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NOISE DIMINUTION THROUGH WAVELET BASED HYBRID FILTER TO SEGMENT AN IMAGE

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ABSTRACT

Image denoising is a complicated task to remove noise from an image and also to maintain the quality, which is based on the nature of noise. In this paper, an image denoising method wavelet based asymmetrical triangular median fuzzy filter (WATMED) is proposed based on wavelet transform with fuzzy filter, wiener filter and median filter. This paper also discusses the performance analysis of various existing image denoising algorithms to remove the different types of noise. The projected filtering technique provides improved outcomes for removing all type of noises except salt and pepper noise where median filter gives good results.

Key words: Median filter, Average filter, Wiener filter, Gaussian filter, ATMED filter, Speckle noise, Gaussian noise, Salt and Pepper noise.

INTRODUCTION

Digital images are caught or exchanged by using imaging devices like cameras or systems. Due to the occurrence of noise, the captured image may be corrupted. So, noise removal is an essential preprocessing technique to be performed in any image processing task on the arrived image[1,2]. Various kinds of noises such as Gaussian noise (Amplifier noise), speckle noise (Multiplicative noise), salt & pepper noise (Impulse noise) may be present in an image and different kind of noise removal algorithms are presented to perform de-noising based on the application. The standard technique for image de-noising is filtering which is based on the filters like Gaussian filter, median filter, wiener filter, average filter (Mean filter) and many more. Image denoising is one of the preprocessing techniques for image segmentation. It is used in lot of applications such as agriculture, military, medical

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imaging, etc for analysing the images by segmenting an image into sub-images. The proposed WATMED filter with wiener and median filter gives better results i.e noise free images for the given image set. It produces high PSNR value and minimum MSE values. The results are compared with existing filters.

Related work

Median filter is used[3] for removing salt and pepper noise which has minimized error with high computation time. A technique is proposed to decrease Gaussian noise from digital gray scale images efficiently[4]. A method is proposed[5] to remove additive noise. Median filter is proposed to remove impulsive noise from an image which also protects the details of the image[6]. This filter is simple and flexible one. To remove speckle noise from digital images, mean filters are used[7]. It provides better performance for filtering than median filter whereas mean filter has high computational complexity. Fuzzy Impulse noise Detection and Reduction method was used for reducing impulse noise. To remove impulsive noise, a technique is used[8] as variable size detection window which detects flag image for removal, pixel modification, identification and correction using detected flag image. The filter reserved the loyalty of the image. A method is proposed[9] for denoising impulsive noise from the image with low computation time and protects complex features of the image. In[10], it used fuzzy median filter for removing salt and pepper noise. It protects image detail and also improves the smoothing rate for an image. Fuzzy rule is proposed[11] for detecting noise and removing Gaussian noise from an image which also reduce blurring. In[12], filter is designed for removing salt and pepper, Gaussian and speckle noise, which finds the type of noise accurately. Hybrid technique is proposed[13] for filtering to remove Gaussian noise from an image which is basic and simple to execute. Average filter is applied[14] for removing speckle noise to enhance the quality of an image. An adaptive fuzzy based filtering method was presented[15] for removing noise in medical images. In[16], fuzzy hybrid max filter is proposed for removal of Gaussian noise from images which is easy to implement and gives the best results. The method for pixel comparison with all its neighbour pixels for noise detection and Gaussian noise removal is performed[17]. In[18], it is offered various salt and pepper noise reduction algorithms for restoration of contaminated images. It has several drawbacks for restitution of contaminated image.

Wavelet transform and ATMED fuzzy filter

Discrete wavelet transform (DWT) performs image decomposition and reconstruction. In a two level decomposition, the image is splitted as four blocks which is represented as sub-bands as HH, HL, LH and LL. DWT consists of consecutive operations on rows and columns of the image which forms a matrix and left side of the matrix has low pass coefficients of each row and the high pass coefficients are placed in the right side. Next, again disintegration is connected to all segments. In a fuzzy filter, central pixel value is replaced by the mean or median value of the neighbourhood pixels. To compute the value of the center pixel, the weighted membership function is applied to an image within a window and this filter gives fast output and used for removing all kind of noise levels. Let I (n, s) is the noised image and Y (n, s) is the denoised output image of the fuzzy filter[19], which is given in Eq. 1.

$$Y(n,s) = \frac{\sum_{i,j\in A} \mathrm{Fuz}_{atmed}\,[I\,(n+i, s+j)].[I\,(n+i, s+j)]}{\sum_{i,j\in A} \mathrm{Fuz}_{atmed}\,[I\,(n+i, s+j)]} \qquad \ldots(1)$$

Where A is a window and Fuz_{atmed} [I (n, s)] is the window function with discrete indexes (n, s)[20] and i, j $\in$ A.

