Denoising Medical Image Using Wavelet Transformation Methods

A Dissertation Proposal
submitted by

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PAC Form

ABSTRACT

The primary role of digital image processing is to gather useful or relevant information from digital images. The main motive of image processing is to alter the image in to desired manner. We use image processing in our daily life as well the best example that I can quote here is our brain sensing because when our brain see lot of images from the outside world with eyes, our brain process those images with in fraction of time. In today's scenario there are many techniques which are available to get useful information from image but those all techniques are not universal or in other words no exact processing is defined in those techniques.

But the ultimate aim of image processing is to give better image in terms of visually enhance as compare to its original image. We can use digital image processing in many fields or for many purposes. The various fields where image processing can be used medical processing, radar sonar etc. we can use image processing in industry as well by zooming the image to examine the image closely if its visual quality will be better.

CERTIFICATE

This is to certify that Anshu Vashisth has completed M.tech dissertation titled "Denoising Medical Image Using Wavelet Transformation Methods" under my guidance and supervision. To the best of my knowledge, the present work is the result of his original investigation and study. No part of the dissertation has ever been submitted for any other degree or diploma. This dissertation is fit for the submission and the partial fulfilment of the conditions for the award of M.tech Computer Science & Engineering.

Date: _____

Signature of Advisor

Name: Rohitt Sharma

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"Thanks to the almighty for showering his blessings"
Nothing concrete can be achieved without a combination of inspiration and perspiration. Although writing a few words on a piece of paper is not a proper way of acknowledge those people who has helped me in the completion of this project, yet the words coming from my heart and soul need no mode of communication.

I am very thankful to my Computer Department for all their valuable technical advices. I am also thankful to my mentor Mr. Rohitt Sharma of Computer Dept. who guides me and made me think everything logically.

I take the opportunity to present a vote of thanks to all those guideposts who really acted as lighting pillars to enlighten our way to this Final Dissertation that has led to the completion.

DECLARATION

I hereby declare that the dissertation proposal entitled, Denoising Medical Image Using Wavelet Transformation Methods submitted for the M.Tech Degree is entirely my original work and all ideas and references have been duly acknowledged. It does not contain any work for the award of any other degree or diploma. This dissertation is fit for the submission and the partial fulfilment of the conditions for the award of M.tech Computer Science & Engineering.

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Chapter 1
INTRODUCTION

Digital image processing is procedure to commute the image in to digital form so that some pre-processing operations (Image enhancement, Image pattern recognition, Image compression) could be possible on digital image to get enhanced or good quality image in terms of visual perception. The basic use of image processing is to get useful information from image. It is basically known as signal dispensation where image is taken as input and output must be enhanced image [6]. There are many reasons due to which image processing started:

Visualization- To remark those object characteristics which are not clearly visible in image.

Restoration- To get image characteristics back again or state of image to its former good condition

Measurement- To evaluate various characteristics in image

Recognition- To recognize or differentiate various objects in image

The use of image processing is in many fields like Biology (X-ray images), Astronomy (celestial bodies or universe images), Biometrics (Fingerprint images); Satellite images (GPS location) and can also be use for personal photos. Basically image processing has leveled in to three parts from low level to high level as in figure1.1 [1].
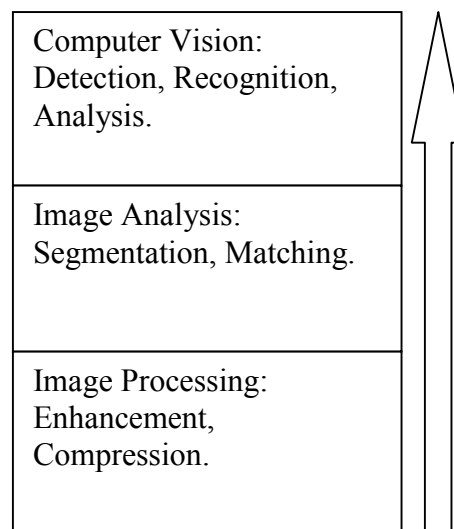
Figure1.1: Level of processing

From the last few years many techniques already have been developed in the field of image processing and most of them are used for enhancement purposes. These all techniques can only possible because of powerful device which has enough memory size and enough processing capabilities [14]. Basically there are two methods are available which are used for image processing [10]:

1.1 Methods for Image Processing:

Analog Image Processing– This type of processing basically refers to modification of image in terms of electrical signal. For example T.V. screen where electrical signal are used for voltage level and varies with change in amplitude to change the value of brightness of image. The appearance of image can be altered by altering the value of signal [14].

Digital Image Processing– This type of processing basically perform that image is converted in to digital form by using scanner or digitizer. The basic meaning of digital image processing is to process an image in 2-dimensional form with help of digital computer. In simple words, digital image is 2- dimensional array which contains real number which is represented by limited number of bits and has special range [0,255] [27].

The selected sub topic is image enhancement under image processing. Image enhancement is one of the major tasks in image processing. The image enhancement can be used as pre-processing operation for many application fields. The use enhancement is also in medical field like in case of x-ray images. Number plate recognition is also the one of the important field where enhancement can be deployed. In recognition, enhancement will be the first step and image recognition will be the second step to get better image.

The basic aim of image enhancement is to change the quality of image for human to provide better visual quality with eye so that it can use for other machine-driven image processing operations.

1.2 Methods for Image Enhancement:

Generally, image enhancement can be possible in two ways either on the basis of pixels or on the basis of Fourier transformation. The methods which operate on pixels known as **spatial domain method** and second method are **Frequency domain methods** which

operate on Fourier transformation. Spatial domain methods include many techniques like Grey scale manipulation, histogram equalization, image smoothing etc [1]. The main part of image enhancement is to modify the image attribute to make it worthier for a given problem. In image enhancement, simply change the state of image or in simple words transforms the image 'a' into image 'b' using 'Z' transformation [4]. Mathematically represented as,

$$P = Z\,(Q) \hspace{4cm} (1)$$

P and Q are the values of pixels in image 'a' and 'b' respectively. Here this equation tells that the new value of pixel is achieved by doing some transformation with original image or simply by manipulating the values of pixel in original image. Here 'Z' is the transformation which actually map the pixel value of 'P' into 'Q'. Here point is about grey scale images in which each bit in image has its own value which will be in the given range which is 8-bit and the range will be [0, 255] [10].

1.3 Image Noise and Its Types:

Image noise is basically a variation in any of the way either in terms of brightness or color. Unwanted signal in image is generally said to be noise. The reason of occurrence of noise can be anything either by device itself like camera or scanner or external environment. According to the shape or reason different noise are classified in image [4] [13]. There are different types of noise, but here main focus is only on those noises which will be removed through implemented method.

Figure1.2: Salt & Pepper noise (Left) and Gaussian noise (Right)

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Gaussian Noise- It is classical noise in all images. The principle reason of occurring Gaussian noise arise during acquisition of image like due to sensor noise. Due to poor illumination or high temperature Gaussian noise may occurred e.g. electronic circuit noise in image [24]. It is independent of each pixel and independent of signal intensity (See Figure1.2).

Salt & Pepper Noise- It is also known as impulse noise or sometimes known as spike noise. Salt & Pepper noise represents dark pixel in bright area and bright pixel in dark area or region. This type of noise can be occur due to analog to digital converter error or can be due to bit error in image during transmission [26] (See Figure2).

1.4 Thresholding and Its Types:

It is the method which is used for image segmentation. Thresholding can be used to create binary image from grey scale image. Basically, thresholding technique interchanges the each pixel in image with black or white pixel according to some fixed value T. e.g. if intensity is less then that particular value T the pixel color will be black or vice –versa [17] [22]. Thresholding separate the area of image which has to be analyzing for meaningful information. There are various ways to select threshold value like hard thresholding and soft thresholding.

Hard Thresholding generally kept edges but noise was not fully removed from the images. It simple does keep or kill. It calculate one fixed value T and do calculations according to that value and decides which pixel is noisy [7] [8]. **Soft Thresholding** does not able to keep edges, but noise was fully removed from images. It simple shrinks the image coefficient to a specific value T for that particular image (See Figure1.3).

Figure1.3: Original Image (Left) and After Thresholding (Right)

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1.5 Wavelet Transformation:

Wavelet is used for signal processing which can be used in image processing for processing a signal or pixel or particular image. Simply used to recover weak signal or pixel from noise that weak signal can be the meaningful information for analyzer. It can clean or enhance the image without any blurring or puddling the details [9]. **Wavelet transformation** is analysis of signal frequency which changes with time and can provide more precise meaningful information of data signal or pixel then all other techniques. There are different types of wavelet names it wavelet family. In implemented method three wavelet are used which are also known as orthogonal wavelet i.e. Haar, Daubechies and Symmlet.

Haar: It is oldest and one of the simplest wavelet type in wavelet family. It basically provides prototype for all other wavelet and it decompose the discrete signal in to equal parts. In which one part of signal is running average and other part is running difference. The main advantages of haar wavelet are that it is faster than other with addition that it is also efficient and simple.

Daubechies: It is first member of wavelet family. It has set of multiple scaling functions which are also known as orthogonal function. It has finite number of vanishing moments. It has equilibrated frequency reply but non-linear phase response. It can be useful in compression and removal of noise in medical images [30]. It can work under low as well as high frequency or simply it is easily adaptable. They are generally asymmetrical.

Symmlet: This name came from the word symmetric wavelet. It provides maximum number of vanishing moments among all. It can be used with both discrete and continuous wavelet transformation. It is also more symmetric than all with respect to the centre, so that energy will be concentrate on the centre [3] [11].

Discrete Wavelet Transformation:

DWT of medical image produce a desired image representation that provides good image information. DWT analysis is basically based on supposal of amplitude not on the location of spectra of signal. This feature allows us to do thresholding of image amplitude to separate signal and noise in the image [3]. Thresholding gives low pass and more fluent interpretation of noisy signal. Wavelet thresholding is basically a method which is based on estimation of signal and who taps the capablenesses of wavelet transform for signal

denomination. Thresholding is simple non-linear method, which can operate only on a single wavelet at a time.

1.6 Decomposition of Image:

It is basically a creation of small segment of image from original image. An original image is broken down into simpler from to extract noise from image. Decomposition level of image should be balanced because it can affect the quality of image as well. If decomposition level will be larger than it can lead to blurring of image and will be loss of efficiency or more time consuming [18]. So, there should be balance between quality, time and computation complexity. So, for particular method decomposition level will be fixed and can be analyze by visualizing the image on the basis of parameter like PSNR and MSE. These are the parameter which can tells the quality of image, for good quality image PSNR should be high and MSE will be low. Both are inversely proportional to each other that if one will increase then second parameter will automatically decrease or vice-versa [13].

Chapter 2
REVIEW OF LITERATURE

The selected sub topic was image enhancement. This study was based on lot of paper related to various field of image processing. This Studied was also based on various research paper related to pattern recognition, watermarking, image enhancement etc. But finally idea came that image enhancement is a better filed to research. Slowly with the time, the approach was going narrow down by doing study of research papers. After this, studied was all about image enhancement that how to remove different types of noise from digital image? The step by step study was relating to image enhancement like first point was to check that what are different types of noise commonly occurred in images which are generally exists in image. To check what different types of noise removal techniques are there? Till this point actually problem was clear. The one of the reason for selecting this topic was that image enhancement has very large scope and it uses in many fields as a pre-processing task. Especially in medical field like, currently in x-ray images or many medical images. So due to these reasons finally selection was medical image enhancement of digital image. There was a Survey paper which was accepted in a **McGraw-Hill** conference. The name of review paper was "A SURVEY OF VARIOUS IMAGE ENHANCEMENT METHODS ON DIFFERENT TYPES OF IMAGES" which is accepted in Fifth International Conference on Advances in Computer Engineering – ACE 2014. This conference is organized by the IDES and the Association of Computer Electrical Electronics and Communication Engineers (ACEECOM) and will be held during Dec 26-27, 2014 in Kochi, Kerala. The major indexing of this conference are EI, ISI Web of Science, DBLP, IET Inspect, Scopus and etc. In literature review discussion is only on those papers which are directly related to image Enhancement. One more final implemented paper was there "Denoising of Medical Image using Wavelet Transformation Method" which was published in IJAER (International Journal of Applied Engineering Research) Journal having major indexing with Scopus. In this paper, explanation was all about removal of salt & pepper noise and Gaussian noise from medical image like brain images in such a way that important characteristics should be preserved.

