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HRCT IMAGE DENOISING USING WAVELET TRANSFORM AND BASIC FILTERING.

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***Abstract*:** Eliminating noise from digital image is considered as an essential problem in image processing, for example in medical images as the noise present in the image will degrade the image quality which cannot be further classified with high accuracy. Hence, it is required to provide the images without any noises for better classification. Since the selection of denoising method to generate the quality image depends on the type of noise present in the image, it is suggested to find the best method to eliminate the noise as far as possible by preserving the edges. This project presents the various denoising techniques such as Bayes Shrink and Visu Shrink wavelet transform, non-local mean filter and median filter to remove the noises added through Gaussian, Speckle and salt and pepper noise in the x-ray images and the MRI images. The experiment shows that wavelet transform method performance is good for removing Gaussian noise and median filter performance is good to remove speckle and salt and pepper noise. The results are measured through visually and through the quality measure using Peak Signal to Noise Ratio (PSNR). By using this project we can improve the appearance of the X- ray images by removing the various noises present in the image. It will be very useful in analyzing the x- ray images**.**

Keywords: *Noise, Filter, Wavelets, Denoising , Guassian noise, speckle noise, Salt and pepper noise, Mean filter, Median filter.*

I.INTRODUCTION

Since over the last few years, medical imaging and diagnostic techniques have been developing rapidly and have played an essential role in clinical analysis and decease diagnosis. Medical images are playing an important role to capture the internal human body parts such as brain, lung, heart etc.. Usually, the digital images are contaminated by noise during transmission and acquisition which reduces the quality of an image and it is to be removed before using the images for further analysis. In the case of medical images such as x-rays, MRI (Magnetic Resonance Imaging), CT (Computed Tomography), etc.., the noise present in the images can reduce the accuracy of image processing operations such as object recognition and classification to detect the decease. Hence, it is essential to restore the original image by removing the noise present in the images as far as possible. Hence image denoising is an important task to be done to obtain the good quality images by preserving the important features such as edges, corners which in turn will be used for better classification.

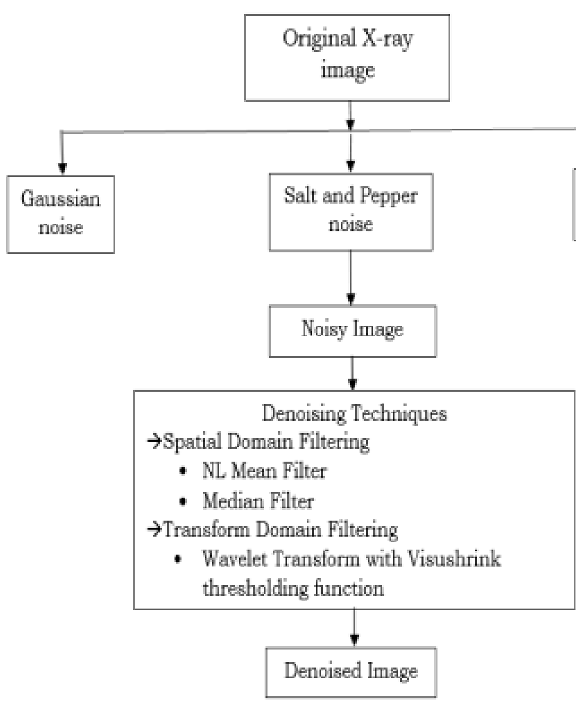
Image denoising is a quality enhancement method in image processing, where the noise is removed from the noisy image and recovers the original image by retaining its quality, which gets corrupted during its acquisition or transmission. In medical field MRI, CT scan, ultrasound, x-ray etc. instruments are used for image acquisition in which noise can be generated . When noise is present in image degrades the objective quality and lowers down the clarity of low contrast object .Denoising is important in medical imaging operations to recover the anatomical details that may be suppressed in the data due to the noise .Bio-medical images are normally - corrupted with noise; which degrade the useful detail of medical images which may affect the diagnosis. As edges is most essential aspect for bio-medical images, therefore the denoising needs to be balanced with edge preservation. The main problem in bio-medical imaging system is the adoption of the images obtained due to imperfect addition and communication errors. Thus, all medical imaging devices need denoising technique to enhance the image quality which will help the doctors and medical experts for proper diagnosis.

