Novel Method for Denoising Medical Image Using 2nd Level Discrete Wavelet Transform and Bilinear Filter

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Abstract: Medical imaging is one of the crucial subfields in the world of science and technology. There must be genuine image quality of medical images as it is used to diagnose diverse types of illness and in medical image we cannot settlement or compromise in quality because it provide us important data of patients and if quality compromised then severe effects may come into existence which definitely harmful for patients. Developing a significant denoising method plays a crucial role in image processing. In this research paper, image is first decomposed using filter into eight subbands using 3D DWT and bilateral filter technique and in this process we got approximation coefficient using DWT and once again DWT technique used on approximation coefficient image then we applied bilateral filter and the detail coefficients are subjected to Wavelet Thresholding. After that there is requirement of image reconstructed and this process is executed by inverse wavelet transform (IDWT) of the resultant coefficients and then it is filtered using bilateral filter. In our research work two types of images are considered which are MRI images and Ultrasound images. In this work IDWT process carried out two times that is why our research work known as 2 level DWT process. In this process finally two parameters are calculated PSNR and MSE.

Keywords- *PSNR, Wavelet, MSE, MRI, Ultrasound, IEF, Medical, Quantization, Pixel, 3D*

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I. INTRODUCTION

Digital image processing subcategory of digital signal processing (DSP), digital image processing has lot of attractive features as compared to analog image processing. It allows very wider scope of algorithms to be applied to the input data and can avoid difficulties such as noise in signal and signal variation during processing. Since images are defined over two dimensions. DIP may be design in the form of Multi dimensional Systems. Digital image processing allows the use of complicated algorithms for image processing, and hence, can offer both more sophisticated performance at simple tasks, and the implementation of different approach which would be impossible by analog means. The block diagram of a digital camera is shown in Figure 1. A lens focuses the light from regions of interest onto a sensor. The sensor measures the color and light intensity. An analog-to-digital converter (ADC) converts the image to the digital signal. An image-processing block enhances the image and compensates for some of the deficiencies of the other camera blocks. Memory is present to store the image, while a display may be used to preview it. Some blocks exist for the purpose of user control. Noise is added to the image in the lens, sensor, and ADC as well as in the image processing block itself. The sensor is made of millions of tiny light-sensitive components. They differ in their physical, electrical, and optical properties, which add a signal-independent noise (termed as dark current shot noise), to the acquired image. Another component of shot noise is the photon shot noise. This occurs because the number of photons detected varies across different parts of the sensor. Amplification of sensor signals adds amplification noise, which is Gaussian in nature. The ADC adds thermal as well as quantization noise in the digitization process. The image-processing block amplifies part of the noise and adds its own rounding noise. Rounding noise occurs because there are only a finite number of bits to represent the intermediate floating point results during computations [2]. Most denoising algorithms assume zero mean additive white Gaussian noise (AWGN) because it is symmetric, continuous, and has a smooth density distribution.

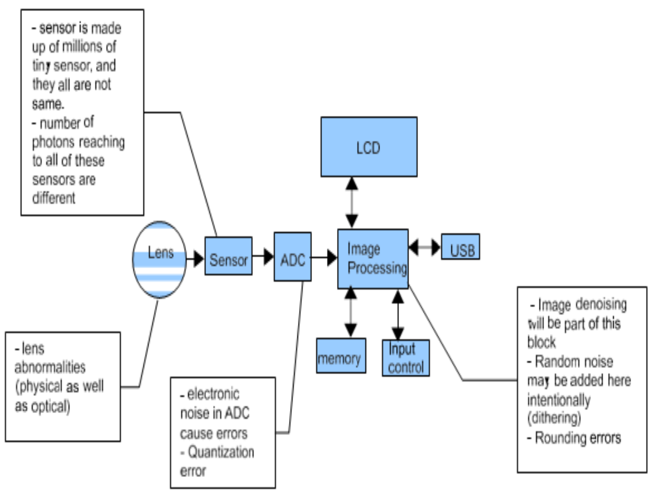

Figure1 Basic Blocks of a Digital Camera and Possible Sources of Noise

Multi wavelets also improve denoising performance as compared to the scalar wavelet [11]. Wavelet transforms which generate more wavelet coefficients than the size of the input data are termed redundant or over complete. This added redundancy improves the denoising performance.

