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# Review on: De-noising of Medical Images using hybrid filters & classifiers

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**Abstract:** *Medical imaging technology is becoming an important integral of larger number of applications such as diagnosis, research and analysis. Medical images like X-Ray, MRI, PET and CT have minute to minute information about brain and whole body. So the images should be exact and free of noise. Noise reduction shows the necessary role in medical imaging. There are various methods for removal of noise like filters, wavelets and thresholding. These techniques produced good results but still have some faults. The limitations of the previous technique are considering and analyzing this research and the new proposed technique presents Bilateral and Gabor Filter along with Neuro-Fuzzy and LDA as an efficient tool for noise reduction. Several published algorithms and each access has its assumptions, advantages, and limitations. This research presents a review of some important work in the area of image denoising. The proposed method gives more clear image with higher PSNR , MSE and improved SSIM value than the previous methods. In this research , the techniques used for proposed work are discussed. Noise removal from magnetic resonance images is important for further processing and visual analysis. In edge preservation Image De-noising using Bilateral filter is more effective. The proposed iterative bilateral filter polishes the denoising efficiency, preserves the fine structures and also reduces the bias due to noise. The visual and diagnostic nature of the image is well preserved. The quantitative analysis based on the basic metrics like peak signal-to-noise ratio and mean structural similarity index matrix display that the proposed method works better than the other recently proposed denoising methods for MRI. Thresholding neural networks (TNN) with a new class of easy nonlinearfunction have been widely used to enhance the efficiency of the denoising procedure. Our proposed work will be done using the Bilateral and Gabor Filter along with Neuro-Fuzzy and LDA.*

**Keywords:** *De-noising, LDA, Gabor filter, Neuro Fuzzy, Bilateral Filter.*

## I. INTRODUCTION

Image processing is a system of signal processing for which the input is an image such as a photograph or video frame and the output of image processing may be one of two image or the image parameters. An image is a two dimensional function of two real variables. Image= f1 (z, c) where, z and care the spatial coordinates known as pixels and f1 is the amplitude.

Image is handled in two ways:
1. Spatial domain: Spatial domain refers to the image plane itself, it is based on the straight manipulations of the pixels in the image.
2. Frequency domain: In frequency domain, image is processed in form of sub bands. All category of transformations are applied in frequency domain e.g. DWT, DFT etc.

The purpose of image processing is divided into two groups:
1. Visualization: Observe the objects that are not visible.
2. Image Sharpening and Restoration: To create a better image.

**Medical Image Processing:** Medical imaging is the approach and process used to design images of the human body for clinical purposes and diagnosis (medical procedures searching to reveal, diagnose or examine disease) or medical science. While imaging of removed organs and tissues can be executed for medical reasons, such strategies are not usually referred to as medical imaging.

**Types of medical images**

**1. Computer Tomography:** Computed Tomography (CT) scans, also called as CAT (Computed Axial Tomography) scans, produce various cross-sectional images of the body by using special X-rays and computer improvement.

**2. Magnetic Resonance Imaging:** MRI gives extremely detailed images of body, bones, organs and tissue rather than using X-rays or radiation. In lieu, it uses two natural, safe forces: magnetic fields and radio waves.

Noise: Image noise is the random difference of brightness or color information in images produced by the sensor and circuitry of a scanner or digital camera. Image noise can also make in film grain and in the unavoidable shot noise of an ideal photon detector. Image noise is generally watched as an undesirable by-product of image capture.

**Types of Noise**

**1. Amplifier Noise:** The basic model of amplifier noise is additive, Gaussian, independent at each pixel and independent of the histogram of signal. A type of constant noise is Gaussian noise that has its probability density function equal to that of the normal distribution, which is also called as the Gaussian distribution.

**2. Salt and Pepper Noise:** An image in bright region having salt-and-pepper noise will have dark pixels in brighter regions and bright pixels in dark regions.

**3. Speckle Noise:** Speckle noise in straight radar results from random variations in the return signal from an object that is no bigger than a single image-processing element.