II.PROPOSED METHOD

In this paper, we proposed various denoising techniques such as spatial domain filtering(NL-means and median) and transform domain filtering(wavelet transform) to remove the noise added in the chest x-ray images and MR FLAIR modality images through Gaussian, speckle noise and salt and pepper noise.

I. A sample image from chest x-ray image data set is added with Gaussian, Speckle and Salt and Pepper noise with the sigma value as 0.15, 0.15 and 0.10 respectively.
II. A sample image from brain MRI image data set is added with Gaussian, Speckle and Salt and Pepper noise with the sigma value as 0.1, 0.15 and 0.10 respectively.
III. Then the noisy images are denoised using NL-means, median filters and wavelet transform methods with two thresholding functions such as VisuShrink.

III.BLOCK DIAGRAM



IV.NOISE

Noise is an unacceptable signal that changes the property and performance of the signal. Normally images are corrupted with noise likely Gaussian, Salt & pepper and speckle distribution.

4.1 GAUSSIAN NOISE

Gaussian noise, named after Carl Friedrich Gauss, is a term from signal processing theory denoting a kind of signal noise that has a probability density function (pdf) equal to that of the normal distribution (which is also known as the Gaussian distribution). In other words, the values that the noise can take are Gaussian-distributed. A special case is White Gaussian noise, in which the values at any pair of times are identically distributed and statistically independent (and hence uncorrelated). In communication channel testing and modelling, Gaussian noise is used as additive white noise to generate additive white Gaussian noise. In telecommunications and computer networking, communication channels can be affected by wideband Gaussian noise coming from many natural sources, such as the thermal vibrations of atoms in conductors (referred to as thermal noise or Johnson–Nyquist noise), shot noise, black-body radiation from the earth and other warm objects, and from celestial sources such as the Sun. Gaussian noise is arising in electronic components which is normally known as electronic noise. It is the demographical noise to that of the original distribution. The noise is independent of each pixel as well as signal intensity and is preservative in nature . The probability density function 'g' of a Gaussian random variable 'u' is given by:

g(u)=$1/\sigma\sqrt{2}\Pi e-(z-\mu)2\ /\ 2\sigma^2$

P(Z)=$1/\sqrt{2\pi\sigma e}e^{-(z-u)^2/2\sigma^2}$

Where:
z: Grey level
μ : Mean or average value
σ: Standard deviation

The sample image is added with Gaussian noise with the sigma value as 0.15 to produce a noisy image. It is an additive noise in which each pixel is the sum of Gaussian distributed random noise value and true pixel values . Where z is the gray level, μ is a mean value, σ is a standard deviation and σ2 is the variance of g. The noise is generated by multiplying the sigma with the standard Gaussian distribution of mean 0 and variance 1 and then the noise is added with original image to produce a noisy image.

4.2 SPECKLE NOISE

Speckle is a granular interference that inherently exists in and degrades the quality of the active radar, synthetic aperture radar (SAR), medical ultrasound and optical coherence tomography images. The vast majority of surfaces, synthetic or natural, are extremely rough on the scale of the wavelength. Images obtained from these surfaces by coherent imaging systems such as laser, SAR, and ultrasound suffer from a common interference phenomenon called speckle. The origin of this phenomenon is seen if we model our reflectivity function as an array of scatterers. Because of the finite resolution, at any time we are receiving from a distribution of scatterers within the resolution cell. These scattered signals add coherently; that is, they add constructively and destructively depending on the relative phases of each scattered waveform. Speckle results from these patterns of constructive and destructive interference shown as bright and dark dots in the image Although commonly referred to as "speckle noise", speckle is not noise in its generally understood sense of an unwanted modification to a desired signal. Rather, it is the signal itself that fluctuates, because the scatterers are not identical for each cell, and the signal is highly sensitive to small variations in scatterers. Another type of noise which corrupts the quality of the active radar, medical images and optical coherence tomography images is known as speckle noise .

