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Removal of Salt and Pepper Noise through Unsymmetric Trimmed Median Filter

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ABSTRACT

Here a modified decision based unsymmetrical trimmed median filter algorithm for the restoration of gray scale, and colour images that are highly corrupted by salt and pepper noise is proposed. This 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), Modified Decision Based Algorithm (MDBA), and Progressive Switched Median Filter (PSMF). The proposed algorithm is tested against different gray scale and colour images and it gives better Peak Signal-to-Noise Ratio (PSNR) and Image Enhancement Factor (IEF).

Index Terms— **Median filter, salt and pepper noise, unsymmetrical trimmed median filter.**

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I. INTRODUCTION

Bit errors in transmission or introduced during the signal acquisition causes impulse noise in images. There are two types of impulse noise, they are salt and pepper noise and random valued noise. Salt and pepper noise can corrupt the images where the corrupted pixel takes either maximum or minimum gray level. Several nonlinear filters have been proposed for restoration of images contaminated by salt and pepper noise. Among these standard median filter has been established as reliable method to remove the salt and pepper noise without damaging the edge details. However, the major drawback of standard Median Filter (MF) is that the filter is effective only at low noise densities [1]. When the noise level is over 50% the edge details of the original image will not be preserved by standard median filter. Adaptive Median Filter (AMF) [2] performs well at low noise densities. But at high noise densities the window size has to be increased which may lead to blurring the image. In switching median filter [3], [4] the decision is based on a pre-defined threshold value. The major drawback of this method is that defining a robust decision is difficult. Also these filters will not take into account the local features as a result of which details and edges may not be recovered satisfactorily, especially when the noise level is high. To overcome the above drawback, Decision Based Algorithm (DBA) is proposed [5]. In this, image is de noised by using a 3×3 window. If the processing pixel value is 0 or 255 it is pro-cessed or else it is left unchanged. At high noise density the median value will be 0 or 255 which is noisy. In such case, neigh-boring pixel is used for replacement. This repeated replacement of neighbouring pixel produces streaking effect [6]. In order to avoid this drawback, Decision Based Unsymmetric Trimmed Median Filter (DBUTMF) is proposed [7]. At high noise densities, if the selected window contains all 0's or 255's or both then, trimmed median value cannot be obtained. So this algorithm does not give better results at very high noise density that is at 80% to 90%. The proposed Modified Decision Based Un-symmetric Trimmed Median Filter (MDBUTMF) algorithm re-moves this drawback at high noise density and gives better Peak Signal-to-Noise Ratio (PSNR) and Image Enhancement Factor (IEF) values than the existing algorithm. The rest of the paper is structured as follows. A brief introduction of unsymmertric trimmed median filter is given in Section II. Section III describes about the proposed algorithm and different cases of proposed algorithm. The detailed description of the proposed algorithm with an example is presented in Section IV. Simulation results with different images are presented in Section V. Finally conclusions are drawn in Section VI.

II. PROPOSED ALGORITHM

The proposed Modified Decision Based Unsymmetric Trimmed Median Filter (MDBUTMF) algorithm processes the corrupted images by first detecting the impulse noise. The pro-cessing 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 which is

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processed by MDBUTMF. The steps of the MDBUTMF are elucidated as follows.

Step 1: Select 2-D window of size 3×3. Assume that the pixel being processed is.

Step 2: If then is an uncorrupted pixel and its value is left unchanged.

Step 3: If or then is a corrupted pixel then two cases are possible as given in Case i) and ii).

Case i): If the selected window contains all the elements as 0's and 255's. Then replace 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 with the median value.

Step 4: Repeat steps 1 to 3 until all the pixels in the entire image are processed. The pictorial representation of each case of the proposed algorithm is shown in Fig. 1.

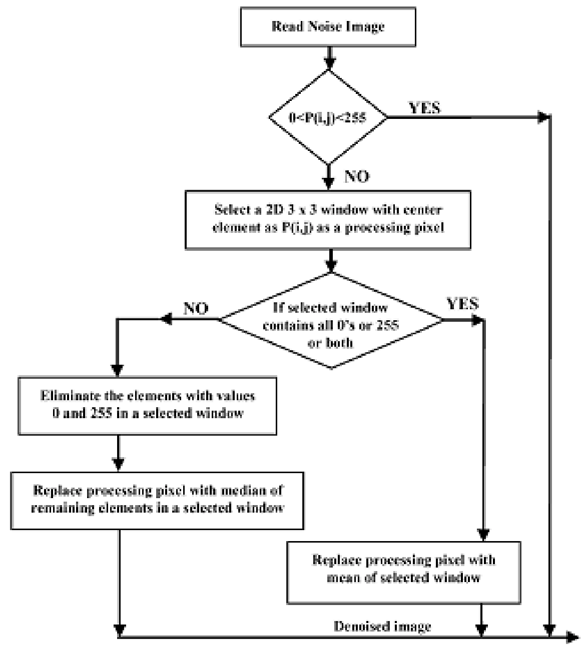

Fig. 1. Flow chart of MDBUTMF.

