Decision Based Trimmed Adaptive Windows Median Filter

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Abstract: ***In this research we have proposed a median filter which is capable of identifying and eliminating salt and pepper noise within the image and keeps the uncorrupted pixels intact. It is based on growing window concept and makes use of simplified and full window for low and high noise densities respectively. The proposed filter replaces the center processing pixel's value with the median of the window calculated among noise free candidates. The algorithm works well for both low and high noise density.***

Keywords: Salt and pepper noise

1. Introduction

The noise usually alters the contents of a image making the image unsuitable for certain process. Image is captured or acquired by any image capturing device like camera or scanner and then it is stored in the mass storage of the computer system. Then it is processed using the image processing/editing tool like MATLAB, photo-shop etc. and then displayed on the displaying device and also transmitted to the owner required party. During transfer noise may get added along the actual information. Noise is basically unwanted information which gets added along the required information due to certain environmental variations, faulty locations in a memory or during transfer. Some of its common types are salt and pepper noise (SPN) and random valued impulse noise. Pixel in an image affected by SPN takes on either maximum or minimum value resulting in white or black dots in an image. The white dot corresponds to 255 i.e. maximum value and black dot corresponds to 0 i.e. minimum value. Various median filters such as Standard Median Filter (SMF), Adaptive Median Filter (AMF), Decision Based Algorithm (DBA), Modified Decision Based Unsymmetric trimmed median filter (MDBUTMF), Decision Based Coupled Window Median Filter (DBCWMF) have been proposed to overcome low and high noise density but there always remains some loop hole in the algorithm which sometimes causes inefficient noise suppression leading to loss of natural information.

The organization of the paper trails as. Review of previous median filters is given in Sect. II. Section III focuses on the formulation of the proposed algorithm. Section IV reports a number of experimental results to demonstrate the performance of the new algorithm. Finally, conclusions are drawn in Sect. V.

2. Literature Survey

Median filters at a halt are the nucleus of nearly all up to date noise elimination schemes for salt and pepper noise. Standard median filters are the easy non-linear filter where each pixel is reinstate by the median of gray intensity in the environs [4]. A fast 2D median Filtering Algorithm [1] utilizes the histogram for the median calculation selects the first window. After performing this, it deletes the column from the left side of the window and adds one column, set gray level and updates the histogram. Then, it finds the median value and number of pixels in it having the gray level less as compared to the median value. This now will act as the next window. Again it will repeat all these stepladders until the end of the line.

Chan have specified that before applying filtering method to any pixel, they do not consider whether it is noise free or not. As it does not bestow stare to this piece of evidence of shady pixel and thus replaces non corrupted pixels as well. [5]. Thus, Standard Median Filters (SMF) is not successful in the removal of noise from the high density noise image and results in blurring as it delight both the corrupted and uncorrupted pixels. There is one other shortcoming of these SMF that in case of high density noise, the quantity of noisy pixel in the special consideration window around the central pixel is greater than that of noise free ones and thus, the odds is that the median value could also be noisy. The other last consequences of these is that when the pixel is noise free in nature, it may be put back by the median value which marks in the blurring effect.

New Decision-Based Algorithm can be applied for both gray scale plus color images[7]. At the outset, it makes a distinction between the corrupted and the uncorrupted pixels. For this, it brings into play the similar scheme as used by the AMF. Then the filter is applied only to the destroyed pixels. It helps to get rid of the problems of both i.e. AMF and Fast DBA. There is enhanced edge conservation as compared to the fast DBA. It works almost same as the fast DBA. In previously discussed fast decision based technique, which reinstate the current pixel with the left formerly processed pixel if median value is piercing. The problem it encounters due to this is that image illustration quality is not good due to the smooth changeover between the pixels. The researchers concluded the reason for this is the use of the single neighborhoods pixel. [8] So they provided the solution by using all until that time processed pixels of the window. Thus, there is improved visual perception, and smooth shift between pixels. And last but not least, it too uses the window of one size.

Modified Decision Based Unsymmetric Trimmed Median filter (MDBUTMF) [9] can also be used for high concentration of salt and pepper noise. It also first of all checks whether the pixel is ruined or not and if it is then it sets the window of 3×3 around it. It trade it by spick and span midpoint value of the unaffected pixels of the window and when all the pixel values in the window are 0"s and 255"s then is swapped by mean of the elements present in the selected window.

Modified Decision Based Unsymmetric Trimmed Adaptive Median Filter (MDBUTAMF) [11] given by Chandra *et al. (2013)* It works same as of previous filters in applying it to the destroyed intensities and using only the informative intensities for finding the median value. But there is one extra stipulation for finding the median and is that it looks not only for even a single intensity value for finding it but the destroyed intensities of elements should not be 3/4th or more of the total entities. This is coz of the reason that let in smallest window dimension, there are only two informative intensity values out of eight values, and thus, they are not enough to estimate the informative median.

