Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IMPACT FACTOR: 5.258

IJCSMC, Vol. 5, Issue. 6, June 2016, pg.279 – 287

NOISE REMOVAL FOR NATURAL IMAGES USING FILTERS IN DWT TRANSFORM

Latha Rani G.L[1], Jannath Firthouse P[2], Shajun Nisha S[3]

[1,2]M.Phil. Student, Dept. of Computer Science, Sadakathullah Appa College, India

[3]Prof & Head, Dept. of Computer Science, Sadakathullah Appa College, India

[1] latharanigl@gmail.com; [2] ayesha7192@gmail.com; [3] shajunnisha_s@yahoo.com

Abstract*— Image denoising is the elemental chore to oust the noise presence in an image. Noise may egress due to several external or internal stimuli that devised the noise. To eliminate the presence of noise in natural images, denoising algorithms are used. The input image is debased with Gaussian noise and Salt & Pepper noise. The input image is decomposed using Discrete Wavelet Transform (DWT) transform. The decomposition process is accomplished by discriminating the input image with lower and higher image coefficients as LL, LH, HL, and HH. Filtering techniques are employed to deplete the noise presence in an image. The Adaptive Weighted Median Filter (AWMF) and Switching Median Filter (SMF) is used to expel the Gaussian noise and Salt & Pepper noise. The denoised natural images are measured using the metrics like Peak Signal to Noise Ratio (PSNR), Correlation of Coefficient (COC) and Universal Quality Index (UQI).From the results it observed that Salt &pepper noise removes well for both the filters SMF and AMF.

***Keywords*— DWT transform, AWMF, SMF, COC, UQI and PSNR.**

I. INTRODUCTION

Image denoising is one of the substantial process in digital image processing. It is the procedure of the reduction of the corrupted image which are found during the image acquisition. In image, the noise may spring up by various factors like electronic sensor and climatic changes.

The occurrence of noises may degrade the quality of an image. To overcome such issues, the image denoising algorithms are used. Salt and pepper noise is replicated with white and black pixels in an image. Affected pixels having the values of true or false. Gaussian noise may occur deficient quality of image. Generally it is known as additive white noise.

DWT transform is a multiresolution tool, which decomposes the image into various details like horizontal and vertical. It is potent tool for representing both the stationary and non-stationary signals. DWT defines the image with lower and higher coefficients. The decomposed input image is laid in LL, LH, HL and HH.

Filtering is one of the technique to wipe out the noise present in image. It will help to maintain the edge details of image. The filters are capable to retain edges and image detail saving features are highly worthy for visual perception.

A.Related Works

Image Denoising plays a key role in Image Processing area. Denoising is one of the famed steps in Image Processing and it is also called as Pre-Processing Phase. It becomes notable for denoise the image before utilizing to the various application. The main aim of denoising is to remove the unwanted noises or signals without losing any information[1].Image Denoising is a central pre-processing step in image processing to eliminate the noise in order to strengthen and recover small details that may be hidden in the data [3].

The principal sources of noise in digital images arise during image acquisition and/or transmission [13]. A noise can be categorized depending on its source, frequency spectrum and time characteristics. Depending on a source, the noises are categorized into six types: acoustic noise; thermal and shot noise; electromagnetic noise; electrostatic noise; channel distortions, echo and fading; processing noise. [19]

Pepper and Salt noise are a form of the noise classically seen on the images. Salt and pepper noise represents itself as randomly happening black and white pixels. Salt and pepper noise is random in nature, it distributed randomly in the image pixel values [18]. This term arises because detection and recording processes involve random electron emission having a Poisson distribution with a mean response value [5].

Wavelet transform is a mathematical technique that decomposes the signal into series of small basis function called wavelets. It allow the multiresolution analysis of image and is well localized in both time and frequency domain. As a result of wavelet transform the image is decomposed into low frequency and high frequency components. The information content of these sub images that corresponds to Horizontal, Vertical and Diagonal directions implies unique feature of an image[2]. The conventional wavelet transform decomposes only the low frequency components to obtain the next level's approximation and detail components; the current level of the detail components remains intact [4].Wavelet denoising attempts to remove noise which is present in the signal while retaining all the signal characteristics regardless of its frequency contents[6].Using a set of analyzing functions the wavelet transform provides multiresolution representations which are dilations and translations of a few functions (wavelets) [7].

