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Enhanced Profuse Clustering Technique for Image Denoising for Different Types of Noises

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ABSTRACT: Digital Image processing is the field which is continually grows into different fields. While capturing, storing and retrieving the image there can be various types of noises. Due to these noises image the image clarity will be lost. So there requires careful processing of the image for the noise detection and restorations to the original state. The noises in the image lies in various forms like Salt and Pepper, Gaussian, Speckle, Poisson noises. PCT based technique in comparison to all the base techniques like K-SVD, BM3D, NLM, is having better results in the noise detection and restorations. Denoised image has been compared on various parameters like SSIM, PSNR, FOM. All these parameters are having better results for PCT based techniques in comparison to all the base techniques.

KEYWORDS: K-SVD, BM3D, NLM

I. INTRODUCTION

Image processing is a field that continues to grow, with new applications being developed at an ever increasing pace. It is a fascinating and exciting area with many applications ranging from the entertainment industry to the space program. One of the most interesting aspects of this information revolution is the ability to send and receive complex data that transcends ordinary written text. Visual information, transmitted in the form of digital images, has become a major method of communication for the 21st century. Image processing is any form of signal processing for which the input is an image, such as photographs or frames of video and the output of image processing can be either an image or a set of characteristics or parameters related to the image. Most image processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it.

“**Image denoising** is a restoration process, where attempts are made to recover an image that has been degraded by using prior knowledge of the degradation process”. It is theyll known that while receiving the input image some aberrations get introduced along with it and hence a noisy image is left with for future processing. The image denoising naturally corrupted by noise is a classical problem in the field of signal or image processing. Images are often corrupted with noise during acquisition, transmission, and retrieval from storage media. For example, many dots can be spotted in a photograph taken with a digital camera under low lighting conditions as shown in Fig. 1.1.

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Fig. 1 (a) Clean Barbara Image[1]



Fig. 1 (b) Noisy Barbara Image[1]

Appearance of dots is due to the real signals getting corrupted by noise (unwanted signals). Whereas in television, random black and white snow-like patterns can be seen on the television screens due to loss of reception. Hence noise corrupts both images and videos. In addition, some fine details in the image may be confused with the noise or vice versa.

Many image processing algorithms such as an improved non local Denoising algorithm, pattern recognition etc. need a clean image to work effectively.

1.2 NOISE IN IMAGES

In this section various types of noise corrupting an image signal are studied. The sources of noise are discussed and mathematical models for the different types of noise are presented.

1.3 SOURCES OF NOISE

During acquisition, transmission, storage and retrieval processes an image signal gets contaminated with noise. Acquisition noise is usually Additive White Gaussian Noise (AWGN) with very low variance. In many engineering applications, the acquisition noise is quite negligible. It is mainly due to very high quality sensors. In some applications like remote sensing, biomedical instrumentation, etc., the acquisition noise may be high enough. But in such a system, it is basically due to the fact that the image acquisition system itself comprises of a transmission channel.

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1.3 CLASSIFICATION OF DENOISING METHODS

There are two basic approaches to image denoising, spatial domain filtering methods and transform domain filtering methods. Spatial Domain Filtering Methods: A traditional way to remove noise from image data is to employ spatial filters. These filters are further classified into linear filters and non-linear filters.

1.3.1 Linear Filters

Most classical linear image processing techniques are based on the assumption that image processing applications in which both edge enhancement and noise reduction are desired. Linear filters tend to blur sharp edges, destroy lines and other fine image details and perform poorly in the presence of signal-dependent noise.

1.3.2 Non-Linear Filters

Non-linear filters modify the value of each pixel in an image based on the value returned by a non-linear filtering function that depends on the neighbouring pixels. Non-linear filters are mostly used for noise removal and edge detection. The traditional non-linear filters are the median filter. Spatial filters employ a low-pass filtering on groups of pixels with the assumption that the noise occupies the higher region of the frequency spectrum.

II. LITERATURE SURVEY

Many researchers have proposed various denoising techniques like Wavelet-based thresholding, Wiener filtering, etc. The Curvelet transform is a recently introduced non-adaptive multi-scale transform that is mainly popular in the image processing field.