Ashraf Aboshosha, M. Hassan, M. Ashour and M. El Mashade (2009) [2], "Image Denoising based on Spatial Filters, an Analytical Study", tried to explain the spatial filter with cascading of median and Coiflet filter. The main advantage of this cascading was that it able to preserve the edges and also have a feature to preserve image from blurring. This filter is almost better one for all types of images. Propose filter compared with all type of noise like salt & pepper noise, Gaussian noise, speckle noise and Poisson noise and it has been found that it is giving better image quality by using spatial cascading filter with median and Coiflet filter.

Jasdeep Kaur, Mamta Garg (2011) [12], "An Improved Weighted Median Filter for the Image Processing Application", tried to improve visual quality image by using some detection algorithm of the grey scale image. Two major tasks were there, detection of impulse noise and removal of impulse noise from image. Each algorithm can only give better result if and only if detection will be strong. The comparison was done with other existing techniques in terms of PSNR and MSE values. Main task was to select any two pixels from image and perform difference. If difference will be greater than thrash hold value then the result of that particular pixel must be median of neighboring values of pixels inside that sinking window else particular pixel remain same in the origin. In traditional technique, flag procedure was used to find the noisy pixel. Voting procedure was used to consider that pixel was noisy or not. It means that maximum votes were used to decide the median of pixel inside the sinking window. 3x3 windows window was taken, to compare the value with threshold to decide about the presence of the impulse noise, if the value of processing pixel will be greater than 6 votes than that pixel will be considered as a noisy pixel. The same process was repeated for 2x3 matrix and 3x2 matrix to make detection algorithm more strong, in addition to this 4x4 window mask was also used but in 3x2, or 2x3 window mask only greater than 3 votes was considered and on 4x4 window mask 12 votes was used to consider that particular pixel was noisy pixel or not which means that if 75% votes will be against for the pixel then that pixel will be treated as noisy pixel and noisy pixel must be exchange with the new calculated value according to the median of the all neighboring pixels in the particular sinking window.

Gnanambal Ilango and R. Marudhachalam (2011) [5], "New hybrid filtering techniques for removal of Gaussian noise from medical images", tried to remove Gaussian noise from medical images which was commonly found in medical images.

Proposed method was used in different hybrid filtering techniques to remove the Gaussian noise using some topological or structural approach. It has used some finite set of operations for the estimation of noise. In proposed filter there was use of some different filter properties to remove Gaussian noise from the image and compared result on the basis of some statistical quality measure like RMSE (Root Mean Squared Error). In addition to this, there was also use of some existing filter to make new hybrid filter to provide better image quality. All the filters were already applied, in medical image like ultrasound images. The different types of filters in proposed method was hybrid cross median filter (H_1F), hybrid min filter (H_2F), and hybrid max filter (H_3F). At the end conclusion was that proposed method was useful in many images like images of brain tumor, CT scan images because this Gaussian and impulse noise most commonly occurred in these types of images. Gaussian noise commonly occurred due to poor illumination (low degree of visibility) and impulse noise occurred due to dead pixel. The reason for dead pixel can be anything. Dead pixel can be due to low visibility or it can be due to the radiant energy emitted by the photon. The experimental results of proposed method suggest that proposed method was better than much other surviving proficiency and gave better result after much successive iteration. The proposed method was very simple in terms of complexity.

Kother Mohideen, Arumuga Perumal, Krishnan and Mohamed Sathik (2011) [17], "Image Denoising and Enhancement Using Multi wavelet With Hard Threshold in Digital Mammographic Images", tried to enhance the image quality by using multi wavelet and thresholding methods. Proposed method was implemented on mammographic having very less resolution and Gaussian noise with different variance. Multi-wavelet method used with decomposition level of 2 to 4. And it has been found that fourth level of decomposition gave better result. Implemented method done with variable size window or variable matrix e.g. 3*3. But, it has been found that 3*3, 5*5 was the good choice for the mammographic image. This experiment was helpful to detect breast cancer in its early stage. Proposed method was able to preserve edge with addition it also able to give good PSNR and MSE than all other conventional method. Proposed method was compared with modified Neighshrink, Neighshrink, weiner filter and Visushrink. So, it has been found that proposed method was helpful to detect the early stage of breast cancer with edge preserving quality.

Harnani Hassan and Azilah Saparon (2011) [9], "Still Image Denoising Based on Discrete Wavelet Transform", tried to improve the image quality using wavelet transformation methods by using haar, Daubechies and Symmlet (orthogonal wavelet family). The hard and soft thresholding is used to suppress the noise. With addition to preserve the image artifacts translation invariant is used. Translation invariant is a signal estimation technique for Denoising. Noise was removed with hard thresholding, soft thresholding and translation invariant. First step was rescaling the image to speed up the process and then Gaussian noise to original image than proper thresholding and proper decomposition level selected. Orthogonal wavelet basis was used because they can concentrate the energy in to smaller level and performed better PSNR. The quality of reconstructed image was also depend on decomposition level because larger the decomposition level can lead to blurring the image and increase computation complexity. So, decomposition level should be balances between computation complexity and image quality. Hence, it was fixed to 2 to get better PSNR and MSE.

Kanwaljot Singh Sidhu, Baljeet Singh Khaira and Ishpreet Singh Virk (2012) [18], "Medical Image Denoising In the Wavelet Domain Using Haar and DB3 Filtering", tried to improve the quality of image using wavelet transformation method in which haar and DB3 filtering techniques are used in a combination. Four different images were taken up with 512 *512 resolutions like ultrasound, MRI, X-ray, CT scan having different level of speckle noise. Haar and DB3 wavelet applied on images with soft and hard thresholding on different level to check the PSNR and MSE of reconstructed image. And finally it has been found that haar and DB3 giving better result than conventional method. DB3 gave better result than haar but it depend on image that how much level of noise an image has.

S. Suryanarayana, Dr. B.L. Deekshatulu, Dr. K. Lal Kishore and Y. Rakesh Kumar (2012) [24], "Estimation and Removal of Gaussian Noise in Digital Images", tried to improve image quality by detecting Gaussian noise from the image and then reduction of Gaussian noise with efficient enhanced method which was slandered mean filter. This method was using 3*3 sub windows used in which all the test pixel will appear. All the parameters will calculated like standard deviation for reference, minimum standard deviation, maximum standard deviation and average of standard deviation whose standard deviation falls in the range of minimum standard deviation and maximum standard deviation. This average of standard deviation was used for detecting and removing of

Gaussian noise from the digital image. The comparison was based on performance with existing standard mean filter. It was proved that proposed method was better than standard mean filter. In proposed method test pixel decision was done on the basis of difference within the range [a, b] where a= (u- 0.5 * standard average) and b= mean of 3*3 central sub window. This process was repeated for the entire matrix which will create for the entire noisy image. The main motive of algorithm was to detect and eliminate the Gaussian noise. Comparisons were all about performance on the basis of some parameter PSNR and MSE. All parameters were calculated and compared with standard mean filter for various combination of mean and variances of additive Gaussian noise.

Dr. Karim M. Al-Jebory, Dr. Ekbal H. Ail, Dr. Ekhlas H. Karam (2012) [4], "Mixed noise reduction in grey scale images using hybrid filters scheme", tried to improve image quality with hybrid approach which means to merge more than one method to make one single method to speed up the detection process. For an enhanced image detection must be strong and fast. Detection of noise was basically pre-processing task which must be strong. So window was taken out which has specific length and uses arithmetic median filter and on the other hand mean filter was used with only five neighboring point. In proposed method after using median and mean filter image has to pass through Kalman filter. It means image has to enter in to the kalman filter for better enhancement after going through all the filtration (median and mean filtering) process. Kalman filter was actually used to modify the output of median and mean filtering.

Rakesh Kumar and B. S. Saini (2012) [22], "Improved Image Denoising Technique Using Neighboring Wavelet Coefficients of Optimal Wavelet with Adaptive Thresholding", tried to remove the noise from Lena image using discrete wavelet transformation having noise level up to L=3 (sub band). Than next step was to calculate optimal threshold value for each band and compute the shrinkage factor for the same. Perform appropriate wavelet method on all sub bands and then finally perform inverse DWT. The main point of focus was on selection of wavelet but it has been found that coiflets gave better PSNR result than other wavelet.

J UMAMAHESWARI, Dr. G. RADHAMANI (2012) [13], "Hybrid Denoising Method for Removal of Mixed Noise in Medical Images", tried to improve image quality in the field of medical diagnosis. During acquisition, most of the time distortion occurred in the images. New technique was proposed which was based on hybridization of wavelet filter

and center weighted median filter, which was actually detect the impulse (salt and pepper noise) and Gaussian noise in digital images. This method was implemented on medical images and the performance evaluated on the basis of following parameter PSNR, MAE (Mean Absolute Error), UQI (Universal Image Quality), and ET (Evaluation Time). Final result was utilization of center weighted median filter and wavelet median filter on DICOM (Digital Imaging and Communications in Medicine) images to degenerate the performance of image. The basic procedure of proposed method was that first estimation was related to the Gaussian and impulse noise. Then performed some computation related to standard deviation, noisy coefficient and invert multi-scale decomposition to create noise free image. The noise free image was obtained actually from wavelet method by reducing impulse noise. But still image contained some artifacts which were removed using CWM filter. And to preserve the useful details one more filter was applied and that was CWM filter and finally a noise free image was obtained. At the end conclusion was that improvement in the quality of brain images because it can help us to check early stage of brain related problems.

Kristofor B Gibson and Truong Q Nguyen (2013) [15], "An analysis of single image defogging methods uses a color ellipsoid framework", tried to increase the image quality by increasing contrast using color ellipsoid framework. The sample used was foggy image which was further enhanced using proposed algorithm. The main problem was ability to estimate the relative depth of image which seems to be a difficult task in digital image. If correct value of depth cues of image will be present then only it will be easier to find the transmission image on which enhanced image was depend. This image defogging (Process of removing fog from image) was depend on physical features of picture and one of that characteristic was depth of the scene. Scene depth estimation was most important task in image defogging. This method removed fog from image by understanding the transmission map of original image. Image defogging problem was basically focused on two things: first was to figure out the airlight and second was to find out the transmission map. There was one assumption about airlight that airlight was estimated accurately by other pre-existing method in order to focus on analysis of transmission image (with possible refinement). Therefore, key point in image defogging was to estimate transmission map in given foggy image. This new method was a way for image defogging by using a color ellipsoid framework. The discoveries of this paper were: how depth cues can be identified from fog by using the color ellipsoid framework? Gaussian mixture

model was very essential to calculate the depth separations which were a common issue in removing fog in natural scenes. The discoveries of this paper were: Ambiguity to measuring depth from fog which associated with the color ellipsoid orientation and shape.

T. M. Shahriar Sazzad, Sabrin Islam, Mohammad Mahbubur Rahman Khan Mamun and Md. Zahid Hasan (2013) [29]**,** "Establishment of an Efficient Color Model from Existing Models for Better Gamma Encoding in Image Processing", tried to improve human vision which was obvious light and color. Gamma encoder was the one which helps to improve the properties of human vision and thus to maintain visual quality. It was mentioned over there that all the computer images means digital images represented using RGB (Red, Green, and Blue) color space. Computer graphics RGB color space was the most established way to get desired or required color in image. But even then RGB struggled at some point and that was to deal with efficiently for the images those which belong to the real-world environment. The Images which captured using cameras or videos generally have different magnifications and showed different colors. In most cases during processing, as compare to the original outlook the images appeared either dark or bright in contrast. Due to that, Human vision will affected and thus poor quality of image will be there and thus poor image analysis might occurred. Now, Question came why used gamma encoding when histogram equalization or histogram normalization already available? By increasing the contrast value cannot make any sense to image all the time, to make it enhanced image sometimes enhancement means a lot in some fields. Basically Human perception depends on universal illumination environment which means images should not pitch black or not so much blindingly bright that is why proposed method followed an approximate gamma function or power function. Hence, to change the contrast value was not a good idea all the time when problem was about better human visualization. The grandness of gamma encoding in digital image processing was an efficient color model which was helped to improve visual quality of human for standard transmission processing as well as to examine the images automatically for their comparison and also for the testing purposes. Future scope of this research paper was that HSB color model was more robust than HSI color model or from others because others of unrealistic colors over enhanced resultant images. However, there were still some regions, which need to be taken care related to color enhancement using hue no doubt these cases were prodigious and very uncommon in real world scenario.