Filtering is a vital part of any signal processing system, which entails estimation of signal degradation and restoring the signal satisfactorily with its features preserved intact. The filters having good edge and image detail preservation properties are highly desirable for visual perception [22].

Objective quality measures are based on a mathematical comparison of the original and processed or enhanced image and can give an immediate estimate of the Perceptual quality of an image enhancement algorithm[11][14].

B. Motivation and Justification

In image processing, denoising is the essential work to restore the image details without loss. Its primary intention is to recuperate the best and estimate noise from original image. Denoising method strengthens to retention small details that may be concealed in the data.

DWT is multi resolution analysis, which is a superfluousness decomposition. The information content of these sub images that represent to Horizontal, Vertical and Diagonal directions necessitates unique characteristics of an image. The artifacts are forfend by using DWT Transform. It is a significant precept that varies to cut off the signal from noise. It depicts the features either spatially or spectrally to filter out the noise. The important feature of DWT is to preserve the edge details and quality of image. So I motivated by these facts and justified that DWT transform with filters works well for removing noises present in Natural Images.

C. Organization of the paper

The remaining paper is organized as follows. Methodology which include the proposed work of, Discrete Wavelet Transform and filtering are represented in section II .Experimental results are shown in section III .Performance evaluation are discussed in section IV. Conclusion in Section V.

II. METHODOLOGY

A. Outline of the proposed work

The input image is added with noises like Gaussian noise and Salt & Pepper Noise. Then Wavelet transform is applied with Coiflets and Biorthogonal. Filter are used to expel the noise. The SMF and AWMF are used. Apply inverse transform, finally denoised images are obtained. Fig1 Shows the block Diagram for DWT Transform for natural images using filters.