P. Thamilselvan et. al(2018): Digital images assume a vital part both in day-by-day life applications, for example, satellite TV, computed tomography, magnetic resonance imaging and additionally in ranges of research and innovation, for example, cosmology and geographical information systems. An expansive segment of computerized image processing incorporates image restoration. Image restoration is a technique for removal or decrease of corruption that is caused amid the image capturing. Corruption originates from obscuring as they'll as commotion due to the electronic and photometric sources. Obscuring is the type of data transfer capacity decrease of images caused by flattheyd image development process, for example, relative movement amongst camera and unique scene or by an optical framework that is out of core interest. Image Denoising is an important pre-processing task before further processing of the image like segmentation, feature extraction, texture analysis, etc. which removes the noise while retaining the edges and other detailed features as much as possible. This noise gets introduced during acquisition, transmission & reception and storage & retrieval processes. This paper presents a novel pre-processing algorithm which is named as Profuse Clustering Technique (PCT) based on the super-pixel clustering. K-Means clustering, Simple Linear Iterative Clustering, Fusing Optimization algorithms are involved in this proposed Profuse Clustering Technique and is further used for denoising the Lung Cancer images to get the more accurate result in the decision-making process.

Aravind B. N et. al(2015): Image is one of the most important parts of multimedia that is used in several areas from simple photography to medical and satellite imaging. In each field its usage and requirements are very different. So, an image is required to be clean and free from artifacts to convey better information. But, acquisition is always associated with some sort of degradation that may be due to atmospheric conditions, camera sensors and/or lighting conditions. In this paper they have considered the degradation only due to noise and in specific additive Gaussian noise. Here, they are proposing to use a dual-step approach for denoising. In the first step it uses stationary wavelet-based denoising and in continuation to the second step, a spatial domain method, Non-local means, is used to remove the artifacts. The simulation is done on both real and synthetic images and it shows an improvement over existing methods. Image is one of the most important parts of multimedia that is used in several areas from simple photography to medical and satellite imaging. In each field its usage and requirements are very different. So, an image is required to be clean and free from artifacts to convey better information. But, acquisition is always associated with some sort of degradation that may be

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due to atmospheric conditions, camera sensors and/or lighting conditions. In this paper they are considering the degradation only due to noise and in specific additive Gaussian noise. Here to use a dual step approach for denoising. In the first step it uses stationary wavelet based denoising and in continuation to second step, a spatial domain method, Nonlocal means, is used to remove the artifacts. The simulation is done on both real and synthetic images and it shows an improvement over existing methods.

Xin Sun et. al(2017): In the process of denoising color images, it is very important to enhance the edge and texture information of the images. Image quality can usually be improved by eliminating noise and enhancing contrast. Based on the adaptive wavelet threshold shrinkage algorithm and considering structural characteristics on the basis of color image denoising, this paper describes a method that further enhances the edge and texture details of the image using guided filtering. The use of guided filtering allows edge details that cannot be discriminated in grayscale images to be preserved. The noisy image is decomposed into low-frequency and high frequency subbands using discrete wavelets, and the contraction function of threshold shrinkage is selected according to the energy in the vicinity of the wavelet coefficients. Finally, the edge and texture information of the denoised color image are enhanced by guided filtering. When the guiding image is the original noiseless image itself, the guided filter can be used as a smoothing operator for preserving edges, resulting in a better effect than bilateral filtering. The proposed method is compared with the adaptive wavelet threshold shrinkage denoising algorithm and the bilateral filtering algorithm. Experimental results show that the proposed method achieves superior color image denoising compared to these conventional techniques.

III. PCT BASED ALGORITHM

Pre-Processing Profuse Clustering Technique (PCT) for image Denoising

In the proposed Profuse Clustering algorithm, the following steps are involved for the image denoising and image segmentation.

1: Profuse Clustering Algorithm

- 1: Input image X with white Gaussian noise.
- 2: Set parameters: noise variance, superpixels number N_s , cluster number K .
- 3: **Procedure 1:** This procedure contains the initial super pixel by SLIC algorithm.
- 4: Utilize K-Means clustering method to group super pixel into K cluster to form sub datasets $\{P_k\}$.
- 5: **Procedure 2:** This procedure contains the Refinement method for super pixels. It fuse the super pixels.
- 6: Repeat till the entire super pixels end.
- 7: Reconstruct the image and output the denoised image Y .

