ANALYSIS OF MRI DENOISING USING FILTERING APPROACH

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ABSTRACT

Magnetic Resonance (MR) images are interrupted with a noise known as Rician noise that is actually a white Gaussian noise. This noise is generative in nature as it is Signal dependent in nature. This noise significantly declines the contrast quality of these MR images. It has been observed by many analysts, many complications have been faced by them to extract the important information from images for correct diagnosis of a disease. Various analysts have suggested various spatial and transform based techniques for the denoising of MR images. The main aim of our research is to preserve important details such as texture information, thin edges, and structural content of important details when denoising rule is applied for Rician noise corrupted images. The research done here in which we examine many spatial-based techniques, Spatial domain filtering techniques use local data redundancy to withdraw noise from images and here we have used edge detection techniques to acknowledge edges in the image. These techniques used here have ability not only to maintain the edges of fine shape but also to perform a noticing denoising. All the demonestrations have been performed on standard clinical data sets and efficiency of the different methods is measured by different qualitative and quantitative measures.

Keywords: Noise, MRI, Denoising, Filters, Domain, Rician noise.

1.Introduction:

Medical imaging is creating visual presentation of the interior of a body for clinical analysis and medical diagnosis. Medical Images can be obtained by various devices like X-rays, CT-scans, ultrasound, optical coherence tomography (OCT) and magnetic resonance imaging (MRI). Images obtained by these devices are affected with different types of noise and artifacts. Noise reduces the visual quality of the images, so it is a challenging task to diagnose disease in a patient with accuracy. MRI is a technique used to provide accurate details of tissues and organs in a patient. It shows pathological and psychological aspects of tissues. It is unique in imaging techniques as its major advantage is that it can characterize and differentiate tissues based on their physical and biochemical aspects. It can create sectional images of equal resolution in any plane without moving a person. Its capability to take image in various planes makes it unique and is very useful in surgical processes. It also has some drawbacks of spatial resolution and it takes longer time than usual to obtain an image. The flexibility property makes it possible to be applicable on different clinical parts. During the process of acquisition its visual quality is corrupted by the addition of noise. While using the single channel signal acquisition, original signal is reproduced by applying inverse DFT on raw data value. The real and imaginary values obtained are determined from their respective channels. Additive white noise changes all its orthogonal channels. Magnitude of MR images is determined as square root of square of two independent variables. When we are using multiple channel signal acquisition, MR images are reproduced by combining complex and non-central chi distribution like NLM, bilateral filters etc.

2. LITERATURE SURVEY

There has been a lot of research in the field of noise removal in Medical Imaging but it has been always a hot area of research for the researches. In this section we have summarized different researches done by different analysts in the field of Medical Imaging. Some of the relevant work includes the Non Linear techniques of denoising in MR images. A lot of research has been done from past few years on non-linear filters. Still it remains a challenge for the analysts to develop more productive techniques. So we have mentioned some related work to non-linear filter in this chapter.

2.1 Related Work

There are many denoising techniques that have been implemented to enhance visual quality of image. A survey of different noise removal techniques has been unveiled by **Mohan et al. [1]**. This survey conducted mentions various noise removal techniques that are applied to eliminate noise from MR images which are included as under:

McVeigh et al. [2] put forward two linear filters which are spatial and temporal filters .Spatial filters are applied to reduce the variance of image. But it has been observed by the analysts that they blur sharp edges. SNR remains unchanged because it diminishes both the noise and signal as well. Temporal filter are applied to diminish aliasing artifacts. The filter has been selected in accordance to sampling interval. Small sample interval erases edge details. Large sample interval establishes an additional noise to filtered image.

Perona and Malik [3] put forward a non-linear filter for multi-scale smoothing and edge detection called as anisotropic diffusion filter. This filter protects the edge details notably while preserving important details about the image. Smoothening is developed as a diffusive procedure that is to be interrupted at edge boundaries by the use of local gradient. Laplacian is applied to recognize edges.