The major cause of speckle noise generation is the effect of environmental conditions during imaging sensor in the process of image transmission. Speckle noise follows gamma distribution which is shown below:

A(x,y)= f(x,y)*N(x,y)+N1(x,y)

Where A(p,q) denotes observed image, N(p,q) and N1(p,q)indicate multiplicative, additive components. It has gamma distribution as probability density function, and it is given as:

$$F(G)=\frac{g^{\alpha-1}e^{\frac{g}{\alpha}}}{\alpha-1!\alpha^{\alpha}}$$

4.3 SALT AND PEPPER NOISE:

Salt-and-pepper noise is a form of noise sometimes seen on images. It is also known as impulse noise. This noise can be caused by sharp and sudden disturbances in the image signal. It presents itself as sparsely occurring white and black pixels. An effective noise reduction method for this type of noise is a median filter or a morphological filter. For reducing either salt noise or pepper noise, but not both, a contraharmonic mean filter can be effective. Salt and Pepper noise is appeared due to the error in data transmission and the error in analog to digital converter. It produces white and black spot in the image by taking either maximum value (i.e.255) or the minimum value (i.e.0) which can reduce the quality of an image. The PDF of this noise is given by:

$$P(z)=f(x)=\begin{cases} pa, & for\ z=a \\ pb, & for\ z=b \\ 0 & otherwise \end{cases}$$

V.FILTERS

Filtering is a technique for modifying or enhancing an image. For example, you can filter an image to emphasize certain features or remove other features. Image processing operations implemented with filtering include smoothing, sharpening, and edge enhancement. It is necessary step used before the image detail is analyzed. It is important to use a better denoising method to recover the image from the data corruption.

5.1 NON-LOCAL MEAN FILTER

Non-local means is an algorithm in image processing for image denoising. Unlike "local mean" filters, which take the mean value of a group of pixels surrounding a target pixel to smooth the image, non-local means filtering takes a mean of all pixels in the image, weighted by how similar these pixels are to the target pixel. This results in much greater post-filtering clarity, and less loss of detail in the image compared with local mean algorithms. If compared with other well-known denoising techniques, non-local means adds "method noise" (i.e. error in the denoising process) which looks more like white noise, which is desirable because it is typically less disturbing in the denoised product. Recently non-local means has been extended to other image processing applications such as deinterlacing, view interpolation, and depth maps regularization Non-Local Mean filter estimates the value of a pixel based on the weighted average of all pixels in the image but the family of weights depend on the similarity between the pixels which means the weighted average is calculated only for the pixels that are similar to the current pixel. It has the following representation:

$$NLM[v](i)=\sum_{J\in I} w(i,j)\,V(j)$$

Where NLM[v] (i) is a estimated value on the noisy image v at position i and w(i, j) is the set of weights which is calculated based on the correspondence ofthe pixels i and j.

5.2 MEDIAN FILTER

The median filter is a non-linear digital filtering technique, often used to remove noise from an image or signal. Such noise reduction is a typical pre- processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise (but see the discussion below), also having applications in signal processing. Median filter is a non-linear spatial filter in which the center pixel value is changed by the median of the intensity values in the adjacent pixels to achieve the smoothness in an image. It provides less blurring for an image for some types of random noise . The two-dimensional median filter is given by the equation:

f(x,y) = median{g(p,t} and (p,t) E Pxy

Where pxy denotes the m x n sub image of a noisy input image ‘g’ at the coordinate (x, y) and f(x, y) is a result of median filter at the coordinate (x, y).

5.3 WAVELET TRANSFORMS

In Wavelet based denoising scheme, the signal f (k) is first decomposed using the DWT into the various wavelet coefficients. By using the thresholding function these coefficients are thresholded and then apply the inverse transform to these coefficients to achieve a denoised image. In this paper, VisuShrink and BayesShrink thresholding methods are implemented using three levels of decomposition.

