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Hybrid technique for better noise removal to enhance edge detection

Gurinder Singh
gurinder3098@gmail.com
Adesh Institute of Engineering and Technology, Faridkot, Punjab

Pankaj Sharma
er.pankajsharma85@gmail.com
Adesh Institute of Engineering and Technology, Faridkot, Punjab

Puneet Jain
puneetjain988@gmail.com
Adesh Institute of Engineering and Technology, Faridkot, Punjab

ABSTRACT

Edge detection technique is used to detect the edge of the image. But before edge detection, the image must be free from noise. The solution for removal of image and image recovery is image de-noising models which give a better solution to remove the possible pixel noise from the target image matrix. The image data is taken in the form of matrix data (2-D, 3-D or N-D), which is processed in the different dimensions with various practices in order to remove (eventually fix) the noise pixels. In this paper, the weight of the pixel is taken and covariance is calculated in the 3x3 pixel blocks. This algorithm does the cross-validation and checks the best fitness value of the pixel. Then the image is enhanced by using enhancement technique. Then the edges of the image are taken by using edge detection technique. The performance of proposed model has been estimated under various experiments. The results are found improved for all of the dataset images on the basis of PSNR (peak signal to noise ratio) and SSIM (structural similarity) based parameters.

KEYWORDS—*Image de-noising, Weighted Average, Pixel fitness, edge detection, image enhancement*.

1. INTRODUCTION

Noise removal is one of the most important areas within digital image processing. One type of noise that can appear in images is salt and pepper noise, which can be produced during image acquisition, storage, or transmission. These types of noises are removed by the de-noising modals and regenerate the corrupted image into original form. Many techniques have been proposed for the restoration of images corrupted by salt and pepper noise. Salt and pepper noise degrades the visibility of image. So many types of de-noising techniques are researched by many researchers however some techniques are more powerful as compare to others to regenerate image into original form. Main objective of de-noising models are preserve the important information in the image. Bilateral filter can be used to edge-preserving and noise-reducing smoothing for image. There are two types of computer image processing- space domain and spatial domain processing which used frequency domain through the orthogonal transformation. Spatial filters operate a low-pass filtering on a set of pixel data with an assumption that the noise reside in the higher region of the frequency spectrum. Spatial low-pass filters not only provide smoothing but also blur edges in signals and images. Whereas high pass filters improve the spatial resolution, and can make edges sharper, but it will also intensify the noisy background. Edge detection is very important area in the field of noise removal models. Edges defined the boundaries between the background and object present in an image and also defined the location of object present in image and their size, shapes, image sharpening and enhancement.

2. EXPERIMENTAL DESIGN

Image de-noising models are useful in many image processing models, in which problem of image noise persists. Image noise may occur due to many causes, which contain the dust particles, electromagnetic disturbance, etc. Image de-noising practices are identified to improve the image value, which has been expected by using the strength of the individual pixel, while the image is processed in 3x3 blocks. This proposed model is de-noising as based on the multiple things. The cross-validation and reference oriented image de-noising model has been designed. This computes the pixel recovery rate with the hybrid mechanism of variance, weighted average, and fitness rate. The following algorithm explains the step-wise execution of the proposed image de-noising model:

Algorithm 1: Hybrid Image De-noising Model (HIDM)

1. Acquire the input image matrix
2. Take the number of components → y
3. Take the parameter of smoothness and weights
    a. Set the limit of smoothness intensity
    b. Take the value of smoothness weight
    c. Input the maximum of iterations
    d. Give the tolerance value on the smooth output
    e. Start the guess parameters on pixel to guess the noise present in pixel
4. Give the size of windows
5. Calculate the no. Of cell in the image (Either overlapping or non-overlapping)
6. Run iteration for each of the block
    a. Run the method of noise assessment → decision N
    b. If decision N == 1 (Means noise exists)
        i. Take the surrounding pixels and calculate the weighted average
        ii. From the calculated weight Compute the variance and covariance to Produce the candidate value to update the pixel
        iii. Check the candidate value with respect to surrounding pixels
        iv. Apply the weight based criteria over the center pixel
        v. Choose the candidate value according to maximum fitness value
    c. Return the block
7. Join all blocks to construct the final image matrix
8. Return the final image matrix

