An Impressive Method to Get Better Peak Signal Noise Ratio (PSNR), Mean Square Error (MSE) Values Using Stationary Wavelet Transform (SWT)

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Abstract

Impulse noise in images is present because of bit errors in transmission or introduced during the signal acquisition stage. There are two types of impulse noise, they are salt and pepper noise and random valued noise. In our proposed method, first we apply the Stationary wavelet transform for noise added image. It will separate into four bands like LL, LH, HL and HH. The proposed algorithm replaces the noisy pixel by trimmed median value when other pixel values, 0?s and 255?s are present in the selected window and when all the pixel values are 0?s and 255?s then the noise pixel is replaced by mean value of all the elements present in the selected window. This proposed algorithm shows better results than the Standard median filter (MF), decision based algorithm (DBA). The proposed method performs well in removing low to medium density impulse noise with detail preservation up to a noise density of 70

Index terms— Peak signal-to-noise ratio (PSNR), mean square error (MSE) values.standard median filter (MF), decision based algorithm (DBA).

1 Introduction

n the transmission of images over channels, images are corrupted by impulse noise, due to faulty communications. The objective of filtering is to remove the impulses so that the noise free image is fully recovered with minimum signal distortion. Noise removal can be achieved, by using a number of existing linear filtering techniques which are popular due to their mathematical simplicity and the existence of the unifying linear system theory. A new and efficient algorithm Jayaraj etal [1] proposed high-density salt and pepper noise removal in images and videos. The non-linear filter like standard median filter (SMF), adaptive median filter (AMF), decision based algorithm (DBA) and robust estimation algorithm (REA) shows better results at low and medium noise densities. At high noise densities, their performance is poor.

Salt and pepper impulse noise is one commonly encountered noise type during image and video communication. So far the state of the art methods can reasonably restore images corrupted by salt and pepper noise whose level is up to 90%. A novel quadratic type variation formulation of this noise removal problem is reported by wanetal [2]. This approach first uses a simple yet fast method to eliminate all salt-andpepper noise pixels as well as possibly some clean pixels, then the clean image is efficiently reconstructed from the remaining clean pixels by minimizing a carefully designed functional. Because the functional is quadratic type, fast unconditional convergence is guaranteed.

Recently a new adaptive weight algorithm Jianetal [3] for the removal of salt and pepper noise in. It consists of two major steps, first to detect noise pixels according to the correlations between image pixels, then use Different methods based on the various noise levels. For the low noise level, neighborhood signal pixels mean method is adopted to remove the noise, and for the high noise level, an adaptive weight algorithm is used. A switching bilateral filter (SBF) with a texture and noise detector for universal noise removal is proposed by

Tsaietal [4]. Here the operation was performed in two stages: detection followed by filtering. For detection, the sorted quadrant median vector (SQMV) scheme, this includes important features such as edge or texture information. This information is utilized to allocate a reference median from SQMV, which is in turn compared with a current pixel to classify it as impulse noise, Gaussian noise, or noise-free. The SBF removes both Gaussian and impulse noise without adding another weighting function. The range filter inside the bilateral filter switches between the Gaussian and impulse modes depending upon the noise classification result.

To remove salt and pepper noise in video a new algorithm is proposed by **??**sakkirajan etal [5]. This proposed adaptive decision algorithm first checks whether the selected pixel in the video sequence is noisy or noise free. Initially the window size is selected as 3×3. If the selected pixel within the window is 0's or 255's, and some of other pixels within the window are noise free, then the selected pixel value is replaced by trimmed median value. If the selected pixel is 0 or 255 and other pixel values in a selected window **??**3×3) all are 0's and 255's, then change the selected window size (D D D D) F as 5×5, then the selected pixel value is replaced by trimmed median value. In the selected new window **??**5×5), all the elements are 0's or 255's then the processing pixel is replaced by the previous resultant pixel.

