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Comparative Study Of Performance Analysis Of Various Filtering Approaches For The Removal Of High Density Salt And Pepper Noise On Color Images And Videos.

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ABSTRACT

While transmission of images, salt and pepper noise get induces in images. It is very difficult to process the images with this noise. Hence a suitable filter has to be formulated. In this paper, we proposed a performance analysis of various filtering approaches for the removal of high density salt and pepper noise at very high densities in color images and videos. The term filter is commonly used to mention to these image processing operations. Filter action can be used to recover the images corrupted by various types of noise. The best noise reduction technique is one which removes the noise at the same time preserves the sharp details of the image. The performance of the filtering approaches is evaluated based on some image quality parameters such as MSE, PSNR and SSIM.
Keywords: weighted mean, salt and pepper noise, non linear filter, MSE,PSNR and SSIM.

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INTRODUCTION

Noise is the outcome of errors in the image acquisition process which results in the value of pixel that will not replicate the factual intensity value of the original image. The unwanted noise signal or pixel is not the ingredient of the original or real signal. Environmental disparity, transmission or quantization errors, discrepancy in the detector sensitivity, the discrete nature of radiation etc are the various sources of noise. The term filter is also commonly used to mention to these image processing operations. Filter action can be used to recover the images corrupted by various types of noise. The best noise reduction technique is the one which removes the noise at the same time preserves the sharp details of the image. Over these years there were so many median filter proposed by Research scholars. A simple median filter is a non linear filter .It will preserve the edges and remove the low density impulse noise. Filters such as weighted median filter, adaptive filter progressive switching median filter and center weighted median filter to eradicate the low density impulse noise. However they not succeed to safeguard the edges if the noise density is more. Chan & Nikolova proposed [1] a two phase algorithm where first phase uses adaptive filter to classify whether the pixels are noise free or not. The second phase is regulation methods which are utilized to the noisy pixel and the result is that it conserves the edges and also suppresses the unwanted noise. Srinivasan.K.S & Ebenezer [2] explained a sorting algorithm where the corrupted noisy pixels are restored using preprocessed pixel or median value. Eng & Ma [3] proposed a median based non linear adaptive algorithms under non stationary assumption to remove impulse noise in a images. Hamza and krim [4] proposed a novel filtering approach based onvigorous assessment statistics for the removal of high density noise. Vijayakumar et al [5] proposed a robust estimation filter which works on two phases. Manikandan.S and Ebenezer [6] explained an efficient approach for the artifacts and noises using window based approach. Md Roomi.S et al [7] proposed an iterative, selective based edge preserving filter that differentiate pixels as noisy and image pixel for finding noisy edges and noise free edges which uses blur metric for iteration. Florencio & Schafer [8] proposed switching schemes where it employed no filtering to conserve true pixels and a simple median filter to remove impulse noise. Manglem Singh et al proposed [9] an adaptive rank ordered median filter (AROM) which uses two stage switching. Md Roomi et al proposed a method [10] which gave normalized, truncated, trimmed and scaled Gaussian weighed function as weights using statistical estimation based on the non noisy neighborhood pixel and the filter is applied recursively on noisy pixels and it uses adaptive filtering approach. In Shitong Wang et al [11] used novel impulse detection techniques which detect the noisy pixels by categorize the window and values less than the minimum of the window and the value greater than the maximum of the window is considered to be noisy. Zhou wang et al [14] proposed a new method of median filters for noise removal. This progressive switching median filter uses switching scheme for detection of impulses. The progressive methods employed detect the impulses and noise filtering is applied progressively. Hence a suitable filter has to be formulated that removes high density salt and pepper noise. Section II deals with proposed algorithm. Section III briefs the simulation results and discussion and section IV elaborates the conclusion.

APPROACHES FOR THE REMOVAL OF HIGH DENSITY SALT AND PEPPER NOISE

This work mainly concentrated on the analysis of existing nonlinear and linear filtering approaches for the removal of high density salt and pepper noise in color images and videos. There are number of methods that are proposed for the elimination or reduction of low density salt and pepper noise, however in case of high density salt and pepper noise, the proposed filters are not execute very well. In this work, we had compared the performance of various types of filters to remove the high density salt and pepper noise. The following methods are taken into consideration to select the efficient approach for removal of high density salt and pepper noise.