Algorithm 2: Image Enhancement algorithm

1. Take input matrix
2. Set lower limit and upper limit
3. Take standard deviation of the matrix
4. Subtract the value of standard deviation from our limit
5. Return the final matrix

After restoration and enhancement apply edge detection to detect the edges

3. RESULT ANALYSIS

The results of the proposed model have been obtained in the form of PSNR and SSIM parameters, where PSNR defines the frequency of the images, and measured in the decibels. The SSIM parameter is used to determine the similarity between the original and de-noised image, and the distance is measured in the form of pixel correlation, which is converted in percentage to prepare the representing value. The following image (Figure 1) shows the results upon the Lena image, which has undergone the tests in the different noise levels. The SSIM value is recorded between the 0.9 dB to 1, where 1 shows the ultimate performance, whereas 0.9 dB value shows the significantly lower performance.

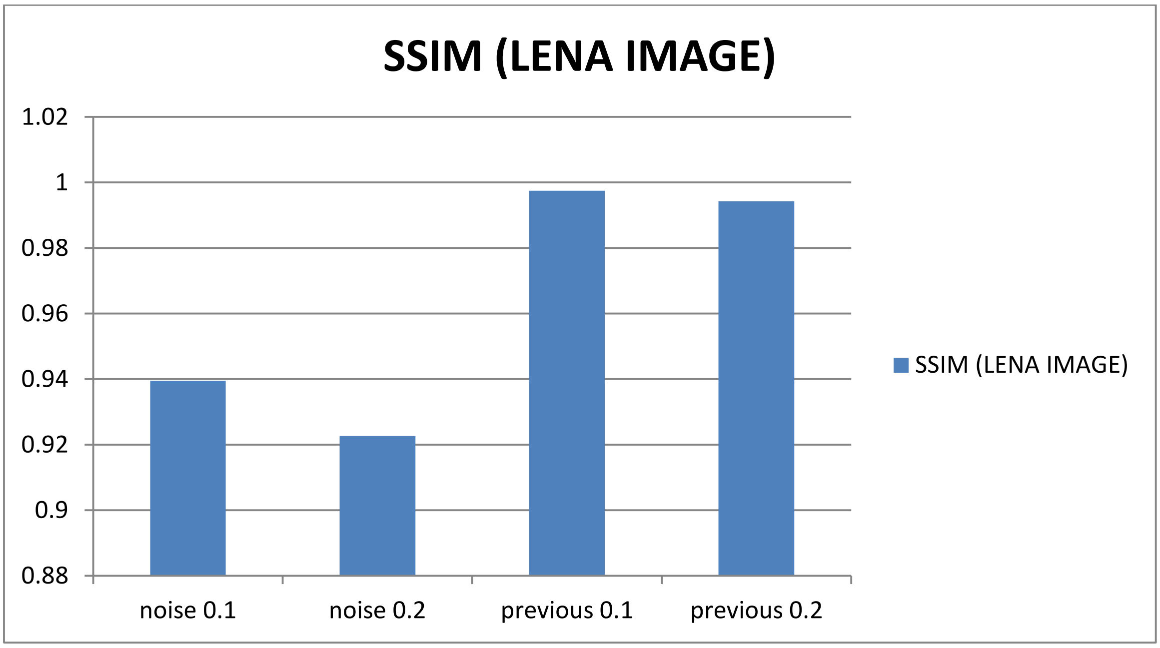

Figure 1: SSIM value-based performance assessment of Lena image

The following image (Figure 2) shows the results upon the Boat image, which has undergone the tests in the different noise levels. The SSIM value is recorded between the 0.81dB to 1, where 1 shows the ultimate performance, whereas 0.81 dB value can be considered as higher than the Lena image. The results on Boat are considerably higher than Lena image, which might be the case due to the large background area.

