ISSN: 2278 – 1323
International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 2, Issue 11, November 2013

A Survey on Image Denoising based on Wavelet Transform

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Abstract— **An image is a two dimensional function represented as F(x,y),it can be defined as an artifact that depicts or records visual perception for example two dimensional picture that has a similar appearance to some objects. All digital images contain some degree of noise. Often we suffered with noise in image that is occurred due to the sensor and circuitry of a scanner or digital camera during image acquisition and/ or transmission. In this survey noise removal technique is presented through the Wavelet shrinking algorithm along with the edge detection. The two threshold value is used in order to remove noise from the noisy image. In the proposed algorithm, coefficients are selected due to their magnitude, and only subsets of those selected coefficients which exhibit a spatially regular behavior remain for image reconstruction. Therefore, two thresholds are used in the coefficient selection process. The first threshold is used to distinguish coefficients of large magnitude and the second is used to distinguish coefficients of spatial regularity. The performance of the proposed wavelet denoising technique is an improvement upon several other established wavelets denoising techniques, as well as being computationally efficient to facilitate real-time image-processing applications. But along with the above algorithm used for denoising, to differentiate between false and real edges on images corrupted by noise, we have to detect the edges of an image also. Thus the paper shows the image denoising along with the edges of an image.**

Index Terms—**Image denoising, Wavelet transforms, Wavelet Shrinking, Threshold value, Wiener Filtering.**

I. Introduction

In Image Processing, noise reduction plays a very vital role. Many enormous amounts of researches in the field of image and video processing came into existence in recent days such as compression, noise removal techniques, and other preprocessing functions for noise removal. Image Denoising plays very essential role in image restoration. In order to improve denoising, it is important to preserve the edges of an image thus an edge detection algorithm can also be performed along with wavelet shrinkage. The stationary edge detection algorithm is an efficient method for edge detection with improved image-to-noise ratio.

One of the methods used to suppress noise is the wavelet transform in digital image. A wavelet is a mathematical function useful in digital signal processing and image compression . The use of wavelets for these purposes is a recent development, although the theory is not new. The principles are similar to those of Fourier analysis. In signal processing; wavelets make it possible to recover weak signals from noise . This has proven useful especially in the processing of X-ray and magnetic-resonance images in medical applications. Images processed in this way can be "cleaned up" without blurring or muddling the details. Techniques based on thresholding of wavelet coefficients are gaining popularity for denoising data. The idea is to transform the data into the wavelet basis, where the large coefficients are mainly the signal and the smaller ones represent the noise.

In the proposed algorithm coefficient are selected based on two threshold values. The reduction of absolute value in wavelet coefficient is successful in signal restoration. This process is known as wavelet shrinkage. The wavelet shrinkage is a signal denoising technique based on the idea of thresholding the wavelet coefficients. Wavelet coefficients having small absolute value are considered to encode mostly noise and very fine details of the signal. The two basic approaches are defined for coefficient modification. Eric J Balster & Yuan F Zheng gives the difference between Probabilistic Wavelet Shrinkage and Feature based wavelet Shrinkage.

1. Probabilistic Wavelet Shrinkage
2. Feature based wavelet Shrinkage.

Probabilistic Wavelet Shrinkage: In this method in order to calculate the coefficient value, it assumes the level of reduction of coefficient is continuous between 0 & 1. In other words we can say that the magnitude of the wavelet coefficient is reduced by the probability of its contribution to the overall quality of the image.

Feature based Wavelet Shrinkage: In this method a binary method is used, in which the reduction of coefficient magnitude is either 0 or 1 i.e., wavelet coefficients are either selected or rejected. According to the Eric J Balster, the difference between probabilistic wavelet shrinkage methods and the selective wavelet shrinkage methods came in the modification of the wavelet coefficients. In the first method, the level of reduction of coefficient magnitude is continuous between 0 and 1. In other words, the magnitude of the wavelet coefficient is reduced by the probability of its contribution to the overall quality of the image.