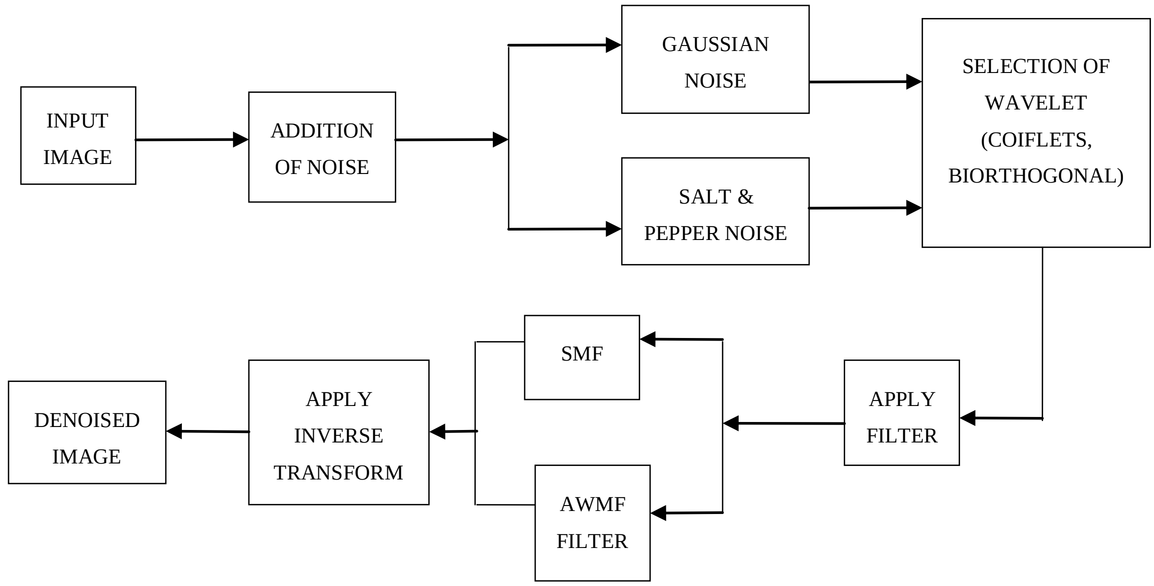

Fig1: Block Diagram for DWT Transform for natural images using filters

B. DWT

Wavelet denoising attempts to remove noise which is present in the signal while retaining all the signal characteristics regardless of its frequency contents. Discrete wavelet transform decompose the original cover image into four frequency sub-bands namely LL, HH, LH and HL. LL frequency sub-band establishes the estimate details. The frequency sub-band LH is used to constitute the vertical details of the image, HL contains the horizontal details of the image and the HH sub-band contains the diagonal details of the image. The LL sub-band that is the approximation of the digital image could be further decomposed with the use of discrete wavelet transform to get any level of decomposition of the digital content and it will generate the further four sub-bands.

LL	LH
HL	HH

Fig.2 Decomposition of image at Level

Thus multiple levels of decomposition could be obtained by applying the discrete wavelet transform on the approximation part, that is, on the LL part of the digital content as desired by the application. These sub band are the decomposition of original image. Sub band LL caries approximate element of image, LH contain the vertical element of image, HL contain the horizontal element of image and HH contains diagonal element of image. Thus the information of image is stored in decomposed form in these sub bands[20]. Fig.2 shows decomposition of image at Level 1.

1) Coiflets:

It is same as daubechies and maximal number of vanishing moments and the scaling function form 2N-1 moment equal to 0. And this general wavelet function has 2N moments equal to 0. The two function support of length 6N-1[23].

2) Biorthogonal:

They are denoted as bior wavelet, biorthogonal if often used instead of orthogonal i.e. rather than having one scaling and wavelet function, there are two scaling functions that may generate different multi-resolution analysis, and accordingly two different wavelet functions used in the analysis and combination [23].

C. Types of Noises

1) Gaussian Noise:

Gaussian noise is the statistical noise which has its probability density function equal to that of a normal distribution, which is called as the Gaussian distribution. In the different words, the noise values can take on being Gaussian distributed. A different case is white Gaussian noise, values at any pair of the times are identically distributed and also statistically independent. In applications, Gaussian noise is normally used as additive white noise to the yield additive white Gaussian noise[5]

$$g(x,y)=f(x,y)+n(x,y) \quad (1)$$

Where g(x,y) is the output of the original image function f(x,y)corrupted by the additive Gaussian noise n(x,y)

Probability density function for Gaussian noise given below

$$p(g) = \sqrt{\frac{1}{2\pi\sigma^2}}\, e^{\frac{-(g-\mu)^2}{2\sigma^2}} \quad (2)$$

Where g represents the grey level, μ the mean value and σ the standard deviation.

2) Salt and Pepper Noise:

Pepper and Salt noise are a form of the noise classically seen on the images. Salt and pepper noise represents itself as randomly happening black and white pixels. A real noise reduction technique for this kind of noise includes usage of the median filter, contra harmonic mean filter or a morphological filter. Pepper and Salt noise creeps into images in circumstances where quick transients, such as defective switching, take place. Salt and pepper noise is random in nature, it distributed randomly in the image pixel values [18].

D. Filtering Techniques

1) Adaptive Weighted Median Filter

The Adaptive Median Filter performs spatial processing to determine which pixels in an image have been affected by noise. The Adaptive Median Filter classifies pixels as noise by comparing each pixel in the image to its surrounding neighbor pixels. The size of the neighborhood is adjustable, as well as the threshold for the comparison. A pixel that is different from a majority of its neighbors, as well as being not structurally aligned with those pixels to which it is similar, is labeled as a noise [17]. With a proper weight set, the WMF has efficient impulsive noise suppression and an excellent image detail -preserving capability [4].