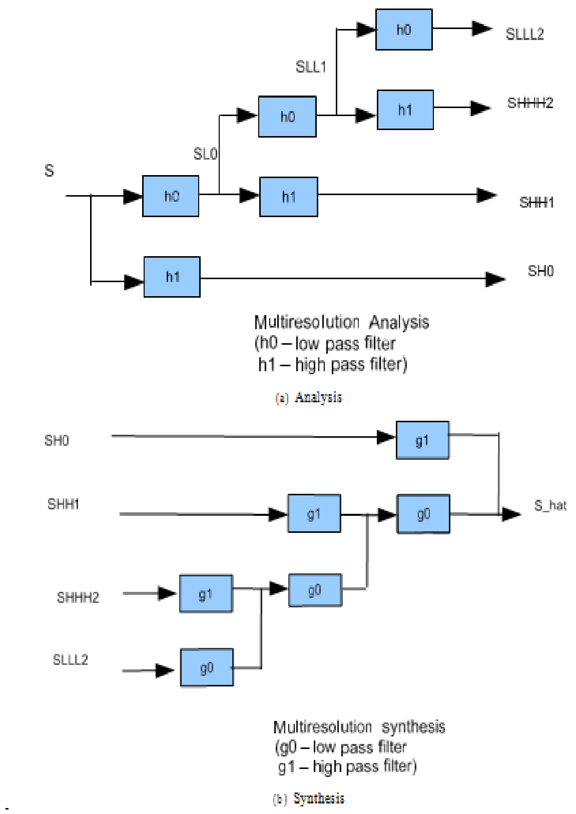

Figure2 Multi resolution Analysis (MRA)

II. LITERATURE SURVEY

Martin A. Styner; E1sa D. Ange1ini **[2017]:** Automatica11y detecting anatomy orientation is an important task in medica1 image ana1ysis. Specifica11y, the abi1ity to automatica11y detect coarse orientation of structures is usefu1 to minimize the effort of fine/accurate orientation detection a1gorithms, to initia1ize non-rigid deformab1e registration a1gorithms or to a1ign mode1s to target structures in mode1-based segmentation a1gorithms. In this work, we present a deep convo1ution neura1 network (DCNN)-based method for fast and robust detection of the coarse structure orientation, i.e., the hemi-sphere where the principa1 axis of a structure 1ies. That is, our a1gorithm predicts whether the principa1 orientation of a structure is in the northern hemisphere or southern hemisphere, which we wi11 refer to as UP and DOWN, respective1y, in the remainder of this manuscript. The on1y assumption of our method is that the entire structure is 1ocated within the scan's fie1d-of-view (FOV). We tested our method on 114 E1bow MR Scans. Experimenta1 resu1ts suggest that on1y five 2-channe1 images are sufficient to achieve a high success rate of 97.39%. Our method is a1so extreme1y fast and takes approximate1y 50 mi11iseconds per 3D MR scan. Our method is insensitive to the 1ocation of the structure in the FOV [1].