- Standard Median filter (SMF)
- *Adaptive Median Filter (AMF)*
- Center Weighted Median Filter (CWMF or CWF)
- Threshold decomposition filter (*TDF*)
- Alpha Threshold decomposition filter (α*TDF*)
- *Progressive Switched Median Filter* (*PSMF*)
- *Decision Based Algorithm* (*DBA*)
- Improved Decision Based Filter (*IDBA*)
- Modified decision based median filter (*MDBMF*)

- Tri-State Median Filter (TSMF)
- Decision based unsymmetrical trimmed mean filter (DBUTMF)
- Modified decision based unsymmetrical trimmed mean filter (MDBUTMF)
- Modified Non-linear filter (MNF)
- Adaptive Weighted Median Filter (AWMF)

The performance analysis of various filtering approaches for the removal of high density salt and pepper noise on color images and videos is evaluated using image qualitymeasures such as Peak signal to noise ratio (PSNR) , Structural similarity index measures (SSIM), and Mean Square Error (MSE).

In this work, f(j,k) and g(j,k) denotes the original input and segmented output image respectively. Similarly, M and N represents the number of pixels in rows and columns respectively [12][13]. Number of image quality measures is used in this work for comparing the segmentation result with the original image.

Mean Squared Error (MSE) is the average squared difference between input and segmented output image. This is most frequently used image quality measure due to its mathematical tractability and straightforward to design systems. The smaller the value of Mean Square Error, the lower the error i.e., there is a small difference between the two images. The larger value of MSE indicates that the image is poor quality.MSE is described as follows

$$MSE = \frac{1}{MN}\sum_{j=1}^{M}\sum_{k=1}^{N}[f(j,k) - g(j,k)]^2 \quad (1)$$

The PSNR represents a measure of the peak value of the error. The main advantage of PSNR is ease of computation but it does not reflect perceptual quality. If MSE is zero, then PSNR is infinity. This means that a high value of the PSNR provides a higher image quality. Similarly, the smaller value of the PSNR implies that the difference between the images is larger. PSNR can be defined as in (2)

$$\mathrm{PSNR} = \frac{1}{MN}\sum_{j=1}^{M}\sum_{k=1}^{N}[f(j,k) - g(j,k)]^2 / \sum_{j=1}^{M}\sum_{k=1}^{N}\mathrm{Max}\,[f(j,k)]^2 \quad (2)$$

The structural similarity index measure (SSIM) is a renowned quality metric used to compute the similarity or dissimilarity between the input and segmented images. This metric is well correlate with the human visual system (HVS). In SSIM any image distortion can be modeled as a combination of three features: contrast distortion, luminance distortion and loss of correlation. SSIM is defined as:

$$\mathrm{SSIM}(f,g) = L(f,g)C(f,g)S(f,g) \quad (3)$$

$$L(f,g) = \frac{2\mu_f\mu_g + C_1}{\mu_f^2 + \mu_g^2 + C_1} \quad (4)$$

$$C(f,g) = \frac{2\sigma_f\sigma_g + C_2}{\sigma_f^2 + \sigma_g^2 + C_2} \quad (5)$$

$$S(f,g) = \frac{\sigma_{fg} + C_3}{\sigma_f\sigma_g + C_3} \quad (6)$$

The luminous comparison function or distortion, $L(f,g)$, measures the closeness of the mean of the input and segmented image (μ_f and μ_g). If $\mu_f = \mu_g$, L(f,g) is equal to 1 i.e., maximum value. The contrast comparison function or distortion, $C(f,g)$, measures the proximity of the standard deviation of the input and segmented image (σ_f and σ_g). If $\mu_f = \mu_g$, C(f,g) is equal to 1 i.e., maximum value. The structure comparison function or loss of correlation, S(f,g), measure the covariance (correlation coefficient) between the input and segmented image. The value of zero indicates that no correlation between images and one means that input and segmented image is equal. The positive constants (C1, C2 and C3) are used to avoid a null denominator. Here σ_f, σ_{fg} and μ_f represent the standard deviation, cross correlation and mean respectively. $C_1 = (K_1L)^2$, $C_2 = (K_2L)^2$, and $C_3 = C_2/2$ are small constants. So the SSIM index can be defined as

$$SSIM = \frac{(2\mu_f\mu_g + C_1)(2\sigma_{fg} + C_2)}{(\mu_f^2 + \mu_g^2 + C_1)(\sigma_f^2 + \sigma_g^2 + C_2)} \quad (7)$$

The values of the PSNR can be predicted from the SSIM and vice-versa. The PSNR and the SSIM mainly differ on their degree of sensitivity to image degradations.