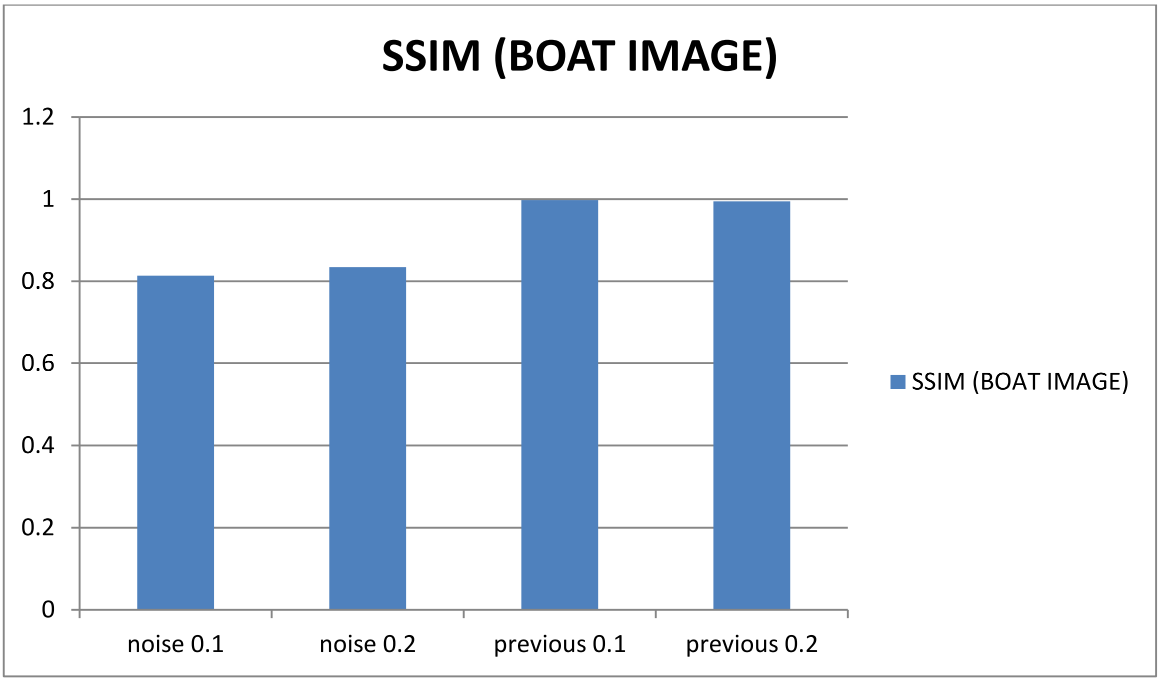

Figure 2: SSIM value-based performance assessment of Boat image

The following image (Figure 3) shows the results upon the Zelda image, which has undergone the tests in the different noise levels. The SSIM value is recorded between the 0.9 dB to 1, where 1 shows the ultimate performance, whereas 0.9 dB value can be considered as higher than the Lena and Boat images. The results on Zelda are considerably higher than Boat and Lena image, which might be the case due to the lower variance in the image matrix as compared to the latter images.