Sonia Goyal and Seema Baghla (2013) [23]**,** "Region Based Contrast Limited Adaptive HE with Additive Gradient for Contrast Enhancement of Medical Images", tried to improve the visual quality of x-ray image so that doctors can give better prescription to the patient. If the image quality will be better it will help in medical field to understand deeply. At the time of acquisition intensity of x-ray machine cannot increased. It actually harms the body parts which was not a solution for the problem. So, problem was to improve x- ray image so that it has good visual quality. Already lots of techniques were there which were used for enhancing the visual perception of medical image. For enhancement of medical images, Contrast Enhancement was one of the most used method which was already used everywhere. Different contrast enhancement techniques already available like Linear Stretch, Histogram Equalization, and Region based enhancement, Adaptive enhancement and many more. But dependability of functionality of all the methods directly depends on features of image. This paper basically deals with contrast enhancement of all medical Resonance images (MRI) and in addition to this the proposed new method was also used for contrast enhancement which was based on Adaptive Neighborhood technique. Comparative analysis of proposed technique was done with the all others existing contrast enhancement techniques and results has been evaluated to prove hypothesis. The proposed algorithm was related to enhancement of the quality of x-ray image in a sequential procedure: The basic procedure was selection of pixel from the sample image to make it as seed point (staring point). Save that particular seed pixel value into a vacate queue (data structure to store pixel information with specific properties). Now next task is to check intermediate 8-connected contiguous pixel from top of the queue and this was done for each pixel or for each contiguous point, after this next step was to check the pixel grey level pixel value that whether the value of that contiguous pixel was between the assigned deviation or not. The deviation was specified as: $(f(m, n)-seed) / seed <= £$ where $f(m, n)$ which was the gray level value of the current processed pixel and the threshold $£ = 0.5$. If the processed pixel will meet the given standards then it was summed up to the foreground queue, else summed up to background queue. All the pixels will be processed until queue will not be empty. If in case any pixel will come again then proposed method will ignore that particular pixel and process will repeat go on in same step? Or it will move to next processing pixel in the queue. After completing all the steps the grey level value of each pixel will be changed in the foreground buffer by using adaptive histogram equalization. The final task of method was to summed up the values of all the pixels of foreground and background buffer to

create the partially enhanced image. After calculating the enhanced images next task was to get the magnitude of the original image and append with the final enhanced image to display enhanced image.

Kashif Iqbal, Rosalina Abdul Salam, Azam Osman and Abdullah Zawawi Talib (2013) [16], "Underwater Image Enhancement Using an Integrated Color Model", tried to improve the image which clicked under water. In underwater situations, clarity of images always degraded due to the property of light (light absorption and light scattering). Due to this one color will always endures the other colors in the image. In order to improve the quality of underwater digital images, paper presented a new approach which was based on slide loading. The objective of this approach was dual. First was contrast stretching of RGB algorithm which was applied to equalize the color contrast in images. Second was saturation and intensity stretching of HSI was there which was used to raise verity of color in image to figure out the problem of lighting. Already much Interactive software was available. To establish the usefulness of method, the main task was to develop an interactive software utility tool which was used for underwater image enhancement. This paper gave idea to perform contrast stretching on RGB color model, saturation and intensity stretching on HSI color model. The main reason of applying two stretching models was only that, it was useful to make exact match with the color contrast in the images and also deals with the problem of lighting. By applying the proposed approach, the promising (predicted results) outputs were generating.

S. Vijaya Kumar (2013) [25], "Hybrid filters for medical image reconstruction", tried to remove Gaussian noise and impulse noise which was commonly found in medical images. The Proposed approach was used to remove both noises with one method to speed up the detection process. Filter behaved as finite set of estimation and neighborhood operations. The proposed method followed some sequence of steps first read the image and converted that image in to grey scale if it will be in RGB, Then applied adaptive histogram equalization method on original image with some hybrid filter which was basically four filters H_1F, H_2F, H_3F, and H_4F. These all filters has specific name that was hybrid median filter, hybrid min filter, hybrid max filter, and hybrid sigma filter respectively. Each filters which was use in proposed method having different set of operation. Finally resultant was an enhanced image.

P.VENKATESAN & G.NAGARAJAN (2013) [20]**,** "Removal of Gaussian and impulse noise in the color image procession with fuzzy filters", tried to remove impulse and Gaussian noise but with new approach by using fuzzy filters. Adaptive statistical quality based filtering techniques was used for removal of both the noise in color images. In each step fuzzy rules were used to detect the noisy pixel in image and finally it was proved that proposed method was better in terms of visual quality on the basis of some parameter. Two approaches was used in proposed method the first was to detect impulse noise corruption of the color images in the RGB space. ASQFT (Adaptive Statistical Quality based Filtering Techniques) was used with low complexity for the restoration of all digital images which was effected with impulse and Gaussian noise. Proposed method used set of novel noise detection for corrupted pixel which was actually based on 2-D geometrics. The second approach was to smooth Gaussian noise. So to smooth the pixel weighting coefficient was used for each color by using fuzzy filter. Along with removal of noise proposed method was also able to preserve edge and other useful details in image.

Jaspreet kaur and Rajneet kaur (2013) [11]**,** "Image Denoising for Speckle Noise Reduction in Ultrasound Images using DWT Technique", tried to reduce speckle noise from medical images like ultrasound images. Weiner filter is used with wavelet transformation method to remove the noise from image and it has been found that restored image has very less distortion parameter and has better quality in terms of visual perception. Restored image is also compared with MSE of wavelet, and it has been found that haar wavelet with the combination of weiner filter provide better image quality than other wavelet like Symmlet and coiflets. And it is also observed that haar wavelet gave better result than coiflets wavelet and coiflets gave better result than Symmlet wavelet.

SUKHWINDER SINGH & NEELAM RUP PRAKASH (2014) [26]**,** "Hybrid filter with impulse detector for noisy grey scale images", tried to remove mixing of Gaussian and salt-pepper noise from noisy grey scale image. The main use of hybrid filter was to speed up the filtering process. One window was used to observe the noisy pixels in image. If impulse noise will be detected in selected window then impulse noise filter called otherwise window followed Gaussian filter which was also the part of proposed filter. To calculated performance of proposed method various parameters were there and experimentally it proved that proposed method was more capable for detecting the

impulse and Gaussian noise or mixture of both the noise. Ultimately it was proved that preservation of the useful details of image was better was better in proposed method as compared to the other existing standard filters like bilateral, median filter and trilateral filters etc. and evaluation parameter was PSNR, MSE, UQI (universal quality index). The performance of proposed method was calculated in both ways either subjectively and objectively. For the objective evaluation there was three experiments were performed for the performance measure that already discuss PSNR, MSE, and UQI. Moderate and high density of Gaussian noise PSNR value was the highest among the all the existing filters. But on other hand in salt and pepper noise at low noise density the performance of median filter was better than the proposed one in terms of PSNR. Proposed method was much better than the all other conventional filter. The last case was where both noises can be mixed it was better one.

Sezal Khera and Sheenam Malhotra (2014) [27], "Survey on Medical Image De noising Using various Filters and Wavelet Transform", tried to explain the advantages of wavelet transformation method. Survey includes the study of various noises and their corresponding filter. Normal filter can work efficiently if the level of noise will be low but unable to give good result when level of noise will be high and more complicated noise will be there. In such scenario, combination of filter can be good choice for researcher to enhance the quality of image. Wavelet transformation is best for denoising the noise because they exhibit many features in them like multi-scale nature. On the basis of noise research can select the appropriate wavelet from wavelet family.

Vivek Kumar Soni and Varsha Karanjgaokar (2014) [30], "Wavelet Based Noise Reduction in Medical Images", tried to explain that after denoising the image some of important characteristics of image can be destroyed and which are required for further processing. So, in that case Denoising affect the image even if it used for Denoising. This problem comes frequently in medical images like ultrasound images, CT scan images and MRI images. In these types of images image coefficient should be preserved like edge of image. So, to overcome this problem, a good edge preserving and noise removal image Denoising method developed and implemented by using wavelet transformation method for many medical images. Noisy image was taken up and selection of wavelet as well as threshold was the main part of implemented method. Decision of level of decomposition was also a main task to reduce the noise and to preserve the edges.

Chapter 3
PRESENT WORK

3.1 Objective of Research:

When the process of problem formulation was going on, a hypothesis was made that after removing of noise, image should be enhanced by any means. But as the process move one step forward many problems came like what type of medical image will be the sample for research? Why only medical images? What type of noise will be removed by the proposed method? How wavelet and which wavelet will be used for Denoising of image? Which thresholding will be appropriate? What will be the optimum decomposition level? The entire problem was there in hypothesis and solution of all problems was the result of hypothesis. At the end, it has been found that two type of noise will be removed with proposed filter and that will be salt & pepper noise and Gaussian noise. The sample images will be brain images and x-ray images. It has been found that decomposition level will be fixed in such a way that it should not affect the image quality. Medical will be the final sample of implementation because enhancement in medical image is very important. Doctors cannot take risk even of one percent. So, to detect the diseases like cancer, brain tumor, bone fracture image enhancement play important role. If image will not be clear then it is difficult to detect the actual characteristics of image and also will be difficult to detect edge which is important in bone fracture. Hence, in final proposed method all these points were considered and compared the result of proposed method with other conventional filter like median filter and median filter on the basis of PSNR and MSE.

Objective of work means the goal which intended to be attained or believed to be attainable. Either it can be new methodology or it can be pre-existing one in which some optimization can be there in any of the sense like in terms of speed, space or time. Now the question comes what will be the achievable goal in context to image by using image enhancement? For the good image enhancement detection of noisy pixel must be strong. If detection will be strong then only image will be of good quality. In simple words, that the procedure for selection of noisy pixel must be strong. The more detection method strong the more is the quality of image. So, wavelet transformation method is used in proposed method to attain good quality image in terms of visual perception and also with preservation of edge.

The main objective is to remove Gaussian noise and salt & pepper noise from the medical images so that image quality would be better. Objective should be very clear so that hypothesis could move in right direction. Objective of topic is to make better quality image in terms of human perception. In medical field extraction of useful information is very important from original noisy image. If the quality will be better the description or analysis of image will be better. Brain is the most powerful image processor who processes the images with eye.

The objective of image enhancement is only to enhance visual quality now it depends on approach of research work. Image enhancement is basically a sub area or topic which comes under image processing. The basic principle behind the image enhancement is to process image in such a way that result must be more desirable than the original noisy image for any application area. Now, in proposed method area of application is medical field. Objective is very much clear that enhancement will be related to enhancement of brain images, or x-ray images by implementing wavelet transformation method to remove mixed noise from medical images such as Gaussian and salt & pepper (impulse noise) which are most commonly occur in medical images.

3.2 Scope of Research:

Scope of study directly relates with the question, why select image enhancement? The reason was as simple as that only because of its scope. The scope of image enhancement is very wide range. The actual meaning of scope is an area in which something acts or operates. Scope tells that, is there any feasibility of work? Can it benefit to society? Ultimately problem definition must have good scope. Hypothesis should be taken on the basis of some valid points or in other words it should have base idea which defines scope. So, topic is image enhancement which has very large scope in almost every field. Enhancement is necessary in each field like it can use in image recognition because in recognition of image must be of good quality or if image compression will be concerning point then after compression image must be of good quality. So, ultimately a good quality image is required in each scenario and this can be achieved only with image enhancement methods. In proposed method scope was medical field in which many medical images were be taken up for analyzing the performance of algorithm. It means somewhat image enhancement is pre-processing task for many application areas. Now the question comes, what is the purpose of enhancing the medical images? Doctors cannot take any risk

related to patient. In medical field risk is very much is high because, in medical field one percent is equal to hundred percent. Doctor has to treat with the patient on the basis of result and result should be correct as much as possible better will be the result or on the basis of quality of image like x-ray images and brain images what obvious analyzsation will be good. Doctor provides prescription on the basis of images and if image will be of good quality than it directly means image must be of good quality with better visual perception.

Now, there are already various techniques are available to enhance the image but even then images are not so clear. At the end visual quality of any image is only depend on the person who seeing it. Now in medical images like in case of x-ray risk cannot be taken by the doctors, if they increase the intensity of x-ray because it will harms the patient body parts. But doctors cannot take the decision on the basis of noisy image. Noisy image means unwanted signal in image. Now noise can be of many types but in medical images most of time impulse (salt-pepper noise) and Gaussian noise will occurred. There are various conventional filters which are used for removing all kind of noise from medical images e.g. weiner filter and median filter.