SIMULATION RESULTS AND DISCUSSION

The reduction of salt and pepper noise is more important for quality image and video processing. This work proposed the comparative study of performance analysis of various filtering approaches for the removal of high density salt and pepper noise on color images and videos. Every method has its own advantages and disadvantages. The performance of the filtering approaches had evaluated based on some image quality parameters such as MSE, PSNR and SSIM. Figure 1 shows the perfomance (MSE) of filtering approaches for Lena.gif image corrupted by Salt and Pepper Noise. The low MSE value indicates the restored image is in par with original image i.e., less affected by salt and pepper noise. The highest value of MSE indicates that the image is poor quality.

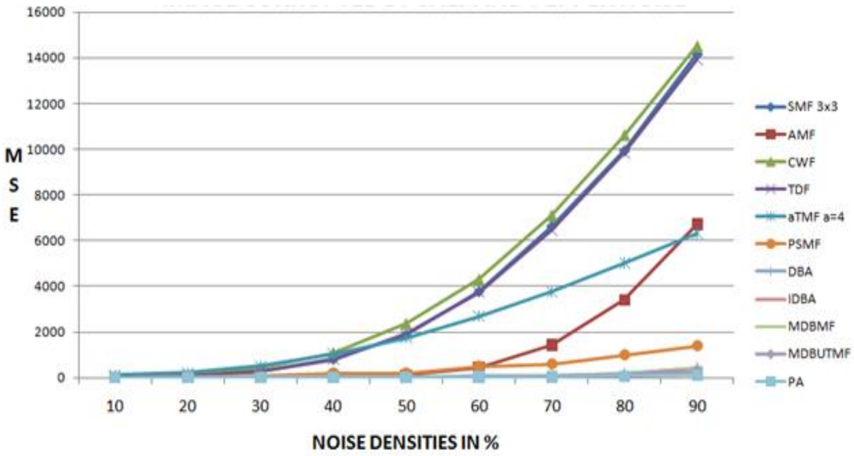

Figure 1: Perfomance (MSE) of filtering approaches for Lena.gif image corrupted by Salt and Pepper Noise.

Figure 2 illustrates the perfomance (PSNR) of filtering approaches for Lena.gif image corrupted by Salt and Pepper Noise. The high value of PSNR indicates the restored image is in par with original image i.e., less affected by salt and pepper noise. The low value of PSNR indicates that the image is poor quality.

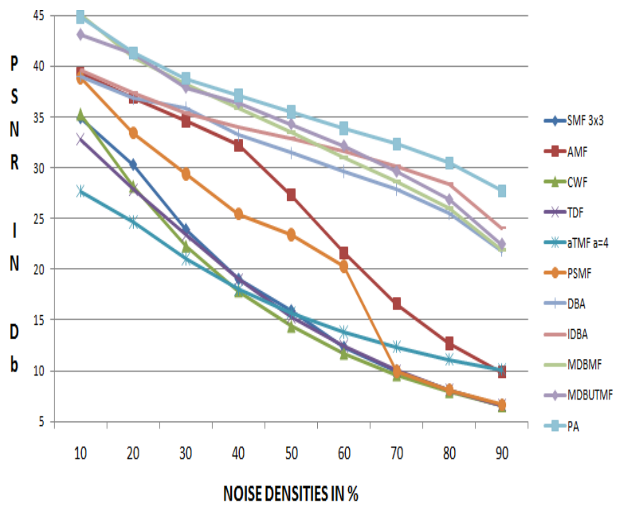

Figure 2: Perfomance (PSNR) of filtering approaches for Lena.gif image corrupted by Salt and Pepper Noise.