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IV. FLOWCHART

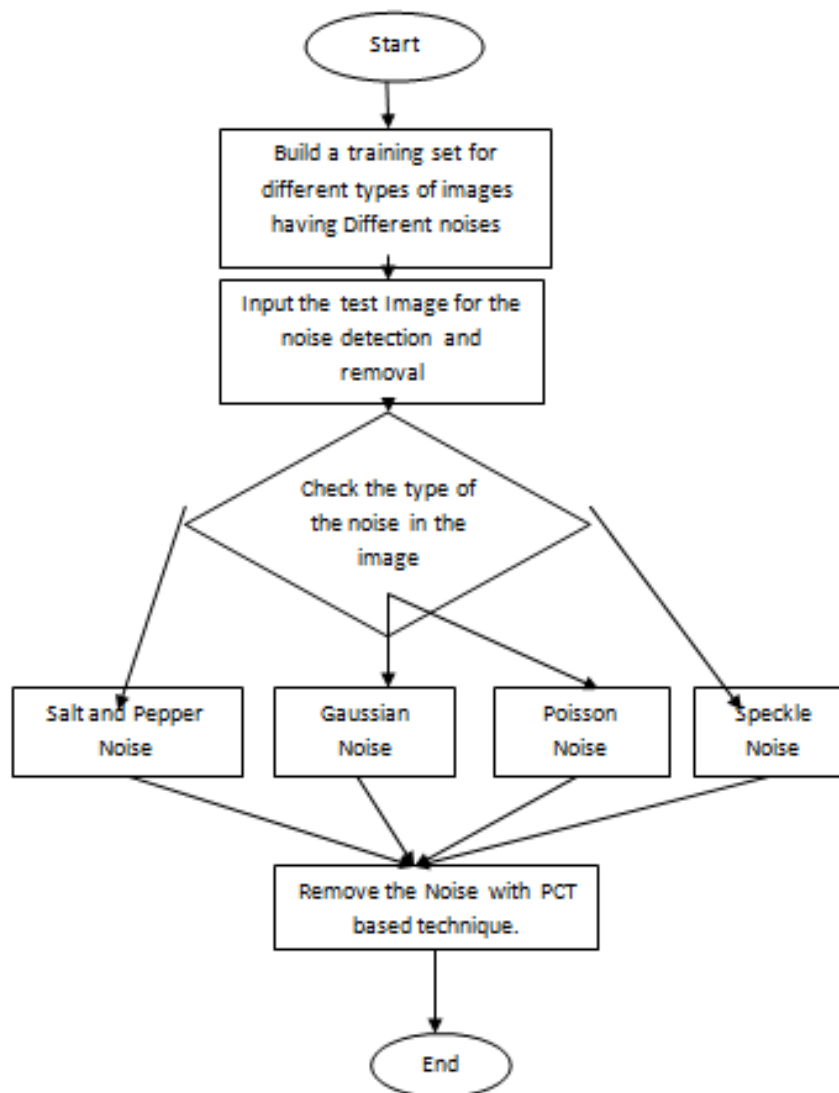


Fig. 2 Flowchart

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V. RESULTS AND ANALYSIS

5.1 Salt and Pepper Noise

5.1.1 PSNR Comparison

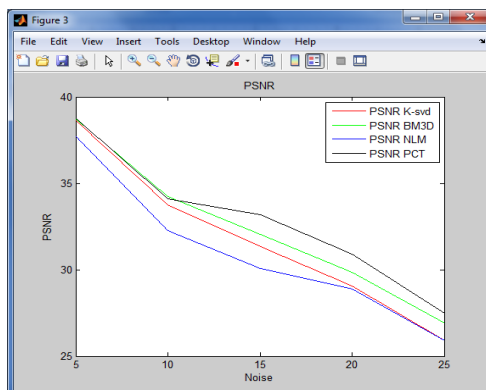


Figure 3 PSNR Comparison for Salt and Pepper

Figure 3 shows the PSNR Comparison for the four different Techniques like K-SCD,BM3D,NLM and proposed PCT technique. PSNR for the proposed PCT based technique is highest in all the techniques.

Table 1 PSNR for Salt and Pepper

KSV D	38.62	33.73	31.34	29.06	25.9
BM3D	38.71	34.25	32.05	29.86	26.89
NLM	37.71	32.25	30.05	28.86	25.89
PCT	38.74	34.12	33.18	30.92	27.5

Table 5.1 shows the PSNR values for all the four techniques. PCT based technique has highest values. So its performance is better than the base technique.

