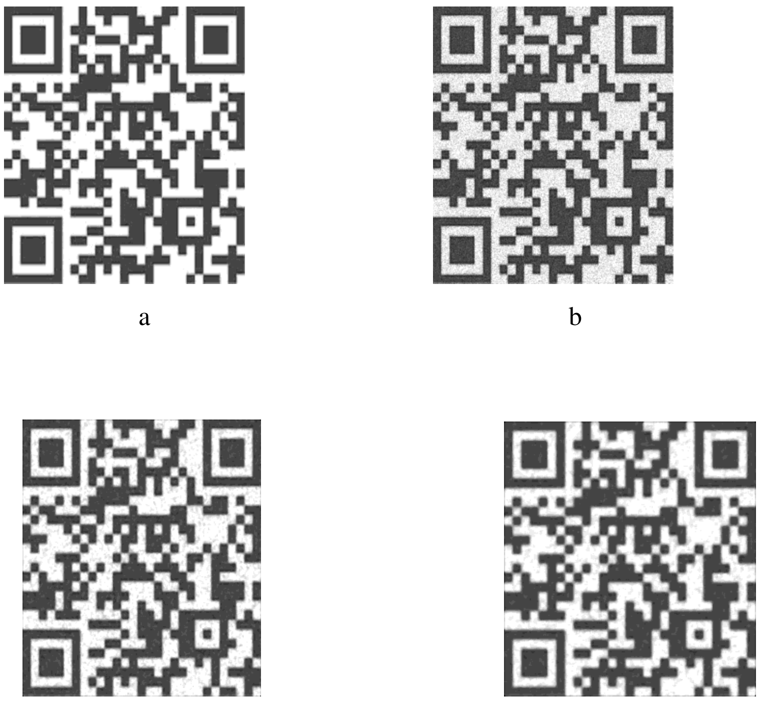
Figure 1. Wavelet transform flow graph

RESULTS AND DISCUSSION

A statistical analysis based comparison between wavelets are carried out.. The analysis will then be performing based on the three parameters mainly Mean Square Error, Peak Signal to Noise Ratio and most importantly Edge Preserving Index. The most important parameters likely Mean Squared Error and Peak Signal to Noise Ratio often used for evaluation of image denoising processes and the Edge Preserving Index is used to assess preservation of edges during image denoising, higher value of EPI indicating higher edge preservation [16].A high peak signal to noise ratio would normally shows that the rebuild is of higher quality [17]. The sparsity analysis is complemented by the quantitative study of partial reconstructions,. PSNR of best m-term estimate:

$$PSNR = 20\log_{10}(\max(f(x)) - \min(f(x))/(\|f - fm\|^2)\ (dB)$$



a b

c d

e

f

g

Figure 2. Comparison of different types of wavelet transform denoising technique for OCR Images:(a) Original image,(b) Noisy image ,(c) Haar (d) Daubechies (db10), (e) Coiflets (coif 5), (f) Bi-orthogonal (g) Symlets.

Table I. Comparison Of Psnr Values Using Different Wavelets For Ocr Image Having Gaussian Noise

OCR IMAGES	PSNR OF DENOISED IMAGES				
	Haar	***Daubechies***	***Coiflet***	***Bi- orthogonal***	***Symlet***
QR-Code Image	43.203	43.045	43.063	42.893	43.065
Bar Code Image	44.417	45.881	45.293	44.882	45.388
China Code Image	60.946	53.944	55.053	55.282	56.455

MSE is Mean Square Error, and it is defined as follows:

$$\mathbf{MSE}= {}^{\mathbf{1}}/_{\boldsymbol{m} * \boldsymbol{n}}\{\textstyle\sum_{i=1}^{m} \sum_{j=1}^{n} |\mathbf{Io} - \mathbf{Ip}|^2\} \quad (8)$$

Table II. Comparison Of MSE Values Using Different Wavelets For OCR Image Having Gaussian Noise

OCR IMAGES	MSE OF DENOISED IMAGES				*Symlet*
	Haar	*Daubechies*	*Coiflet*	*Bi- orthogonal*	
QR-Code Image	3.109	3.225	3.211	3.34	3.21
Bar Code Image	2.351	1.678	1.921	2.112	1.88
China Code Image	0.052	0.262	0.203	0.192	0.147

The greater value of EPI gives a much better hint of image .

$$EPI = \frac{\sum(|I_p(i,j)-I_p(i+1,j)|+|I_p(i,j)-I_p(i,j+1)|)}{\sum(|I_o(i,j)-I_o(i+1,j)|+|I_0(i,j)-I_0(i,j+1)|)} \quad (9)$$

Table-III Comparison Of EPI Values Using Different Wavelets For OCR Image Having Gaussian Noise.

OCR IMAGES	***Haar***	**EPI OF DENO**	**ISED I**	**MAGES**	***Symlet***
		Daubechies	***Coiflet***	***Bi- orthogonal***	
QR-Code Image	3.173	4.055	3.959	4.018	3.963
Bar Code Image	3.433	4.396	4.458	4.615	4.4
China Code Image	4.2	5.682	5.674	5.521	5.53

From the results tabulated in table I, II and III , it is evident that for all OCR images with all noise conditions the developed provides least MSE, and Higher PSNR as compared to different wavelets. In addition to this, the most important parameter of this paper is Edge Preservation Index (EPI), higher value of EPI corresponds to good edge preservation during image denoising.

CONCLUSION

Image preprocessing is the most essential and critical part of Digital image processing, of many a times even a good algorithm does not provides required result because lack of appropriate preprocessing of the input image. This problem becomes much crucial in case of OCR images included bar code reader (BRC) etc. In this paper, a highly edge preserving and noise removal image denoising is developed and implemented using newly developed 2Dimensional Discrete wavelet transformation technique in MATLAB for various OCR images. For the complete evaluation of developed technique, three different OCR images have been used. After implementation of the proposed technique, a statistical analysis based comparison between wavelets filter. Therefore the developed Wavelet Transformation is not only able to provide much higher noise removal from OCR images, as well as it preserves the image quality.

FUTURE SCOPE

The research paper mainly focusing on the implementation of the denoising techniques for gray scale images but in future same can be applied to color images also. New Age Fuzzy Logic can also be incorporated with wavelet technique in this field to take the image processing technology to a whole new level.

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