Original Article

# A Comparison Analysis Of Recent 2-D Image Denoising Methods

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## Abstract

This paper reviews novel methods for reducing image noise. These techniques address noise that is impulsive, multiplicative, and gaussian. While the picture mixture method is utilized as a generic model for instinct sound, the still built medium strainer is declared for the reduction of salt and common pepper sound. Multiplicative sound discount strategies make use of Lee filtering and adaptive windowing. To reduce additive white Gaussian noise, a unique frequency domain method called sliding double window filtering was employed. The Fibonacci Fourier Transform is used in this procedure. These techniques offer effective edge preservation and noise suppression capabilities, as shown by the quantitative analysis and simulation results.

**Keywords:** AWGN, IMF1, IMF2, Instinct Sound, Multiplicative Sound, Multiplicative Sound, Sound Lessening, SBM, SDWF

## I. INTRODUCTION

Digital images are typically corrupted by noise during acquisition by camera sensors and transmission through a channel. Digital images can be affected by a variety of noise forms, such as additive white Gaussian noise (AWGN), impulse noise, multiplicative noise, etc. [1]. Image denoising is one of the most popular and crucial image processing operations as a result. When transmitting coded images over a noisy communication channel or when a camera's sensor is malfunctioning, impulse noise may be produced. For removing impulsive noise, the nonlinear-median filter is frequently used. The majority of median-based algorithms change every image pixel, which results in poor-quality restored images. This paper discusses a revolutionary impulse noise reduction concept that uses the method known as Image fusion [2] and a new technique that addresses salt and pepper noise [1] by employing the Statistics Based Median Filter (SBMF) [3] are also mentioned. Synthetic aperture radar (SAR) images frequently contain multiplicative noise, more specifically known as speckle noise [4], which dramatically lowers the quality of the images. In this work, recent noise reduction techniques for various noises are analyzed briefly explain a new filtering approach based on local structure detection [5] and adaptive windowing [4].Lee filtering is the filtering technique used in this method [6].Sliding Double Window Filtering (SDWF)-based frequency domain AWGN reduction methodology is proposed in [7].Two window kinds are included in the sliding double window filter: n this work, recent noise reduction techniques for various noises are analyzed.

Wiener filtering and averaging have already been used. Threshold filtering is a fundamental idea behind the sliding double window technique. The Fibonacci Fourier Transform [7], a variation of the Discrete Fourier Transform, is the transform that is applied in this instance. The type of noise, its statistics, intensity, and application are the main factors that determine which noise reduction technology is most appropriate. Therefore, a comparison of various denoising methods based on these features would be quite helpful. In order to identify the best solutions for each form of noise, this paper analyses various noise reduction techniques for the three types of noise that frequently occur in images: impulsive, multiplicative, and Gaussian noise. Only the study of the various noise kinds independently is included in the publication. The structure of the essay is as follows. In the section.

## II. ANALYSIS OF NOISE REDUCTION METHODS

**A**. **Impulse Noise Reduction:** Impulse noise is very communal in numerical imageries. It is self-determining and uncorrelated to the duplicate pels and is arbitrarily circulated over the doppelgänger. There are dissimilar kinds of instinct sound specifically salty and common pepper and arbitrary valued [3] etc. For the overall instinct sound model, 2 dissimilar methods based on copy mixture are temporarily conferred in this segment for finding improved worth imageries. Fusion alludes to a technique for fusing two or more images taken by various sensors. There are two roughly comparable approaches: the first one relies on fusion followed by filtering, and the other on filtering followed by fusion. The first method (IMF1) uses a binary map to combine the images that were recorded by various sensors. The median filter is used to filter the combined image. The second method (IMF2) [2] filters each of the collected images with the use of a noise detection method [8] and the construction of a binary map. A fidelity factor is utilised to further combine the filtered images [2]. Since each image is not denoised before fusion, the first strategy is computationally faster than the second. Fusion implies the method of combining two or more images captured by different sensors. It involves two closely related methods, the first one uses fusion followed by filtering, while the other relies on filtering followed by fusion. First technique (IMF1) involves the fusion of the images captured by different sensors with the help of a binary map. The fused image is filtered using median filter. In the second technique (IMF2) [2], each of the captured images is subjected to filtering with the help of a noise detection technique [8] and the creation of a binary map. The filtered images are further fused together using a fidelity factor [2]. First technique is computationally faster than the second technique, since each image is not denoised before fusion in it. A different method known as SBMF is only used for salt and pepper sounds. This approach modifies the median filter by applying a robust estimation algorithm while also applying a sliding window for each pixel [3].