5.1.2 SSIM Comparison

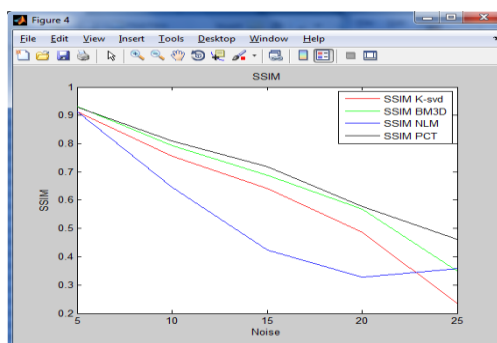


Figure 4 SSIM Comparison for Salt and Pepper

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Figure 4 shows the performance of the different techniques for SSIM under salt and pepper technique. The proposed technique based on PCT is performing better than the base technique.

Table 2 SSIM for Salt and Pepper

KSV D	0.9125	0.7552	0.642	0.4858	0.2338
BM3D	0.9303	0.792	0.6885	0.5677	0.3487
NLM	0.9113	0.6457	0.4242	0.3266	0.3577
PCT	0.9289	0.8093	0.7178	0.5769	0.4598

Table 2 shows the SSIM values for all the four techniques. The proposed technique based on PCT based technique is performing better compared to base techniques like BM3D,KSV D,NLM.

5.1.2 FOM Comparison

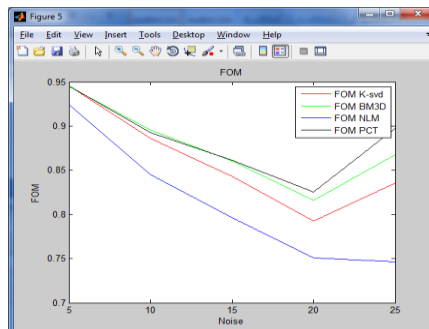


Figure 5 FOM Comparison for Salt and Pepper

Figure 5 shows the comparison of the FOM for base and proposed technique. FOM for the proposed technique is better than the base technique.

Table 3 FOM for Salt and Pepper

KSV D	0.9455	0.886	0.8428	0.7928	0.8354
BM3D	0.9444	0.8953	0.8607	0.8159	0.8676
NLM	0.9239	0.8454	0.7964	0.7511	0.7467
PCT	0.9453	0.8928	0.8615	0.8253	0.8976

Table 3 shows the values comparison for the base and proposed technique for FOM under Salt and Pepper technique.

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5.2 Gaussian Noise PSNR Comparison

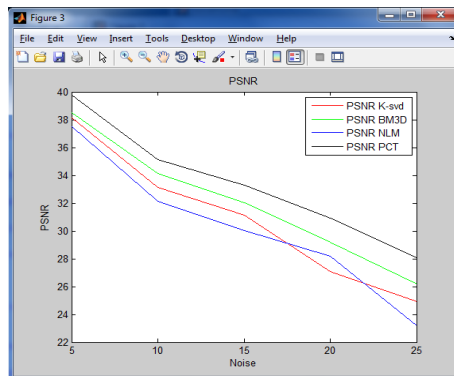


Figure 6 PSNR comparison for Gaussian Noise

Figure 6 shows the performance for PSNR for base and proposed technique under Gaussian noise. The proposed technique is better performing technique compared to the base technique.

Table 4 PSNR for Gaussian Noise

KSVD	38.12	33.12	31.14	27.06	24.9
BM3D	38.51	34.15	32.05	29.16	26.19
NLM	37.51	32.15	30.05	28.16	23.19
PCT	39.74	35.12	33.28	30.92	28.1

Table 4 shows the values for PSNR for the base and proposed technique for the PSNR under Gaussian Noise. PCT based proposed technique has higher values.

SSIM Comparison

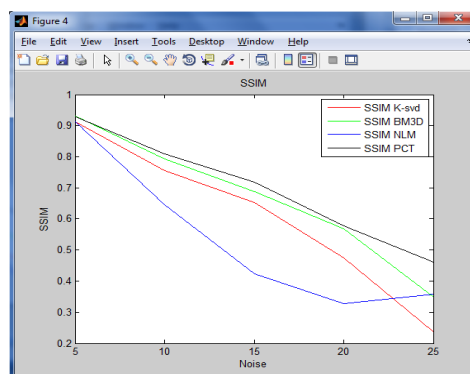


Figure 7 SSIM Comparison for Gaussian Noise

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Figure 7 shows the comparison for the SSIM under Gaussian Noise for base and proposed technique. The proposed technique based on PCT is performing better compared to the base technique.

Table 5 SSIM for Gaussian Noise

KSVd	0.9125	0.7552	0.652	0.4758	0.2358
BM3D	0.9303	0.792	0.6885	0.5677	0.3487
NLM	0.9113	0.6457	0.4242	0.3266	0.3577
PCT	0.9289	0.8093	0.7178	0.5769	0.4598

Table 5 shows the comparison values for all the base and proposed technique. Proposed PCT based technique has higher level performance for SSIM.

