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Evaluation of Image Denoising Filters

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Abstract: Images are usually exposed to noise. Noise is gained while capturing an image, transmission etc. Reduction of noise in image processing is an essential step. Noise removal has a strong influence on the quality of the image processing techniques. Color image processing has various noise removal techniques. Different types of noise needs different types of removal techniques. Various linear and non-linear methods of filtering are being used for noise reduction. Impulse noise reduction by linear filters are prone to blur the edges. Non linear filters have an upper hand in this case. Few other techniques will be NLM filter, Median filter and Mode filter. Salt and pepper noise, Speckle noise and Gaussian noise are to be discussed in this article. Results of various filtering techniques shall be compared and measured in Peak signal noise ratio (PSNR) and Mean square error (MSE).

Keywords: NLM filter, Mode filter, Median filter, Salt and Pepper Noise, Speckle Noise, Gaussian Noise.

I. INTRODUCTION

Noise is a random variation of the intensity of the image and is visible as part of the grains in the image. It can be caused to emerge in the image as effects of the photonic nature of the basic physics of light or the thermal energy of heat within image sensors. Noise means that the pixels in the image display different intensity values instead of the actual pixel values that are originated from the image. The denoising algorithm is the process of decreasing noise from the image. Eliminate the visibility of noise by smoothing the global region of the entire image. But these methods can obscure fine, low-contrast details. The common types of noise that arise in the image are: a) Gaussian noise, b) Salt and Pepper noise, c) Speckle noise. Every noise have individual characteristics that make them distinguishable from others. Image noise can also be stiffened in film grain and in the inevitable shooting noise of an ideal photon detector. Image noise is an undesirable by-product of the captured image. The rest of the paper is organized as section II about the related work, methodologies in section III, and experimental results in section IV

II. LITERATURE REVIEW

Paper [1]: This paper presents the noise removal algorithm based on pixel processing. This algorithm not only works on gray scale image, but also can remove the noise in the color image based on three correlative components by call the algorithm from one to three times. In algorithm they have used the pixel operation on both gray scale and color images.
Paper [2]: In this paper they have used the Fuzzy Filter. The first sub filter computes the fuzzy distances between the color components of the central pixel and neighbourhood pixel. The second sub filter is used to correct the pixels where the color components differences are corrupted much that they appear as outliers in comparison to their environment. From this paper they conclude that this proposed method and wavelet based together will result in numerically and as well as visually.
Paper [3]: In this paper they have discussed different filtering techniques for removing noise on color images and compared results. They have taken the filters like Linear Filter, Adaptive Filter, NonLinear Filter and Gaussian Filter and compared the results. They resulted that Median Filter technique works better in removing noise from the color images.

Paper [4]: In this paper they have used the two algorithms maximum gradient algorithm and Euclidean gradient algorithm. Gradient peer group used to detect noise on color images and the peer group averaging algorithm will remove the noise detect the most of the noisy pixels in the image and rebuild the pixels through the peer group averaging.
Paper [5]:In this paper they have used mathematical based Morphology and Trimmed standard Median filter. Morphology namely Erosion and Dilation. This filter removes the noise from edge regions and inner regions of noisy images without distorting the features and color components.

Paper [6]: In this paper they have presented the results of different filtering techniques and they have compared the results for those techniques. The results obtained was using the Fuzzy Filter ensures noise free and quality of image as well and increases the computational complexity. From these anlysis they concluded that Fuzzy filter works better on color image.

Paper [7]: This paper proposes that support vector machine (SVM) based fuzzy filter for restoration of corrupted images from impulse noise in color image domain. In this work, the system has been trained with the optimal feature set. During

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the testing phase, pixels within test image are classified using knowledge achieved during the training phase into noisy and non-noisy. This proposed filter not only tries to improve the image details but also requires less computational complexity while preserving images from its corrupted version.

III. METHODOLOGY

Types of Noises

1) Gaussian Noise (Amplifier Noise)

The standard model of amplifier noise is additive, Gaussian, dependent on each pixel and dependent on signal strength, mainly caused by Johnson-Nyquist noise (thermal noise), including that coming from reset noise of capacitors ("kTC noise"). It is an idealized form of white noise, which is caused by random fluctuations in the signal [8]. Amplifier noise is an important part of the image sensor noise, that is, the constant level of noise in the dark areas of the image. In Gaussian noise, every 40 to 4 pixels in the image will change from its original value (usually) by a small amount. Figure 1 shows an example image.