In the Asymmetrical Triangular Median fuzzy Filter (ATMED), the central pixel value is replaced with the median value of the neighbourhood pixels based on fuzzy triangular membership functions as given in the Eqs. 2, 3 and 4 based on the different values of noised image I. Based on the I values, Fuz_{atmed} [I (n, s)] was computed.

$$\mathrm{Fuz}_{atmed}\,[I\,(n+i, s+j)] = \begin{cases} 1 - \dfrac{I_{med}(n,s) - I\,(n+i, s+j)}{I_{med}(n,s) - I_{min}\,(n,s)}, \\ \text{for } I_{med}(n,s) \le I\,(n+i, s+j) \le I_{med}(n,s) \end{cases} \qquad \ldots(2)$$

$$\mathrm{Fuz}_{atmed}\,[I\,(n+i, s+j)] = \begin{cases} 1 - \dfrac{I\,(n+i, s+j) - I_{med}\,(n,s)}{I_{max}(n,s) - I_{med}\,(n,s)}, \\ \text{for } I_{med}(n,s) \le I\,(n+i, s+j) \le I_{max}(n,s) \end{cases} \qquad \ldots(3)$$

$$\mathrm{Fuz}_{atmed}\,[I\,(n+i, s+j)] = 1, \begin{cases} \text{for } I_{med}(n,s) - I_{min}\,(n,s) = 0 \\ \qquad\text{or} \\ \text{for } I_{max}(n,s) - I_{med}\,(n,s) = 0 \end{cases} \qquad \ldots(4)$$

Where I_{max} (n, s) denotes Maximum value, I_{min} (n, s) means Minimum Value and I_{med} (n, s) denotes median value for all input values [I(n + I, s + j)] for i, j ϵ A within the window A at index values (n, s).

Proposed WATMED algorithm

In the proposed system framework, it has three stages such as image acquisition, noise removal and performance evaluation. In the image acquisition stage, the input images are collected. These input images are pigeonholed by including various types of noises. In Noise removal, wavelet based ATMED (WATMED) was applied for removing the noises. In WATMED, initially DWT decomposition and reconstruction is performed on the noisy images. The output of the DWT is given as the input for ATMED fuzzy filter. Fuz_{atmed} [I (n, s)] is computed based on the equations 2, 3 and 4. Based on the value of I, the corresponding Fuz_{atmed} value is applied in equation 1 for detecting a denoised image. The proposed WATMED approach is integrated with wiener and median filter for improving noise reduction. The outcome of the proposed work produces an output image as noise free image. The denoised image was compared with the existing filtering techniques in terms of PSNR and MSE is presented in the subsequent segment. The noise diminution of the overall anticipated system is represented in Fig. 1.

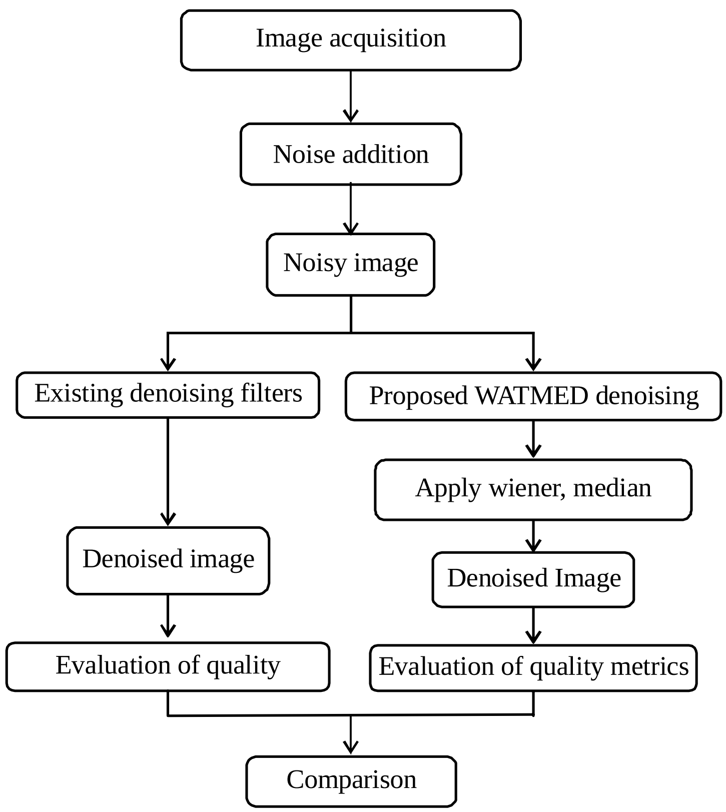

Fig 1: Block diagram of proposed denoising filter with evaluation metrics comparison

RESULTS AND DISCUSSIONS

Gray scale images are taken as reference images. Then the variety of noises like impulsive noise, multiplicative noise, Gaussian noise is added to the input images. After adding the noises to the image, denoising is applied by using filtering technique as median, wiener, Gaussian, average filter and proposed system. The simulation results show distinctive noise removal by utilizing diverse filters. Comparative analysis between them is evaluated through peak signal to noise ratio (PSNR) and mean square error (MSE). Various parameters[21] are used for evaluation for filtered images. Table 1 and 2 gives the average PSNR and average MSE values for various filters with different kind of noises like Speckle noise, Salt and Pepper Noise and Gaussian Noise. A range of filters with its average PSNR values are plotted in the Fig. 3 for different kind of noise and Fig. 4 describes the graph based on the average MSE values of various filters. Average filter gives better result for speckle noise and Gaussian noise removal where as Gaussian filter has high MSE value and Very low PSNR values. So, Gaussian noise is not suitable for this kind of noise exclusion. The median filter performed well in eliminating Salt & Pepper noise. Wiener filter perform well with Gaussian noise and speckle noise compared with median and Gaussian filters. The proposed filtering scheme produces best result for removing Gaussian noise than the others in terms of PSNR and MSE.