A) VISUSHRINK

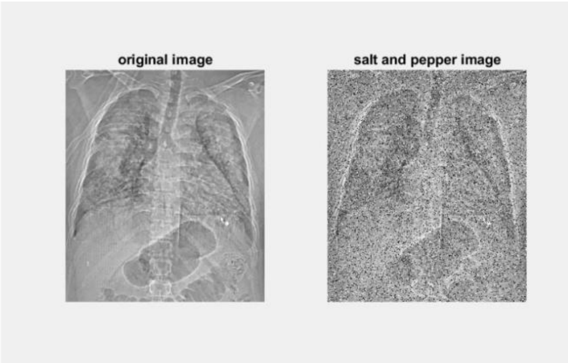
VisuShrink method is proposed by Dohono and Johnstone . It is a universal thresholding, non-adaptive method in which the threshold is calculated by the following equation:

$Tv=\sigma\sqrt{2}\log K$

Where σ is noise variance and K is number of pixels of the image. For denoising the images, it is found to produce a smooth estimate as it has high threshold due to the dependency on the number of pixels in the image . It can be defined as σ√2log I where σ is the noise variance and I is the number of pixels in the image.The maximum of any I values can be given by N(0,σ 2) with the probability approaching 1 as number of pixels in the given image increases. Therefore if it has high probability, a pure noise signal is calculated
as being identically zero.

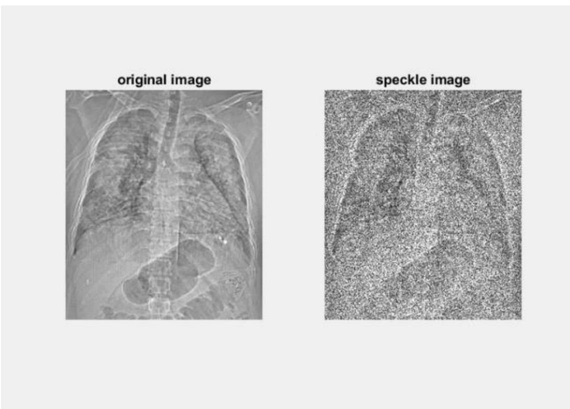
However, for denoising images, Visushrink is found to yield an overly smoothed estimate as seen. This is because the universal threshold (UT) is derived under the constraint that with high probability the estimate should be at least as smooth as the signal. The universal threshold is high for large values of I,
killing many signal coefficients along with the noise. Thus, the threshold does not perform well at discontinuities in the signal.

VI.RESULT AND DISCUSSIONS

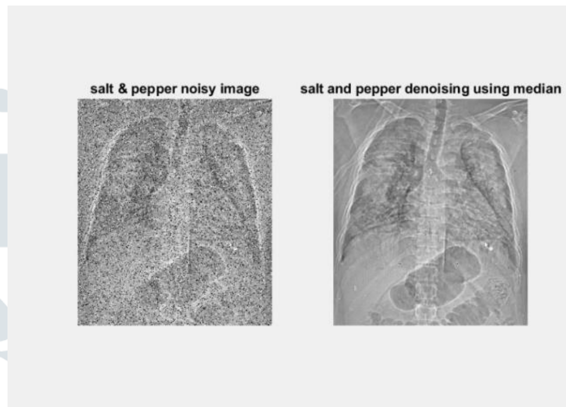


Adding of salt and pepper noise to original image

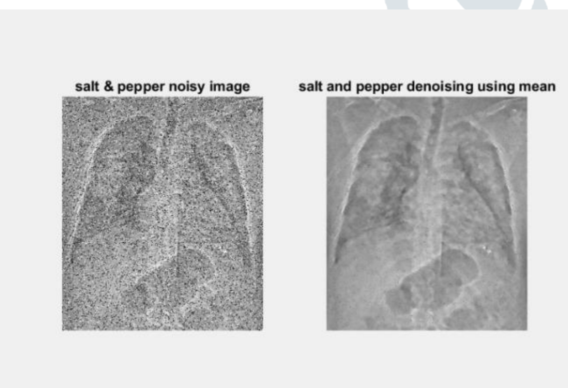
Adding gaussian noise to original image:



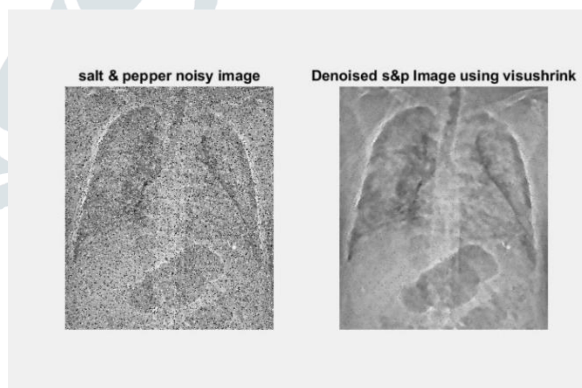
adding speckle noise to original image



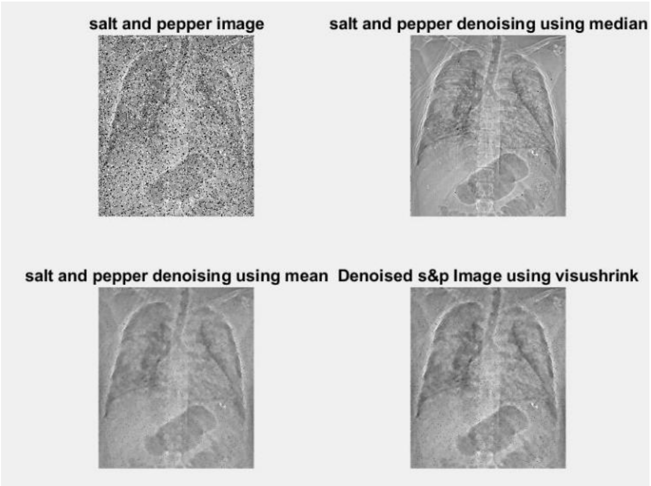
denoising the salt and pepper noisy image using median filter



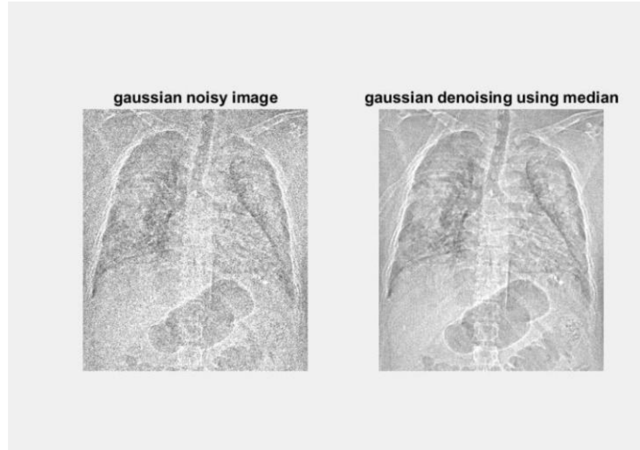
denoising the salt and pepper noisy image using mean filter



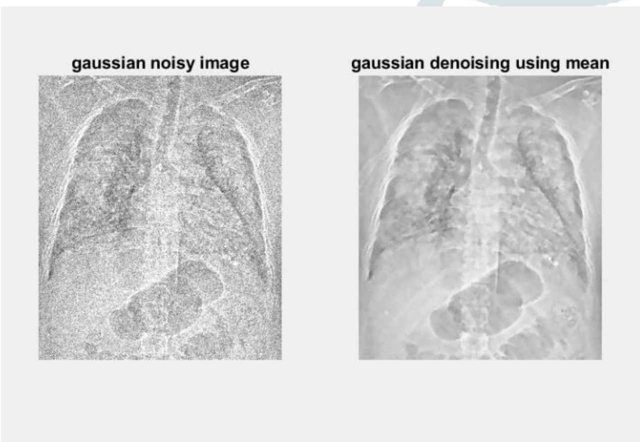
denoising the salt and pepper noisy image using wavelet transform



