# A Review On Medical Image Denoising Techniques

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**Abstract:** Medical images are images that contain visual and meaningful information that cannot be observed by an ordinary person. Medical images remain frequently corrupted through noise in its acquisition in addition to Transmission. The noisy image may convey the information in a different way. The key impartial of Image denoising methods is essential to eliminate such sounds whereas remembering as much as probable the required significant image features. In this paper, it is planned to review the maximum number of latest possible medical image denoising methods and give comparison of these popular models.

**Index Terms:** Machine learning, Image De-Noise, , Medical Image, Quality parameters.

## I. INTRODUCTION

THe image quality is degraded with the environmental surroundings while image acquisition also the excellence of the imaging sensor components distress their presentation. In images, Gaussian noise (amplifier noise, develops at amplifier or detector) is one of the frequently occurring noises although Quantization noise (uniform noise Additive White Gaussian Noise), Speckle noise Impulse noise, and Poisson Noise are present. The noise is one of the electronic parameters varies the information of the colour and brightness of the image. Gaussian clamor is a measurable commotion with Probability Density Function, which is equivalent to Gaussian conveyance, as an example, standard dispersion. Gaussian commotion is a measurable clamor having Probability Density Function which is equivalent to the Gaussian stream. It is addictive in nature, each pixel is free and the full-size force of each pixel is likewise autonomous The acquisition area may be affected with unwanted and unnecessary heat components and the resultant lead to Salt in addition to pepper sound is similarly recognized as Impulse noise. It happens in almost all the input devices. Gaussian distribution or Poisson distribution plays a role in Poisson noise. As the noise influence, the statistics of photons that remain taken through the sensors remain not sufficient to detect arithmetical variations in a capacity the Poisson noise is correspondingly named as shot noise. The individual interpretation and diagnosis depend on the excellence of the images, which are exaggerated through speckle noise

## II. LITERATURE REVIEW

In the reconstruction of image difficulties solve with the reported empirical results by the new approaches of wavelet methods, using curvelet and ridgelet transforms [1]. As the acquisition time is less in post-processing filtering techniques, it leads to use in MRI denoising. Denoising is the procedure of retrieving the signal since noisy data. The spatial pattern redundancy is the postulated principle for denoising techniques for the images. Noise sources and several artifacts are influence the Magnetic Resonance images. The acquisition of the required data is degraded by noises.


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The thermal noise is one of the parameters, randomly affects the MR signal [2]. The incomplete difference of total similarity is done on the standard medical image structures commencing the vision of image denoising also usage the Open CV display place to simulate the program. The studies of medical image denoising algorithms are emphasized [3]. The performance evaluators like PSNR, Mean Absolute Error, Universal Image Quality Index and Evaluation Time are figured for a hybrid model on standard images like Medicine images [4]. In this approach, edge image alteration amongst the original in addition to the denoised image is evaluated expending the Canny edge indicator. This performance is computed spatial mean filters particularly for removal of the Gaussian noise [5]. The different values of variances of additive white Gaussian noise corrupt medical images with bilateral filtering. Its exhibition becomes a hit to evacuate the brought substance white Gaussian clamor instead of expelling salt and pepper commotion [6]. The proposed flexible NLM denoising plan has three thrilling highlights. In the first area, it is a restricted nearby neighbor-hood in which the real force for each loud pixel is classified from lots of selected neighboring pixels. Second, the hundreds applied are decided by means of the likeness among the fix to denoise and exclusive patches competitors and Third, it's miles carried out the controlling component to defend the subtleties of the pictures [7]. It is performed the combination of the II denoised images consequential commencing total variation approach also Complex Dual Tree wavelet convert technique/ denoising techniques to denoise the medical images [8]. Undecimated Wavelet Transform has less redundancy, also has a good balance between smoothness and accuracy towards the denoised image expending Dual-Tree Complex Wavelet Transform than the DWT as per the proven results [9]. To reconstruct the image from Neural Network and Fuzzy System, the resultant values coefficients with multi-wavelets are taken as input in the training stage and the input CT image is examined at the testing stage [10]. An approach is proposed as a denoising method for thresholding similarly to optimization consuming a stochastic as well as a randomized approach of the Genetic Algorithm for scientific photographs. Before transforms it into the wavelet domain, the noisy image is separated addicted to everlasting sized blocks [11]. In view of disentangled pulse coupled neural system (PCNN), a unique progressed Non-community Means sifting plan for MR images is proposed which pursues heat-blooded creature's visual/perceptual reaction attributes, wherein the noisy MR photograph is passed thru a PCNN because the first stage