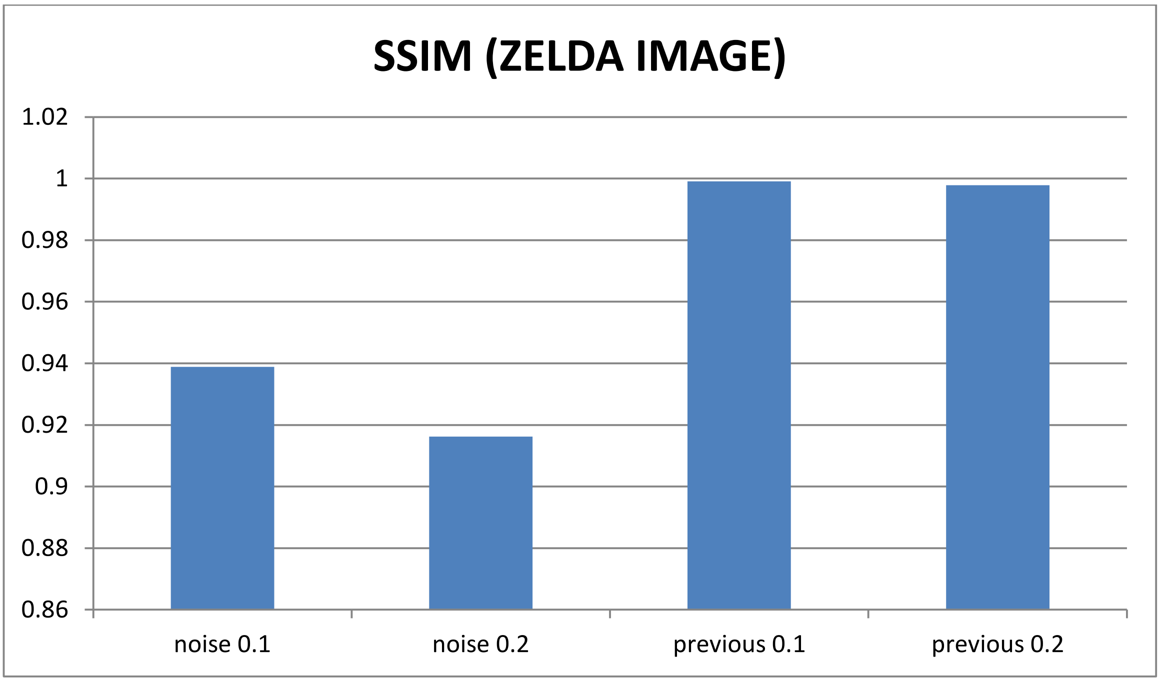

Figure 3: SSIM value-based performance assessment of Zelda image

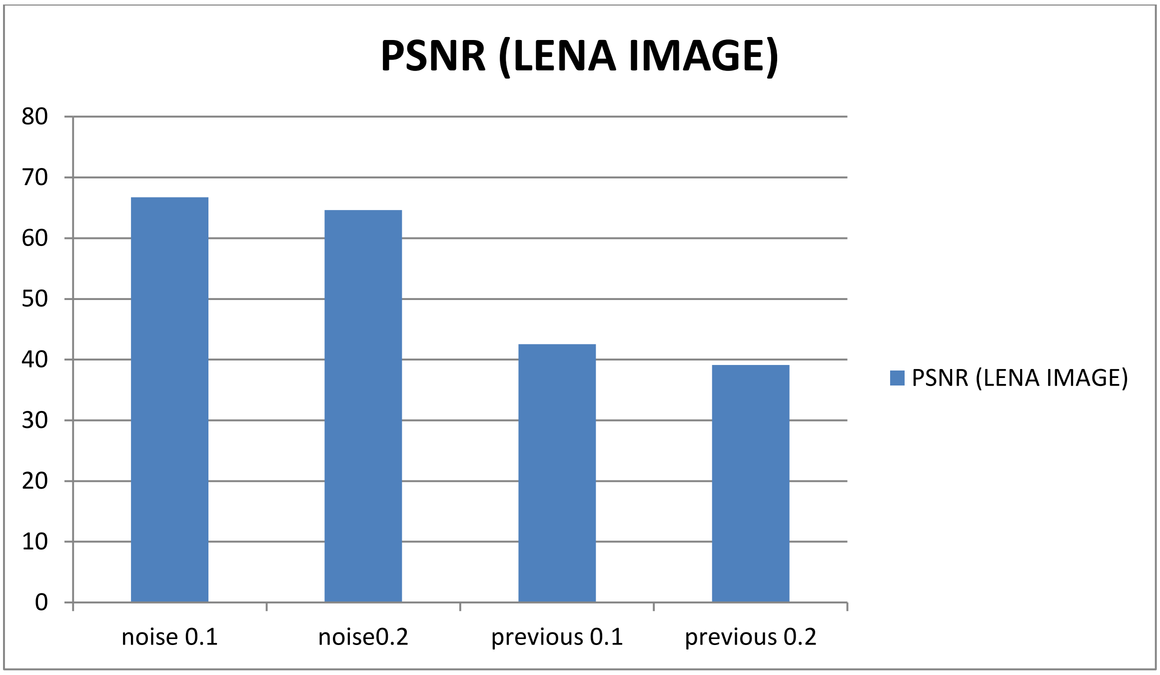

Figure 4: PSNR value-based performance assessment of Lena image

The above image (Figure 4) shows the results upon the Lena image, which has undergone the tests in the different noise levels. The PSNR value is recorded between nearly 67 dB and 39dB, where 39 dB is adequately higher to show higher than average performance, whereas 39 dB is higher than Boat image, but overall range of Boat image is better than Lena image. The high variety in the Lena image matrix is the cause of lower PSNR in comparison to the other images in the dataset. The following image (Figure 5) shows the results upon the Boat image, which has undergone the tests in the different noise levels. The PSNR value is recorded between nearly 36 and 53, where 53 shows the significantly higher performance, whereas range of 36dB to 53dB PSNR can be considered as higher than the Lena image. The results on Boat are considerably higher than Lena image, which might be the case due to the large background area.