The detailed description of each case of the flow chart shown in Fig.1.

III. ILLUSTRATION OF MDBUTMF ALGORITHM

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). Case i): If the selected window contains salt/pepper noise as processing pixel (i.e., 255/0 pixel value) and neighbouring pixel values contains all pixels that adds salt and pepper noise to the image:

$$\begin{bmatrix} 0 & 255 & 0 \\ 0 & \langle 255 \rangle & 255 \\ 255 & 0 & 255 \end{bmatrix}$$

where "255" is processing pixel, i.e., (Pij).

Since all the elements surrounding 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. Here the mean value is 170. Replace the processing pixel by 170. Case ii): If the selected window contains salt or pepper noise as processing pixel (i.e., 255/0 pixel value) and neighbouring pixel values contains some pixels that adds salt i.e., 255 pixel value) and pepper noise to the image:

$$\begin{bmatrix} 78 & 90 & 0 \\ 120 & \langle 0 \rangle & 255 \\ 97 & 255 & 73 \end{bmatrix}$$

where "0" is processing pixel, i.e., P (i, j).

Now eliminate the salt and pepper noise from the selected window. That is, elimination of 0's and 255's. The 1-D array of the above matrix is [78 90 0 120 0 255 97 255 73]. After elimination of 0's and 255's the pixel values in the selected window will be [78 90 120 97 73]. Here the median value is 90. Hence replace the processing pixel by 90.

Case iii): If the selected window contains a noise free pixel as a processing pixel, it does not require further processing. For example, if the processing pixel is 90 then it is noise free pixel:

$$\begin{bmatrix} 43 & 67 & 70 \\ 55 & \langle 90 \rangle & 79 \\ 85 & 81 & 66 \end{bmatrix}$$

where “90” is processing pixel, i.e., P(ij).

Since “90” is a noise free pixel it does not require further processing.

RESULT

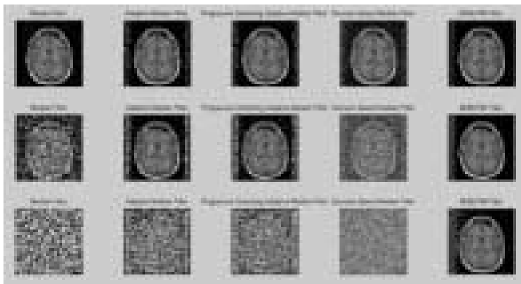

Fig: Results of different algorithms for image corrupted by 30%, 60% and 90% noise densities, respectively.

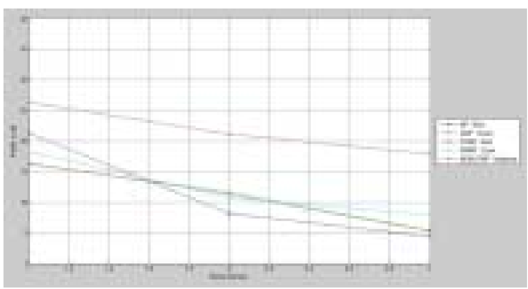

Fig: Comparison graph of PSNR at different noise densities.

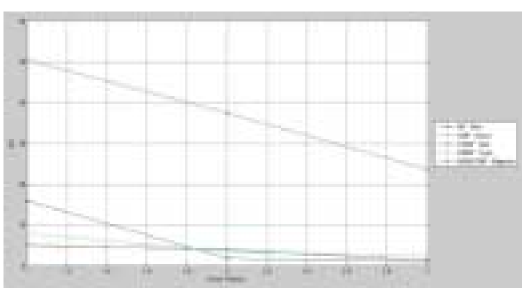

Fig: Comparison graph of IEF at different noise densities.

IV. CONCLUSION

In this letter, a new algorithm (MDBUTMF) is proposed which gives better performance in comparison with MF, AMF and other existing noise removal algorithms in terms of PSNR and IEF. The performance of the algorithm has been tested at low, medium and high noise densities on both gray-scale and colour images. Even at high noise density levels the MDBUTMF gives better results in comparison with other existing algorithms. Both visual and quantitative results are demonstrated. The proposed algorithm is effective for salt and pepper noise removal in images at high noise densities.

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