and the firing time output (time signature) of the PCNN is recorded as 2d stage [12]. This paper suggests a significant denoising technique founded on dictionary learning on behalf of denoise the images efficiently. To define a new iteration more reasonably the image size and pixel distribution are introduced. The compression of the threshold comes with the invitation of the iteration function. The obtained results give better computing time with high noise reduction and also the effect of dictionary updating is better with the algorithms of KSVD and MOD [13]. The image denoising in the wavelet area called Bayes Shrink. Bayes Shrink uses subband adaptive data-driven thresholding method. The proposed approach is an adaptive threshold approximation technique on behalf of image denoising. The parameters such as picture quality, PSNR, noise variance, vision are enhanced in the proposed algorithm [14]. The proposed algorithm integrates the adaptive inception in addition to an enhanced fuzzy usual in place of medical image enhancement founded on the nonsubsampled contourlet transform (NSCT). The original medical image is decayed addicted to a low-frequency sub-band that sits to the NSCT domain and several high-frequency sub-bands. The content available in low-frequency is analysed and utilized with some suitable linear transformation for the better visibility. High-Frequency image noise is removed with the adaptive threshold method. The details of the medical images are enhanced by Laplace operator and global contrast enhancement takes with the fuzzy set [15].

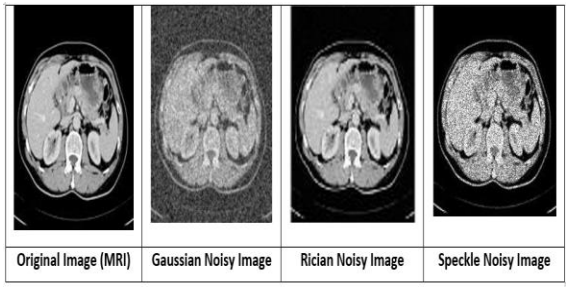


***Figure 1:*** *Medical and its Noisy Images*

For analysis purpose, some popular and state of art techniques like Lee filter, wavelet, curvelet, Two stage Principal Component Analysis (PCA), Non-Local Mean (NLM), Block Matching 3D (BM3D), Compressive Sensing 3D (CS3D) and Auto Encoder (CAE) are considered for medical denoising on images. These methods are compared by considering for medical denoising rician noise with noise variance of 0.1 and evaluated different quality parameters PSNR), MSE , SSIM (Structural Similarity Index Measure), Table 1shows that, the auto encoder model is producing best PSNR value among all the methods considered. This method denoised the medical image in a faster manner with a time of 0.454 seconds. It has proved the best model by considering the parameters like PSNR, CC, CNR, IE, MSE and ET. Mean filter, wiener filter and lee filter are basic denoising statistical models. Wavelet and curvelet models are the transformation models which dominated the denoising fields in producing remarkable results before last decade. Non-Local Mean, Modified Principal Component Analysis, Block Matching 3D and Compressive Sensing 3D are the denoising models that produced better results in last decade. An auto encoder is a machine learning model. So many machine learning methods are there in the same area that in the last two years to denoised the medical, camera, satellite and other type of images. This paper onveys the general comparison of denoised models on medical images.

CNR (Contrast to Noise Ratio), Information Entropy, Cross Correlation and Processing time. Table 1 shows the comparison of different popular denoising methods to get different quality parameters. Figure 2 shows the denoised images of different methods for a MRI image. Figure 3 to Figure 5 shows the comparison different parameters with denoising techniques.