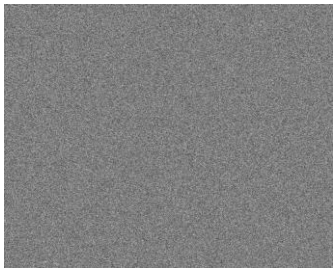

Fig 1.Gaussian Noise

2) Salt and Pepper Noise (Impulse Noise)

Salt and pepper noise is also called impulse noise or spike noise or random noise or independent noise. In salt and pepper noise (little light and dark disturbance), the pixels in the image are very different in color or intensity as opposed to the surrounding pixels by a sudden sharp disturbance in the image signal. Basically, this type of noise will only affect a few number of pixels in the image. In the visualization, the image contains few dark dots and few white dots, hence the term salt and pepper noise. An image containing this type of noise will have dark pixels in bright regions and vice versa [9]. Salt and Pepper noise can be caused due to dead pixels. This can sometimes occur with memory cell errors, with synchronization errors during image digitization or transmission. This type of noise can be caused by analog-to-digital converter errors and bit errors in transmission. Figure 2 shows an example image.

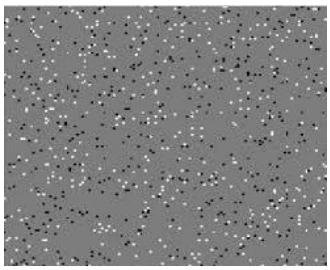

Fig 2. Salt and Pepper Noise

Speckle Noise (Multiplicative Noise)

'Speckle' is a granular 'noise' inherent in a degrades the quality of the active radar and the synthetic aperture radar (SAR) images.Noisy noise in conventional radar results of random fluctuations in the return signal of an object not more than one image-processing element. It will increases the mean gray level of a local area. Speckle noise in SAR is generally more severe, causing difficulties for image interpretation. It is caused by coordinated processing of backscattered signals from multiple distributed targets.The SAR image is the average intensity estimate for the radar reflectance of the area being imaged. This type of noise can be modeled by random values multiplied by pixel values and hence it is also known as multiplicative noise. Multiplicative noise is a major problem in some radar applications [10] [12]. Figure 3 shows an example image.

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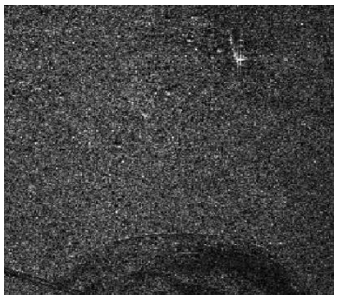

Fig 3. Speckle Noise

Types of Filters

1) Mode Filter

Mode Filter is used to remove noise from an image by replacing pixels with the most frequent pixel value selected from a certain window size. The mode filter is very effective in removing noise while not destroying sharp edges of an image. The mode filter is an edge- preserving the smoothing filter by taking the mode of empirical density. This can have applications in image processing such as image segmentation. The mode filter is an image filter very similar to the mean filter and median filter. They process every pixel in an image. For a given pixel, the pixel value will be replaced by the mean or median over all pixels within a distance or away. The mean and median filter can be used in Image, it results in a smoothing of the image [13].

2) NLM Filter

An average of all the pixels in the image is used, weighted by how similar these pixels are to the target pixel. Compared to other known denoise techniques, non-local means add "method noise" that looks more like white noise is desirable because it is typically less obtrusive in the denoise product. Recently, non-local resources have been extended to other image processing applications, such as deinterlacing view interpolation and depth map regularization. The approach of filtering non-local means is based on estimating each pixel intensity from the information provided from the entire image, and thus takes advantage of the redundancy caused by the presence of similar patterns and features in the image [9]. The restored gray value of each pixel is obtained by taking the weighted average of the gray values of all pixels in the image.