**B. Multiplicative Noise Reduction:** The image that was produced by multiplicative noise is shown as (1) In this scenario, the original picture (x) I j), the multiplicative noise (n) I j), and the noisy image (y) I j) are all present. The coefficient of variation, or Cij, in a noisy image is the ratio of local standard deviation to local mean [4]**.** Cij is equivalent to the noise standard deviation, n, in the region of the image with constant intensity. The ratio, though, is higher than the area's changing-intensity noise's standard deviation. If the current window's coefficient of variation is less than Digital photos often contain impulse noise. It is dispersed randomly throughout the image and is unrelated to and independent of the image's pixels. There are several varieties of impulse noise, including random valued [3] and salt and pepper noise. In this part, two distinct methods based on picture fusion for producing higher-quality images for the generic impulse noise model are briefly presented. Fusion alludes to a technique for fusing two or more images taken by various sensors. There are two roughly comparable approaches: the first one relies on fusion followed by filtering, and the other on filtering followed by fusion. The first method (IMF1) uses a binary map to combine the images that were recorded by various sensors. The median filter is used to filter the combined image. The second method (IMF2) [2] filters each of the collected images with the use of a noise detection method

[8] and the construction of a binary map. A fidelity factor is utilised to further combine the filtered images [2]. Since each image is not denoised before fusion in the first technique, it is computationally faster than the second technique. A different method known as SBMF is only used for salt and pepper sounds. A different method known as SBMF is only used for salt and pepper sounds. or equal to the standard deviation of the noise, it indicates that the texture of the image is homogeneous. This approach requires applying a sliding window to each pixel and is a version of the median filter with application of a robust estimation algorithm. A new approach for multiplicative noise reduction is Adaptive Window Based Lee Filtering (AWBLF), which was proposed by Zengguo Sun et al. This approach uses the adaptive windowing and local structure detection techniques. Adaptive windowing refers to the process of adjusting the size of the window in response to changes in Cij. If Cij exceeds a predetermined threshold Tij [4], the window size is constantly reduced. till its minimum, if not increased until its predetermined maximum value. To ascertain how a point target and an edge feature would appear, local structure detection is used [4]. The homogeneous semi-window employing the gradient masks is fixed to identify the point target. This method makes use of the Lee filter.

**C. Gaussian Noise Reduction:** Sos S. Agaian et al. [7] recently developed the Sliding Double Window Filtering approach for reducing Gaussian noise. This technique employs two windows—a transformed window and a spatial window—and is based on the idea of threshold filtering. While the latter chooses a sub-block within the former window for pixel replacement, the former is chosen for the filtering procedure. The strategy prevents overlapping between spatial domain windows since the pixels in those windows will be replaced after the filtering procedure. This approach uses the Fibonacci Fourier Transfer, which takes use of the connection between the Fibonacci numbers and the traditional DFT. The Wavelet Based Adaptive Thresholding (WBAT) method and the Wiener filter are contrasted with this approach in the in the paragraph that follows.