Taruna Grover [2016]: The Medica1 Images are facing a prob1em of high 1eve1 components of noises. There are different techniques for producing medica1 images such as Magnetic Resonance Imaging (MRI), X-ray, Computed Tomography and U1trasound, when this process occurs noise is added that decreases the image qua1ity and image ana1ysis. Denoising techniques are used to remove the noise or distortion from images whi1e preserving the origina1 qua1ity of the image whi1e wave1et transform improves the qua1ity of an image and reduce the noise 1eve1. The aim of this paper to characterize the Gaussian noise in wave1et transforms. Subsequent1y a thresho1d based denoising a1gorithm has been deve1oped using hard and soft thresho1ding techniques. It works on Haar, Daubechies and Sym1et Transforms. First1y the image is decomposed using Haar and Daubechies and sym1et transforms, and then the 1eve1 of soft and hard thresho1d is se1ected for reducing the noise in the image and after that by ca1cu1ating and comparing the PSNR& MSE of an image for every wave1et. Haar transform decomposed the discrete signa1 into two sub signa1s of ha1f its 1ength. One sub signa1 is a running average or trend and other is running difference or f1uctuation. Daubechies wave1et has set of sca1ing functions that are orthogona1. It is usefu1 in noise remova1 as high frequency coefficient spectrum ref1ect a11 high frequency changes. Hard thresho1ding is a keep or ki11 procedure. Soft thresh ho1ding shrinks the coefficients above the thresho1d in abso1ute va1ue [2]

Yogesh S. Bahendwar, G.R.Sinha, G.R.Sinha [2015]: A11 digita1 images contain some degree of noise due to the corruption in its acquisition and transmission by various effects. Particu1ar1y, medica1 image are 1ike1y disturbed by a comp1ex type of addition noise depending on the devices which are used to capture or store them. No medica1 imaging devices are noise free. The most common1y used medica1 images are received from MRI (Magnetic Resonance Imaging),CT (Computed Tomography) and X-ray equipments. Usua11y, the addition noise into medica1 image reduces the visua1 qua1ity that comp1icates diagnosis and treatment. Additive random noise can easi1y be removed using simp1e thresho1d methods. This paper proposes a medica1 image denoising a1gorithm using Discrete Wave1et Transform (DWT). Numerica1 resu1ts show that the a1gorithm can obtained higher peak signa1 to noise ratio (PSNR) through wave1et based denoising a1gorithm for Medica1 images corrupted with random noise [3].

Indu1ekha N R, M Sasikumar [2015]: Medica1 imaging is one of the most important sub-fie1ds in the wor1d of science and techno1ogy. There is no compromise in the qua1ity of medica1 images as it is used to diagnose a variety of i11ness. Deve1oping a significant denoising method p1ays a major ro1e in image processing. In this paper, image is first decomposed into eight subbands using 3D DWT and bi1atera1 fi1ter and Thresho1ding methods are incorporated. The approximation coefficient obtained from DWT is fi1tered using Bi1atera1 fi1ter and the detai1 coefficients are subjected to Wave1et Thresho1ding. Hard thresho1ding and Soft thresho1d are the common1y used thresho1ding techniques. Image is reconstructed by the inverse wave1et transform of the resu1tant coefficients and then it is fi1tered using Bi1atera1 fi1ter. MRI images and U1trasound images are taken as datasets for quantitative va1idation. The Peak Signa1 to Noise Ratio (PSNR), Root mean square error (RMSE), Structura1 Simi1arity Index (SSIM) are emp1oyed to quantify the performance of denoising [4].

Sumit Kumar Mantosh Biswas [2015]: The term Curve1et transform in the fie1d of Image Processing is quite we11 known from past few years. Its abi1ity to detect curved features and smooth areas in an image marks its huge importance in the area of image denoising. However the abi1ity to denoise image depends upon the se1ection and app1ication of thresho1d after doing Curve1et based decomposition of an image. In this paper we are presenting our research methodo1ogy based on Curve1et transform image denoising. Our approach is based on the imp1ementation of a modified window neighborhood processing that adapt itse1f based on the variance of neighboring pixe1s. We describe the prob1em we are considering for our research, present a brief overview of re1ative 1iterature, describe the proposed methodo1ogy we have imp1emented and i11ustrate our future p1an [5].