FOM Comparison

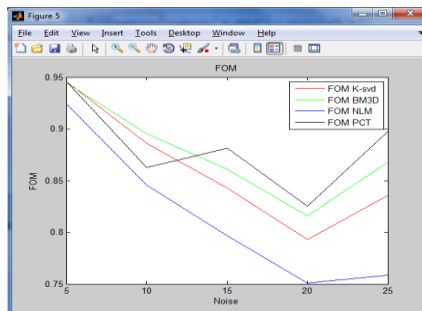


Figure 8 FOM Comparison for Gaussian Noise

Figure 8 shows the performance comparison for the base and proposed technique for the FOM under Gaussian Noise. The performance of the PCT based technique is better than the proposed technique.

Table 5 FOM for Gaussian Noise

KSVd	0.9455	0.886	0.8428	0.7928	0.8354
BM3D	0.9444	0.8953	0.8607	0.8159	0.8676
NLM	0.9239	0.8454	0.7964	0.7511	0.7587
PCT	0.9454	0.8628	0.8815	0.8253	0.8976

Table 5 shows the performance values for base and proposed technique. The proposed technique has higher performance compared to the base technique for FOM under Gaussian Noise.

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5.3 Speckle Noise PSNR Comparison

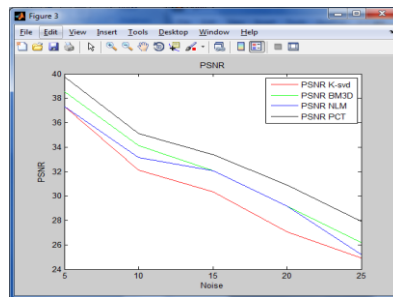


Figure 9 PSNR Comparison for Speckle Noise

Figure 9 shows the performance comparison for PSNR for the base and proposed technique under Speckle noise. The performance of the proposed PCT based technique is better than the base techniques.

Table 7 PSNR for Speckle Noise

KSVD	37.32	32.12	30.34	27.06	24.9
BM3D	38.51	34.15	32.05	29.16	26.19
NLM	37.31	33.15	32.05	29.16	25.19
PCT	39.74	35.12	33.38	30.92	27.9

Table 7 shows the performance comparison for the different technique in comparison to the proposed PCT based technique. The Proposed PCT based technique is performing better than the base technique.

5.3.3.2 SSIM Comparison

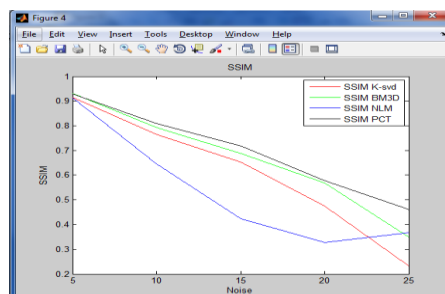


Figure 10 SSIM Comparison for Speckle Noise

Figure 10 shows the performance comparison for SSIM for the base and proposed technique under Speckle noise. The performance of the proposed PCT based technique is better than the base techniques.

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Table 8 SSIM for Speckle Noise

KSVd	0.9135	0.7652	0.652	0.4758	0.2318
BM3D	0.9303	0.792	0.6885	0.5677	0.3487
NLM	0.9113	0.6457	0.4242	0.3266	0.3677
PCT	0.9289	0.8093	0.7178	0.5769	0.4598

Table 8 shows the performance comparison for the different technique in comparison to the proposed PCT based technique. The Proposed PCT based technique is performing better than the base technique.

FOM Comparison

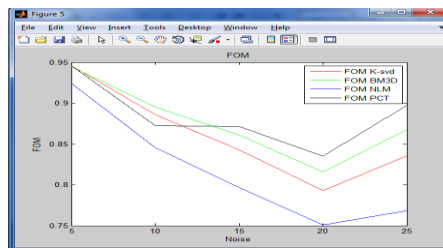


Figure 5.10 FOM Comparison for Speckle Noise

Figure 5.10 shows the performance comparison for FOM for the base and proposed technique under Speckle noise. The performance of the proposed PCT based technique is better than the base techniques.