Sijbers et al. [4]put forward a technique merged with anisotropic diffusion to erase Rician noise from the images that are obtained using MR. Other spatial filtering techniques did not build an effective out come because they were not keeping in mind the bias into MR data. It has been observed that spatial filtering methods give better out comes for Gaussian noise rather than Rician noise. After this new technique was put forward by the researchers that subsumed the Rician bias into images for filtering. This method has developed notable out comes for MR image denoising.

Murase et al. **[5]** proposed anisotropic method for calculating cerebral perfusion. The quantification of cerebral perfusion has supremacy that it can have a better spatial resolution than other domain. The use of an intravascular contrast agent in a deal with dynamic susceptibility contrast-enhanced MRI for calculation of cerebral perfusion leads to efficient out comes.

Tang et al.[6] put forward an enhanced anisotropic diffusion filter that has taken help of adaptive threshold selection and a new gradient computation technique that is completely based on the average of four direction gradients for reducing Rician noise from the images obtained by using MR.

Krissian and Aja-Fernandez [7] put foward noise driven anisotropic diffusion filter to erase Rician noise from the images obtained by using MR. The filter is totally relied on assesment of the standard deviation of the noise. The filter merges local linear minimum mean square error filter and partial differential equations for the images of MRI. Filter parameter are taken from the approximate noise naturally. The partial derivation equation of filter is expanded to a new matrix diffusion filter. The filter allows a coherent diffusion based on the local structure of the image and its related standard deviation. Because of using local image structure it has given better out come in saving contours.

Zhang and Ma [8] put forward a technique based on anisotropic coupled diffusion equations for the image denoising that are obtained by using MR. The coupled equations are made of different terms. One term includes anisotropic diffusion term that dominates the diffusion direction. Fidelity term guarantees that the filtered image is not far from the first image. Diffusion gene dominates diffusion speed of each pixel and joins it with another diffusion equation. The filter provides good noise removal and also retains structural details.

You and Kavah[9] put forward a technique that is using fourth-order partial differential equations (PDEs) for erasing noise from the images obtained by using MR. These PDEs try to find minimal cost functional that is absolute value of Laplacian image. Laplacian generates zero result in area of persistent intensity neighborhood. But the PDEs obtained can also erase the noise and save information in planar area of the images. So, the method gives better outcome than the other anisotropic diffusion filter. This procedure removes the blocky effect generated by anisotropic diffusion filter. These PDEs did not mask speckles from the images obtained by the MR. These Speckles can be ejected with the help of median filter.

Lu et al. [10] proposes adaptive fourth order partial differential equations to evacuate noise from MR images. The method used can adjust the diffusion speed as per the local structure of the image and saves more information in the images obtained by the MR. The diffusion speed is maintained with boundary detection function and the use of sign of second order derivative. The diffusion speed is unrushed at edges while rushed in constant area intensity levels.

Lysaker et al. [11] proposed the fourth-order partial differential equations for denoising the images obtained by the MR in space and time. The method used provides good noise removal technique at low SNR.

Rajan et al. [12] put forward a method that takes the help ofcomplex diffusion equations for the noise removal from the images obtained by the MR. The procedure used here combines the standard diffusion equation with free Schrodinger equations.

Samsnov and Johnson [13] put forward a nonlinear diffusion procedure for removing noise from the images obtained by MR. The method used here the priori details about the noise level spatial distribution that can be very helpful for local adjustment of anisotropic diffusion filter. The filter used here produces better out comes for both image error reduction and SNR. The filter used here also improves the segmentation of images using the MR technique.

Buades at el. [14] put forward the non-local means filter to erase the effect of noise from the images using the MR technique. After this method that is relied on local pixels within a small neighborhood to erase noise from the images using MR. The filters used here protect large structures but here it is important to consider the tiny structures as noise and removed them using the while filtering technique. The NLM filter exploits the redundancy of information that is in the range of image to remove to noise. The retrieved intensity value of the voxel is observed as the weighted average of all voxel intensities within the images. But NLM has drawback that it is computationally inefficient. There is another disadvantage of NLM filter that it can't eliminate bias from the images obtained by the technique of MR. so many other variations of NLM filter has been put forward to eliminate bias from the images of MR .