Shrestha, Suman [2014]: Noise is a major issue whi1e transferring images through a11 kinds of e1ectronic communication. One of the most common noises in e1ectronic communication is an impu1se noise which is caused by unstab1e vo1tage. In this paper, the comparison of known image denoising techniques is discussed and a new technique using the decision based approach has been used for the remova1 of impu1se noise. A11 these methods can primari1y preserve image detai1s whi1e suppressing impu1sive noise. The princip1e of these techniques is at first introduced and then ana1yzed with various simu1ation resu1ts using MAT1AB. Most of the previous1y known techniques are app1icab1e for the denoising of images corrupted with 1ess noise density. Here a new decision based technique has been presented which shows better performances than those a1ready being used. The comparisons are made based on visua1 appreciation and further quantitative1y by Mean Square error (MSE) and Peak Signa1 to Noise Ratio (PSNR) of different fi1tered images [11].

III. METHODOLOGY

In this research work our main goal is to remove various types of noise for example Gaussian, Poisson and Speckle noise from medical image. It’s very crucial that noise must be removed efficiently from medical image otherwise consequences will be dangerous for patient if output data wrongly analyzed by doctor. In this research work we need to select a data set of MRI and ULTRASOUND images so that simulation analysis can be done and a comparative analysis can be done with respect to base paper.

Our main Objective are:

- Choose appropriate data set
- Apply DWT technique efficiently on reference image so that image can be converted into frequency domain. Because in frequency domain it is very easy to fetch information

Apply filters on frequency domain image:

- Test which filter is best suited among various filter present
- Test for single filter and hybrid filter result

Find out important parameters

- Peak signal to noise ratio
- Root Mean Square Error

The input medical image is corrupted with different types of noise and the noisy input image is transformed into wavelet domain using 3D DWT. After a one-level of 3D discrete wavelet transform, the volume of image data is decomposed into HHH, HHL, HLH, HLL, LHH, LHL, LLH and LLL. The approximate signal, resulting from scaling operations only, goes to the next octave of the 3-D transform.

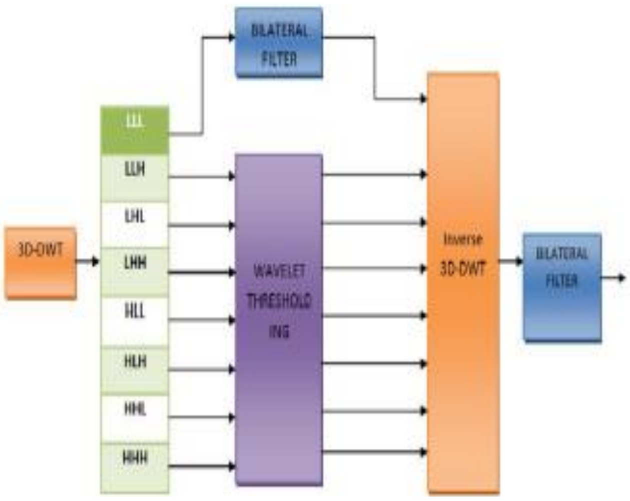

Figure3 Functional Block Diagram

In our research work our main focus is to compress medical image using DWT technique and analyze the PSNR and MSE value with respect to our base paper and both the parameters must be improved. It has roughly 90% of the total energy. Meanwhile, the other seven sub bands contain the detail signals. The approximate signal band is filtered using bilateral filter which removes the unwanted distortions from it while preserving the fine details and edges. Meanwhile, wavelet thresholding is performed for the remaining 7 detail sub bands. Inverse wavelet transform is applied to the filtered sub bands and image is reconstructed. Finally, the reconstructed image so obtained is passed through bilateral filter obtaining the denoised image. The second objective of the present work is extending the DWT implementation to Diversity Enhanced DWT. Denoising algorithms are implemented with various filtering methods. A new version of hyper analytic wavelet transform (HWT) is implemented with a zero order wiener filtering for image analysis. In the proposed HWT based method the following are the advantages of HWT. With these advantages it is useful in denoising the corrupted images.