For different types of noise there are different types of filters are available like mean filter, median filter, histogram equalization. But use of one filter at a time is not a good choice to detect and remove the noise from image. So, main motive is to make a hybrid method which is actually able to detect the noise from medical image irrespective of that what type of noise is occurring? So, that is why wavelet transformation method is used to remove mixed noise from medical image. Most of the time Gaussian and impulse noise will occur in medical image or it can be mixture of both the noise. The proposed approach is able to remove noise from image with one method along with the boost up speed of detection process. Hence, hypothesis gave same result as it was made at the time of problem formulation. It is proved experimentally on the basis of some parameters like PSNR, MSE, RMSE and operation time. So, ultimately scope of research work is very wide and useful in medical field. So, main aim is to merge two or three filter to make one method to remove Gaussian and impulse noise from the image after checking the validity of filters. On the basis of various research papers or on the basis of literature review it was decide that wavelet transformation will be the better choice to remove noise from medical image and it will definitely benefit the medical field to extract the useful

information from the images to detect diseases like brain tumor, early stage of breast cancer and bone fracture in any part of body. Research methodology means the system or the way of methods followed in a particular discipline to prove hypothesis. It is major part of research. Basically, this is a proof of concept to validate proposed method. In this, validity has to be checked or judged on some basis. The main reason of including research methodology is to know about two main questions and that are how collection of data will be possible? And how analyzing of data will be possible? Research methodology should be clear enough so that it is easy to experiment and result must be reproducible. And on the basis of that result final conclusion should be validated.

The explanation and collection of data is very important task because this gives the answer of question that why particular method is good for research? Ultimately research must be replicable. So, research methodology tells about ability of replicablity. Basic study is very much useful in research work which means what are different types of noise, how detection can possible with conventional method to create noise free image. Some sample images which are used in medical filed like x-ray images or brain images useful for the doctors to complete the deep study on sample data or images to extract the useful information. After implementing all the stuff evaluation of performance of proposed method is still remain which is important task and the evaluation of parameters like PSNR, MSE, and operation time. All the calculation will be done on the basis of all these related parameter. Matlab tool will be used for implementing research work, then on the basis of graph and calculations validity of research work will be compared with existing evaluated result with other conventional methods. In figure3.1 final research methodology is drawn that how proposed method was implemented in matlab tool.

3.3 Algorithm of Proposed:

Step1: Read original medical image like brain or skull image as in implemented method.

Step2: Add noise (Gaussian and salt & pepper noise) to raw image with different level.

Step3: Remove the noise by using proper thresholding method i.e. hard and soft thresholding and also with appropriate decomposition level for that particular image.

Step4: Perform wavelet transformation on raw image to form enhanced image and finally compare PSNR and MSE of proposed method with conventional method to show it better.
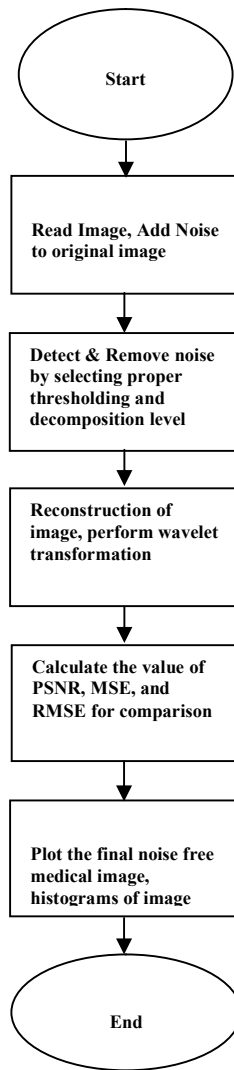
```
                    ┌─────────────┐
                   (    Start     )
                    └──────┬──────┘
                           │
                           ▼
              ┌─────────────────────────┐
              │  Read Image, Add Noise  │
              │  to original image      │
              └────────────┬────────────┘
                           │
                           ▼
              ┌─────────────────────────┐
              │  Detect & Remove noise  │
              │  by selecting proper    │
              │  thresholding and       │
              │  decomposition level    │
              └────────────┬────────────┘
                           │
                           ▼
              ┌─────────────────────────┐
              │  Reconstruction of      │
              │  image, perform wavelet │
              │  transformation         │
              └────────────┬────────────┘
                           │
                           ▼
              ┌─────────────────────────┐
              │  Calculate the value of │
              │  PSNR, MSE, and         │
              │  RMSE for comparison    │
              └────────────┬────────────┘
                           │
                           ▼
              ┌─────────────────────────┐
              │  Plot the final noise free│
              │  medical image,         │
              │  histograms of image    │
              └────────────┬────────────┘
                           │
                           ▼
                    ┌─────────────┐
                   (     End      )
                    └─────────────┘
```

Figure3.1: Research Methodology of Implemented Method

RESULT AND DISCUSSION

Orthogonal wavelet methods (Haar, Symmlet, and Daubechies) gave better PSNR, MSE, RMSE values as compared to other filter like median filter, wiener filter and basic filter in both cases either soft thresholding or hard thresholding to remove the Gaussian and salt & pepper noise from medical images. The important point of proposed method is that it can detect both noise (Salt & pepper and Gaussian) from the medical image and can remove from the image with addition that it can also preserve important characteristics of image like edge detection in case of hard thresholding. Hard thresholding basically kept edges but noise not fully suppressed but on other hand soft thresholding not kept edges but noise fully suppressed. During hard thresholding it kills image coefficient or characteristics to determine good threshold value but during soft thresholding image coefficient shrinks threshold value toward its peak value. Basically, in hard thresholding, it takes one value randomly and decides noisy pixel but in soft thresholding it takes average or threshold value of all the values and then it take decision of noisy pixel.
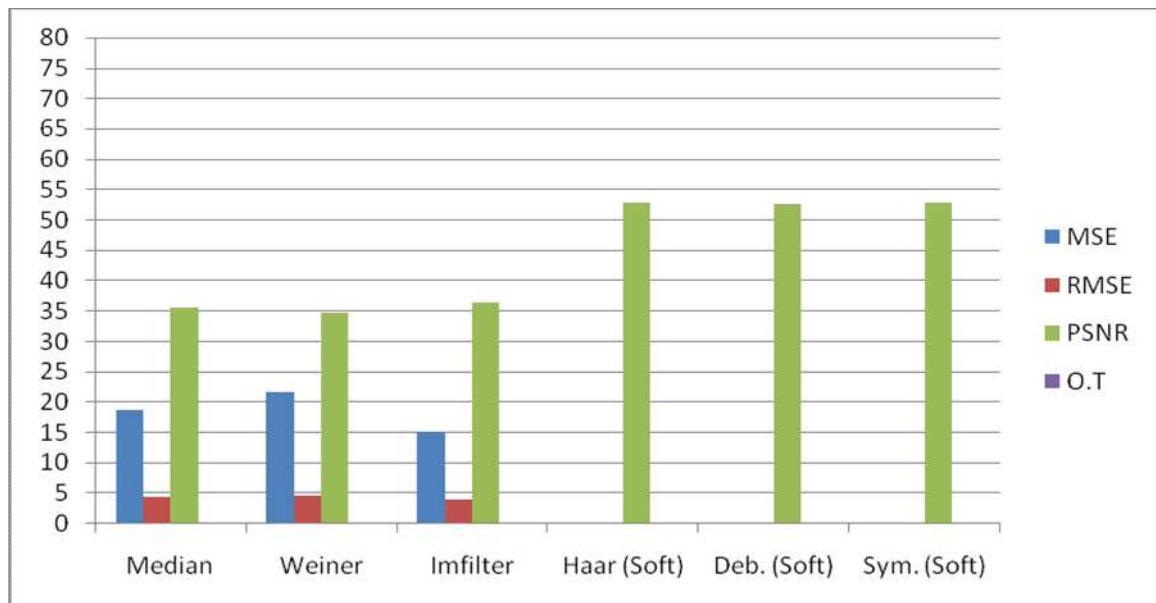
Figure4.1: PSNR Comparison at 10% level of salt & pepper noise

Above figure4.1 is a graph which showing PSNR comparison of existing method and proposed orthogonal wavelet method with soft thresholding by taking Salt and pepper noise at 10% level and it is showing that proposed method is giving better PSNR value which ultimately means good quality of image then other compared methods.

Figure4.2 is also showing PSNR comparison of existing method and proposed method on salt & pepper noise with soft thresholding at 30% noise level and also giving more PSNR and Less MSE value which is the reason for the good quality image.
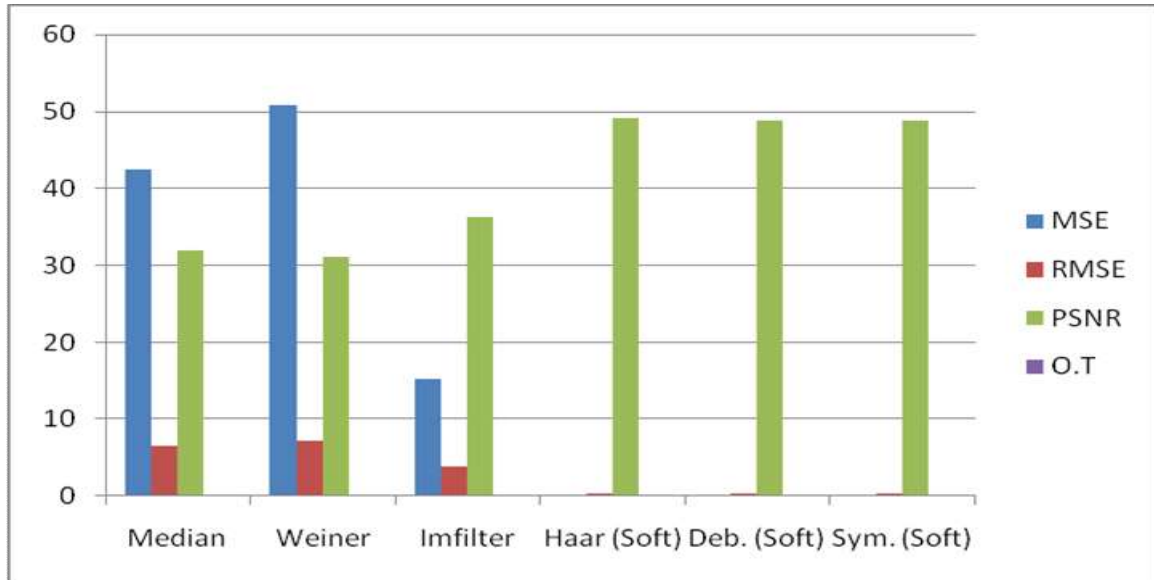

Figure4.2: PSNR Comparison at 30% level of salt & pepper noise

Table4.1 is showing MSE, RMSE, PSNR and O.T (Operation Time) comparison of proposed method with hard and soft thresholding among all conventional and proposed filter at 10% level of noise (salt & pepper). Table4.2 is also showing same PSNR comparison with both thresholding but with 30% level of salt & pepper noise. Table1 and table2 both are showing the values with their corresponding figure4.1 and figure4.2.

Table4.1: PSNR Comparison at 10% level of salt & pepper noise

Salt & Pepper,10% Decomposition Level=5	Med.	Wei.	Imfilter	Haar Thresholding		Deb. Thresholding		Sym. Thresholding	
				Soft	Hard	Soft	Hard	Soft	Hard
MSE	18.81	21.74	15.23	0.05	0.06	0.06	0.06	0.05	0.06
RMSE	4.34	4.66	3.90	0.23	0.25	0.24	0.25	0.23	0.25
PSNR	35.54	34.76	36.31	52.95	51.93	52.56	51.89	52.86	51.74
OT	0.01	0.01	0.00	0.13	0.14	0.17	0.14	0.16	0.12

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Table4.2: PSNR Comparison at 30% level of salt & pepper noise

Salt & Pepper,30% Decomposition Level=5	Med	Wei	Imfi - lter	Haar		Deb.		Sym.	
				Soft	Hard	Soft	Hard	Soft	Hard
MSE	42.47	50.79	15.23	0.08	0.10	0.09	0.10	0.09	0.10
RMSE	6.52	7.13	3.90	0.29	0.32	0.29	0.32	0.29	0.32
PSNR	31.85	31.07	36.31	49.08	47.30	48.81	47.19	48.83	47.30
OT	0.01	0.01	0.00	0.15	0.11	0.10	0.13	0.22	0.09