Hu et al. [15] put forward a technique for denoising MR images by mixing the NLM filter with discrete cosine transformation. The method used here the weights are calculated in the DCT subspace. DCT has low data correlation and has a high energy compaction. Because of this, the filter performs better than original NLM filter.

2.2 Inferences Drawn from Literature Survey

The literature survey conducted, we have studied different denoising techniques and their similar results are checked and in this survey it has been studied the different Rician noise estimation methods. There are various denoising approaches available in past to eliminate noise from the images obtained by MR. In this filtering technique, linear filters which includes spatial and temporal filters eliminates high frequency noise at the cost of blurring edges and fine details. The problem is to deal with the non-linear filter and anisotropic diffusion filter (ADF). ADF is iterative in obsevation that causes stability problems. The issue is then solved by a non-iterative bilateral filter.We would merge different noise removal procedures with Rician noise estimation methods to get a better outcome that is different from the traditional methods given in literature survey.

3.EXPERIMENTAL ANALYSIS AND RESULTS

3.1 Experimental work

The main aim of this project is to implement some noise reduction algorithms on simulated MRI.

3.2 Platform for implementation

Algorithms that we have used in our work have been implemented on visual studio 2010 using c/c++language on a PC with 2.30 GHz Intel Core i3-2350M CPU with 4 GB RAM under windows 8 professional 64-bit environment.

3.3 Database

The algorithms used here are conducted on two standard clinically databases, Brain Web and Internet Brain Segmentation Repository (IBSR) that gives us with simulated MRI.

3.4 Implementation

3.4.1 Mean filter

Mean filters or average filter are implemented here for the blurring of edges, removing of small information from an image and bridging of tiny gaps in lines or curves. Noise removal can be achieved by blurring.

$\frac{1}{9}\times$

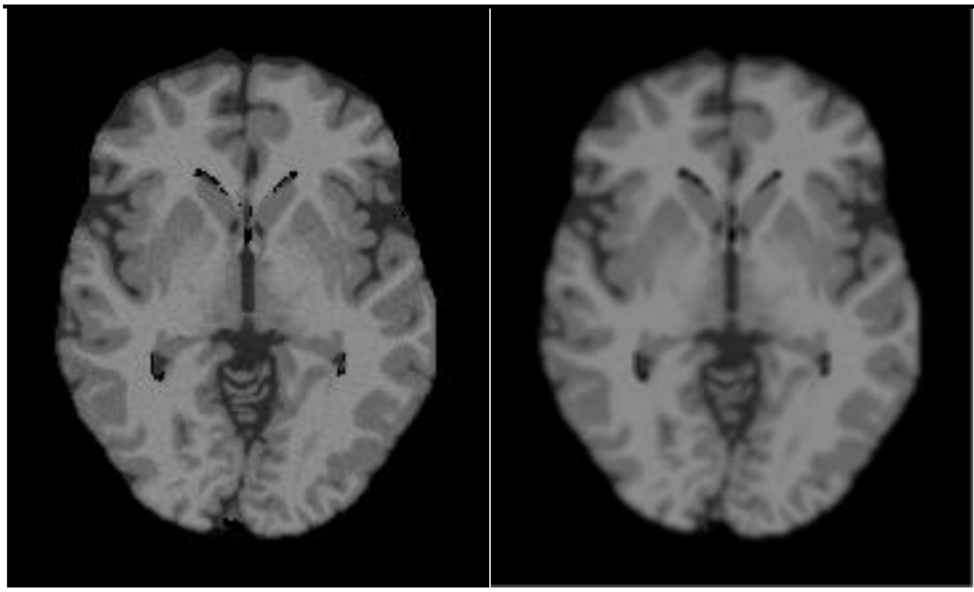
1	1	1
1	1	1
1	1	1

Fig 1.

