De-Noising of Image, Using Combination of ATMED And ATMAV Filters With Fuzzy Logic In Wavelet Transform

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Abstract- *In this paper, a image denoising method based on the wavelet transform are proposed. The wavelet transform is used to convert the image to wavelet coefficients. Wavelet transform produce approximation, horizontal, vertical and diagonal with detailed coefficient. It represents the various frequency bands. These coefficients may be filtered by fuzzy filter. The paper presents two different techniques for image denoising, the first one is ATMAV (Asymmetrical Triangular Moving Average Filter) with HAAR wavelet transform and second one is ATMED (Asymmetrical Triangular Median Filter) with HAAR wavelet transform. Both techniques are based on fuzzy filters. A Comparative analytical study based on PSNR shows that HAAR with ATMED wavelet is the best technique for image denoising.*

Keywords- ATMED, ATMEV, RMSE, PSNR, Wavelet Transform.

I. INTRODUCTION

Denoising method is used to remove the noise from corrupted image, this noise gets introduced during transmission, storage and retrieval processes. Digital camera's imperfection is called noise. Which affects the image quality. Noise can be classified as follows: Substantive noise or impulsive noise, salt and pepper noise, random valued impulse noise, additive noise and speckle noise. The noisy image is diagnosed by this methods. In the wavelet technique multi resolution decompositions can be used to analyze signals and images. the goal of any noise removal scheme is to suppress noise as well as to preserve the details and edges of the image as much as possible. Figure 1 shows the basic model for diagnosing of the image

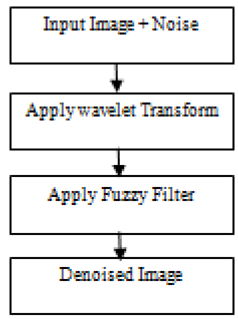


Fig.1. Basic model for denoing of image

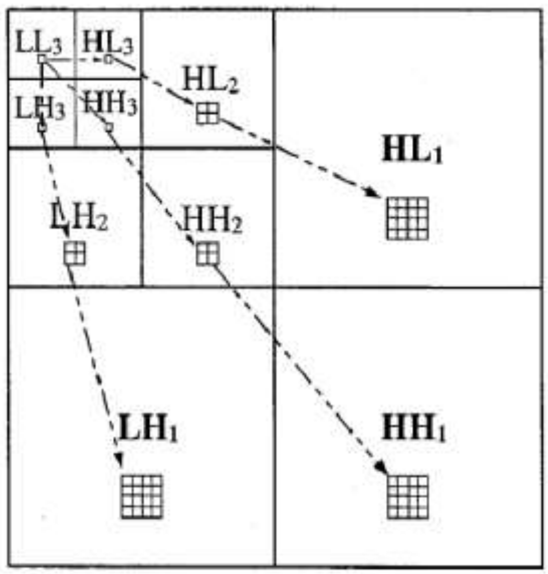
When applying Wavelet transform on images and work with their approximate coefficient, we face the problem of unsharpened edges and poor quality of background during the removal of the blurriness of the image. To overcome these drawbacks we are using fuzzy filters like , ATMAV (Asymmetrical Triangular Moving Average Filter) and ATMED (Asymmetrical Triangular Median Filter) filters.

II. DENOISNG METHODS

A. Wavelet Transform

In numerical and functional analysis ,a wavelet Transform is transform in which the wavelets are discretely sampled. It captures both frequency and location information (location in time). Wavelet transform is promising technique for image processing, due to its flexibility in multi-scale solution representation of image signals, And high quality of the reconstructed image. In 2D image, each decomposition level can have four filtered sub bands, LL, LH, HL and HH (here L and H are stands for Low and High respectively).

The sub Bands labeled LH_I, HL_I and HH_I are sets of wavelet coefficients in the fine level. The following sub bands, LH2, HL2 and HH2, are obtained from the scaling coefficients in the finer level LL1. In a sub band and its adjacent coarser level of sub band generated by the same filters have the parent-child relationship as shown in the figure 2 below. For example, HH3 is a parent sub band of HH_2 and the current sub band HH $_2$ is a child. We also call a sub band at the finest level of the current one offspring sub band. In the same example, HH_1 is an off-spring sub band of HH_2 accordingly. This type of multi resolution representation is called as sub band coding. This scheme for 2D wavelet transforms of the image has been used throughout the paper to denoise the image.