To begin with, to forestall the considerable calculation burden created through the usual NLMF calculation and to expel the clamor from the mind pix, Enhanced Nonlocal Means Filter (ENLMF) is proposed. Second, to element, the restorative photos fluffy level set calculation is proposed. Vitality compaction, sparsity, and multi dreams count on a activity for denoising MRI snap shots with the DWT machine. A mix of edge-primarily based DWT with Modified K-Singular Value Decomposition (K-SVD) calculation is proposed to upgrade the outcome. Another adjusted strategy referred to as Neigh Sureshrink is additionally proposed in this paintings, for in addition denoising, along existing Thresholding methods, as an instance, Visushrink, Neighshrink, and Sureshirnk [16].

## III. ANALYSIS OF DIFFERENT DENOISING TECHNIQUES

Medical image can be degraded at any point of time from inception to final step. The general noises are disturbed the medical images are speckle, gaussian, rician, salt & pepper, etc. The Images are generally used in medical field are MRI, CT and X-Ray. Figure 1 shows the different noises that are possible for medical image. The noise variance may also the important point to be noted in denoising process.

***Table 1:*** *Comparison of different denoising techniques for evaluating different parameters on MRI Image*

| | PSNR | CC | SSIM | CNR | Information Entropy | Mean Squared Error | Elapsed Time (in sec) |
|---|---|---|---|---|---|---|---|
| LEE filter | 10.488 | 0.748 | 0.225 | 11.672 | 6.635 | 0.066 | 18.514 |
| CS3D | 16.781 | 0.947 | 0.821 | 15.341 | 6.353 | 0.026 | 13.029 |
| BM3D | 16.331 | 0.941 | 0.816 | 15.389 | 6.294 | 0.023 | 36.685 |
| PCA-LPG | 19.984 | 0.950 | 0.484 | 6.504 | 6.338 | 0.004 | 192.746 |
| Wavelet | 16.528 | 0.907 | 0.241 | 10.040 | 7.627 | 0.022 | 0.639 |
| Curvelet | 18.408 | 0.966 | 0.291 | 10.790 | 6.936 | 0.014 | 32.926 |
| NLM | 20.163 | 0.967 | 0.293 | 11.476 | 7.245 | 0.009 | 4.623 |
| CAE | 23.351 | 0.969 | 0.295 | 12.226 | 7.310 | 0.005 | 0.454 |

Figure 3 to Figure 5 shows the comparison different parameters with denoising techniques.