Medical Image De-Noising: Image de-noising still remains a task for researchers because noise removal presents artifacts and causes blurring of the images. Medical images such as magnetic resonance imaging (MRI) and ultrasound images have been widely broken for extra truthful pathological changes as well as diagnosis. However, they suffer from a number of drawback and these contains: acquisition noise from the equipment, ambient noise from the environment, the existence of background tissue, other organs and anatomical influences like as body fat, and breathing signal. Therefore, noise reduction is very important, as several types of noise generated limits the effectiveness of medical image diagnosis.

**Techniques to De-Noise Medical Images:**

**1. Linear Discriminant Analysis (LDA)**

The linear Discriminant analysis (LDA) is a standard algorithm that has been successfully applied and extended to various biometric signal recognition problems.Linear Discriminant Analysis(LDA) is a techniques used for data classification and dimensionality reduction.In PCA, the figure and the location of the original data sets changes when transformed to a different spaces but LDA doesn't change the location but only tries to provide more class separability and draw decision between the given classes. In discriminant study, two scatter matrices, called *within-class* (*Sw)* and *between-class* (Sb) matrices, are defined to quantify the quality

$$S_w = \sum_{i=1}^{k} \sum_{x \in \pi_i} (x - m_i)(x - m_i)^T$$

$$S_b = \sum_{i=1}^{k} n_i (m_i - m)(m_i - m)^T$$

**Where**

$$n_i = \frac{1}{n_i} \sum_{x \in \pi_i}$$

$$m = \frac{1}{n} \sum_{i=1}^{k} \sum_{x \in \pi_i}$$

**2. Adaptive neuro fuzzy inference system (ANFIS)**

It is a kind of neural network that is built on Takagi–Sugeno fuzzy inference system. Since it integrates both neural networks and fuzzy logic principles, it has likely to capture the benefits of both in a single framework. Its inference system relates to a set of fuzzy IF–THEN rules that have learning capability to approximate nonlinear functions. Hence, ANFIS is considered to be a universal estimator.

**3. Gabor Filter**

Gabor filter is used also for feature detection to provide the quality of face images. Gabor filter works on the different angle and rotation with orientation [16]. It is better use to band pass filters with tunable orientation and radial frequency bandwidths that support low pass filter and high pass filter.

A 2-D Gabor function is defined as:

Complex:

$$g(x, y, \lambda, \theta, \chi, \sigma, \gamma) = \exp\left(-\frac{x'^2 + \gamma'^2 x'^2}{2\sigma^2}\right) \exp\left(i\left(2\pi \frac{x'}{\lambda} + \chi\right)\right)$$

[16]

Where

$$x' = x\cos\theta + y\sin\theta$$

$$y' = -x\sin\theta + y\cos\theta$$

γ sharpness along the Gabor major axis, η sharpness specifies to the Gabor minor axis. The features extracted at different orientation and in direction. In our method Gabor filter is used for blur images and remove the details and noise. Due to large standard deviation the Gabor filter works better on small face images.

**Analysis:-**

Signal-to-noise (SNR) measures are evaluations of the quality of a reconstructed image compared with an original image. The basic idea is to calculate a single number that reflects the quality of the reconstructed

image. Reconstructed images with advanced metrics are judged better. In fact, traditional SNR measures do not equate with human subjective perception. Numerous research groups are working on perceptual measures, but for now we will use the signal-to-noise measures because they are easier to calculate. Just remember that higher measures do not always mean better quality.
The real metric we will calculate is the peak signal-to-reconstructed image measure which is called PSNR. Assume we are given a source image f(i,j) that contains N by N pixels and a recreated image F(i,j) where F is reconstructed by decoding the encoded version of f(i,j). Error metrics are calculated on the luminance signal only so the pixel values f(i,j) range between black (0) and white (255).
First you compute the mean squared error (MSE) of the reconstructed image as follows