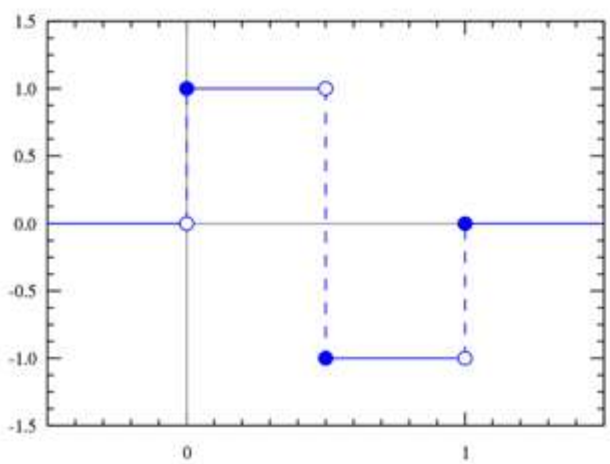


Fig.2. 2D wavelet transform

A) ATMED

ATMED is the abbreviation for Asymmetrical Triangular Median Filter. In a given neighborhood the filter takes into account the deviation of the pixel value with the median value and replaces the noisy pixel with a fitting output based on fuzzy triangular membership functions. The fuzzy filter with triangular function and median value within a window as the center value is given as in the equation below,

$$o(x,y) = \begin{bmatrix} 1-\left(\frac{I_{med(x,y)}-I_{(x+i,y+j)}}{I_{med\,(x,y)}-I_{min(x,y)}}\right) \\ for\ I_{min(x,y)} \le I(x+i,Y+j) \le I_{min(x,y)} \\ 1-\left(\frac{I_{(x+i,y+j)}-I_{med\,(x,y)}}{I_{max(x,y)}-I_{med\,(x,y)}}\right) \\ for\ I_{mav\,(x,y)} \le I(x+i,y+j) \le I_{max(x,y)} \\ for\ I_{max(x,y)}-I_{mav\,(x,y)=0} \\ or\ I_{mav\,(x,y)}-I_{min(x,y)=0} \end{bmatrix}$$

Where: $I_{max}(x, y)$, I_{min} (x,y), and I_{med} (x,y) are the maximum value, the minimum value and the median value in the neighborhood .

B) ATMAV

ATMAV is the abbreviation for Asymmetrical Triangular Moving Average Filter. In a given neighborhood the filter takes into account the deviation of the pixel value with the mean value and replaces the noisy pixel with a fitting output based on fuzzy triangular membership functions. The fuzzy filter with triangular function and mean value within a window as the center value is given as in the equation below,

$$o(x,y) = \begin{bmatrix} 1-\left(\frac{I_{med(x,y)}-I_{(x+i,y+j)}}{I_{med\,(x,y)}-I_{min(x,y)}}\right) \\ for\ I_{min(x,y)} \le I(x+i,Y+j) \le I_{min(x,y)} \\ 1-\left(\frac{I_{(x+i,y+j)}-I_{med\,(x,y)}}{I_{max(x,y)}-I_{med\,(x,y)}}\right) \\ for\ I_{mav\,(x,y)} \le I(x+i,y+j) \le I_{max(x,y)} \\ for\ I_{max(x,y)}-I_{mav\,(x,y)=0} \\ or\ I_{mav\,(x,y)}-I_{min(x,y)=0} \end{bmatrix}$$

Where: $I_{max}(x, y)$, I_{min} (x,y), and I_{med} (x,y) are the maximum value, the minimum value and the median value in the
neighborhood.

B. Haar Wavelet

In mathematics, the Haar wavelet is a sequence of rescaled "square-shaped" functions which together form a wavelet.

Wavelet analysis is similar to Fourier analysis.

The Haar wavelet is also the simplest possible wavelet. the Haar wavelet is also known as Db1.

III. METHODOLOGY

In the first step, the selection of an image is made. By checking, it is found whether an image is a gray or colored image? If it is colored image, then it is convert it into gray image. Then, using this image as an input, Discrete wavelet transform (DWT) has been applied to decompose the noisy image into four sub images: LL, HL, LH, and HH as discussed in subsection and applied thresholding to remaining sub images. The colossus part of the study is, to apply fuzzy filters. The two very important fuzzy filters ATMAV and ATMED have been introduced in this process. Then these ATMAV and ATMED filters are used with HAAR transform

Denoised image is obtained. Finally, PSNR between original image and noisy image and RMSE between the denoised image and original image has been calculated.

IV. RESULTS

In this paper, a mixed domain image denoising method based on the wavelet transforms has been performed. The wavelet transform is used to convert the image to wavelet coefficients. Wavelet transform produces approximation, horizontal, vertical and diagonal detailed coefficient, which represents the various frequency bands. These coefficients may be filtered by fuzzy filter separately. One is based on Median and moving average, while another one used on probabilistic way, respectively. The performance for denoising of image were tested on a set of grayscale images such as Lena image (512 512). The Gaussian noise to the image and impulsive noise, e.g., salt and pepper noise, random valued impulse noise, speckle noise, etc. has been added to the image. Then image denoising has been performed through wavelet transform, using wiener filter and fuzzy filters (ATMAV and ATMED) with HAAR wavelet. The HAAR with ATMED wavelet are showing the best denoising result. The Analysis also done on the following combination,as shown in the figure 3.

1) HAAR wavelet with ATMAV.
2) ATMAV with HAAR.
3) HAAR with ATMED.

The last step gives better result as compared to previous one.