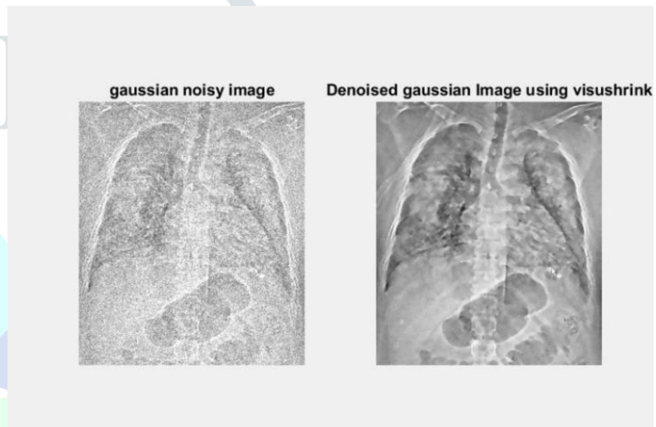
overall result of denoising salt and pepper noisy image



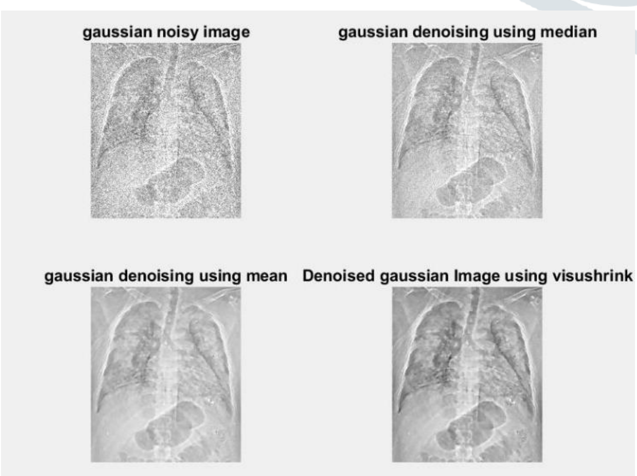
denoising the gaussian noisy image using median filter



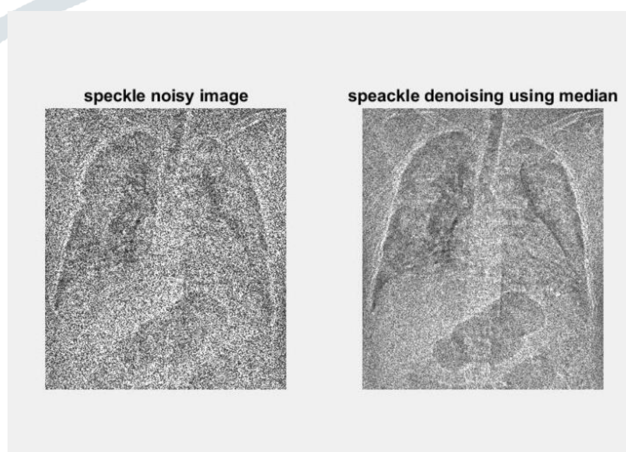
denoising the gaussian noisy image using mean filter



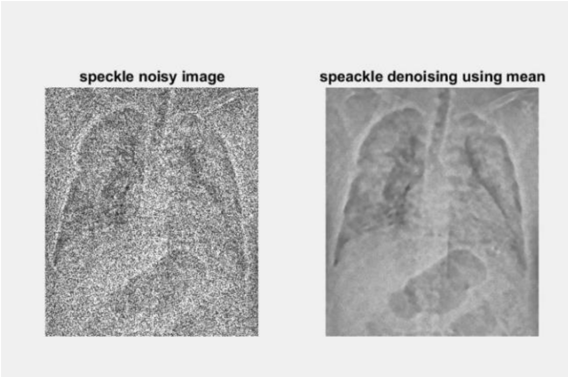
denoising the gaussian noisy image using wavelet transform