The general weighted median filter structure is as follows,

X = [X1, X2, X3………. Xn]

W = [W1,W2,W3……..Wn]

WM = MED[W1 * X1 ,W2 * X2,W3 * X3……….Wn * Xn] (3)

X is the input values form an input image, W is the array of weights and „WM" is the weighted median value [9].

2) Switching Median Filter:

The switched median filter (SMF) is popularly used to remove the impulse noise. The SMF will provide better denoising in an image [10][12]. The switched median filter it switches for the certain condition. We take the window size to be 3×3 in the matrix. Then we calculate the maximum value in the window Wmax, the mini mum value Wmin and the median value M. When Wmin<M && M< Wmax, if this condition satisfies then we replace the fifth value in the window if not the condition is checked if it is satisfied then the median value is replaced or else the mean value of the window is replaced.

Algorithm for Switched Median Filter

STEP 1: Read the noisy image I.
STEP 2: Convert the color image to gray scale image G.
STEP 3: Pad G matrix with zeros at the boundaries to get matrix P
STEP 4: Taking 3×3 matrix of pixel from matrix P.
STEP 5: Calculate maximum pixel in the window Wmax
STEP 6: Calculate minimum pixel in the window Wmin
STEP 7: Calculate median in the window M.
STEP 8: Check the condition
Case A: If Wmin<M && M< Wmax put B(i,j)=0, then move to step9.
Case B: If Wmin<M && M< Wmax put B(i,j)=M, then move to step 9.
Case C: If Wmin<M && M< Wmax put B(i,j)=mean of window, then move to step9
STEP 9: Repeat step 8 for the entire image.

III. EXPERIMENTAL RESULTS

The original input images are shown in Fig 3. Fig 3.a Show the original coin image, Fig 3.b Show the original building image and Fig 3.c Show the original cat image. The original images are added with Gaussian noise and salt & pepper noise and denoised images for a wavelet family Coiflets with the filter are shown in Fig 4. The original images are added with Gaussian noise and salt & pepper noise and denoised images for a wavelet family Biorthogonal with the filter are shown in Fig 5.