The Decision Based Coupled Window Median Filter (DBCWMF) algorithm covers the gaps of MDBUTMF and was removed by using changing window size and such these are called Growing Length Window (GLW) [12]. It set off from the dimension 3×3. If the conditions are not satisfied then it raises the magnitude of the window but only up to 9×9. This is for the reason that on increasing the size supplementary, it will add to the complexity and moreover, the considered median will be not as much of linked with the pixel. Basically, GLW is used to enlarge the prospect of finding the informative pixels.

3. Proposed Algorithm

Let X is the input image and Z is the final de-noised image and as per the algorithm the scanning has to be completed for all the pixels of the image. The detailed flow chart for the algorithm is drawn on next page and the steps are as follows:

Step 1: Read the noisy image $X(i,j)$. This is the input image and let $N(i,j)$ be the noisy image.

Step 2: Start scanning from the 1st pixel and move towards the last pixels i.e. in forward direction. Thus i=1 and j=1.

Step 3: Make decision for the pixel in progress that it is disturbed or actual one. The condition for this is:

$$0 < N(i,j) < 255 \text{ , Noise free (1)}$$

Otherwise, Noisy

Step 4: If it is found to be actual one as per the condition applied then it is assigned as it is to the final image obtained during the scanning and is not treated by the filter.

$$N(i,j) = X(i,j) \quad (2)$$

Step 5: If it is found to be the disturbed one then select a window *L* around it. Its measurement is delineated as:

$$L = (2s+1) \times (2s+1) \quad (3)$$

And start dispensation by starting as s = 1.

Step 6: If in case noise density (ND) is greater than 50% then full window is selected, otherwise simplified window is selected.

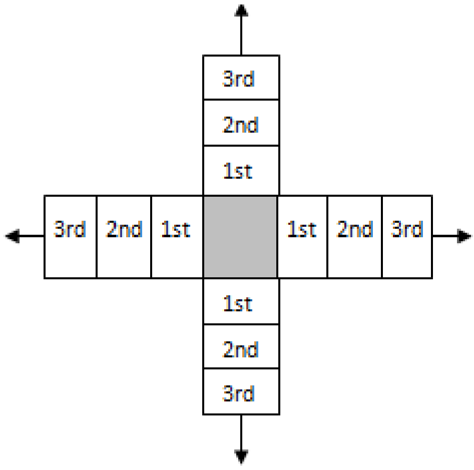

Figure 1: Simplified Window

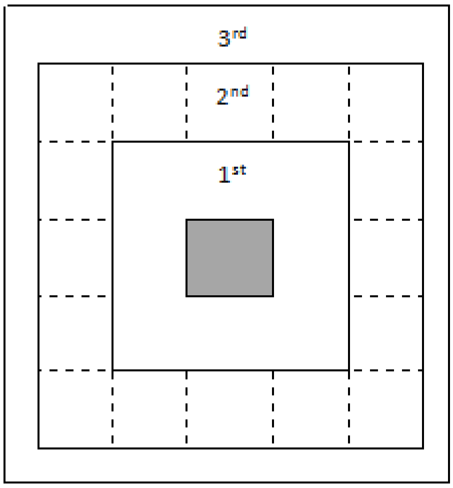

Figure 2: Full Window

Step 7: Case I. If 90% or more pixels are corrupted then size of the window is incremented by one i.e. s = s +1 and the value of „s" is checked, if it equals to 6 then the noisy pixel value is replaced with the mean of window. Otherwise go to Step 6.

Case II. If less than 90% pixels in the selected window are corrupted then after trimming all 0"s and 255"s the noisy pixel value is replaced by the median of the window.

Step 8: Repeat from step 3 to step 7 to process till the last pixel of the image. And get the final restored image.