3) Median Filter

It is a non-linear digital filtering technique that is often used to eliminate noise from the images. Image denoising is the pre-processing step to get the improved image for further processing. Median filtering is very widely used in digital image processing because: Under certain conditions, edges are preserved while noise is removed, and there are also applications in signal processing. A much milder member of this family, such as one that chooses the closest of the neighboring values when the value of a pixel is outside of its neighborhood and leaves it otherwise, is sometimes preferred, especially in photographic applications. Here each output pixel is set to an average of the pixel values in the neighborhood of the corresponding input pixel. However, in this, the output value of a pixel is determined by the median. The median is much less sensitive than the mean for extreme values (called outliers) [11]. Median filtering is consequently better able to remove these outliers without reducing the sharpness of the image.

In the algorithm as a input color (RGB) image were given. For the images different noises that are Gaussian noise, Salt and Pepper noise and Speckle noise were added and then the images are passed through the different filtering techniques that are Mode filter, NLM filter and Median filter. From the obtained filtered image the performance metrics Peak Signal Noise Ratio (PSNR) and Mean Square Error(MSE) are measured and compared then the conclusion are given

Algorithm

Step 1**:-** Input a Color Image
Step 2:- Add a different noise to the input image
Step 3:- Apply different filtering techniques to the image
Step 4:- Obtained filtered output image
Step 5:- Apply Performance Metrics to the obtained output image
Step 6:- Results obtained from the performance metrics

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Flow Diagram

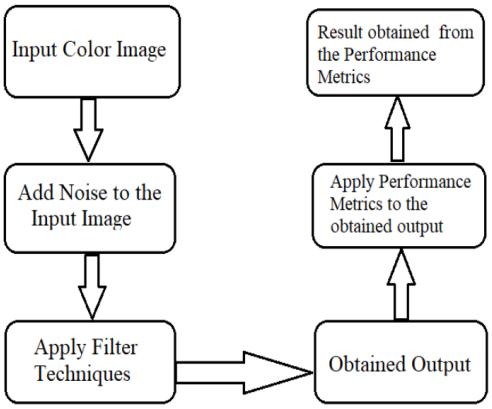

Figure 4. Methodology

IV. IMPLEMENTATION

Environmental Setup

This research is implemented in Anaconda Navigator. It works on Windows OS and it is user friendly Anaconda license has to be renewed periodically to continuously work with. Trial version of Anaconda is easily available in the internet, by following simple steps we can get them installed in our PC with simple configuration.

Experimental Results

Gaussian Noise - Input Image
The input image is a image with a Gaussian noise and the outputs are which obtained by passing through different Filtering techniques. Figure 4 depicts the results of each filter

(a) Mode Filter Output (b) NLM Filter Output (c) Median Filter Output

Figure 4. Experimental results of filters

Performance Evaluation
Table 1: Performance evaluation

Filters	Performance Metrics	Gaussian Noise
Mode Filter	MSE	5.006
	PSNR	41.927
NLM	MSE	58.598

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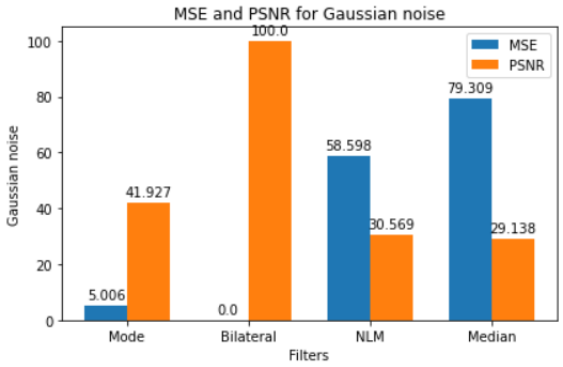
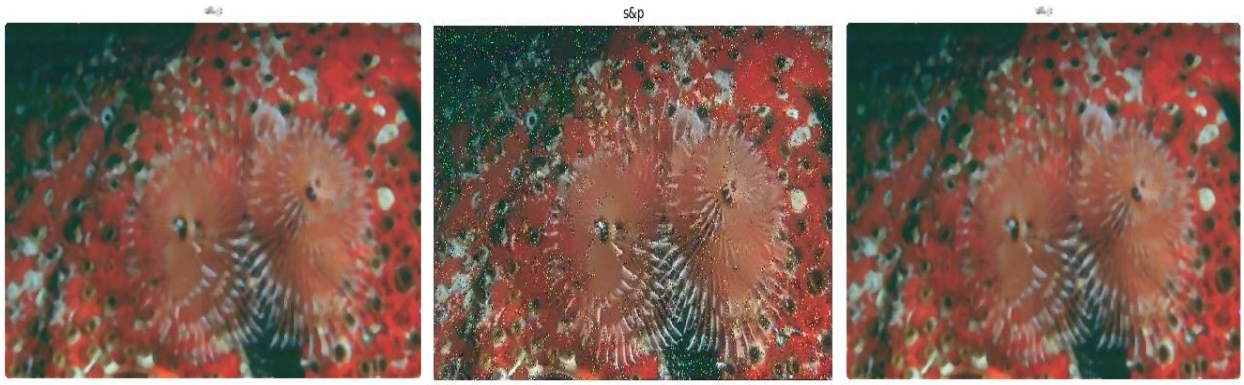
Filter	PSNR	30.569
Median Filter	MSE	79.309
	PSNR	29.138