Table 1: Average PSNR values for various filters with various noises

Noise & filters	Gaussian filter	Mean filter	Median filter	Wiener filter	Proposed work
Gaussian noise	17.5848	22.31644	20.56708	23.15821507	24.73487
Salt & pepper noise	21.88508	25.92363	33.52897	23.29370545	28.9536
Speckle noise	24.03555	27.59177	25.16139	26.32523876	27.63611

Table 2: Average MSE values for various filters with various noises

Noise & filters	Gaussian filter	Mean filter	Median filter	Wiener filter	Proposed work
Gaussian noise	1133.968	381.4493	570.6538	314.2381096	218.5713
Salt & pepper noise	421.2818	166.2332	28.85248	304.5859146	82.74091
Speckle noise	256.7587	113.2147	198.1257	151.55019	112.0649

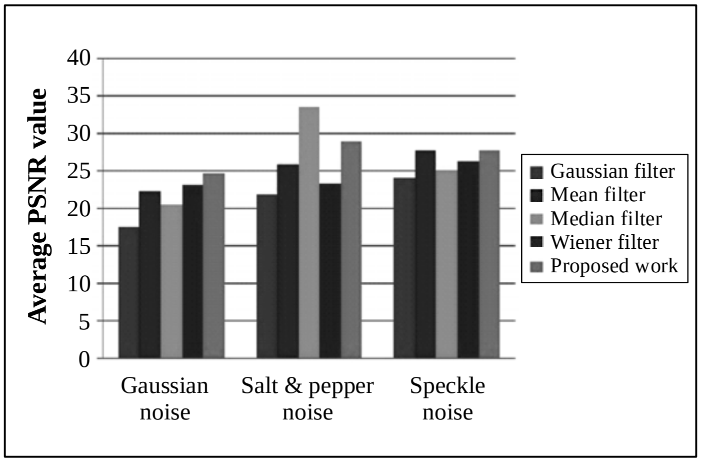

Fig. 3: Comparison of PSNR values for various Filters

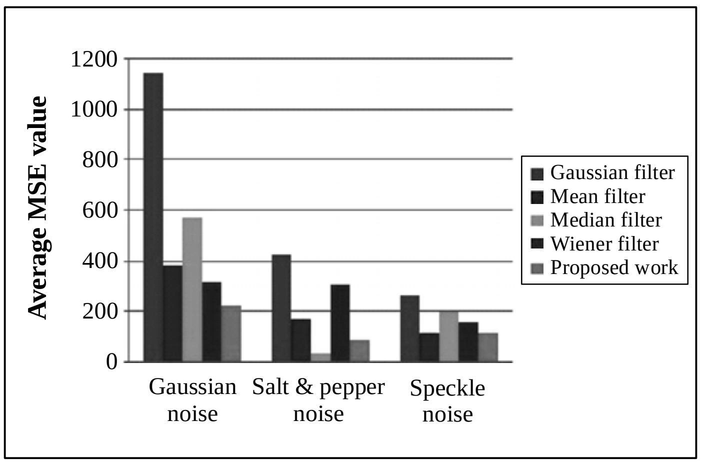

Fig. 4: Comparison of MSE values for various filters

In case of salt and pepper noise deletion it provides improved outcome in MSE and PSNR value than other filters except Median filter and in the Speckle noise removal, it gives better result than other filters. The proposed filtering work expands better results for all kind of noise removal compared with other filters except median filter in Salt and Pepper Noise removal.

CONCLUSION

Noise removal for enhancement of an image is an imperative work in image processing. Filters are utilized for noise removal from the given images to enhance an image without noise. The different kind of noises like Salt and pepper noise, Gaussian noise, and Speckle noise is added to input image. Here, different sorts of noise models and filters techniques are depicted furthermore performance evaluation was contrasted with one with another. The performance evaluation of the filters is analyzed in light of the PSNR and MSE parameters and the yield estimations of these parameters are plotted in the chart. The comparison result demonstrates that the median filters do well in evacuating Salt & Pepper noise. Wiener filter execute good with Gaussian noise and Speckle noise. Mean filter shows better performance in eliminating Gaussian noise and speckle noise. The proposed technique explore the hybrid technique with wavelet based fuzzy filter ATMED (WATMED) for removing noise and performance of this hybrid technique is compared with existing denoising techniques in terms of average PSNR and average MSE. The proposed filtering scheme produces best result for removing Gaussian noise than the others and gives better result for removing salt and pepper noise and Speckle noise. The proposed filtering scheme provides enhanced results for all kind of noise reduction compared with other filtering techniques.

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