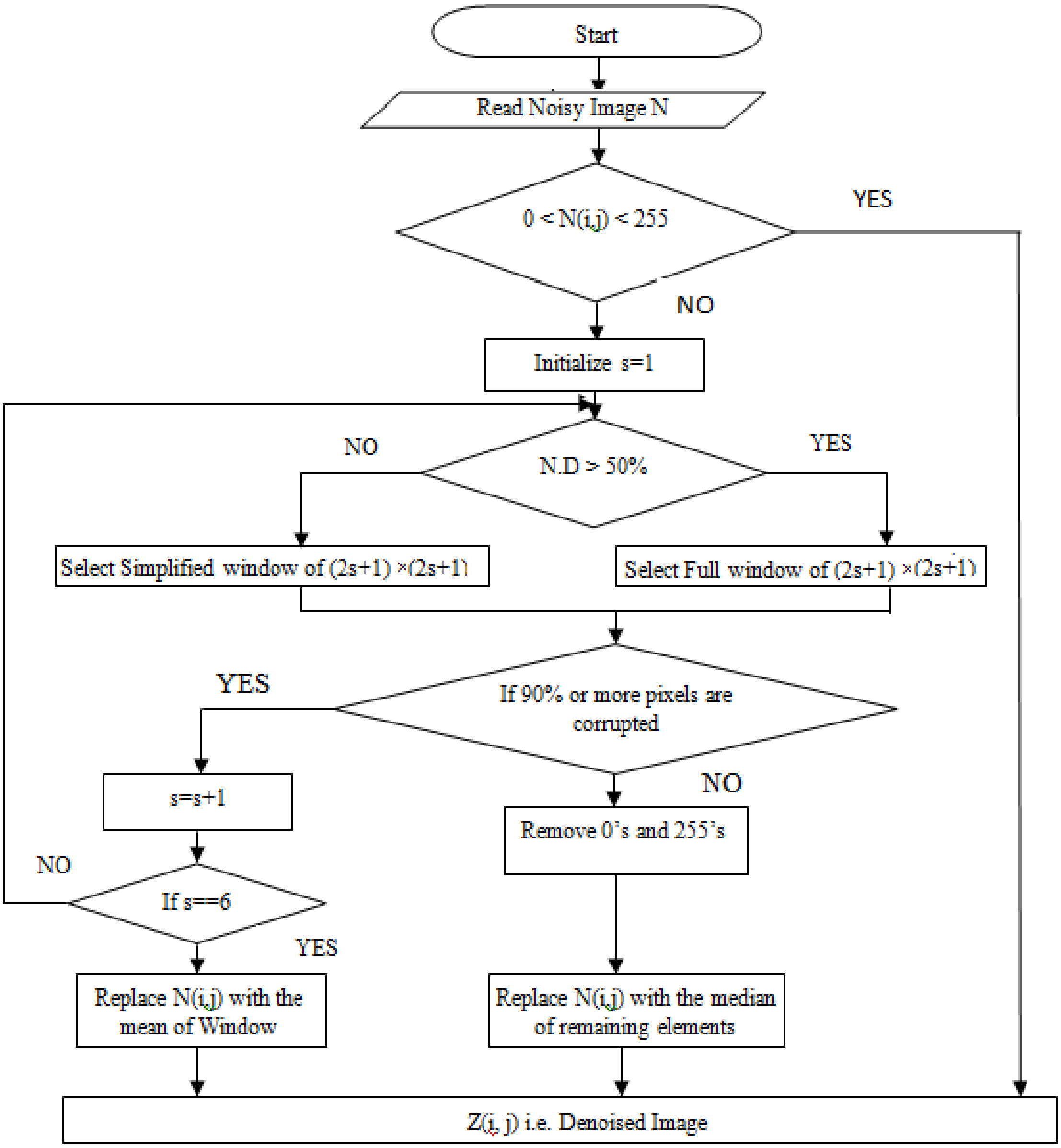

Figure 3: Flow Chart of Proposed Algorithm

4. Results

Noise Removal is an primary part of low-level image processing [6,3] and for a competent system, noise removal algorithms should carry out efficiently in order to smooth the progress of the further image processing stages. MATLAB 7.10.0 is used as the platform for implementing the proposed work & conducting experiments. The performance of the proposed image restoration algorithm is evaluated using many RGB and gray scale images. For this, the noise density is varied from 30% to 90% with an increment of 20%. As a measure of the quality of an image, Bit Error Rate (BER), Peak Signal to Noise Ratio (PSNR) and Mean Squared Error (MSE) is calculated.

$$\mathrm{MSE} = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(x(i,j) - y(i,j))^2 \quad (1)$$

$$PSNR = 10\log_{10}\frac{255}{\sqrt{MSE}} \quad (2)$$

Higher the value of PSNR better is the quality of the Stego frame.

$$BER = \frac{1}{PSNR} \quad (3)$$

Figure 4: Simulation Results of Lena Color Image at various Noise Density (a) 30% (b) 50% (c) 70% (d) 90%

Table 1: Comparison of Proposed Algorithm with Some Other Techniques in terms of PSNR (dB) for Lena image of 512×512

Noise Density in %	*SMF [5]*	*AMF [2]*	*DBA [7]*	*MDBUTMF [9]*	*DBPTGMF [10]*	*MDBUTAMF [11]*	*DBCWMF [12]*	*AGF [13]*	*Proposed*
30	21.86	26.11	32.90	32.29	37.10	32.02	35.84	37.62	**45.71**
50	15.04	23.36	26.41	28.18	32.96	28.89	32.49	34.31	**42.84**
70	9.93	15.25	22.47	24.30	26.72	26.09	26.72	31.07	**40.78**
90	6.65	7.93	17.56	18.40	18.65	22.65	18.65	26.69	**36.70**

5. Conclusion

In this work, we have proposed an improved median filter that is capable of restoring image degraded by high levels of SPN. It has much elevated detection precision than SMF, AMF, DBA, MDBUTMF and DBCWMF especially for high-level SPN. Experimental tests show that our proposed method exhibits better results than previous proposed median filter.

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