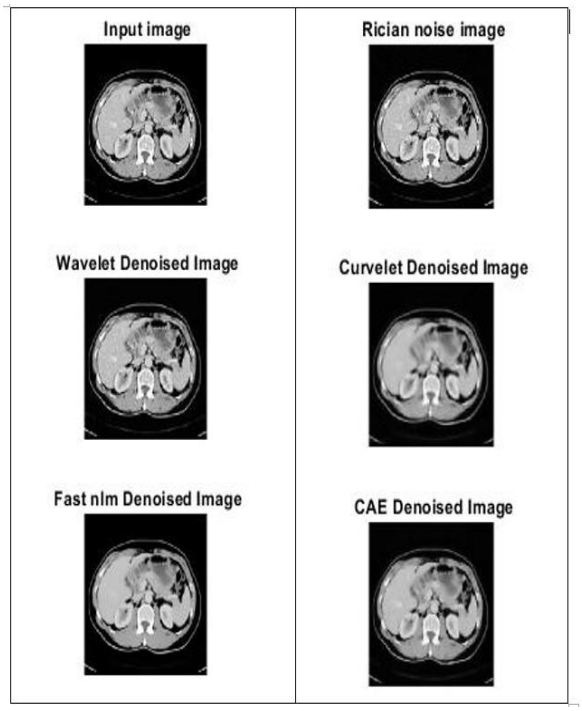


***Figure 2:*** *Comparison different denoised images*

Table 1shows that, the auto encoder model is producing best PSNR value among all the methods considered. This method denoised the medical image in a faster manner with a time of 0.454 seconds. It has proved the best model by considering the parameters like PSNR, CC, CNR, IE, MSE and ET. Mean filter, wiener filter and lee filter are basic denoising statistical models. Wavelet and curvelet models are the transformation models which dominated the denoising fields in producing remarkable results before last decade. Non-Local Mean, Modified Principal Component Analysis, Block Matching 3D and Compressive Sensing 3D are the denoising models that produced better results in last decade. An auto encoder is a machine learning model. So many machine learning methods are there in the same area that in the last two years to denoised the medical, camera, satellite and other type of images. This paper conveys the general comparison of denoised models on medical images.

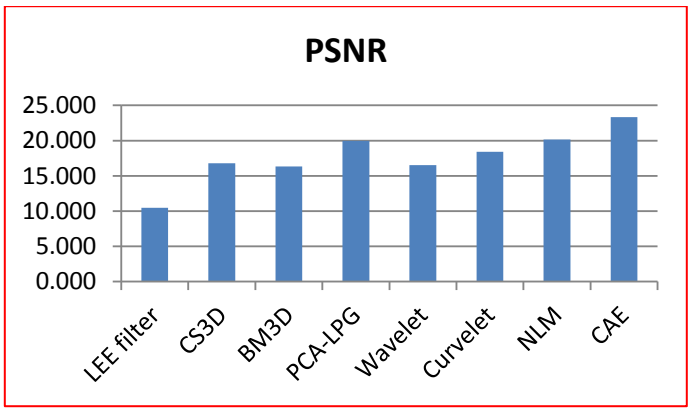


***Figure 3:*** *Comparison different denoised images on PSNR Value*

Fig.3 expalinas different filters and achievd psnr values here all parameters are formed different PSNR values

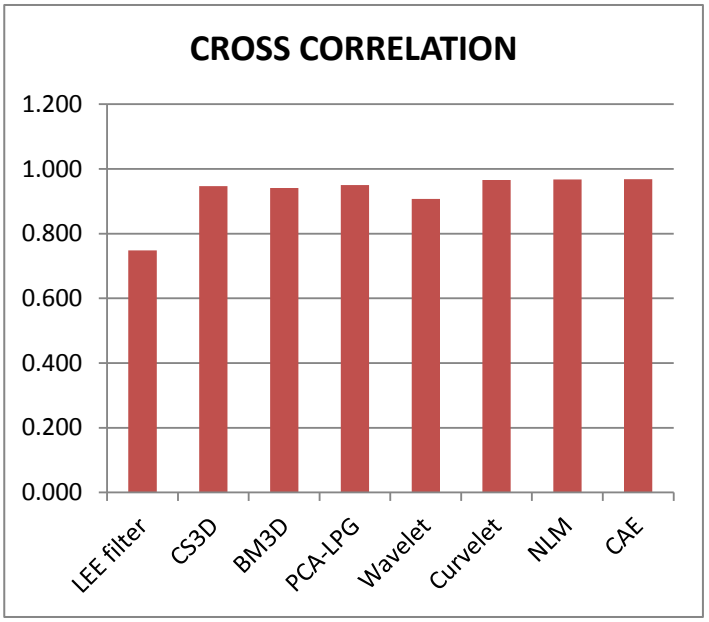


***Figure 4:*** *Comparison different denoised images on CC Value*

Fig.4 explain about comparision of cross correlation values at different methods these all are altertd with different techniques