A modified simple edge preserved de-noising algorithm to remove salt and pepper noise in digital color images is discussed in [6]. This proposed algorithm has three steps: noisy pixel detection, replacement of noisy pixels, and confirmation by comparing with a threshold. In addition a median filtering is added to improve the quality of the image. It prevents the smoothing of edges in the noise removal process, by predicting the possible edges and taking the mean value from the predicted edge. Furthermore, Rahaman etal. [7] reported a new algorithm to remove Salt and Pepper noise from grayscale images. This is an enhanced adaptive median filtering algorithm which initially calculates median without considering noisy pixels in the processing window. If the noise-free median value is not available in the maximum processing window, the last processed pixel value is used as the replacement. However, in extreme situations such as noise corrupted pure black and white images, a threshold value is used to determine the pixel value.

A new wavelet-based de-noising method for medical infrared images was reported by Rabbani etal [8]. Since the dominant noise in infrared images is signal dependent utilize local models for statistical properties of (noise-free) signal and noise. In this base, the noise variance is locally modeled as a function of the image intensity using the parameters of the image acquisition protocol. In the next step, the variance of noise-free image is locally estimated and the local variances of noise-free image and noise are substituted in a wavelet-based maximum a posterior (MAP) estimator for noise removal.

A methodology based on median filters for the removal of salt and pepper noise by its detection followed by filtering in both binary and gray level images has been proposed by sarath etal [9]. Linear and nonlinear filters have been proposed earlier for the removal of impulse noise; however the removal of impulse noise often brings about blurring which results in edges being distorted and poor quality. Therefore, the necessity to preserve the edges and fine details during filtering is the challenge faced by researchers today. It consists of noise detection followed by the removal of detected noise by median filter using selective pixels that are not noise themselves. The noise detection is based on simple thresholding of pixels.

Impulse noise removal is one of the important image preprocessing techniques since the noise will lead the image processing procedures into an unexpected direction. The candidate-oriented strategy that detects the corrupted pixels (noise candidates) and then updates the intensity value of those pixels can achieve better performance than the brute-force strategy. Recently a novel region feature is presented in Ref. [10] to avoid the misclassification problem. In this method the noise pixels are treated as the small-sized regions, and labeled by the multi-scale connected component labeling algorithm. In this way, the region size can be considered as a clue during the noise detection procedure. This newly developed region feature can be easily utilized to the current noise removal algorithms.

2 II.

3 Methodology

The proposed image denoising corrupted by salt and pepper noise is built on Stationary wavelet transform. The following section described the Stationary Wavelet Transform (SWT) and Proposed Algorithms.

4 a) Stationary Wavelet Transform

The SWT provides efficient numerical solutions in the signal processing applications. It was independently developed by several researchers and under different names, e.g. the un-decimated wavelet transform, the invariant wavelet transforms and the redundant wavelet transform. The key point is that it gives a better approximation than the discrete wavelet transform (DWT) since, it is redundant, linear and shift invariant. These properties provide the SWT to be realized using a recursive algorithm. Therefore, the SWT is very useful algorithm for analyzing a linear system. A brief description of the SWT is presented here. Figure shows the computation of the SWT of a signal x(k), whereW_jk, and V_jk are called the detail and the approximation coefficients of the SWT. The filters H_j and G_j are the standard low pass and high pass wavelet filters, respectively. In the first step, the filters H_1 and G_1 are obtained by up sampling the filters using the previous step (i.e. H_j-1 andG_j-1).