Wavelet shrinkage denoising should not be confused with smoothing, whereas smoothing removes high frequencies and retains low ones, denoising attempts to remove whatever noise is present and retain whatever signal is present regardless of the signal's frequency content. But in the proposed methodology denoising of an image will be done with edges also which was not done prior.

Manuscript received Oct, 2013.
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Proposed Methodology: To denoise an image along with the edges we will have to apply some edge detection algorithm and then wavelet shrinkage algorithm.

Edge Detection has been used extensively in the fields of image and signal processing. However many classical edge detection algorithms are there, some of them perform exceptionally well also but classical edge detectors usually fail to handle images with dull object outline or in the presence of strong noise. One of the important requirements for efficient edge detector is that the edge must be accurately detected and the noise is removed as much as possible from the scene. Classical edge detection is a combination of a smoothing filter and a gradient operator. In contrast, S.Nashat & A. Abdullah uses stationary wavelet edge detection. Wavelet based denoising provides multi-scale treatment of noise, down sampling of sub-band images during decomposition and the thresholding of wavelet coefficients may cause edge distortion and artifacts in the reconstructed images. To improve this limitation of the traditional wavelet transform, a multi-layer stationary wavelet transform is adopted. According to them, this edge detection algorithm relies on the difference of behavior along the wavelet scales of the edges, which is useful for edge enhancement and noise reduction. In this case, it is important to preserve the location of the edges as accurately as possible. By S.Nashat & A Abdullah, the stationary wavelet edge detection has several advantages. First, each sub-band has the same size, so it is easier to get the relationship among the sub-bands. Second, the resolution can be retained since the original data is decimated. Also at the same time the wavelet coefficients contain many redundant information which helps to distinguish the noise from feature. Finally, the wavelet transform provides compaction of information thereby spreading the effects of spurious noise over several coefficients.

For applying the wavelet shrinkage on images, according to Eric J Balster & Yuan F Zheng, because the wavelet shrinkage method is based upon the reduction in the magnitude of the coefficient value of corrupted images by a parameter c, between 0 and 1, the modified wavelet coefficient value is calculated by

L., k[x, y] =c[x, y] λ’. k[x, y]

Where L., k[x, y] is the modified wavelet coefficient of scale k and spatial location (x, y),. € {lh,hh,hl}and λ’. K[x, y] is the wavelet coefficient of the corrupted image.

In proposed methodology we will apply the wavelet transform, estimate the threshold value, and remove the coefficient value lesser than threshold and then apply inverse transform.

The wavelet shrinkage approach can be summarized as follows:

1. Apply the wavelet transform to the signal.
2. Estimate a threshold value.
3. Remove (zero out) the coefficients that are smaller than the threshold.
4. Reconstruct the signal (apply the inverse transform).

The selection of wavelet coefficient takes image features into consideration. The proposed methodology to estimate the threshold value we use universal threshold, which will be dependent upon the number of pixels in the image:

T= sqrt (2*log (N))

Where N= no of pixel in the image.

Assuming that the analyzed signal contains noise, the universal threshold must be further adjusted. The entropy in a noise signal is higher than in a signal without noise. By Nevine Jacob and Aline Martin, to denoise an image wiener filtering is applied to the wavelet coefficients but we analyzed that the method used here does not provide high performance since the mean square error is still not minimum between the true and denoised image. With the help of Wavelet shrinking algorithm and wiener filtering we can minimize the mean square error.

II. CONCLUSION

In this paper, the denoising technique along with edges is shown. In order to remove noise from the image, the proposed technique first detects the edges and then applies the wavelet shrinkage algorithm so that the denoised image and the true image will be approximately same. The use of edge detection includes pattern recognition, image segmentation, and scene analysis. The edges are also used to locate the objects in an image and measure their geometric features. The stationary edge detection algorithm could give better performance compared to standard techniques because of its ability to retain higher number of edge points and at the same time incentives to noise.

