Imperial Journal of Interdisciplinary Research (IJIR)
Vol-2, Issue-11, 2016
ISSN: 2454-1362, http://www.onlinejournal.in

Modified Decision Based Coupled Window Median Filter

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Abstract: *In this research work we have proposed a median filter capable enough to recover the original image to great extent, corrupted by high density Salt and Pepper Noise (SPN). It is named so as it appears as white and black dots in an image. The pixels of an image corrupted by SPN attains either maximum or minimum value i.e. '255' or '0'.For the center processing pixel, if out of neighbor pixels, 3/4th or more pixels are noise free then it confiscate the damaged pixels and then analyze the median otherwise the window is expanded up to a level and if in the last window selected no pixel is found noise free then processing pixel is replaced by the mean of each and every one of the elements in the chosen window. This is how image is filtered.*

Keywords*: Salt and Pepper Noise, Center processing pixel.*

I. INTRODUCTION

Anyone can be concerned with digital image processing, which involves using a computer to change the nature of a digital image. First of all any 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. The noise in an image could get added either due to faulty memory locations or malfunctioning pixels in camera sensors. Noise is basically unwanted signal that gets added along the received information. Information could be in the form of text, image or video etc. Besides, noise may also get added due to various environmental disturbances. Various median have been developed so far to eliminate SPN in an image, but there always remains some loop holes in the algorithm resulting in loss of original image.

In our work we have further rectified the drawbacks of previously proposed median filters such as Standard Median Filter (SMF), Adaptive Median Filter(AMF), Center Weighted Median Filter (CWMF), Min-Max Exclusive Mean Filters (MMEF), Decision Based Algorithm (DBA), Improved Median Filter (IMF), Modified Decision Based Unsymmteric Trimmed Median Filter (MDBUTMF), Decision Based Coupled Window Median Filter (DBCWMF) and Adaptive Gaussian Filter (AGF) and proposed a new median filter capable of filtering low and high noise density to a further extent.

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.

II. LITERATURE SURVEY

Various median filters like weighted median Filters (WMF) [1, 4], centre weighted median filter (CWMF) [2], recursive weighted median filters (RWCF) [5] etc demonstrate fine performance by presenting extra weight to several pixels of the window. But are put into operation homogeneously above the picture with no importance to the ruined pixels and do not let alone the noise free pixels. Furthermore, when noise is very tall, they are prone to boundary jitter. This leads to in smearing and deformed description. 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 [6].

To remove the shortcoming of SMF, Adaptive Median Filters (AMF) [3] given by the Hwang and Haddad. In this, at the outset the corrupted and uncorrupted pixels are determined and additionally, only the corrupted pixels are processed. The key differentiation between AMF and SMF is that, the AMF does not apply the window of preset size. The extent to which the window dimensions can be increased will depends up on the median value. It commences with a 3×3 window and test out the value of the median. If this median value is found to be noisy, then the size is amplified and the process is repeated until a noise-free median value is bringing into being. The problem in these filters is that in case of high density salt and pepper noise, the window expands up to 37×37 and as we know the neighborhood pixels are more correlated so we can say that the median value in this case may not be the effective value. It is effective in taking out noise up to medium noise density merely.

New Decision-Based Algorithm can be applied for both gray scale plus color images[8]. 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. [7] 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.

Adaptive Gaussian Filter (AGF) method [11] is a two juncture scheme in which first of all noise free pixels are detected and then filter having adaptive variances depending on the noise level is applied to the corrupted pixels.

Modified Decision Based Unsymmetric Trimmed Adaptive Median Filter (MDBUTAMF) [12] 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 [13], the gaps of MDBUTMF is removed by using changing window size and such these are called Growing Length Window (GLW). 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.

III. PROPOSED ALGORITHM

In the proposed algorithm, the noisy pixel is change over by the median of the by now already processed neighborhood pixels and other noise free elements of the selected window. This algorithm processes the noisy image and starts from 1st pixel of the image and ultimately ends at the very last pixel. The concluding ultimate image from the image scanning is regarded as the restored image or denoised image. For center processing pixel, if out of neighbor pixels, 3/4th or more pixels are noise free then it confiscate the damaged pixels and then analyze the median otherwise the window is expanded up to a level and if in the last window selected no pixel is found noise free then processing pixel is replaced by the mean of each and every one of the elements in the chosen window.In this approach, only the disturbed pixels are treated i.e. 0 and 255. If the current pixel lies between maximum and minimum value, then it is not processed by the proposed filter.

Algorithm Steps

Let X is the input image and D is the final de-noised image and as per the algorithm the scanning has to be completed for all the pixels of the image. Steps are as follows:

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

$0 < X(i,j) < 255$, 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.

$Y(i,j) = X(i,j)$ (2)

Step 5: If it is found to be the disturbed one then select a window *L* around it. Initialize s=1.