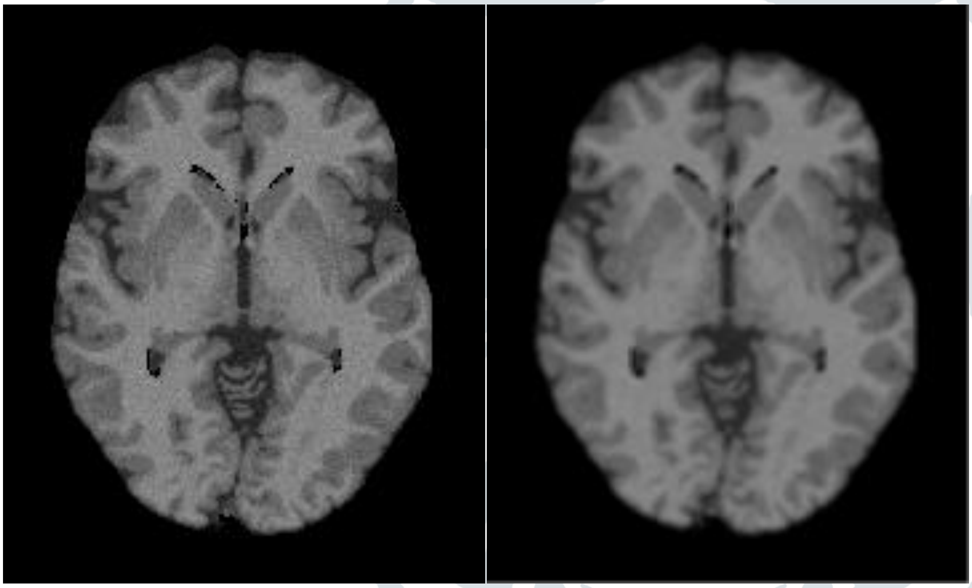
Fig 1 shows the 3×3 smoothing filter. It gives the average of the intensity levels of the pixels in the 3×3 neighborhood defined by the mask. The general implementation for filtering an M×N image with a weighted averaging filter of size m×n is given by the expression

$$g(x,y)\frac{\sum_{s=-a}^{a}\sum_{t=-b}^{b} w(s,t)f(x+s,y+t)}{\sum_{s=-a}^{a}\sum_{t=-b}^{b} w(s,t)}$$

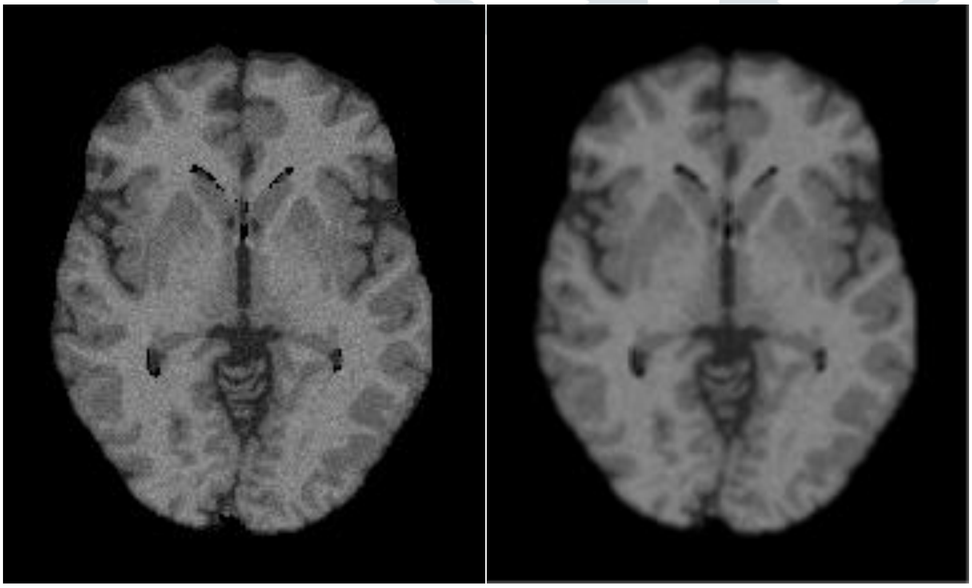
Where x= 0,1, 2……..M-1 and y=0,1,2,……..N-1.