Figure 3 depicts the perfomance (SSIM) of filtering approaches for Lena.gif image corrupted by Salt and Pepper Noise. The high value of SSIM indicates the restored image is in par with original image i.e., less affected by salt and pepper noise. The low value of SSIM indicates that the image is poor quality.

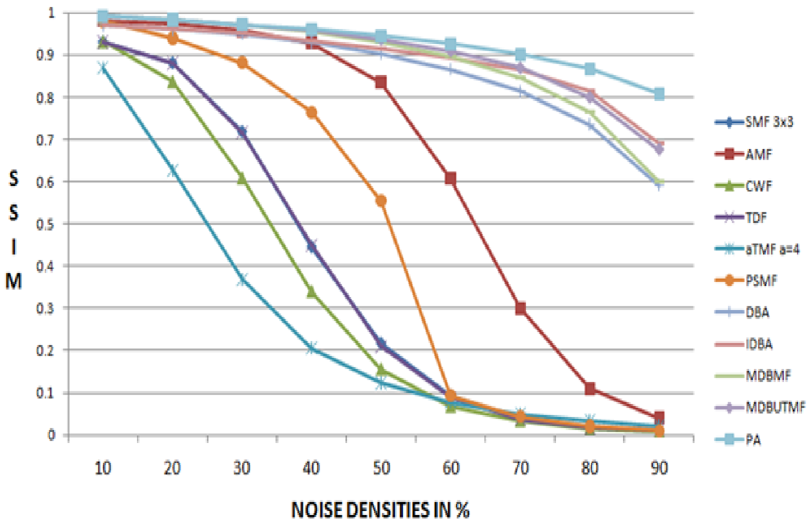

Figure 3: Perfomance (SSIM) of filtering approaches for Lena.gif image corrupted by Salt and Pepper Noise.

Figure 4 shows the performance analysis of the various filtering approaches for lena.gif image corrupted by 85% Salt and pepper noise. Adaptive Weighted Median Filter (AWMF) is fairly more efficient in the reduction of high density salt and pepper noise in images. This method has higher PSNR and SSIM values and low MSE values across a various range of noise densities presented in images.

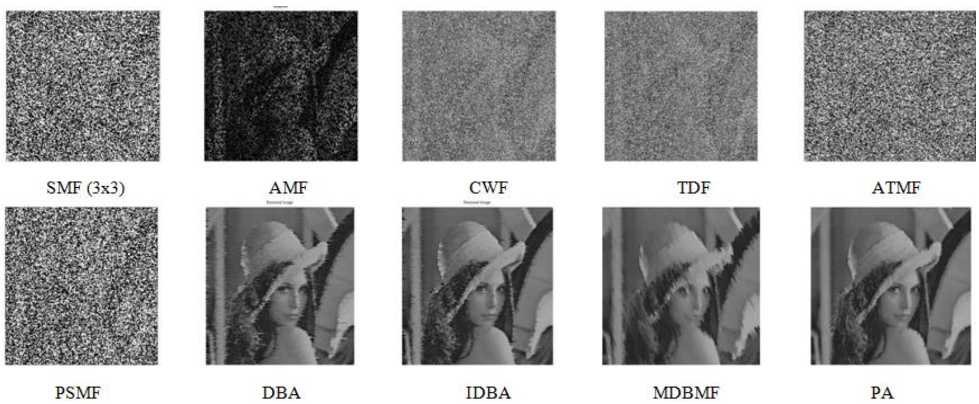

Figure 4: Performance analysis of the various filtering approaches for lena.gif image corrupted by 85% Salt and pepper noise

CONCLUSION

The reduction of salt and pepper noise is more important for quality image and video processing. This work proposed the comparative study of performance analysis of various filtering approaches for the removal of high density salt and pepper noise on color images and videos. Every method has its own advantages and disadvantages. The performance of the filtering approaches had evaluated based on some image quality parameters such as MSE,PSNR and SSIM. Based on the assessment, Adaptive Weighted Median Filter (AWMF) is fairly more efficient in the reduction of high density salt and pepper noise in images. This method has higher PSNR and SSIM values and low MSE values across a various range of noise densities presented in images.

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