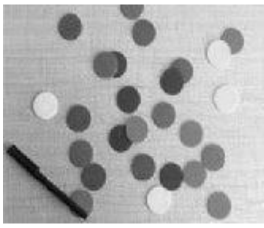
Fig.3.a Original coin


Fig.3.b Original building


Fig.3.c Original cat

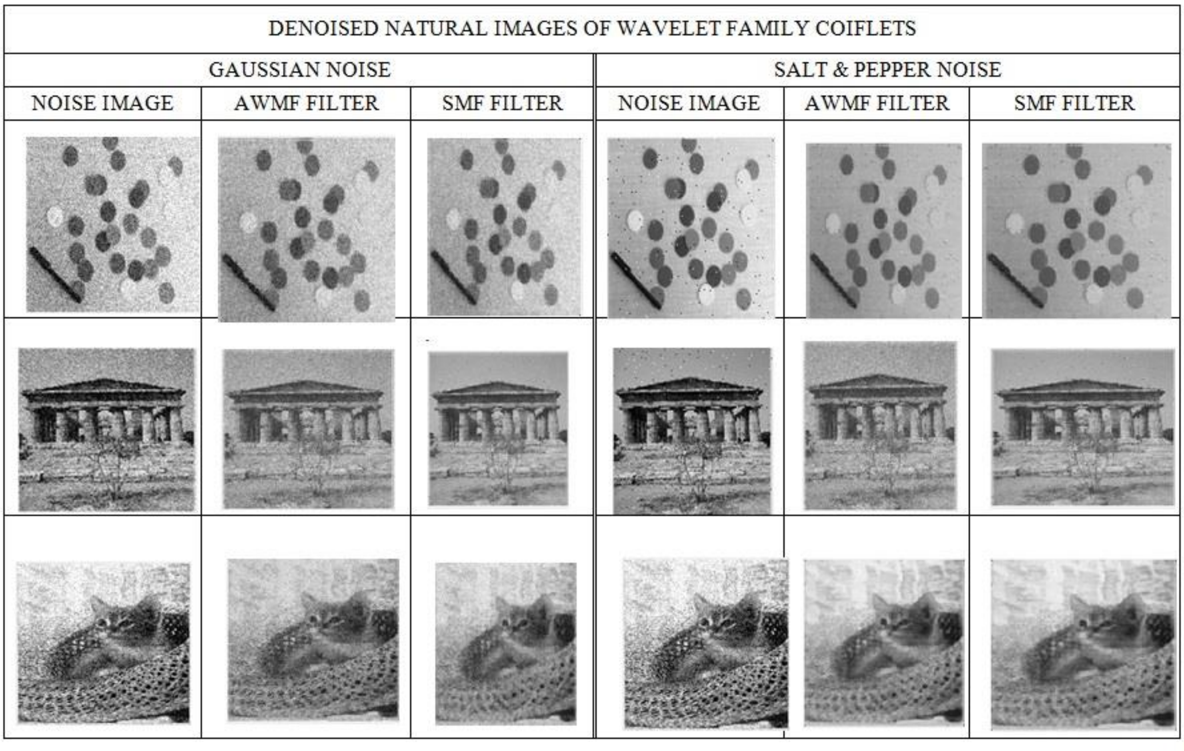

Fig 4. Denoised natural images of wavelet family Coiflets

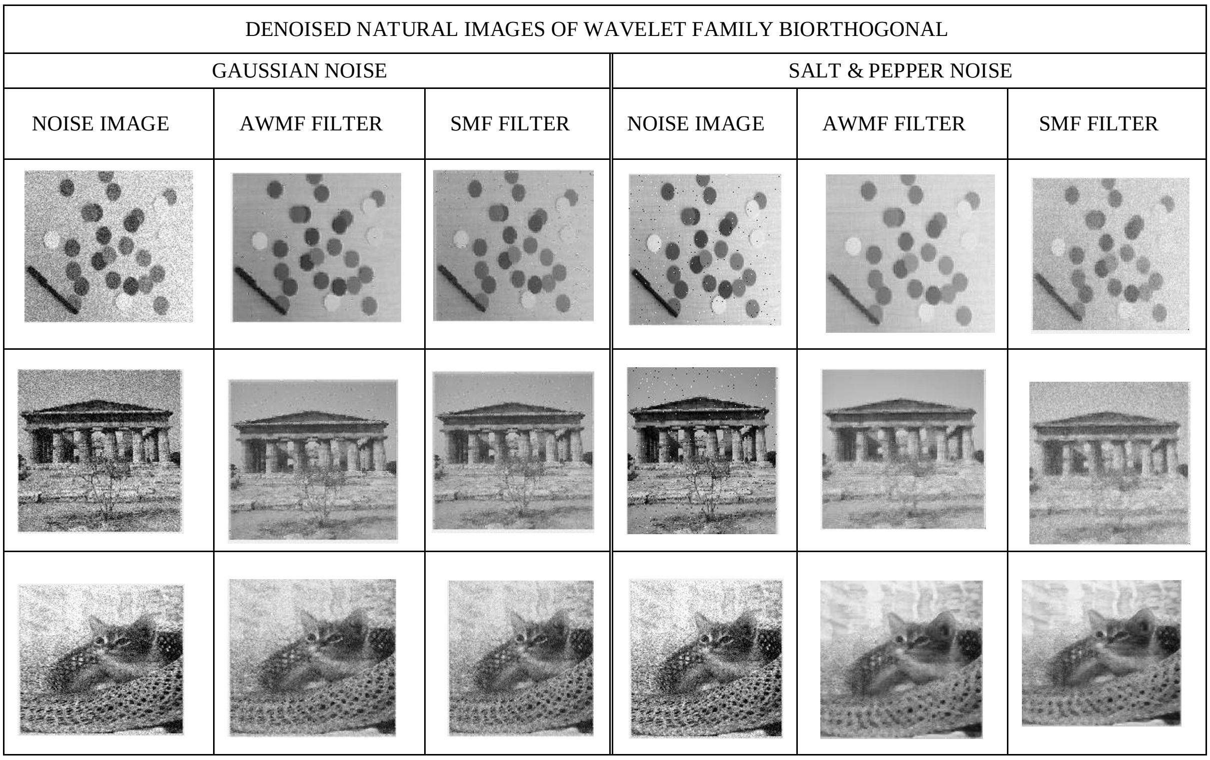

Fig 5. Denoised natural images of wavelet family Biorthogonal

A. Performance Metrics

1) Peak Signal to Noise Ratio (PSNR):