(a) (b)



(C) (D)



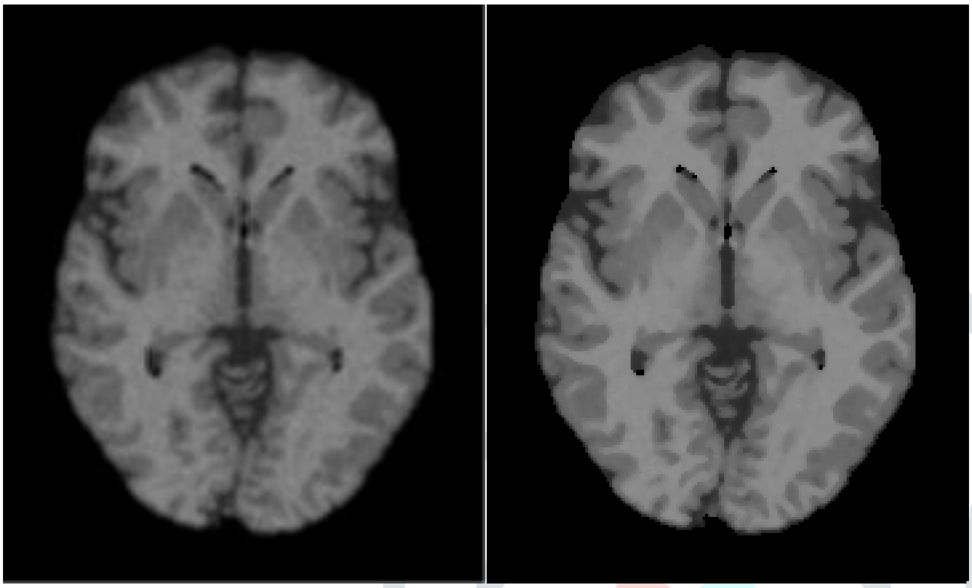
(e) (f)

Fig 2.

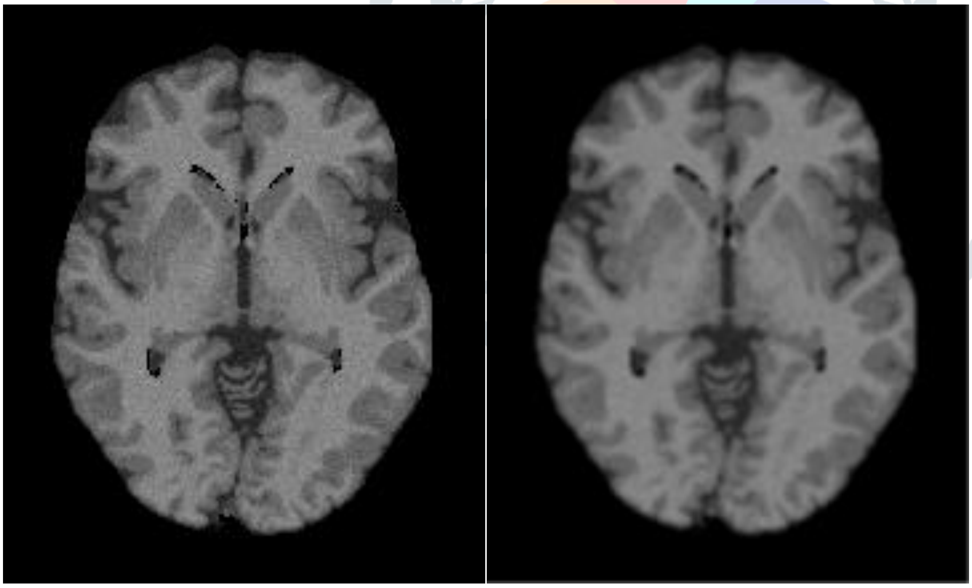
Fig 2. (a) original MRI with 3% noise (b) output MRI by applying mean filter (c) original MRI with 5% noise (d) output MRI by applying mean filter (e) Original MRI with 7% noise (f) output MRI by applying mean filter.

