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Research Article

A Novel Algorithm for Image Denoising using Modified Adaptive Median Filter

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Abstract: In this study a novel algorithm is proposed for image denoising using Modified Adaptive Median Filter (MAMF) on digital images. 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 hence 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 (SMF), Decision Based Algorithm (DBA). Different grayscale and color images are tested by using the proposed algorithm and found to produce better Peak Signal to Noise Ratio (PSNR).

Keywords: Adaptive median filter, decision based algorithm, image denoising, standard median filter

INTRODUCTION

Images often corrupted by various noises during the process of generation and transmission. Mostly Images are corrupted by impulse noise. There are two types of impulses noise, they are salt and pepper noise and random valued noise. Decision Based Algorithm (DBA) is proposed (Srinivasan and Ebenezer, 2010). In this algorithm pixel is processed only when its value is either 0 or 255 or else left unchanged. Even these method uses median as its tool. But in case the output of median will be 0 or 255 which is noisy. In such case, neighboring pixel is used for replacement. Another algorithm was found where instead of just replacing corrupted pixel with neighborhood pixel value it is replaced with mean of neighborhood pixels (Jayaraj and Ebenezer, 2010). But both fail in recovering image at high noise densities. In order to avoid there drawbacks, Decision Based Un-symmetric Trimmed Median Filter (DBUTMF) is proposed (Aiswarya *et al*., 2010).

But at high noise densities, if selected window contains all 0's and 255's or both then, trimmed median cannot be found. To overcome above drawback Modified Decision Based Un-symmetric Trimmed Median Filter (MDBUTMF) is proposed (Esakkirajan *et al*., 2009). It yields better results than all previous algorithms at high noise densities. The proposed Modified Non-linear filter yields better results at very high noise density that is at 80 and 90% and gives better Peak Signal-to-Noise Ratio (PSNR) and Image Enhancement Factor (IEF) values than the MDBUTMF and existing algorithms. To avoid this drawback, open close sequence filter (Ze-Feng *et al*., 2007) has been proposed. This algorithm is based on mathematical morphology, which is suitable only in high density impulse noise (noise density ranging from 45 to 80%). To overcome the disadvantages of the mentioned filtering techniques a two stage algorithm has been proposed (Chan *et al*., 2005). In this algorithm adaptive median filter is used in first stage to classify the values of the noisy and noise free pixels. In second stage regularization technique is used for noisy pixels to preserve the details and edges as much as possible. The main drawback of this algorithm is that its performance deteriorates in both low noise density and very high noise density.

Predefined threshold is the main drawback of the switching median filter (Zhang and Karim, 2002) and decision based filter due to that some details and edges are also removed in case of high density salt and pepper noise. Ideally the filtering should be applied only to the values of the noisy pixel while keeping the values of the noise free pixels.

Here, we proposed a novel algorithm for image denoising based Modified Adaptive Median filter.

Denoising filter: Median filtering is a nonlinear smooth technology. Each pixel of the gray value of a neighborhood has its own pixel gray value of the median. That means all pixels within the neighborhood sort by gray value, taking the median of the group as a neighborhood center pixel output value.

PROPOSED METHODOLOGY

In this proposed method, the noisy image is taken and given as the input to the modified adaptive median filter which filters the noise from the digital image. The