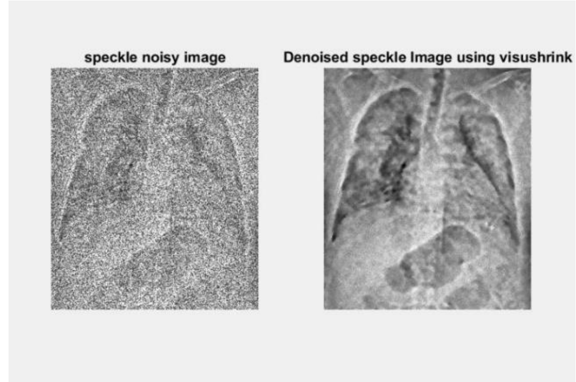
overall result of denoising gaussian noisy image



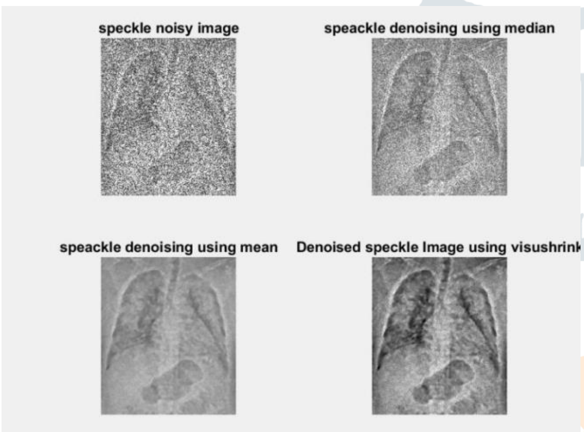
denoising the speckle noisy image using median filter



denoising the speckle noisy image using mean filter



denoising the speckle noisy image using wavelet transform



overall result of denoising speckle noisy image

VII.MERITS AND DEMERITS

MERITS

- Non local mean filter removes the noise and cleans the edges without losing too many fine structure and details.
- Non local mean filter removes noise by exploiting redundant information present in the image.
- Spatial filters are easy to implement and remove noise by reducing variance in an image.
- Wavelets define local features as spectrally or spatially that enable it to filter noise by preserving the fine details and edges of the image.

DEMERITS

- Computationally expensive because of its complexity in evaluating the pixel weights.
- Once the system is damaged the image will be lost.
- In wavelet it is problematic to check the threshold and scale of the wavelet and it may introduce artifacts. It cannot give good performance with smooth edges.

VIII.CONCLUSION

In this study, different denoising methods are analyzed to denoise the image from the chest X-ray images and HRCT images for better classification. The denoised images are evaluated using PSNR. For speckle noise, VisuShrink wavelet transform gives the high PSNR value and for salt and pepper noise

median filter gives the better-quality image with high PSNR value. In the case of brain MRI images, for Gaussian noise, VisuShrink wavelet transform removes the noise in a better way. For Speckle and salt and pepper noise, Median filter gives the better-quality image with high PSNR value. From the results, it is observed that Wavelet transform methods are good to remove Gaussian noise and median filter performs good to remove Speckle and salt and pepper noise. In the Future work, the denoised images will be used for segmentation and better classification Only the high frequency information is de-noised using traditional methods and the low frequency information are preserved to recovery the original image. In this method, the image quality is improved in terms of detail and edge, and the noise was removed. Using traditional denoising methods with the decomposition technique gives better result as compare to the traditional methods only. The proposed algorithm concludes that the method has better denoising effect on medical images.

IX.FUTURE SCOPE

Image denoising is an active field of research and every now and there are amazing architectures being developed to denoise the images. Recently, researchers are using GAN(Generative Adversarial Networks)s to denoise images, which has proven to give some amazing results. A good GAN

architecture will definitely improve the denoising future.

X.ACKNOWLEDGEMENT

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