Figure4.3 and figure4.4 is showing PSNR comparison of proposed method in case of Gaussian noise at 10% and 30% level respectively. Tabel4.3 and table4.4 is showing PSNR values comparison in case of Gaussian noise with soft and hard thresholding with corresponding figure4.3 and figure4.4. And it is shown that proposed method gave better PSNR values then existing methods like weiner and median filter.
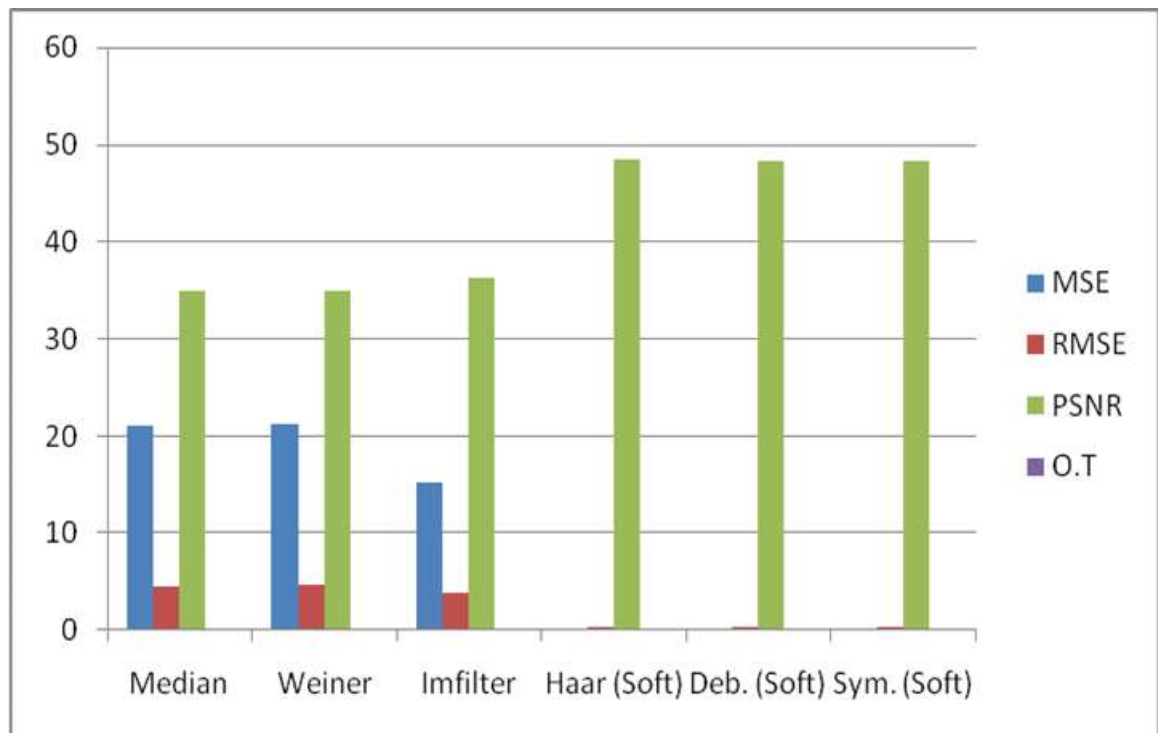
Figure4.3: PSNR Comparison at 10% level of Gaussian noise
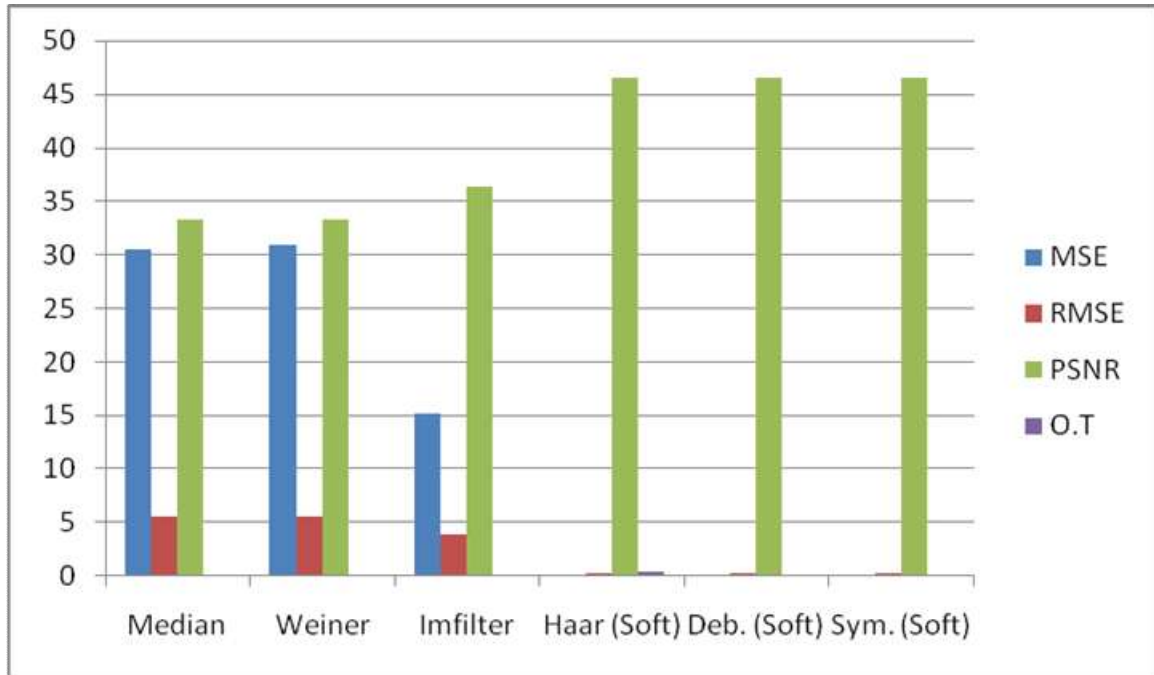
Figure4.4: PSNR Comparison at 30% level of Gaussian noise

Table4.3 is showing value after the implementation of proposed method and it is clear from the give below table that proposed method is also giving better PSNR value at 10 % level of Gaussian noise.

Table4.3: PSNR Comparison at 10% level of Gaussian noise

Gaussian,10% Decom -position Level=2	Med.	Wei.	Imfil.	Haar		Deb.		Sym.	
				Soft	Hard	Soft	Hard	Soft	Hard
MSE	20.93	21.20	15.23	0.09	0.07	0.09	0.07	0.09	0.07
RMSE	4.58	4.60	3.90	0.30	0.26	0.30	0.26	0.30	0.26
PSNR	34.92	34.87	36.31	48.45	51.76	48.28	50.74	48.38	50.74
OT	0.01	0.01	0.00	0.18	0.33	0.23	0.46	0.21	0.17

Table4.4: PSNR Comparison at 30% level of Gaussian noise

Gaussian,30% Decomposition Level=2	Med.	Wei.	Imfilter	Haar		Deb.		Sym.	
				Soft	Hard	Soft	Hard	Soft	Hard
MSE	30.47	30.92	15.23	0.11	0.10	0.11	0.10	0.11	0.10
RMSE	5.52	5.56	3.90	0.34	0.32	0.34	0.31	0.34	0.31
PSNR	33.29	33.23	36.31	46.51	47.60	46.45	47.66	46.46	47.67
OT	0.01	0.01	0.00	0.46	0.13	0.19	0.18	0.18	0.15

Below A, B, C, D, E, F and G images are enhanced images from Gaussian noise at the level of 30% with median, weiner, imfilter, haar wavelet, and deb. wavelet And Sym. wavelet respectively to show the visual quality of proposed method.
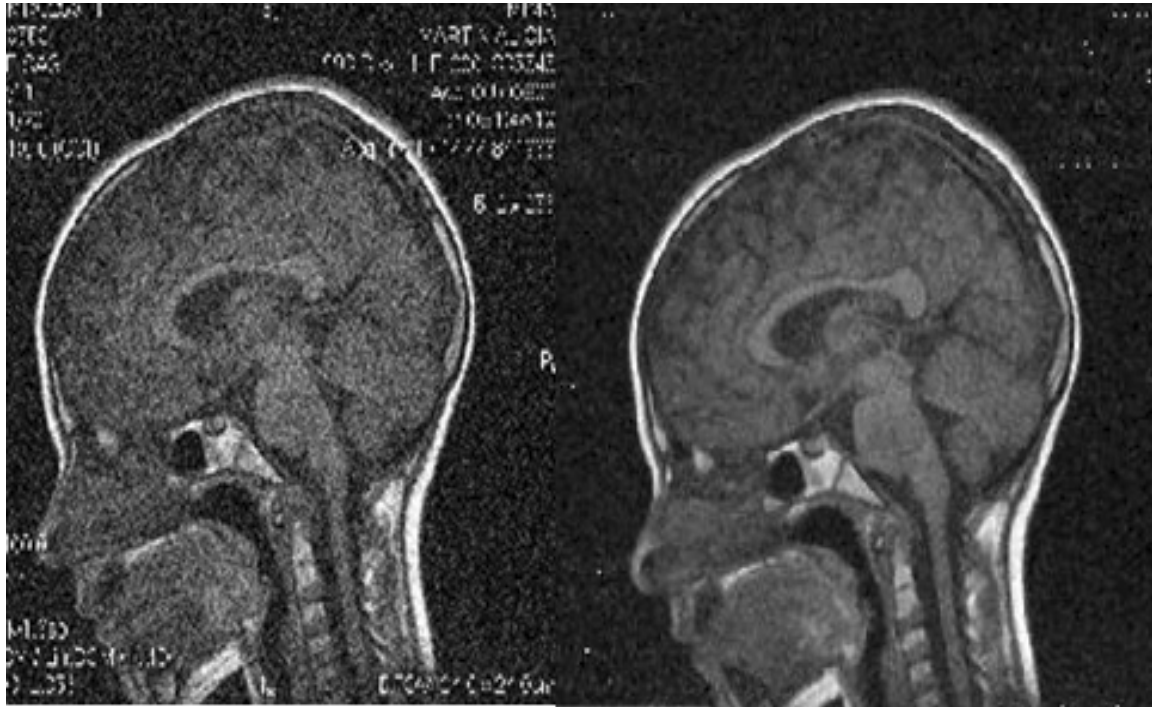
A.NOISY IMAGE   B.MEDIAN FILTER

Figure4.5: Filtered Image using median filter (Right) and Noisy Image (Left) at Gaussian noise
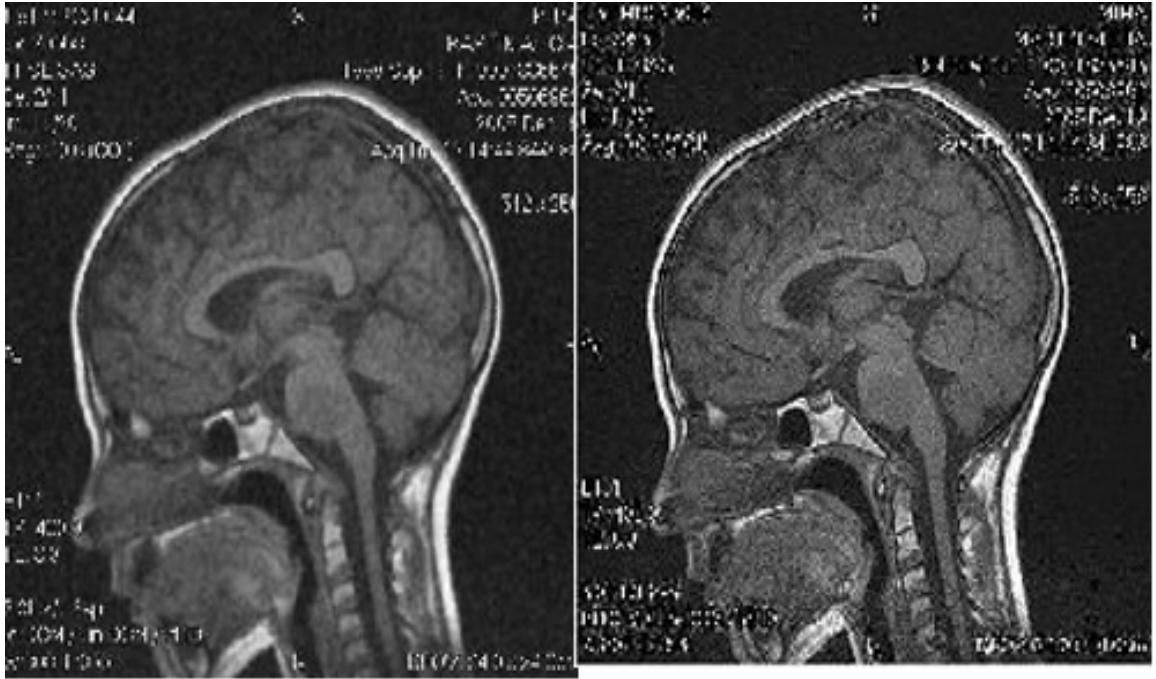
C.WEINER FILTER   D.BASIC FILTER(IMFILTER)