It is the ratio between maximum possible power of a signal and the power of corrupting noise that affects the quality and reliability of its representation. PSNR is calculated as

$$PSNR = 10Log_{10}\left(\frac{MAX^2}{MSE}\right) \quad (4)$$

Where MSE is mean square error and MAX is the maximum pixel value of image [8].

2) Correlation Coefficient (CoC):

$$\text{CoC} = \frac{\sum(X-\bar{X})(Y-\bar{Y})}{\sqrt{\sum(X-\bar{X})^2(Y-\bar{Y})^2}} \quad (5)$$

where, x and y are the mean of the original and denoised image respectively. The CoC is used to measure the similarity between the original image and despeckled image[21].

3) Universal quality Index (UQI):

Universal quality index [14] is the new parameter for comparison of quality of the image. Let x={xi|i=1,2,…,N} and y={yi|i=1,2,…,N} be the original and the test image signal respectively. The quality index Q is defined as:

$$Q = \frac{4\sigma_{xy}\bar{x}\bar{y}}{(\sigma_x^2+\sigma_y^2)[(\bar{x})^2+(\bar{y})^2]} \quad (6)$$

Where

$$\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x_i \;, \quad \bar{y} = \frac{1}{N}\sum_{i=1}^{N} y_i$$

$$\sigma_x^2 = \frac{1}{N-1}\sum_{i=1}^{N}(x_i-\bar{x})^2 \quad , \sigma_y^2 = \frac{1}{N-1}\sum_{i=1}^{N}(y_i-\bar{y})^2,$$

$$\sigma_{xy} = \frac{1}{N-1}\sum_{i=1}^{N}(x_i-\bar{x})(y_i-\bar{y})$$

The range of Q is [-1, 1]. The ideal value Q=1 will achieve iff yi=xi for all i=1, 2,…,, N, i.e. both images are same[16].

B. Performance Evaluation

The performance of Wavelet bases were evaluated by using PSNR, COC, and UQI. Different wavelet bases such as Coiflets and Biorthogonal are used. In Table 1 Denoised natural images of Coiflets for adaptive weighted median filter for Gaussian Noise and Salt & Pepper noise are shown. In table 2 denoised natural images of Coiflets for adaptive weighted median filter for Gaussian Noise and Salt & Pepper noise are shown. In Table 3 denoised natural images of Biorthogonal for adaptive weighted median filter for Gaussian Noise and Salt &Pepper noise are shown. In Table 4 denoised natural images of Biorthogonal Switching median filter for Gaussian Noise and Salt & Pepper noise are shown. From the performance evaluation of original images, it is clearly identified Coiflets performs well against Salt & pepper noise for Adaptive weighted Median Filter.

TABLE I DENOISED NATURAL IMAGES OF COIFLETS FOR AWMF FOR GAUSSIAN NOISE AND SALT & PEPPER NOISE

	Denoised Natural Images Of Wavelet Family Coiflets For AWMF					
	Gaussian Noise			**Salt & Pepper Noise**		
Images	**PSNR**	**UQI**	**COC**	**PSNR**	**UQI**	**COC**
Coin	21.3147	0.19784	0.89479	**25.4471**	0.34722	0.94504
Building	17.4357	0.3005	0.78426	18.4167	0.38621	0.81925
Cat	19.0512	0.26949	0.83686	17.4176	0.85984	0.39316