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

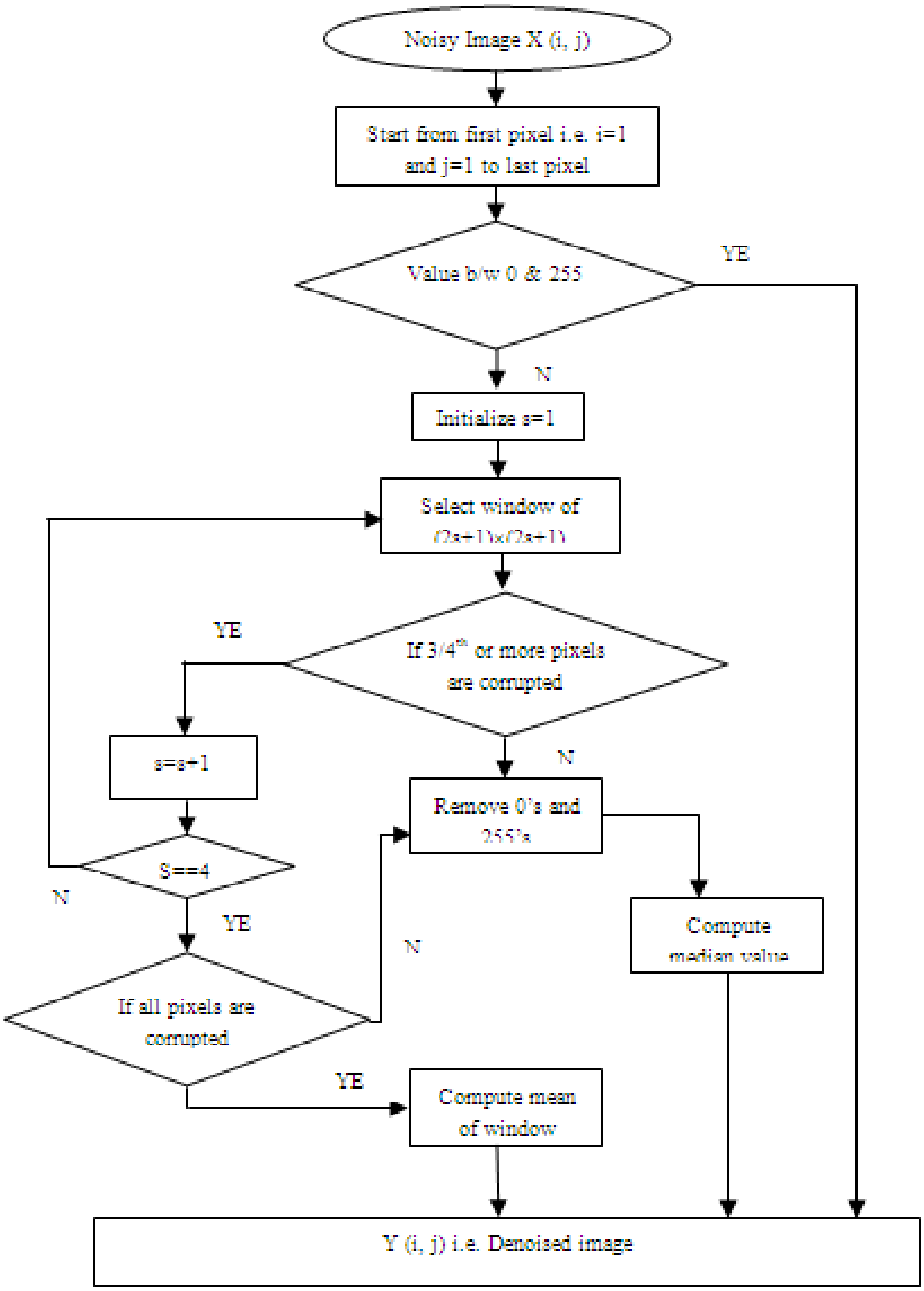

Fig. 1 Flow Chart of Proposed Algorithm

Step 6: Verify if 3/4th or more of the total pixels in the particular window are actual pels or not and if they are then purge all the elements other than the actual ones and discover the median from all the remaining values. Now it is swap over by this value in the final image i.e.

$$Y(i,j) = \text{median}\{X(i,j), (i,j) \in L\} \qquad (4)$$

Step 7: Otherwise for the time being it is left unaltered and size of the window is increased by incrementing the value of s by 1 i.e.

$$s = s+1 \qquad (5)$$

And it is continued till s < 4

Step 8: When s = 4 and still the clause is not met for the median calculation then further it is checked that is there any noise free pixel and if found then median of these pixels is replaced with processing pixel otherwise mean of the window is replaced with the processing pixel

$$Y(i,j) = \text{mean}\ \{X(i,j)\} \qquad (6)$$

Step 9: Repeat from step 3 to step 8 to process till the last pixel of the image. And get the final restored image.

IV. SIMULATION RESULTS

Noise Removal is an primary part of low-level image processing 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 10% to 90% with an increment of 10%.

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.

$$\text{MSE} = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(x(i,j) - y(i,j))^2 \qquad (7)$$

$$PSNR = 10\log_{10}\frac{255}{\sqrt{MSE}} \qquad (8)$$

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

$$BER = \frac{1}{PSNR} \qquad (9)$$

(a)

(b)

(c)

(d)

(e)

Fig. 4 Simulation Results of Lena Color Image at various Noise Density (a) 30% (b) 50% (c) 70% (d) 90%(e) Original Image.

Noise Density in %	SMF [6]	AMF [3]	DBA [8]	MDBU TMF [9]	DBPTG MF [10]	AGF [11]	MDBUT AMF [12]	DBCW MF [13]	Proposed
30	21.86	26.11	32.90	32.29	37.10	37.62	32.02	35.84	**45.78**
50	15.04	23.36	26.41	28.18	32.96	34.31	28.89	32.49	**42.96**
70	9.93	15.25	22.47	24.30	26.72	31.07	26.09	26.72	**40.86**
90	6.65	7.93	17.56	18.40	18.65	26.69	22.65	18.65	**30.06**

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