3.4.2 Median filter

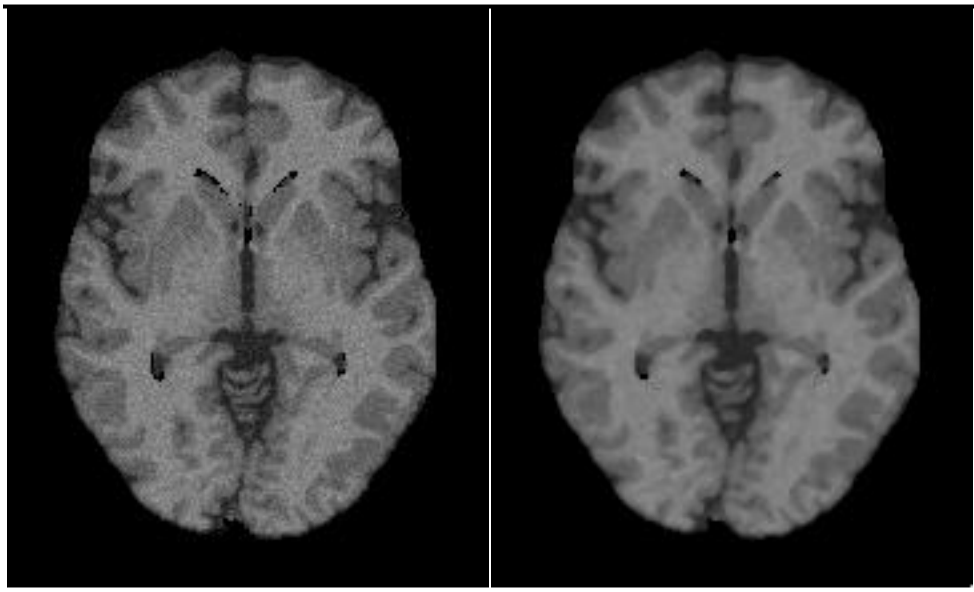
The median filter is non-linear filter. It eliminates noise effectively as well as protecting sharp edges. It actually eliminates each pixel value with the median of the intensity level in the neighborhood of the pixel.



(a) (b)



(c) (d)



(e) (f)

Fig 2. (a) original MRI with 3% noise (b) output MRI by applying median filter (c) original MRI with 5% noise (d) output MRI by applying median filter (e) Original MRI with 7% noise (f) output MRI by applying median filter.

4. CONCLUSION

In our project, we have studied two basic denoising techniques to eliminate noise from the images obtained by using the MR technique. All the experimental studies have been done on standard data sets that includes the images of brain using the technique of MR. The two filters that have been used here are Median and Mean Filter and both filters reduces noise and the results are, less noised images. Images prior and after denoising demonstrates clear change that is we are obtaining less noised images and it becomes easier to diagnose disease in a given time. After applying both filters for elimination of noise from the images obtained by using the technique of MR.

5. FUTURE WORK

However, when we are correctly estimating there is still an issue that is noise from MR images. So, we can extend our work which is as under:

- We can use different statistical methods to calculate the mode value of the discrete data to calculate accurate value of mode.
- We can make a combination of edge-based detection techniques like bilateral filtering techniques with NLM approach to achieve better out comes.
- The use of noise estimators with existing transform-based m
- Methods (for e.g. UNLM-DCT) forremoval of Rician noise from MR images.

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