***Table 2****: Comparison of different denoising techniques for evaluating different parameters on X-Ray Image*

| | PSNR | Cross Correlation | SSIM | CNR | Information Entropy | Mean Squared Error | Elapsed Time (in sec) |
|---|---|---|---|---|---|---|---|
| Wavelet | 20.332 | 0.919 | 0.522 | 5.067 | 6.614 | 0.013 | 0.835 |
| Curvelet | 25.722 | 0.974 | 0.664 | 5.817 | 6.947 | 0.004 | 34.160 |
| NLM | 27.477 | 0.975 | 0.666 | 6.567 | 6.904 | 0.002 | 4.968 |
| CAE | 29.232 | 0.976 | 0.668 | 7.317 | 6.539 | 0.002 | 0.544 |
| LEE filter | 19.591 | 0.909 | 0.546 | 5.575 | 6.562 | 0.034 | 17.214 |
| CS3D | 26.005 | 0.980 | 0.925 | 7.665 | 6.654 | 0.006 | 11.425 |
| BM3D | 25.501 | 0.977 | 0.919 | 7.941 | 6.650 | 0.008 | 30.684 |
| PCA-LPG | 22.461 | 0.943 | 0.508 | 13.784 | 6.902 | 0.041 | 192.285 |

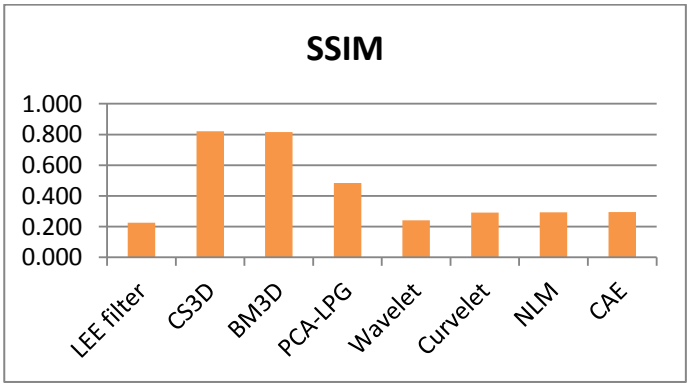


***Figure 5:*** *Comparison different denoised images on SSIM Value*

Fig.5 explains about structural simulator values this value is need be near to one this colud possible using CS3D and BM3D remaing are little fall.

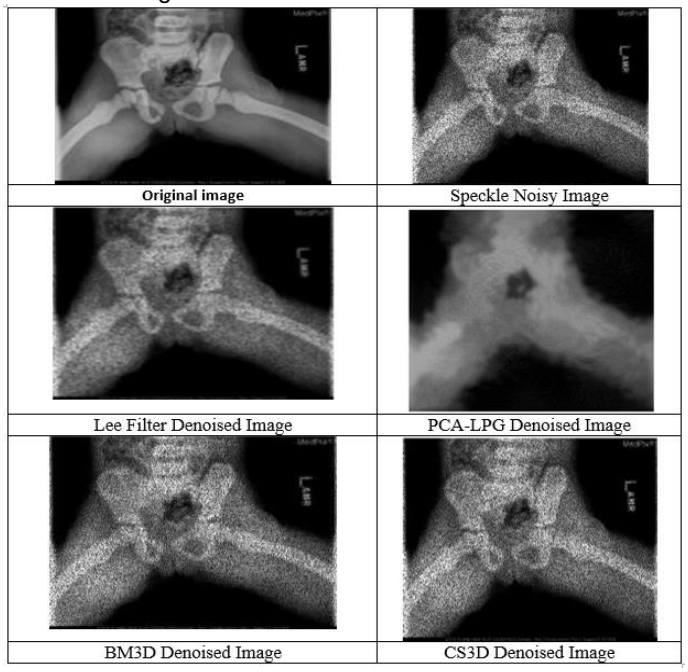


***Figure 6:*** *Comparison different denoised images*

Table 2 shows the assessment of different denoising procedures to evaluate the required quality parameters on X-Ray image. Fig.6 shows that, the auto encoder model is producing as the best PSNR (29.23) value among all the methods considered. This method denoised the medical image in a faster manner with a time of 0.544 seconds. It has once again proved as the best model by considering the parameters like PSNR, CC, CNR, IE, MSE and ET. Figure 6 shows the denoised images of different methods for a MRI image. Figure 7 to Figure 9 shows the comparison different parameters with denoising techniques. In this paper it is compared different denoised models on X-Ray and MRI images. The considered noises are speckle and rician Noises.