5 III.

6 Proposed method

The Proposed method shown in Figure 1. In order to overcome the above mentioned difficulties, a new two-stage cascaded filter is proposed in this paper which removes the noise as high as possible, without blurring and retains the fine edge details. The proposed algorithm removes these drawbacks at high noise density. This algorithm processes the corrupted images by first detecting the impulse noise. The processing pixel is checked whether it is noisy or noisy free. That is, if the processing pixel lies between maximum and minimum gray level values then it is noise free pixel, it is left unchanged. If the processing pixel takes the maximum or minimum gray level then it is noisy pixel. It gives better Peak signal-to-noise ratio (PSNR) and image enhancement factor (IEF) values than the existing algorithm. In adaptive modified filter the pixels are processed using 5 X 5 windows. During processing if a pixel is '0' or '255' then it is processed else it is left unchanged. In decision based algorithm (DBA) the corrupted pixel is replaced by the median of the window. At higher noise densities the median itself will be noisy, and the processing pixel will be replaced by the neighborhood processed pixel. This repeated replacement of neighborhood pixels produces streaking effect. To overcome the above drawbacks, the adaptive modified decision-based unsymmetric trimmed median filter is proposed. The corrupted processing pixel is replaced by a median or mean value of the pixels in the 5 X 5 window after trimming impulse values. The corrupted pixel is replaced by the median or mean of the resulting array. In this, the median value is replaced only when both the processing pixel and all the neighboring pixels are noisy pixels. In other case, if the processing pixel is noisy and all the neighboring pixels are not noisy pixel then the mean value is used for replacement. If the processing pixel itself is not a noisy pixel, then it does not require further processing. Thus the processing pixel value can be modified as median or mean value according to the cases and hence named as adaptive modified decision based unsymmetric trimmed median filter. original image in spatial domain. In the proposed method, soft shrinkage and median absolute difference (MAD) are used. The scaled MAD noise estimator is calculated by (6).

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?????? = ???????????? (|??|) 0.6745 (1)

Where X is the high frequency sub-bands coefficients. From the estimated noise, the non linear threshold T is calculated by equation (2)?? = ?????? * ?2?????????**(2)**

Where N is the size of the high frequency subband array. Then the soft thresholding is applied to remove the noise and the soft shrinkage rule is defined by equation (3). Finally, the noise free image is obtained by taking the inverse SWT.?? ?? (??) = ? ?? ? ??, ???? ?? ? ?? ?? + ??, ???? ?? ? ??? 0, ???? |??| < ??**(3)**

The noise free sub-bands are extracted using adaptive thresholding. Finally, the noise free image is obtained by taking the inverse SWT using the modified high frequencies sub-bands and the low frequency sub band of SWT.

8 IV.

9 Algorithm

Step 1: Select 2 -D window of size 5 X 5. Assume that the pixel being processed is P ij .

Step 2: : If 0<P ij <255then P ij is an uncorrupted pixel and its value is left unchanged.

Step 3: : If P ij =0 or P ij =255 then P ij is a corrupted pixel then two cases are possible.

Case i: : If the selected window contain all the elements as 0's and 255's. Then replace P ij with the mean of the element of window.

Case ii: : If the selected window contains not all elements as 0's and 255's. Then eliminate 255's and 0's and find the median value of the remaining elements. Replace P ij with the median value.

Step 4: : Repeat steps 1 to 3 until all the pixels in the entire image are processed.

Move the window by one step and repeat from step 1 to step 4. The above steps are repeated, until the processing is completed for the entire image.

10 a) Algorithm description

Each and every pixel of the image is checked for the presence of salt and pepper noise. Different cases are illustrated in this Section. If the processing pixel is noisy and all other pixel values are either 0's or 255's is illustrated in Case i. If the processing pixel is noisy pixel that is 0 or 255 is illustrated in Case ii. If the processing pixel is not noisy pixel and its value lies between 0 and 255 is illustrated in Case iii. If the processing pixel value is 0 or 255, then it is a corrupted pixel and it is processed by two cases:

Case (i): If the selected window contains salt or pepper noise as processing pixel (i.e., 255/0 pixel value) and neighboring pixel values contains all pixels that adds salt and pepper noise to the image. Consider the matrix [0 255 0 0 255 255 0 0 255 0 0 255 255 0 255 0 255 0 0 0 255 0 255 255 0 255]. Since all the elements surrounding Pij are 0's and 255's. If one takes the median value it will be either 0 or 255 which is again noisy. To solve this problem, the mean of the selected window is found and the processing pixel is replaced by the mean value.