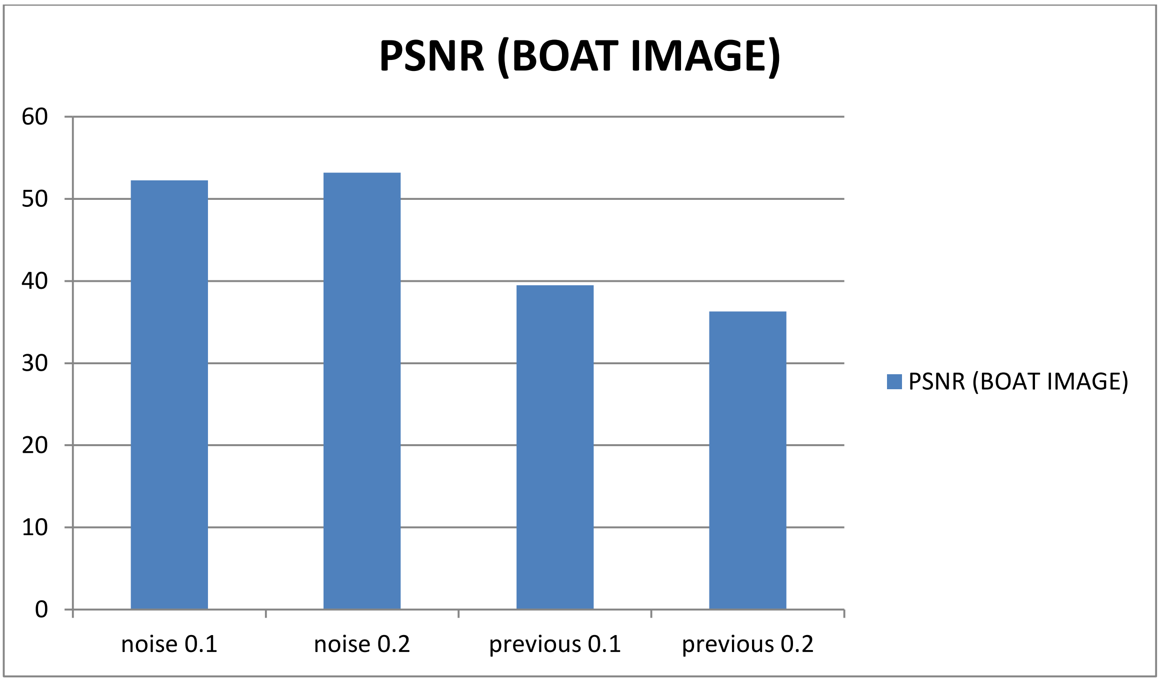

Figure 5: PSNR value-based performance assessment of Boat image

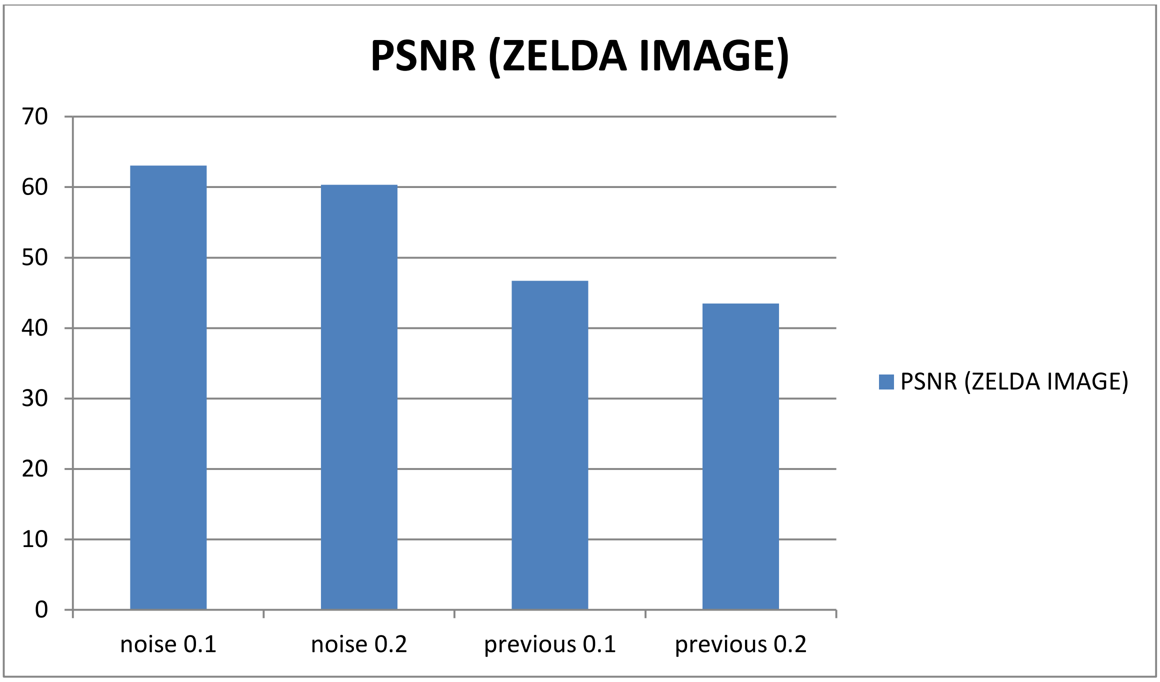

Figure 6: PSNR value-based performance assessment of Zelda image

The above image (Figure 6) shows the results upon the Zelda image, which has undergone the tests in the different noise levels. The PSNR value is recorded between the 43 dB to 63 dB, where 63 shows the ultimate performance, whereas 43 dB PSNR can be considered as higher than the Lena and Boat images. The results on Zelda are considerably higher than Boat and Lena image, which might be the case due to the lower variance in the image matrix as compared to the latter images.

Edge detection

After removing the noise by using de-noising modal, detect the edges of Lena image by using edge detection technique.

Figure 7: Edge detection of Lena image

4. CONCLUSION

To improve the overall performance of the image, this de-noising modal has been designed. In this procedure, the multi-factor noise is recovered by using the block-wise iterative procedure. We used slider window function to remove the overall noise from the pixels of high-quality image. Main advantages of the proposed modal are performed only on the affected or noise containing pixels, not on noise-free pixels of the image. After that enhance the image by using image enhancement and also applied the edge detection technique to detect the edges of the image. The Lena image has been recorded with lowest SSIM value of 0.9 dB, whereas Boat and Zelda images produced the minimum SSIM values of 0.81dB and 0.91 dB. The maximum SSIM value for all the images in nearly at par, and recorded with a higher value than 1, which shows the robustness in the performance of proposed image de-noising filter. The lowest value of PSNR has been recorded in boat image at 36.31, whereas the Lena and Zelda image is recorded with values of 39.12 and 43.47 respectively as minimum PSNR values. The maximum PSNR remains highest among the Zelda image (63.07), where Lena and Boat images are recorded with 66.76 and 53.18 respectively as maximum PSNR values. The proposed model results show the higher performance in order to de-noise the image matrices.

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