Figure4.6: Filtered Image using Basic filter (Right) and Weiner filter (Left) at Gaussian noise
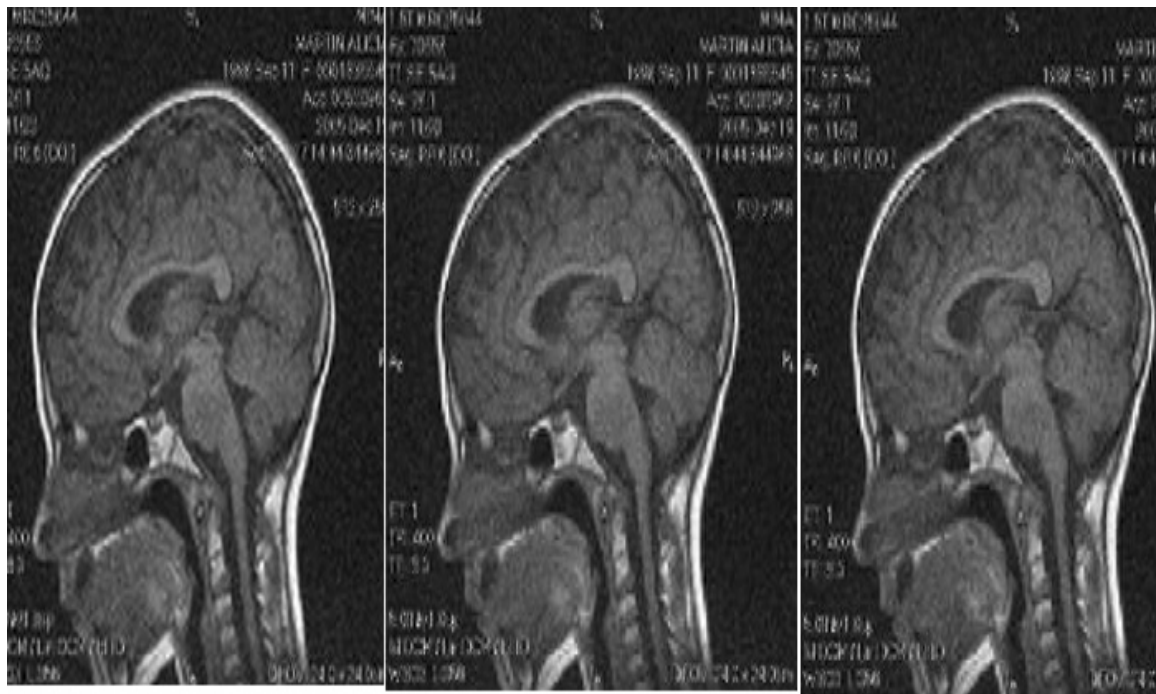
E)HAAR WAVELET FILTER   F)DEB. WAVELET FILTER   G)SYM. WAVELET FILTER

Figure4.7: Filtered Image using haar (Left), Deb. Filter (Middle) and Sym. filter (Right) at Gaussian noise

The below Figure4.8 and figure4.9 are also showing the image comparison in terms of quality when salt & pepper noise at 30% level of noise will be present in image. The image in left in figure 4.8 is noisy image, image in the middle enhanced with median filter, image in the right enhanced with weiner filter.
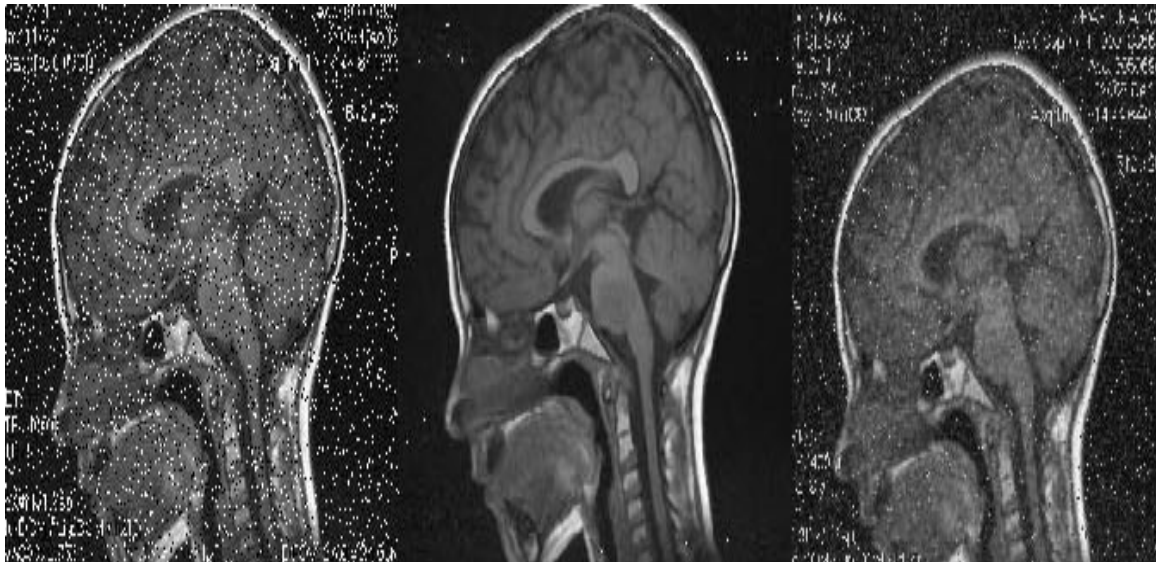
Figure4.8: Noisy Image (Left), Median Filter (Middle) and Weiner filter (Right) at Salt & Pepper noise (30%)

In below figure4.9 image at right most corner enhanced with haar filter, image at the middle enhanced with debauchies filter and image at the left most enhanced with Symmlet filter.

Figure4.9: Filtered by Haar (Left), Deb (Middle) and Sym (Right) at Salt & Pepper noise 30%

4.1 SNAP SHOT of IMPLEMENTATION IN MATLAB:
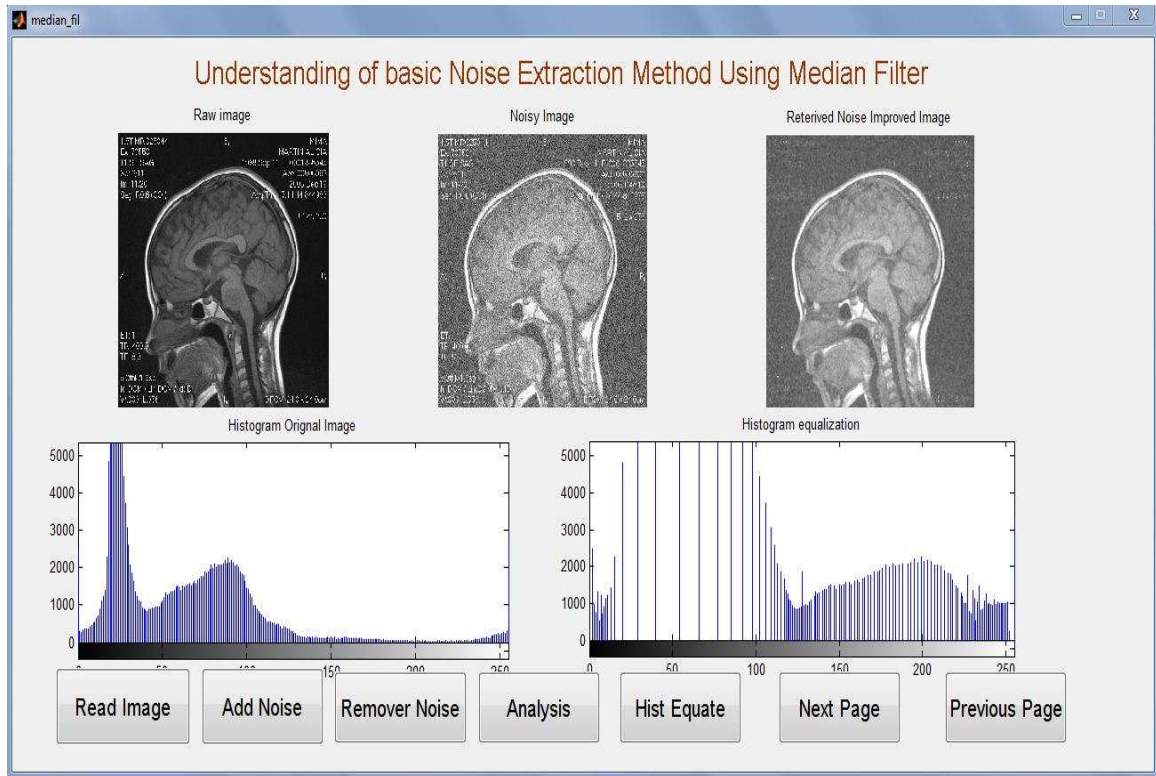
Figure4.10: Snap Shot of Median filter at Gaussian Noise

Figure4.10 is just showing that how median filter was implemented t Gaussian noise in matlab and it is showing clearly that how image has been enhanced with better quality by showing their corresponding histogram equalization. Figure4.11 is also showing the same enhancement process but with weiner filter.
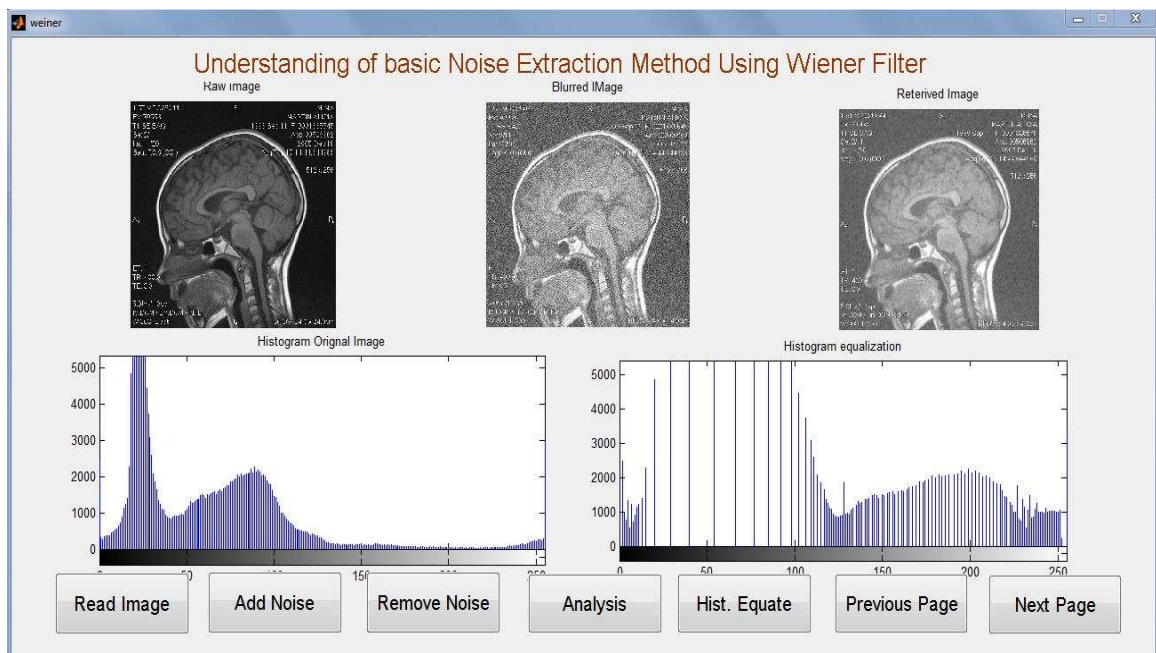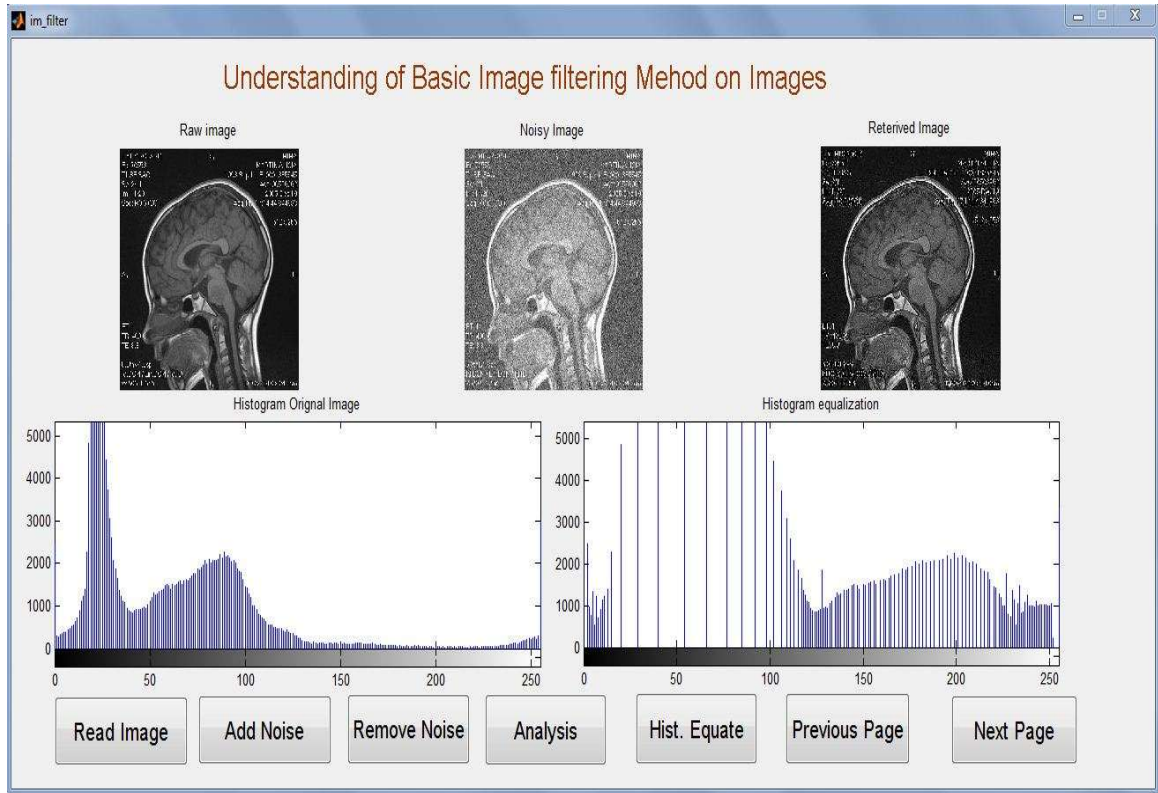