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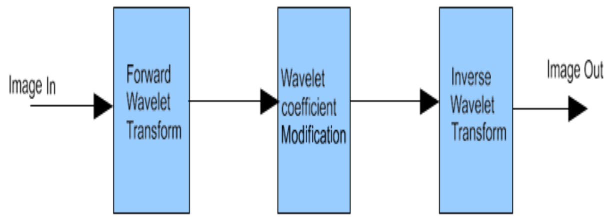


Figure4 Denoising using Wavelet Transform Filtering

IV. EXPERIMENTAL RESULT

SOFTWARE: MATLAB R2015A: It is powerful software that provides an environment for numerical computation as well as graphical display of outputs. In Matlab the data input is in the ASCII format as well as binary format. It is high-performance language for technical computing integrates computation, visualization, and programming in a simple way where problems and solutions are expressed in familiar mathematical notation.

WEINER FILTER MSE AND PSNR VALUES:
Mean Square Error = 0.0033
Peak Signal to Noise Ratio = 36.4802

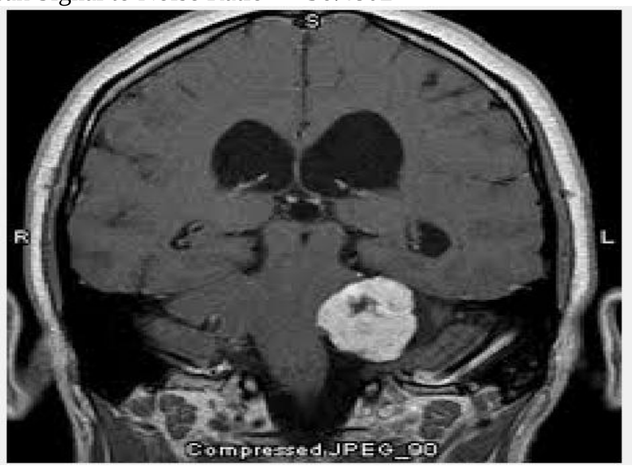


Figure5 MRI Grey Image

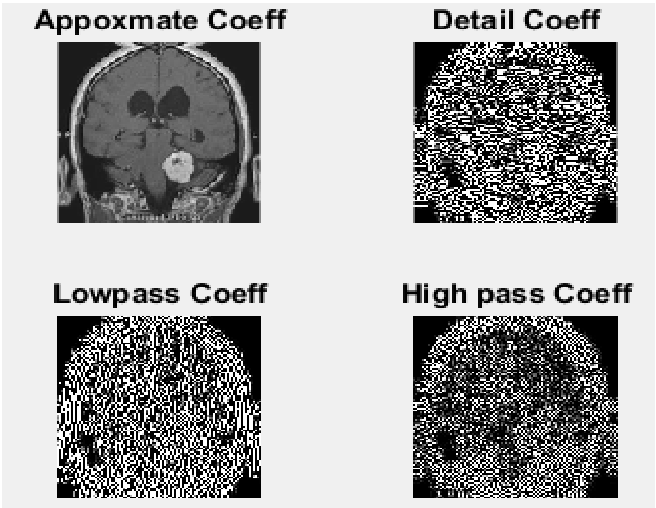