$$MSE = \frac{\sum[f(i,j) - F(i,j)]^2}{N^2}$$

All the pixels of an image are subtracted. The square root of MSE is root mean squared error (RMSE).PSNR i.e., Peak Signal to noise ratio in decibels (dB) is calculated by using

$$PSNR = 20\ log_{10}\left(\frac{255}{RMSE}\right)$$

Typical PSNR values range between 20 and 40. They are typically reported to two decimal points (e.g., 25.47). The real value is not important, but the comparison between two values for different reconstructed images gives one measure of quality. The MPEG committee used an easy threshold of 0.5 dB PSNR to decide whether to incorporate a coding optimization because they supposed that an improvement of that magnitude would be visible.

$$E(i,j) = 2[f(i,j) - F(i,j)] + 128$$

Some explanations of PSNR use 2552/MSE rather than 255/RMSE. Either formulation will work because we are interested in the relation comparison, not the absolute values. For our assignments we will use the definition given above.
The other important technique for showing errors is to construct an error image which shows the pixel-by-pixel errors. The simplest computation of this image is to generate an image by taking the difference between the reconstructed and original pixels. These images are tough to see because zero difference is black and most errors are small numbers which are shades of black. The typical structure of the error image multiples the difference by a constant to increase the visible difference and converts the entire image to a gray level. The computation is
You can regulate the constant (2) or the translation (128) to change the image. Some people use white (255) to signify no error and variation from white as an error which means that darker pixels are bigger errors.

# II. LITERATURE SURVEY

A lot of research has been done in the field of image de-noising still the area of image de-noising, especially for the medical images remains to be an active research.

Ms S. Hyder Ali et al. [10] proposed a new type of thresholding neural networks (TNN) with a new class of smooth non-linear thresholding functions being the activation function. Unlike the standard soft thresholding. A lot of research has been done in the field of image de-noising still the area of image de-noising, especially for the medical images remains to be an active research. Functions the new non linear thresholding functions were infinitely differentiable. The TNN based space-scale adaptive noise reduction algorithm exhibited much superior then the soft thresholding. TNN can be further used to produce over effective learning algorithms for various applications.

Rajesh Kumar Rai et al. [12] conducted a study on various thresholding techniques such as Sure Shrink, Visu Shrink and Bayes Shrink and determine the best one for image de-noising .Wavelet de-noising attempts to remove the noise present in the signal while preserving the signal characteristics, regardless of its frequency content. It involves three steps: a linear forward wavelet transform, nonlinear thresholding step and a linear inverse wavelet transform. Wavelet thresholding is a signal estimation technique that exploits the capabilities of wavelet transform for signal de-noising. It removes noise by killing coefficients that are insignificant relative to some threshold, and turns out to be simple and effective, depends heavily on the choice of a thresholding parameter and the choice of this threshold determines, to a great extent the efficiency of de-noising.

S.Zhang et al. [5] presented a neural network based de-noising method implemented in the wavelet transform domain. In this method, a noisy image is first wavelet transformed into four sub bands, then a trained layered neural network is applied to each sub band to generate noise-removed wavelet coefficients from their noisy ones. The de-noised image is thereafter obtained through the inverse transform on the noise-removed wavelet coefficients. Simulation results demonstrate that this method is very efficient in removing the noise. Compared with other methods performed in wavelet domain, it requires no a priori knowledge about the noise and need only one level of signal decomposition to obtain very good de-noising results.

SME Sahraeian et al. [6] proposed a new method based on the wavelet transform. in this method an improved TNN were introduced by utilizing a new class of smooth non linear thresholding functions as the activation function. This approach introduced best threshold in the sense of minimum MSE mean square error. TNN obtained thresholds were employed using a cycle spinning based technique to reduce the image artifacts. This method outperforms other established wavelet denoising techniques in terms of PSNR and visual quality.