Figure4.11: Snap Shot of Weiner filter at Gaussian Noise

30

Figure4.12: Snap Shot of Basic filter (Im filter) at Gaussian Noise

Figure4.12 is showing that how imfilter (basic filter) filter was implemented t Gaussian noise in matlab and it is showing clearly that how image has been enhanced with better quality by showing their corresponding histogram equalization. Figure4.13 is also showing the same enhancement process but with haar wavelet filter according to proposed method.
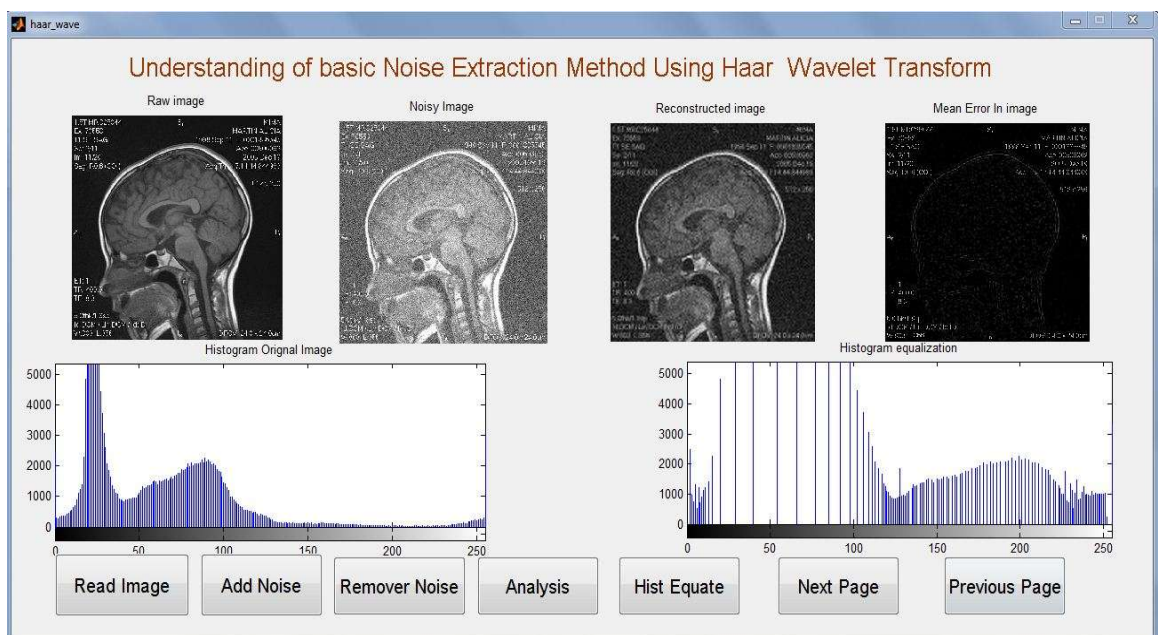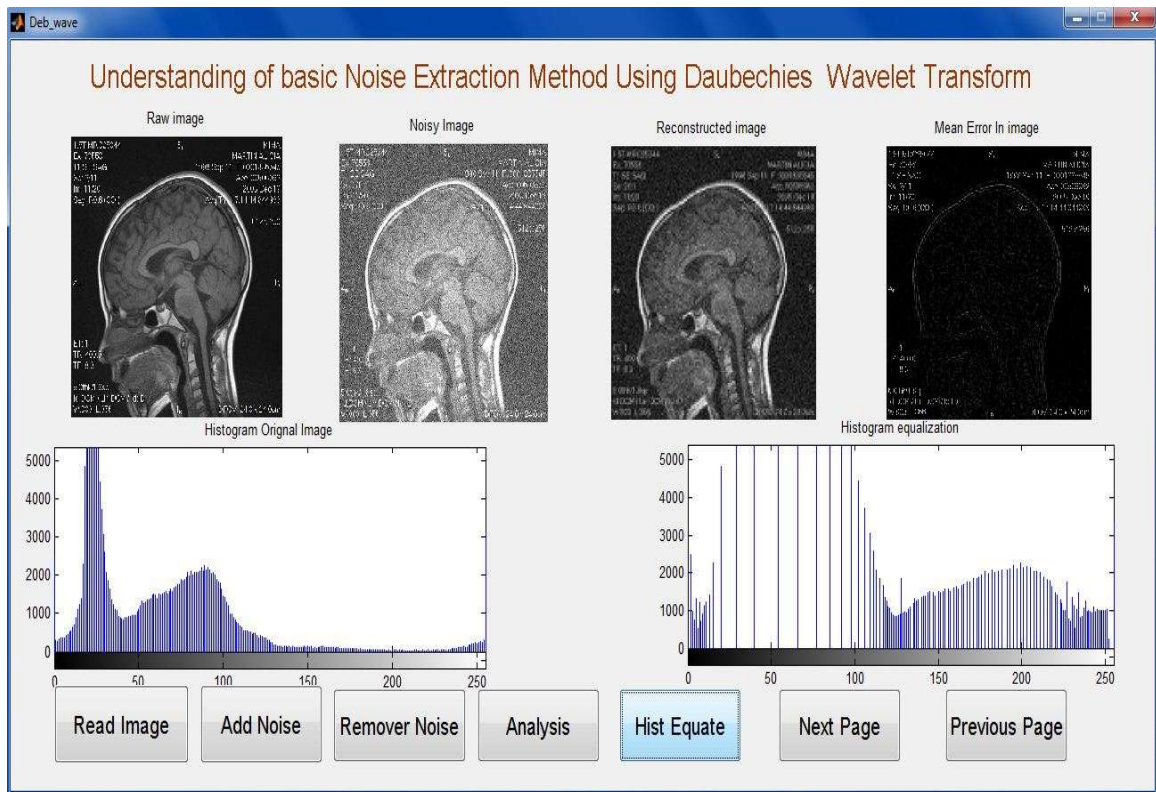

Figure4.13: Snap Shot of Haar Wavelet filter at Gaussian Noise

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Figure4.14: Snap Shot of Deb. Wavelet filter at Gaussian Noise

Figure4.14 is showing that how Deb. filter was implemented at Gaussian noise in matlab and it is showing clearly that how image has been enhanced with better quality by showing their corresponding histogram equalization. Figure4.15 is also showing the same enhancement process but with symmlet wavelet filter according to proposed method.
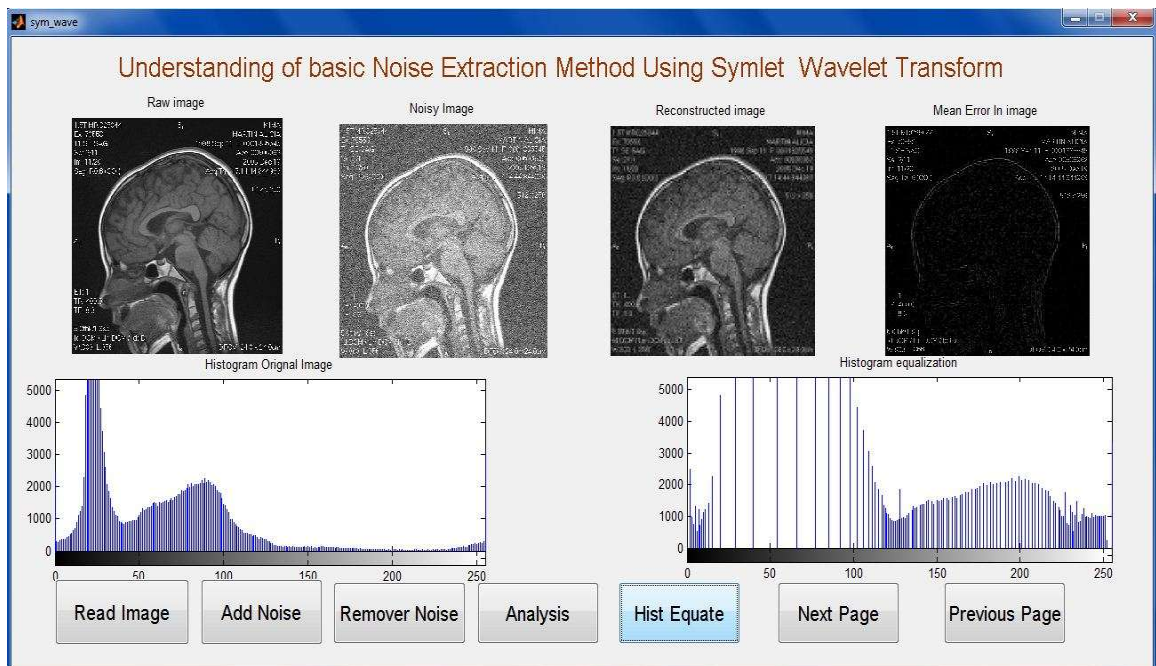

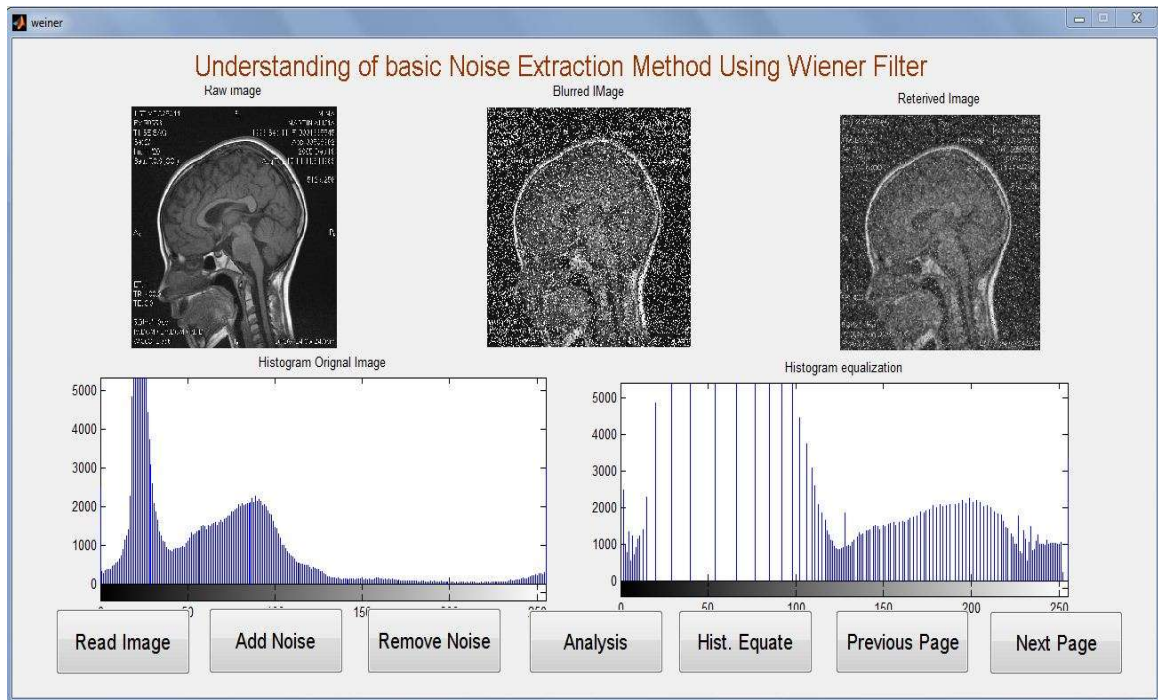**Figure4.15: Snap Shot of Symmlet Wavelet filter at Gaussian Noise**