Salt and Pepper Noise - Input Image

The input image is a image with a Salt and Pepper noise and the outputs are which obtained by passing through different Filtering techniques



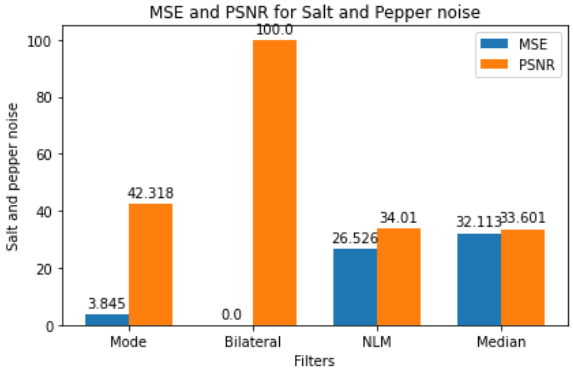
(a) Mode Filter Output (b) NLM Filter Output (c) Median Filter Output

Figure 5. Experimental results of filters

Performance Evaluation

Table 2. Performance evaluation

Filters	Performance Metrics	Salt and Pepper Noise
Mode Filter	MSE	3.845
	PSNR	42.318
NLM Filter	MSE	26.526
	PSNR	34.010
Median Filter	MSE	32.113
	PSNR	33.601



Speckle Noise - Input Image

The input image is a image with a Speckle noise and the outputs are which obtained by passing through different Filtering techniques

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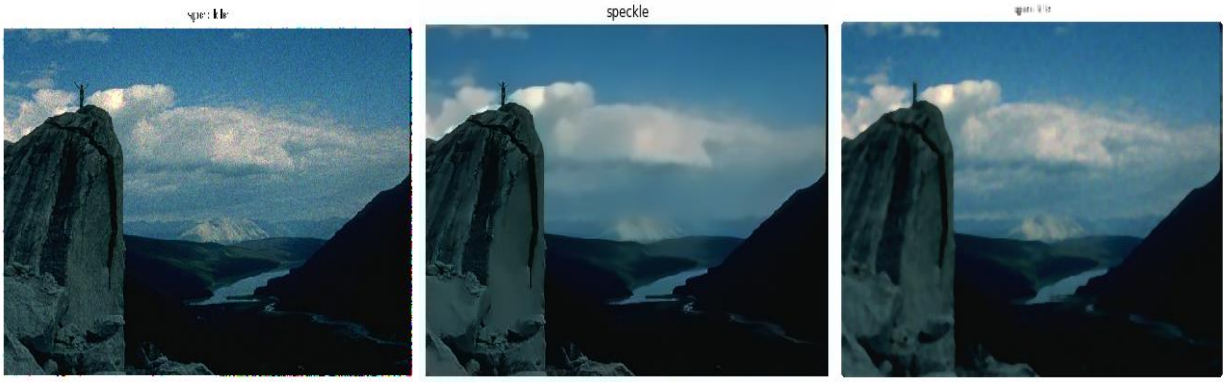
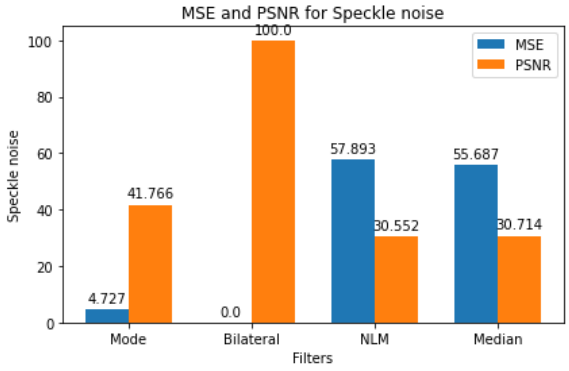