(a) Original image (b) Noisy image (c) Wiener and Wavelet (d) Haar and ATMAV (e) ATMAV and Haar (f) Haar and ATMED

Table I. PSNR result of proposed method (HAAR+ATMED) for Lena, Subaru-Impraza (car), red flower and beach images at noise variance 0.05.

Table I. Comparison of result between reference method and proposed method

Image level	Noise level	Proposed method HAAR+ATMED
Lena	0.05	25.0727
Subaru(car)	0.05	23.7548
Red flower	0.05	24.1452
Beach	0.05	22.9790

A Comparative analytical study based on PSNR; as shown in figure 4 and mean square error; as shown in figure 5; shows that HAAR with ATMED wavelet is the best technique for image denoisin. In the figure 4 and 5 below, the results shown in graphical representation has been calculated on the Lena image only at noise variance 0.05.

Peak signal-to-noise ratio, often abbreviated **PSNR**, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation.

Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale.

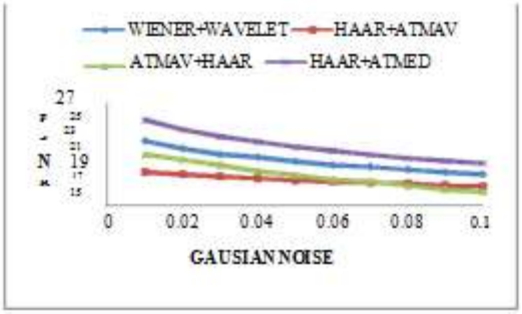


Fig. 4 Graph between PSNR and Gausian noise

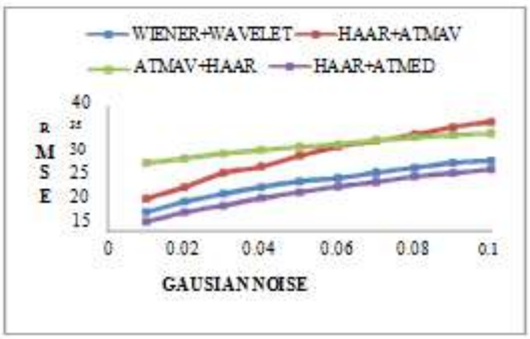


Fig. 5 Graph between RMSE and Gausian noise

V. CONCLUSION

The denoising of images is the initial step in image processing. Robustness and detail preservation are the two most important aspects of modern image enhancement filters. There are several methods for image denoising in spatial and transform domain. The current trends of the image denoising research are the evolution of mixed domain methods. Based on the result, it is clear that ATMAV with HAAR gives vulnerable result for image denoising, While HAAR with ATMED wavelet gives better result as compared to previous techniques, as shown in the result part. Thus HAAR with ATMED is the promising method for image denoising. Future endeavors include a better expansible proportion of wavelet coefficients in order to get better denoising effects using fuzzy filters.

REFERENCES

[1] Sushil Kumar “Image De-noising Using Wavelet-Like Transform” Volume 5, Issue 1 (2017) 70-72 ISSN 2347 - 3258 International Journal of Advance Research and Innovation.

[2] Performance Evaluation and Comparison of Modified Denoising Method and the Local Adaptive Wavelet Image Denoising Method 2015 International Conference on Intelligent Systems and Signal Processing (ISSP).

[3] Ms. Jignasa M. Parmar and Ms. S. A. Patil “Performance Evaluation and Comparison of Modified Denoising Method and the Local Adaptive Wavelet Image Denoising Method” International Conference on Intelligent Systems and Signal Processing (ISSP) 2013.

[4] S.Arunkumar, Ravi Tej Akula, Rishabh Gupta, and M.R.Vimala Devi “Fuzzy Filters to the Reduction of Impulse and Gaussian Noise in Gray and Color Images” International Journal of Recent Trends in Engineering, Vol. 1, No. 1, May

[5] Israr Hussain and Hujun Yin, “A Novel Wavelet Thresholding Method for Adaptive Image Denoising”, IEEE, ISCCSP Malta, pp.1252-1256,2008.

[6] pitas I. and venetsanopoulos A.N., nonlinear digital Filters, Kluwer academic publishers, Boston, 1990.

[7] Kwan H.K. and cai Y., “median Filtering Using Fuzzy concept”, 36th Midwest symposium on circuits and systems, Detroit, MI, vol. 2, pp. 824-827, August 1993.

[8] S.Arunkumar, Ravi Tej Akula, Rishabh Gupta, and M.R.Vimala Devi “Fuzzy Filters to the Reduction of Impulse and Gaussian Noise in Gray and Color Images” International Journal of Recent Trends in Engineering, Vol. 1, No. 1, May 2009.

[9] Nevine Jacob and Aline Martin “Image Denoising In the Wavelet Domain Using Wiener Filtering” December 17, 2004.

[10] Jang, I.H., Kim, N.C., “Denoising of images using locally adaptive Wiener filter in wavelet domain”, *IEICE Transactions on Information and Systems*, 2001.4, pp. 495-501