Figure4.16: Snap Shot of Weiner filter at Salt & pepper Noise

Figure4.16 is showing that how weiner filter was implemented at salt and pepper noise in matlab and it is showing clearly that how image has been enhanced with better quality by showing their corresponding histogram equalization. Figure4.17 is also showing the same enhancement process but with haar wavelet filter according to proposed method.
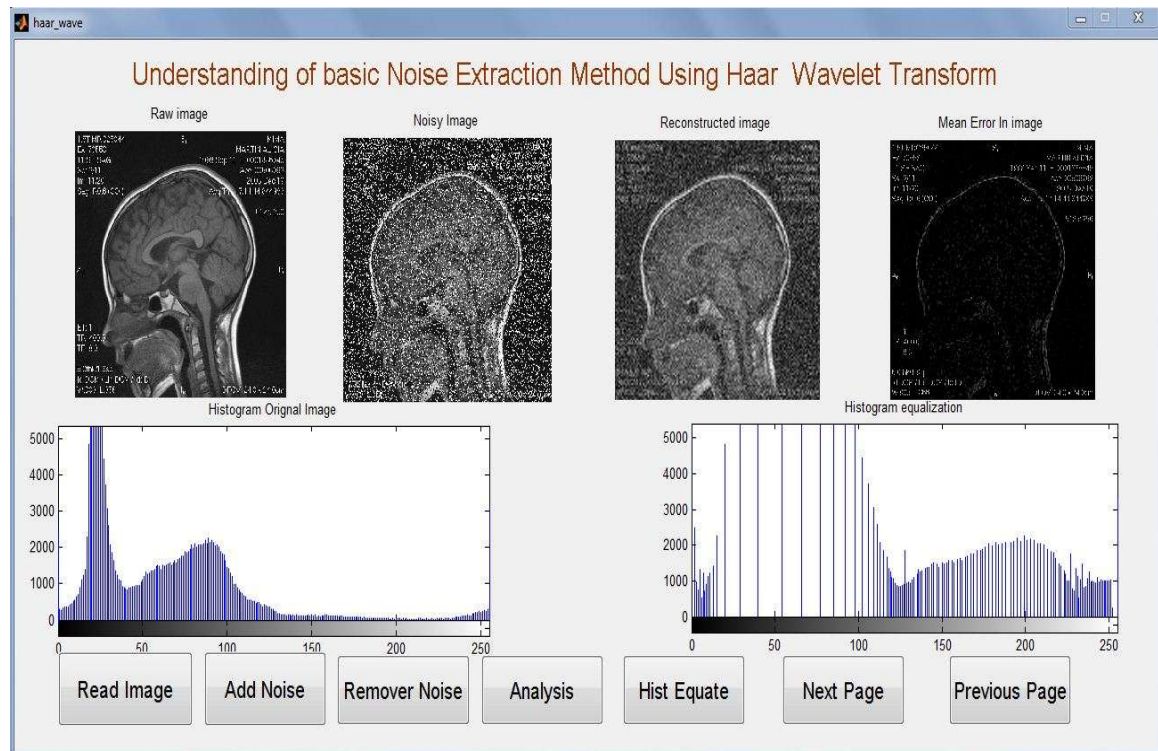

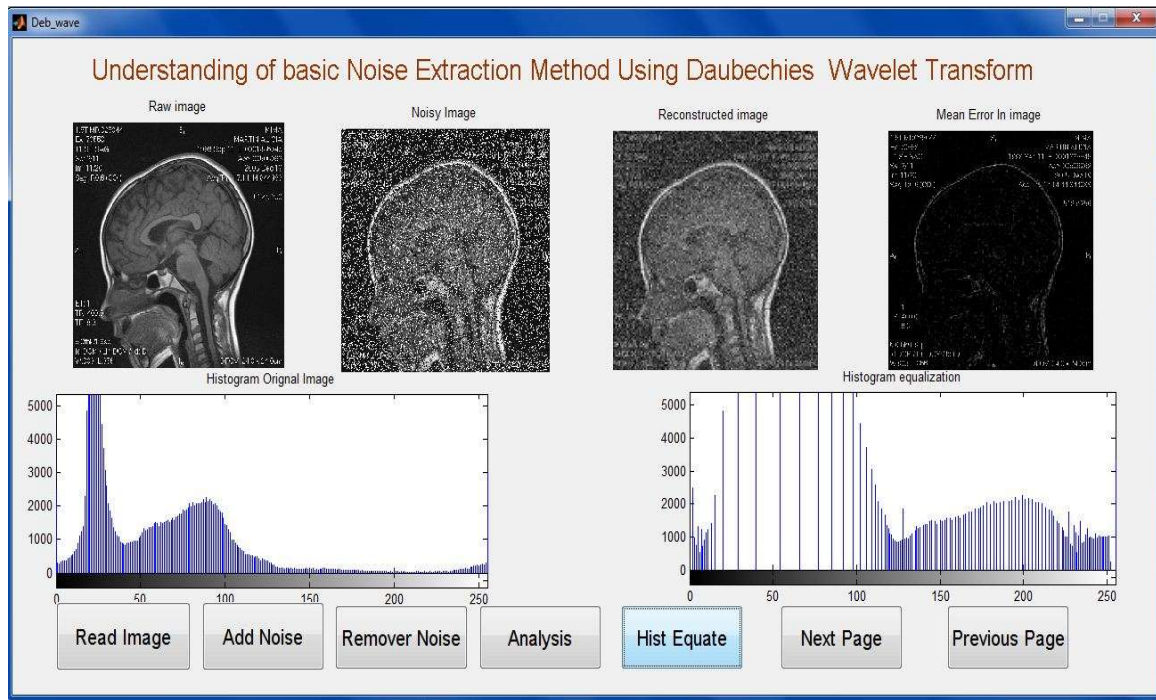**Figure4.17: Snap Shot of Haar filter at Salt & pepper Noise**

Figure4.18: Snap Shot of Deb. filter at Salt & pepper Noise

Figure4.18 is showing that how Deb. wavelet filter was implemented at salt and pepper noise in matlab and it is showing clearly that how image has been enhanced with better quality by showing their corresponding histogram equalization. Figure4.19 is also showing the same enhancement process but with symmlet wavelet filter according to proposed method.
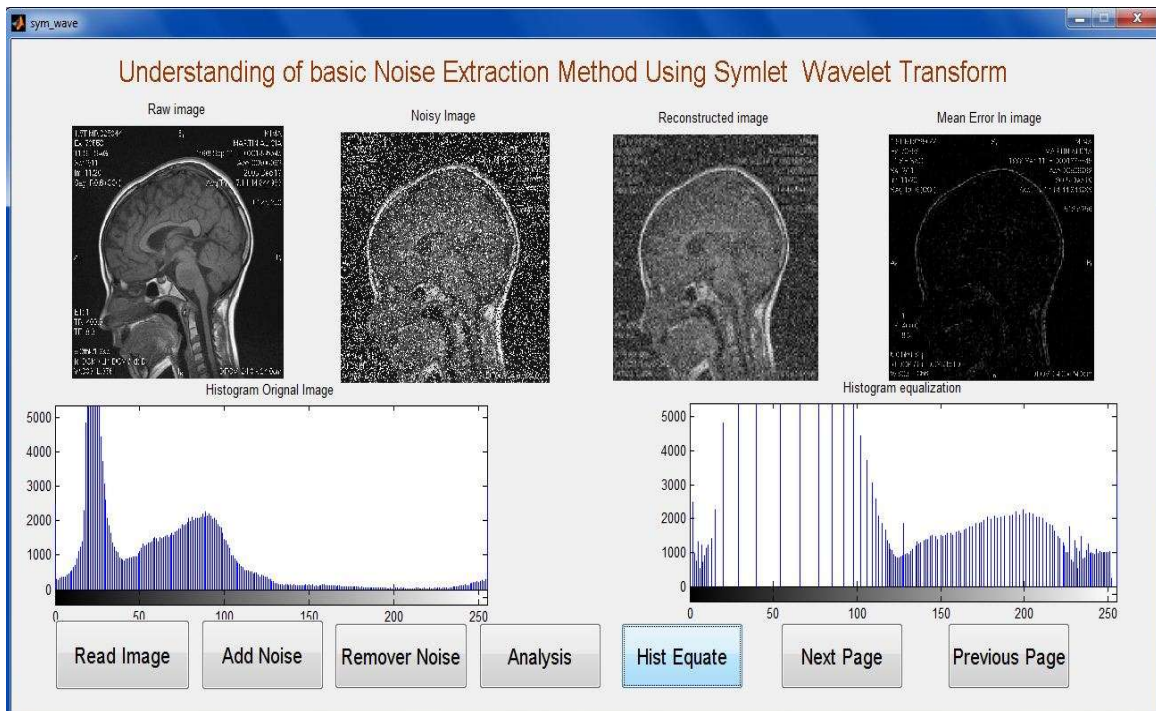

Figure4.19: Snap Shot of Sym. filter at Salt & pepper Noise

Chapter 5
CONCLUSION AND FUTURE SCOPE

In medical image Denoising orthogonal wavelet gave better performance in terms of PSNR, MSE and visual quality then other conventional methods by using appropriate thresholding (Soft thresholding and hard thresholding) and appropriate decomposition level because thresholding and decomposition level both can affect the image if they will not be used in a proper way. Thresholding can kill the important characteristics or can affect the edges of the image whereas decomposition level can also be the reason for blurring of image or can be the reason for increase the time complexity of algorithm, but, it has been found that if thresholding and decomposition will be used in proper by or on the basis of certain parameter like computation complexity and blurring factor of image then it will give good visual quality of medical image. In proposed method, only 2-d grey scaly or monochrome medical images (x-ray images) are considered. In future scope proposed method can be used for 3-D images as well by considering all 3-d images characteristics. Medical images are also being in 3-d form, proposed method can work for those images also by including 3-d images parameter. So, it can be the future scope of proposed method. Enhancement of medical images is helping to doctor in medical filed to detect diseases in earlier states.

It is better to work on medical image enhancement rather than to increase the radiations of x-ray device, because it can harm the human body. Medical image enhancement plays potential contribution in medical filed using hybrid method or by using wavelet transformation method. In past two or three years, the demand of image enhancement is increased in order to make correct diagnosis by the doctors. The main purpose of image enhancement is to preserve the area of interest in reconstructed image. So, wavelet transformation is playing a vital role in that, most of algorithms are using wavelet to enhance the images. There is still no rating scale to rate image quality, you can just simply compare the image with certain fixed parameter like PSNR and MSE. The proposed method can be used in future for 3-d images by applying shaping function to input image having low resolution. From hypothesis, the conclusion is that proposed filtering technique will give better results as comparison with other pre-existing conventional techniques. It will detect and remove noise (impulse, Gaussian, or mixture

of both) from grey scale digital images. It will detect noisy pixel by using hybrid approach (wavelet transformation method) and if some noise will still remain in image then noise will remove with histogram equalization by using the threshold value 'T' of image. Finally, analysis will be done on the parameter that discussed many times in previous chapters. These results will be verifying using matlab tool.

Basically, in medical filed there is no measurement scale or algorithm which can measure the enhancement quality of medical image it's all depend on visual quality of image and perception of human eyes. The actual intension is on brain images means on enhancement of brain medical images so that it is easy to detect brain related diseases like brain tumor. Assumption was that proposed method should be simple and it should easy to implement. By considering all important points proposed filter used some wavelet filter of wavelet family like haar, deb. And Symmlet filter. So, that proposed method can show uniformity and consistency in all the test images like x-ray and brain images or CT (Computerized Tomography: kind of x-ray images), brain images. It might be possible that little bit concept of fuzzy rules can be used in future or can be taken as future scope of this proposed method. The basic aim of image enhancement is to give better visual quality at any cost. So same thing will be there in research work so that goal could reach to expected outcomes from hypothesis and become proof by (using some graphs, data flow diagrams, ER diagrams) with results using some experimental calculated values. All assumptions were valid because now they are implemented in real with matlab tool. But proposed method will use different way to detect noise form medical images so that its visibility should be better in terms of PSNR and MSE.

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Appendix

DWT- Discrete Wavelet Transformation

SWT- Stationary Wavelet Transformation

CT- Computerized Tomography

PSNR- Peak Signal Noise Ratio

MSE- Mean Square Error

RMSE- Root Mean Square Error

OT- Operation Time

Grey Scale Image- Having pixel value in specific range i.e. 0 to 255