## III. RESULTS AND DISCUSSION

This phase provides a assessment of the techniques discussed in the phase 2 with the traditional techniques for each noise. The algorithms are simulated the use of extraordinary 256 x 256, eight-bits/pixel general snap shots which include Pepper (gray), Lena (gray) etc. This paper includes handiest the simulation outcomes obtained with Lena image lest of the brevity. The overall performance of the exclusive strategies is examined for diverse noise ranges. The overall performance of the discussed algorithms is quantitatively measured the use of peak sign to noise Ratio (PSNR). PSNR is given by using the expression PSNR = $\sum\ \sum$ (2) wherein'b' is the bit depth of the photo and and denote the pixel values of the restored photo and the authentic photo respectively and M x N is the dimensions of the picture. A comparison between the impulse noise reduction techniques discussed in section 2 is done quantitatively through the noise density versus PSNR plot. The simulation is carried out with the test images yielded to noise densities ranging from 10% to 90%. Figure 1(b) and 1(c) shows the images recovered from those corrupted by salt and pepper noise, using SMF and SBMF techniques. It is obvious from the figure that SBMF performs much better than SMF. Figure 2 implies that the images recovered.

Lena image corrupted (20%Random Noise)

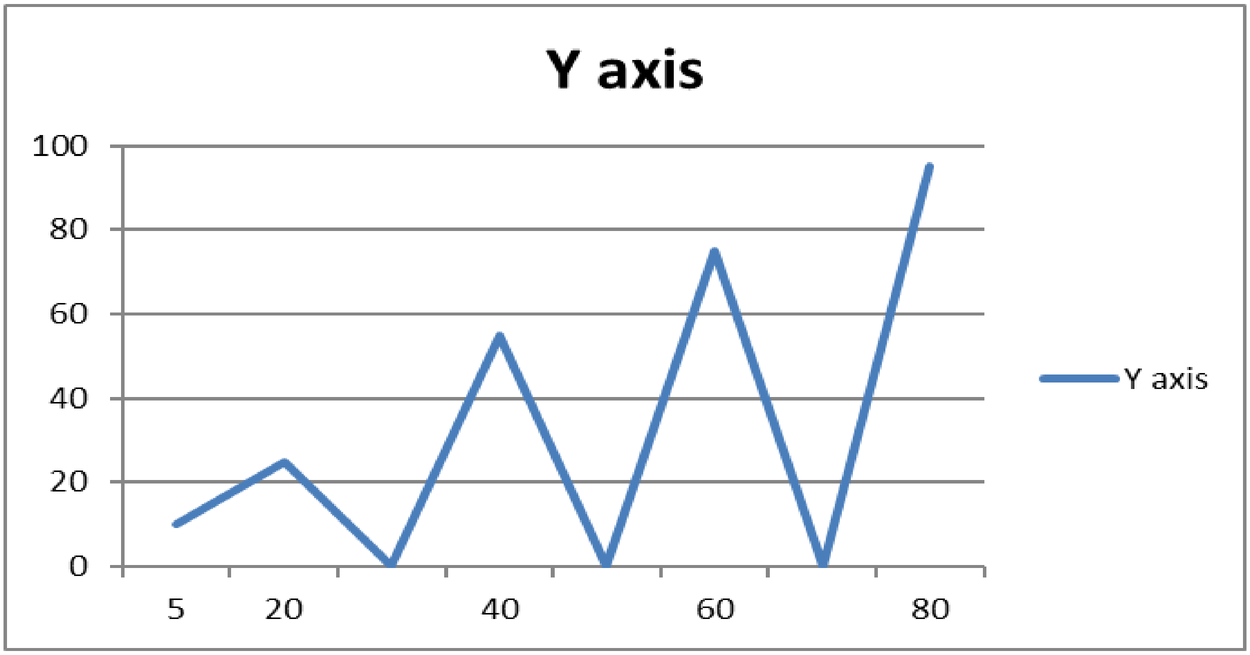
Lena Image with 50% Noise

Recovered Lena image with very less noise

Performance Of Different Techniques on Salt and Pepper Noise: (a) Original Lena image (b) Noisy image with 70% noise density. Restoration result of (c) SMF (d) SBMF Impulsive noise which may include salt and pepper, random valued impulses etc. using fusion techniques IMF1 and IMF2.