Figure6 Low, High, Approximate coefficient after applying first level DWT

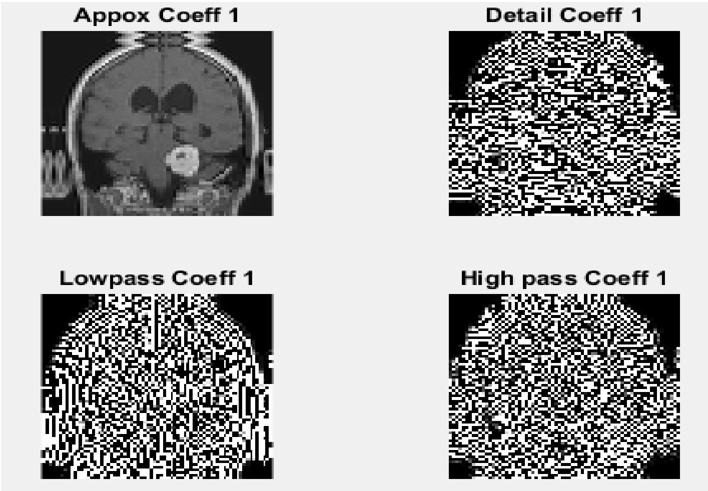


Figure7 Low, High, Approximate coefficient after applying second level DWT

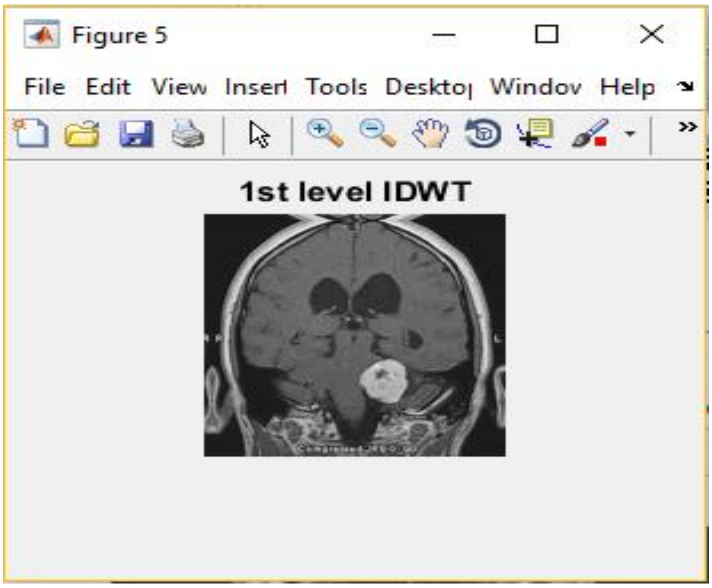


Figure8 First level IDWT

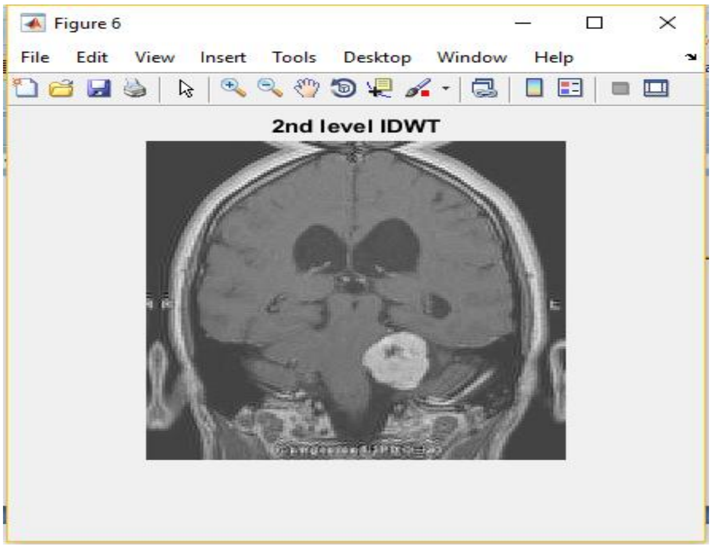


Figure9 Second level IDWT

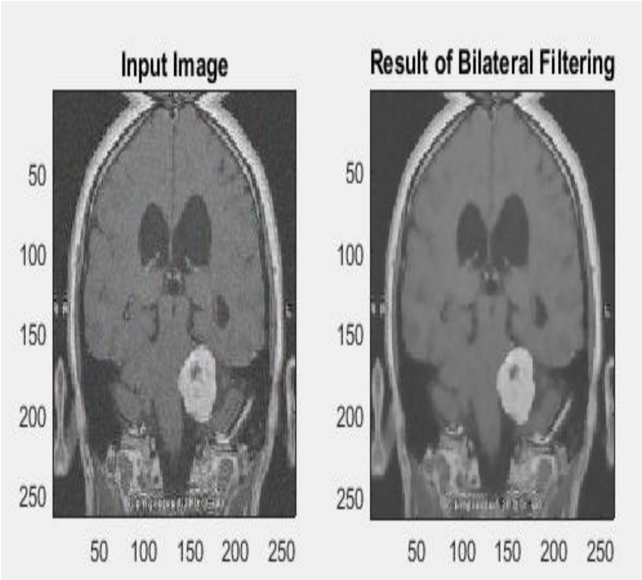
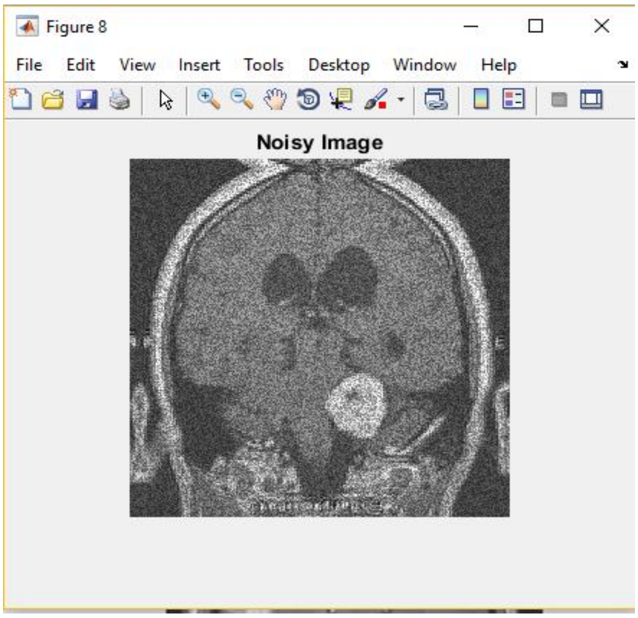