Table 9 FOM for Speckle Noise

KSVd	0.9455	0.886	0.8428	0.7928	0.8354
BM3D	0.9444	0.8953	0.8607	0.8159	0.8676
NLM	0.9239	0.8454	0.7964	0.7511	0.7687
PCT	0.9455	0.8728	0.8715	0.8353	0.8976

Table 9 shows the performance comparison for the different technique in comparison to the proposed PCT based technique. The Proposed PCT based technique is performing better than the base technique.

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5.4 Poisson Noise PSNR Comparison

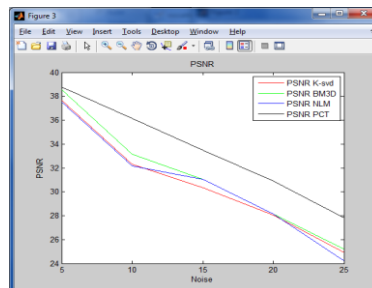


Figure 11 PSNR Comparison for Poisson Noise

Figure 11 shows the performance comparison for PSNR for the base and proposed technique under Poisson noise. The performance of the proposed PCT based technique is better than the base techniques.

Table 10 PSNR for Poisson Noise

KSVD	37.62	32.3	30.34	28.06	24.9
BM3D	38.51	33.15	31.05	28.16	25.19
NLM	37.51	32.15	31.05	28.16	24.19
PCT	38.74	36.12	33.48	30.92	27.8

Table 10 shows the performance comparison for the different technique in comparison to the proposed PCT based technique. The Proposed PCT based technique is performing better than the base technique.

SSIM Comparison

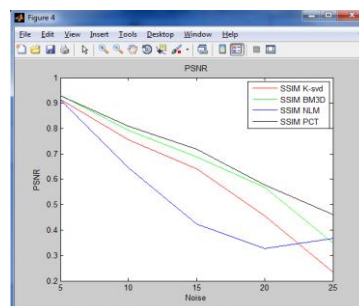


Figure 12 SSIM Comparison for Poisson Noise

Figure 12 shows the performance comparison for SSIM for the base and proposed technique under Poisson noise. The performance of the proposed PCT based technique is better than the base techniques.

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Table 11 SSIM for Poisson Noise

KSV D	0.9145	0.7552	0.642	0.4558	0.2338
BM3D	0.9303	0.792	0.6885	0.5677	0.3487
NLM	0.9113	0.6457	0.4242	0.3266	0.3677
PCT	0.9289	0.8093	0.7178	0.5769	0.4598

Table 11 shows the performance comparison for the different technique in comparison to the proposed PCT based technique. The Proposed PCT based technique is performing better than the base technique.

FOM Comparison

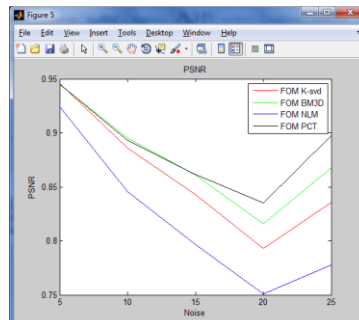


Figure 13 FOM Comparison for Poisson Noise

Figure 13 shows the performance comparison for FOM for the base and proposed technique under Poisson noise. The performance of the proposed PCT based technique is better than the base techniques.

Table 12 FOM for Poisson Noise

KSV D	0.9455	0.886	0.8428	0.7928	0.8354
BM3D	0.9444	0.8953	0.8607	0.8159	0.8676
NLM	0.9239	0.8454	0.7964	0.7511	0.7777
PCT	0.945	0.8928	0.8615	0.8353	0.8976

Table 12 shows the performance comparison for the different technique in comparison to the proposed PCT based technique. The Proposed PCT based technique is performing better than the base technique.

VI. CONCLUSION

Digital Image processing is the field which is continually grows into different fields. While capturing, storing and retrieving the image there can be various types of noises. Due to these noises image clarity will be lost. So there requires careful processing of the image for the noise detection and restorations to the original state. The noises in the image lies in various forms like Salt and Pepper, Gaussian, Speckle, Poisson noises. PCT based technique in comparison to all the base techniques like K-SVD, BM3D, NLM, is having better results in the noise detection and

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restorations. Denoised image has been compared on various parameters like SSIM, PSNR, FOM. All these parameters are having better results for PCT based techniques in comparison to all the base techniques.

VII. FUTURE WORK

Current research is based on PCT based technique for detection and removing of the noise for the image. Current technique has been used for various types of noises like Salt and Pepper, Speckle Noise, Poisson Noise, and the Gaussian noise. In future the result can be further optimized by using Genetic based approach.

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