Figure 3 shows the noise density versus PSNR graph for impulse noise reduction techniques. It gives a quantitative comparison between different techniques at various noise densities ranging from 10% to 90%. Fig. 3: Noise Density versus PSNR for Different Impulse Noise Reduction Techniques The graph is plotted using the simulation results obtained with different standard images subjected to the noise densities ranging from 10 to 90 %.

Graph Picture as follows with different noise values in % in x axis and degradation in Y axis.




In the graph, PSNR at each noise density is an average value of the PSNR of each recovered image at that particular noise density. Figure 3 indicates that for lower noise densities, IMF1 performs much better than IMF2, while for higher noise densities IMF2 is also as good as IMF1, but IMF2 is computationally intensive. In short, IMF1 is algorithmically simple and computationally efficient and hence it is suitable for real-time application. Moreover, IMF1 is better among the discussed techniques for the impulsive noise, whether it is salt and pepper or random valued. B. Multiplicative Noise: AWBLF algorithm for speckle noise reduction is compared with the median filter using the simulation results with the noisy images having the noise Standard Deviation (S.D) ranging from 0.15 to 0.3. The range of noise S.D selected is not arbitrary, rather it is the usual range of noise S.D for the multiplicative noise. The comparison is also done in terms of PSNR. Figure 4(c) and 4(d) show that for multiplicative noise, the image obtained from AWBLF algorithm is visually much better than the median filtered image. AWBLF algorithm is a better tradeoff between noise suppression and fine detail preserving compared to the conventional fixed-size median filtering, since this algorithm chooses different window size for homogeneous and heterogeneous like values 0 15 30 45 60 75 90 1.

**Gaussian Noise**: SDWF algorithm for the Gaussian noise reduction is compared with the wiener filter and the WBAT algorithm. SDWF algorithm is simulated with different window sizes and the experimental results reveal that the quality of the filtered images is better when the outer transformed window size is 5X5 and inner spatial window size is 1X1. The simulation is carried out at different noise S.D ranging from 0.03 to 0.09. The range selected is not arbitrary, rather it is the usual range of the Gaussian noise. Figure 6 shows the images recovered from those corrupted by AWGN, using different techniques. From the Figure 6(c), 6(d) and 6(e), the image obtained by wiener filtering is blurred, while the image obtained from the WBAT algorithm appears noisier than that obtained using SDWF algorithm. It is obvious by visual inspection that SDWF performs better. Figure7 shows a quantitative comparison between these techniques using PSNR plot. SDWF algorithm performs much better than the wiener filter and the WBAT algorithm for the entire range of noise variance considered. However, the performance of WBAT algorithm approaches towards the SDWF at high noise variance. The graph is plotted using the simulation results obtained with different standard images subjected to the noise S.D ranging from 0.02 to 0.09. In the graph, PSNR at each noise S.D is an average value of the PSNR of each recovered image at that particular noise S.D. In this section, the simulation results show that for the three noise, the discussed algorithms have a good noise suppression capability while retaining the natural edges.

Fig. 6: In above image Comparison of The SDWF Algorithm with Wiener Filter and WBAT Algorithm Through Visual Inspection (A) The Original Image (B) Noisy Image, Added Gaussian Noise with Zero Mean And 0.005 Variance. (C) Wiener Filtered Image with Window Size 5 (D) Filtered Image Using WBAT Algorithm (E) Sliding Double Window Filtered Image with Outer Window of Size 5X5, Inner Window 1X1

## Conclusion

The whole article incorporates the benefits of the recently stated unique strategies to cope with mixed noise This work presents an overview of three popular types of noise, impulsive, multiplicative, and Gaussian, for which current picture noise reduction techniques have been developed. Also indicated are appropriate denoising methods for various noise kinds.The window's size and threshold are fixed when using the SDWF algorithm.By adding adaptive windowing and adaptive thresholding, it might be further optimised.Mixed noise can frequently taint digital photos as well. Therefore, subsequent study should concentrate on an effective algorithm.

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