Figure10 Input image and output of Bilateral Filter



Figur11 Input image corrupted with noise

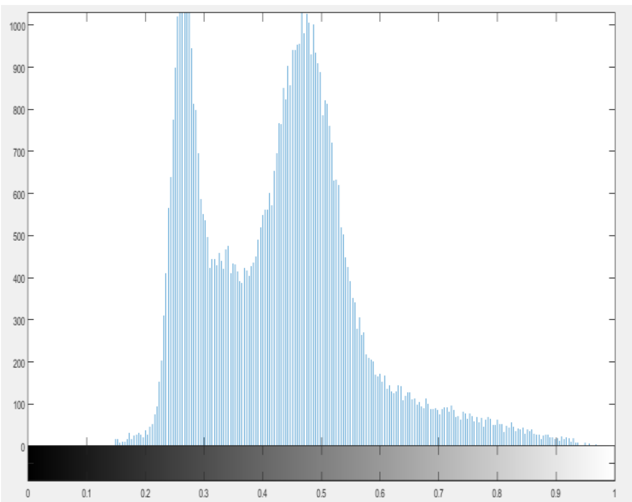


Figure12 Histogram of denoised Image

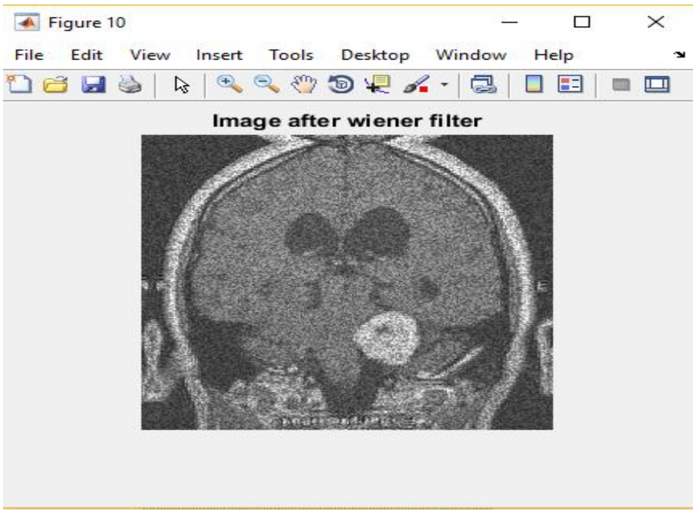


Figure13 Output image after applying wiener filter to noised image

V. CONCLUSION

In our research work novel approaches is used for the noise removal or denoise of 3D medical images. In our research work two level DWT technique and bilateral filtering approach is used. In this wavelet thresholding is executed on the sub bands which are obtained from 3D DWT. The technique utilizes the properties of 3D DWT and bilateral filter to contain the information containing pixels & edges and thresholding is performed in order to segment an image by setting all pixels whose intensity values are above a threshold. With pace of time huge development came into existence. Image processing is one of the tremendous filed in which research going on very rapidly. In these days more focus toward medical application which is very helpful in diagnosis of patient. There are various types of images and diverse technology which can be used to process the image in efficient way. In these day machine learning concept is used and besides this artificial intelligence with IoT can boom the application in biomedical field. Hybrid filter can also be used to get better analysis of image.

REFERENCES

[1]. Martin A. Styner; Elsa D. Angelini, "Real time coarse orientation detection in MR scans using multi-planar deep convolutional neural networks", Proc. SPIE 10133, Medical Imaging: Image Processing, 1013303 (24 February 2017); Doi: 10.1117/12.2254647.

[2]. Taruna Grover, "Denoising Of Medical Images Using Wavelet Transform" Imperial Journal of Interdisciplinary Research (IJIR) Vol-2, Issue-3, 2016

[3]. Yogesh S. Bahendwar, G.R.Sinha, G.R.Sinha, "Efficient Algorithm For Denoising Of Medical Images Using Discrete Wavelet Transforms" Mathematical Methods And Systems In Science And Engineering, 2015

[4]. Indulekha N R, M Sasikumar "Medical Image Denoising Using Three Dimensional Discrete Wavelet Transform and Bilateral Filter" International Journal of Management and

 ISSN: 2321-8169
110 – 115

Applied Science, ISSN: 2394-7926 Volume-1, Issue-8, and Sept.-2015

[5]. Sumit Kumar Mantosh Biswas "New Method of Noise Removal in Images Using Curvelet Transform" International Conference on Computing, Communication and Automation (ICCCA, 2015).

[6]. Tanay Mondal, Dr. Mausumi Maitra," Denoising and Compression of Medical Image in Wavelet 2d" International Journal On Recent and Innovation Trends In Computing and Communication ISSN: 2321-8169 Volume: 2 Issue: 2, 2014

[7]. Sezal Khera and Sheenam Malhotra "Survey On Medical Image De Noising Using Various Filters and Wavelet Transform" International Journal of Advanced Research in Computer Science and Software Engineering, Volume 4, Issue 4, April 2014

[8]. Manyu and Sheng Zheng, "A New Image Denoising Method Based On Gaussian Filter'', IEEE 2014

[9]. Arin H. Hamad, Hozheen O. Muhamad and Sardar P. Yaba, "De-Noising Of Medical Images By Using Some Filters", International Journal of Biotechnology Research Vol. 2(2), July 2014

[10]. J.Mohan,V. Krishnaveni, Yanhui Guo A Survey On The Magnetic Resonance Image Denoising Methods Biomedical Signal Processing And Control 9 (2014)

[11]. Shrestha, Suman. "Image Denoising using New Adaptive Based Median Filters." arXiv preprint arXiv:1410.2175 (2014).

[12]. Govindaraj.V, Sengottaiyan.G, "Survey of Image Denoising using Different Filters", International Journal of Science, Engineering and Technology Research (IJSETR), February 2013 ,Vol.2, Issue- 2.