Case (ii): If the selected window contains salt or pepper noise as processing pixel (i.e. 255/0 pixel value) and neighboring pixel values contains some pixels that adds salt (i.e. 255 pixel value) and pepper noise to the image. Now eliminate the salt and pepper noise from the selected window. That is, elimination of 0's and 255's. If the processing pixel (P ij) value is not 0 or 255, then it is an uncorrupted pixel and it is processed by following case.

Case (iii): If the selected window contains a noise free pixel as a processing pixel, it does not require further processing. For example, 1-D array of the matrix is [43 67 70 55 75 108 112 143 164 85 97 45 80 95 100 45 87 43 190 87 90 79 85 81 66]. Here the processing pixel is 80 then it is noise free pixel. Since "80" is a noise free pixel it does not require further processing.

Repeat the steps until all the pixels in the entire image are processed.

11 V.

12 Experimental results

The proposed algorithm foe tested for 256x256 images. It is tested for various levels of noise values and also compared with Standard median filter (SMF).

13 Conclusion

In this work, image denoising based on Stationary wavelet transform (SWT) and soft threshold method are discussed. Experimental results show that the proposed method restore the original image much better than standard non linear median-based filters and some of the recently proposed algorithms. The proposed filter requires less computation time compared to other methods. The visual quality results clearly shows the proposed filter preserve fine details such as lines and corners satisfactorily. This filter can be further improved to apply for the images corrupted with high density impulse noise up to 90% and random valued impulse noise. [1] [2]

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Figure 1: Figure 1 :

Figure 2:

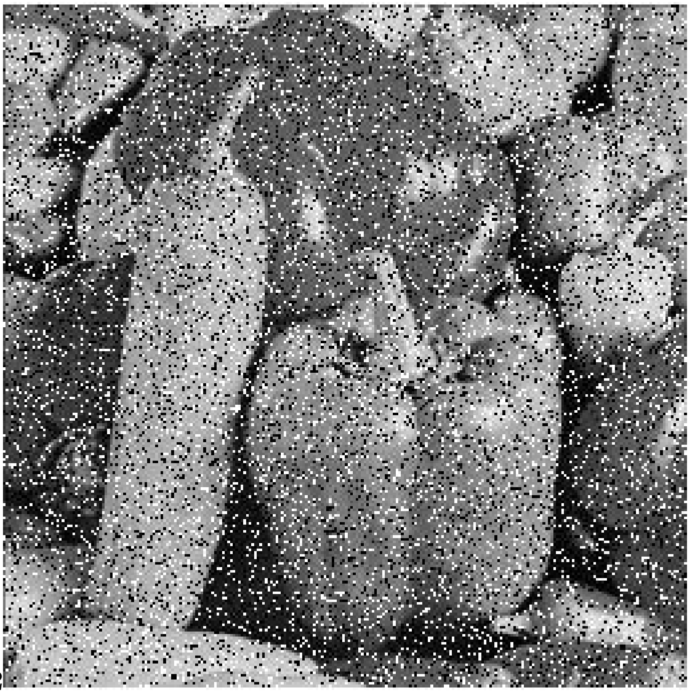

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Figure 3: Figure. 2 Figure 2 :

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		PSNR in db			
Noise density in %	Median filter	PSMF	DBA	Our Method	Proposed
10	31.60	26.42	39.78	39.91	
20	31.38	26.42	37.29	37.31	
30	31.04	26.42	35.42	35.63	
40	30.64	26.42	34.09	34.42	
50	30.63	26.42	34.08	34.44	
60	29.59	26.42	32.06	32.54	
70	28.86	26.42	31.14	31.57	
80	28.21	26.42	30.14	30.54	
90	27.55	26.42	29.49	29.51	

Figure 4: Table 1 :

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