The wavelet Transform is a multiresolution analysis tool commonly applied to texture analysis and classification and also wavelet based pre-processing. In this paper the noise removal techniques is discussed based on wavelet shrinking. In order to reduce the noise, the wavelet shrinkage algorithm is compared with the probabilistic wavelet shrinkage algorithm. By Eric J Balster, the performance of this wavelet denoising technique is an improvement over other established wavelet denoising technique, as well as being computationally efficient to facilitate real time image-processing application. The two-threshold criteria are an efficient and effective way of using the magnitude and spatial regularity of wavelet coefficients to distinguish useful from useless coefficients. Furthermore, the two-threshold criteria are a non iterative solution to selective wavelet shrinkage to provide a computationally simple solution, facilitating real-time image-processing applications. By minimizing the error between the coefficients selected by the denoising method we can determine the values of the two thresholds.

ACKNOWLEDGEMENTS

The author would like to thank the editor and the anonymous reviewers for their contributing comments, as well as Mr. R.K. Dewangan, Ast. Prof., department of Computer science & Engineering, Chhatrapati Shivaji Institute of Technology for providing their guidance.

REFERENCES

[1] Feature Based Wavelet Shrinkage Algorithm for Image Denoising, IEEE Transaction on Image Processing, December 2005, by Eric J Balster member IEEE, and Yuan F Zheng Fellow IEEE.
[2] A Stationary Wavelet Edge Detection Algorithm for Noisy Images. S. Nashat, A. Abdullah, M. Z. Abdullah.
[3] Rafael Gonzalez Richards Woods, Digital Image Processing, Pearson Publications.
[4] D. L. Donoho and I. M. Johnstone, "Ideal spatial adaptation by wavelet shrinkage," Biometrika.
[5] M. Ghazel, G. H. Freeman, and E. Vrscay, "Fractal-wavelet image denoising," in Proc. IEEE Int. Conf. Image Processing, vol. 1, 2002.
[6] M. Malfait and D. Roose, "Wavelet-based image denoising using a Markov random field a priori model," IEEE Transaction. Image Process. vol.6, no. 4, pp. 549–565, Apr. 1997.
[7] C.S. Burrus, R.A. Gopinath and H. Guo, Introduction to wavelets and Wavelet Transforms, A Primer. Englewood Cliffs, NJ Prentice-Hall, 1998.
[8] W. S. Lu, "Wavelet approaches to still image denoising," in Proc. Alisomar Conf. Signals, Systems, and Computers, vol. 2, 1998, pp. 1705–1709.
[9] O. Ojo and T. Kwaaitaal-Spassova, "An algorithm for integrated noise Reduction and sharpness enhancement," IEEE Trans. Consum. Electron. vol. 46, no. 5, pp. 474–480, May 2000.
[10] A. De Stefano, P. R. White, and W. B. Collis, "An innovative approach for spatial video noise reduction using a wavelet based frequency decomposition, "In Proc. IEEE Int. Conf. Image Processing, vol. 3, 2000, pp. 281–284.
[11] Image Denoising in the Wavelet Domain using Weiner Filtering Nevine Jacob and Aline Martin December 17,2004
[12] Wavelet domain image denoising by thresholding and Wiener Filtering Kazubek, M.; Signal Processing Letters, IEEE , Volume: 10 , Issue: 11 , Nov. 2003
[13] De-noising by soft-thresholding Donoho, D.L.; Information Theory, IEEE Transactions on , Volume: 41 ,Issue: 3 , May 1995 Pages: 613 – 627.
[14] Image Denoising using Wavelet Thresholding and Model Selection Zhong, S. ; Cherkassky, V.; Image Processing 2000, Proceedings. 2000 International Conference on, Volume: 3, 10-13 Sept. 2000 Pages: 262 -265 vol. 3.
[15] J. J. Benedetto and M. W. Frazier-Wavelet mathematics and Applications, CRC Press Inc. 1994.
[16] G. K. Shrivastava, R. Verma, R. Mahrishi, S. Rajesh- A novel wavelet edge detection algorithm for noisy images, Proceedings of the IEEE International Conference on Ultra Modern Telecommunications ICUNT, Petersburg, Russia, 2009.
[17] Wavelet Shrinkage and Denoising Brian Dadson and Lynetee Obiero Summer 2009 Undergraduate Research Supported by NSF.

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