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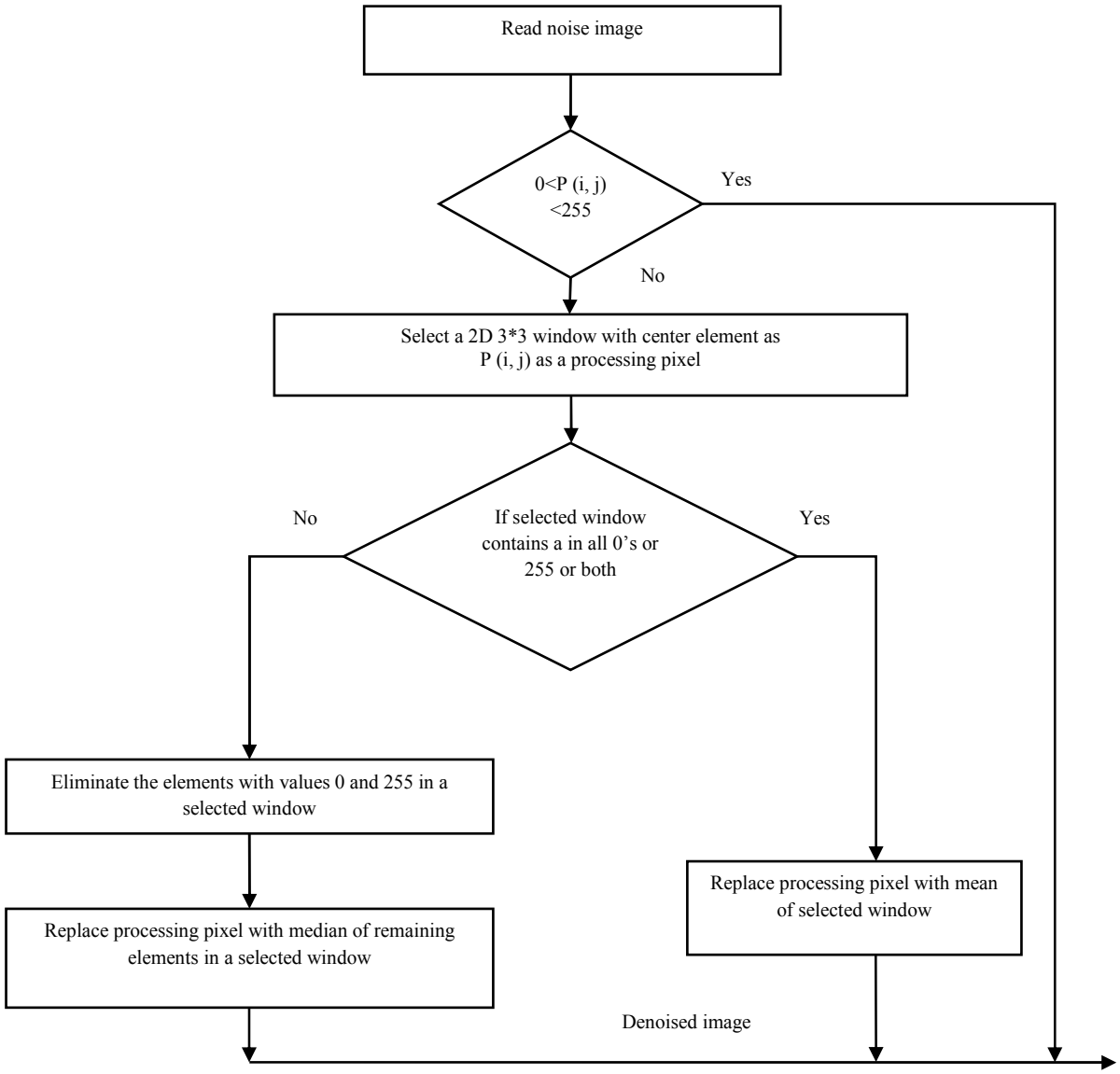

Fig. 1: Block diagram of the proposed method

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 hence the noise pixel is replaced by mean value of all the elements present in the selected window. Figure 1 gives the block diagram of the proposed method.

RESULTS AND DISCUSSION

The Proposed algorithm is tested using 512*512, 8 bits/pixel image. The developed algorithm performance is tested using various levels of noises and it is performed on various images like Lena, Barbara and baboon. The proposed filter is compared with two standard filters namely Standard Median Filter (SMF) and decision Based Algorithm (DBA). Each time the test image is corrupted by salt and pepper noise of different density ranging from 10 to 90 with an increment of 10 and it will be applied to various filters Fig. 2a and b gives the noisy image and the output image.

In addition to the visual quality, the performance of the developed algorithm and other standard algorithms are quantitatively measured by the following parameters such as Peak Signal-to-Noise Ratio (PSNR), Mean Square Error (MSE). All the filters are implemented in MATLAB 7.10 on a PC equipped with 2.4 GHz CPU and 1 GB RAM memory for the evaluation of computation time of all algorithms. The quantitative performances in terms of PSNR and MSE for all the algorithms are given in Table 1 and 2. Reconstructed images with higher PSNR are better. PSNR is defined in DB in Eq. (1):

(a)

(b)

Fig. 2: (a) Noisy image, (b) output image

Table 1: Quantitative results of various filters for 30% corrupted baboon image

Types of filter	PSNR	MSE
SMF	32.45	32.200
DBA	29.06	55.450
MAMF	44.58	1.996

Table 2: Quantitative results of various filters for 90% corrupted baboon image

Types of filter	PSNR	MSE
SMF	30.75	35.80
DBA	26.58	68.85
MAMF	42.58	7.84

$$PSNR = 10 * \log_{10}\left(\frac{255^2}{MSE}\right) \quad (1)$$

where, MSE is mean squared error between original image (x) and denoised image ($\hat{x}$) which is given by Eq. (2):

$$MSE = \frac{1}{N_1 * N_2}\sum_{i=1}^{N_1}\sum_{j=1}^{N_2}(x(i,j) - \hat{x}(i,j))^2 \quad (2)$$

CONCLUSION

The proposed algorithm is effective for salt and pepper noise removal in images at high noise densities. An efficient algorithm is proposed to remove high density salt and pepper noise. This increases the efficiency of the system. The proposed method is compared with two standard existing methods and gives better PSNR values and MSE.

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