(a) Mode Filter Output (b) NLM Filter Output (c) Median Filter Output

Figure 4. Experimental results of filters

Performance Evaluation

Filters	Performance Metrics	Speckle Noise
Mode Filter	MSE	4.727
	PSNR	41.766
NLM Filter	MSE	57.893
	PSNR	30.552
Median Filter	MSE	55.687
	PSNR	30.714



V. CONCLUSION

From the analysis different filtering techniques for removing different noises in color image. Furthermore, from the compared results for these filtering techniques. The results obtained using Mode filter technique ensures noise free and quality of the image as well. The main advantages of his Mode filter are the denoising capability of the destroyed color component differences. Hence the method can be suitable for other filters available at present. But this technique increases the computational complexity. Our future research will be focused on the construction of other filtering methods for color images to suppress other types of noises.

REFERENCES

1. Wang Jianwei "A Noise Removal Algorithm of Color Image" TELKOMNIKA Indonesian Journal of Electrical Engineering Vol.12, No.1, January 2014, pp. 565 ~ 574 Received April 29, 2013; Revised July 11, 2013; Accepted August 6, 2013.
2. Stefan Schulte, Valérie De Witte, and Etienne E. Kerre "A Fuzzy Noise Reduction Method for Color Images" IEEE Transaction on Image Processsing, Vol. 16, No. 5, May 2007.
3. Abdalla Hambal, Zhijun Pei, Mr. Faustini Libent Ishabailu "Image Noise Reduction and Filtering Techniques" International Journal of Science and Research (IJSR) Volume 6 Issue 3, March 2017.
4. Rui Zhang, Wei He "Noise Removal in Color Images Based on Image Gradient Information" Volume: 6 Article first published online: February 12, 2015; Issue published: January 1, 2014.
5. Isma Irum, Muhammad Sharif, Mudassar Raza and Sajjad Mohsin "A Nonlinear Hybrid Filter for Salt & Pepper Noise Removal from Color Images" Journal of Applied Research and Technology (2015), 13(1), 79–85. doi:10.1016/s1665-6423(15)30015-8.
6. Mrs. C. Mythili , Dr. V. Kavitha "Efficient Technique for Color Image Noise Reduction" University College of Engineering Nagercoil. The research bulletin of jordan ACM.

DOI: 10.17148/IJARCCE.2022.11219

7. Amarjit Roy, Joyeeta Singha, Rabul Hussain Laskar"Impulse Noise Removal from Color Images:An Approach using SVM Classification Based Fuzzy Filter"Proc. of the 2017 IEEE Region 10 Conference (TENCON), Malaysia, November 5-8, 2017.
8. Analysis of denoising filters on MRI brain images, international Journal of Imaging Systems and Technology · August 2017
9. M. H. C. Lakshmi Devasena, "Noise Removal in Magnetic Resonance Images using Hybrid KSL Filtering Technique," Int. J. Compute. Appl., vol. 27, no. 8, pp. 1–4, 2011.
10. M. a. Yousuf and M. N. Nobi, "A New Method to Remove Noise in Magnetic Resonance and Ultrasound Images," J. Sci. Res., vol. 3, no. 1, pp. 81–88, Dec. 2010.
11. D. Ray, D. Dutta Majumder, and A. Das, "Noise reduction and image enhancement of MRI using adaptive multiscale data condensation," 2012 1st Int. Conf. Recent Adv. Inf. Technol., pp. 107–113, Mar. 2012.
12. M. R. Jose V. Manjon, Pierrick Coupe, Antoni Buades, D Louis Collins, "New methods for MRI denoising based on sparseness and self-similarity," Med. Image Anal., vol. 16, pp. 18–27, 2012.
13. J. M. Waghmare and B. D. Patil, "Removal of Noises In Medical Images By Improved Median Filter," Int. J. Eng. Sci., vol. 2, no. 7, pp. 49–53, 2013.