Yongjian Chen et al. [2] proposed a novel filter by applying back propagation neural network (BPNN) ensemble where the noisy signal and the reference one are the same. The neural network(NN) ensemble filter not only well reduces additive and multiplicative white noise inside signals, but also preserves signals' characteristics. It is proved that while power of noise is larger, the reduction of noise using NN ensemble filter is better than the improved ε nonlinear filter and single NN filter, and compared with the improved ε nonlinear filter, degradation of the capability for reduction of noise by NN ensemble due to the increase of noise power is much suppressed. Furthermore, it presented the relationship between noise reduction and bandwidth of noises. The performance of the NN ensemble filter is demonstrated in computer simulations and actual electroencephalogram (EEG) signals processing.

Masakuni Oshiro et al. [13] conducted study on a Multi-Layer Back-Propagation Neural Networks (MLBPNNs) with the Epanechnikov fuzzy function and proposed to reduce the speckle, and while at the same time, enhance the lesion boundaries of the Ultra Sound (US) image. The main goal of the proposed method is to improve the quality of US image so as to improve the quality of the humans interpretation and the computer systems auto-edge detection. In order to automatically detect the lesion boundary by a computer system, an edge enhancement is required. Evaluating the simulation results by Peak Signal to Noise Ratio (PSNR), Normalized Mean Square Error (NMSE), Detail Variance (DV), and Background Variance (BV), the proposed method demonstrates an increased performance of reducing the speckle and enhancing the edge. The proposed method has higher PSNR than conventional methods and can remove the speckle sufficiently, so that tumour boundaries of real US breast tumor image could be preserved and detected.

Tanzila SABA et al. [11] presented an novel approach based on the Cellular neural networks(CNN) to de-noise an image even in the presence of very high noise. Image De-noising was devised as a regression problem between the noise and signals solved using CNN. The noises are detected with surrounding information and removed. The proposed algorithm exhibited promising results from qualitative and quantitative point of view. Experimental results of the proposed algorithm exhibit high performance in PSNR and visual effects in color image even in the presence of high ratio of the noise.

Lysaker et al. "Noise removal using fourth-order partial differential equation with applications to medical magnetic resonance images in space and time," [8] introduced a new method for image smoothing based on a fourth-order PDE model. The method was tested on a broad range of real medical magnetic resonance images, both in space and time, as well as on nonmedical synthesized test images. Their algorithm demonstrates good noise suppression without destruction of important anatomical or functional detail, even at poor signal-to-noise ratio.

Aja-Fernández et al. "Noise and signal estimation in magnitude MRI and Rician distributed images: a LMMSE approach" [9] proposed a new method for noise filtering in images that follow a Rician model-with particular attention to magnetic resonance imaging-is proposed. To that end, they have derived a (novel) closed-form solution of the linear minimum mean square error (LMMSE) estimator for this distribution. Additionally, a set of methods that automatically estimate the noise power are developed. These methods use information of the sample distribution of local statistics of the image, such as the local variance, the local mean, and the local mean square value. Accordingly, the dynamic estimation of noise leads to a recursive version of the LMMSE, which shows a good performance in both noise cleaning and feature preservation. This paper also included the derivation of the probability density function of several local sample statistics for the Rayleigh and Rician model, upon which the estimators are built.

## III. PROPOSED WORK

1. Design and development of an improved algorithm for medical image de-noising using Bilateral and Gabor Filter, neuro-fuzzy and LDA.
2. To remove the noise and enhance the medical image.
3. Performance analysis using different parameters like MSE, SSIM and PSNR.

# IV. CONCLUSION

In this research paper, we are going to implement gabor filter, neuro-fuzzy and LDA as a tool for medical image de-noising. The Bilateral filter is used to remove the rician noise. Bilateral filter preserving the edges and make a fine structure of an image. The proposed approach and de-noising medical image using Linear Discriminant Analysis exhibit outcomes of noise decrease and image quality improvements, with different noise level is suitable for image de-noising. The previous work or result is compare with proposed work and it shows improvement on the basis of PSNR, MSE and Mean SSIM.

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