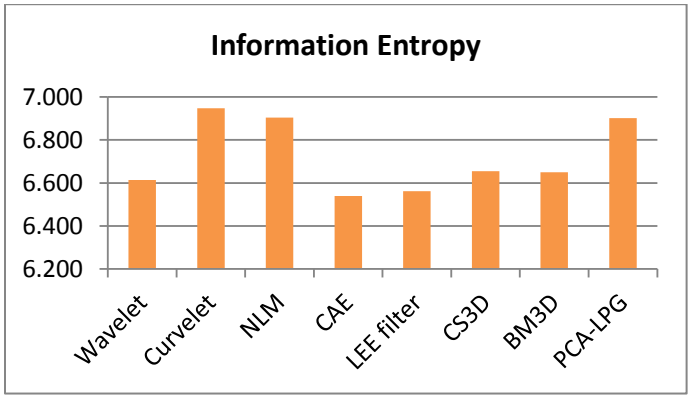


***Figure 7****: Comparison different denoised images on IE Value*

Fig.7. explains about entropy values here information is varied with modular convolutional summation in additive modules and multipliers etc

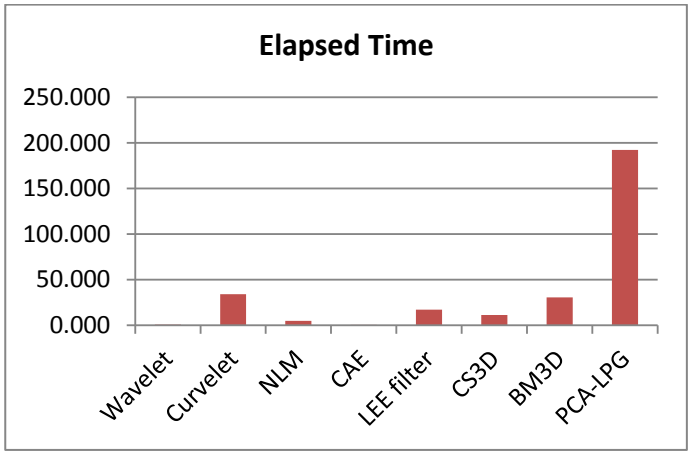


***Figure 8:*** *Comparison different denoised images on ET Value*

Fig.8 explains elapsed time calculation this can be PCA-LPG is more comparative all methods.

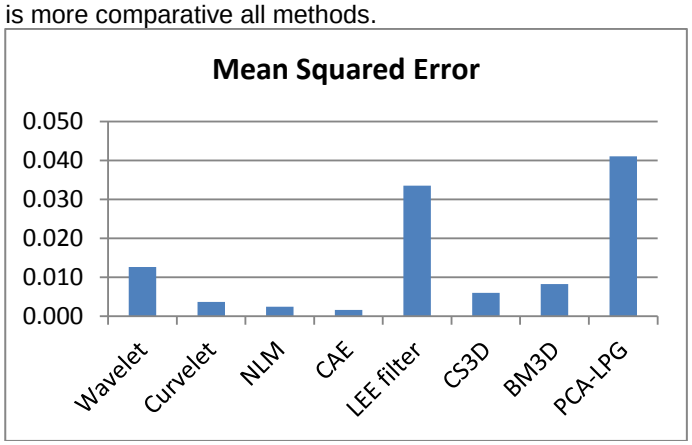


***Figure 9:*** *Comparison different denoised images on MSE Value*

Fig.9 explains MSE values of denoised images here noise error is less means that is best method last method is efficient method.

## IV. CONCLUSION

This manuscript explained a complete survey of different noises and their removal techniques in medical images. Majority of the authors considered gaussian noise in their work. The authors seriously focused on a particular type of image like MRI or CT or X-Ray, but not all the images in single paper. The major quality parameters considered in denoising of these methods are PSNR, SSIM, MSE, etc. From the rigorous analysis of these papers it is coming to one conclusion that the major research ie being done with machine learning models. The state of art techniques are considered for comparison for evaluating different quality parameters. This process can be extended to more medical images with different noise models and variance values with machine learning model for achieving better performance.

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