Table II DENOISED NATURAL IMAGES OF COIFLETS FOR SMF FOR GAUSSIAN NOISE AND SALT & PEPPER NOISE

	Denoised Natural Images Of Wavelet Family Coiflets SMF					
	Gaussian Noise			**Salt & Pepper Noise**		
Images	**PSNR**	**UQI**	**COC**	**PSNR**	**UQI**	**COC**
Coin	22.3709	0.21488	0.91349	**24.9381**	0.37366	0.95082
Building	18.9779	0.2624	0.79613	18.7163	0.33783	0.82506
Cat	17.5856	0.25424	0.86292	19.2694	0.38819	0.8822

Table III DENOISED NATURAL IMAGES OF BIORTHOGONAL FOR AWMF FOR GAUSSIAN NOISE AND SALT & PEPPER NOISE

	Denoised Natural Images Of Wavelet Family Biorthogonal For AWMF					
	Gaussian Noise			**Salt & Pepper Noise**		
Images	**PSNR**	**UQI**	**COC**	**PSNR**	**UQI**	**COC**
Coin	22.7132	0.21383	0.90441	**26.1871**	0.47038	0.9666
Building	18.4534	0.26401	0.70165	20.2663	0.42561	0.80905
Cat	18.5832	0.43054	0.89378	19.8978	0.63694	0.92039

TABLE IV DENOISED NATURAL IMAGES OF BIORTHOGONAL SMF FOR GAUSSIAN NOISE AND SALT & PEPPER NOISE

	Denoised Natural Images Of Wavelet Family Biorthogonal For SMF					
	Gaussian Noise			Salt & Pepper Noise		
Images	**PSNR**	**UQI**	**COC**	**PSNR**	**UQI**	**COC**
Coin	22.7999	0.22572	0.92151	**26.4828**	0.4409	0.96413
Building	17.1293	0.26841	0.79292	18.9784	0.4402	0.85939
Cat	18.7643	0.35976	0.8953	19.9039	0.57741	0.9175

From the above table I, it observed that coin image denoise well with salt & pepper noise for AWMF. In table2 it found that coin denoise well with salt & pepper noise for SMF. From table III it found that coin image denoise well with salt & pepper noise for AWMF filter .Finally table 4, it found that coin denoise well with salt & pepper noise for SMF.

IV. CONCLUSION

The DWT transform is applied to natural images. The wavelet family Coiflets and Biorthogonal are chosen. The Gaussian Noise and Salt & Pepper Noise s are added with images. Filters are utilized to decimate the noises. The Qualitative measure such as PSNR, COC, and UQI are used to estimate the noise removal of images .From the performance evaluation of original images, it is found Coiflets performs well against Salt & pepper noise for Adaptive weighted Median Filter. Biorthogonal denoise the Salt & Pepper noise with a Switching Median Filter.

REFERENCES

[1] Latha Rani G. L, Jannath Firthouse. P, Shajun Nisha. S," A Study on Medical Image Denoising using Wavelet and Contourlet Transform", International Journal of Advance Research in Computer Science and Management Studies, March 2016.

[2] Renjini L,Jyothi R L, "Wavelet Based Image Analysis:A Comprehensive Survey" ,International Journal of Computer Trends and Technology (IJCTT),Mar 2015

[3] Abbas H. Hassin AlAsadi,"Contourlet Transform Based Method For Medical Image Denoising", International Journal of Image Processing (IJIP), Volume (9): Issue (1): 2015

[4] Reena Thakur,"Analysis of Orthogonal and Biorthogonal Wavelet using Gaussian noise for image denoising", IJAIEM, ISSN-2319-4847, 2013

[5] Er.Ravi Garg and Er. Abhijeet Kumar, "Comparison of Various Noise Removals Using Bayesian Framework", International Journal of Modern Engineering Research , Jan-Feb 2012.

[6] S.Agrawal ,R. Sahu,"International Journal of Science, Engineering and Technology Research" 2012.

[7] Shan Lal, Mahesh Chandra, Gopal Krishna Upadhyay, Deep Gupta, "Removal of Additive Gaussian Noise by Complex Double Density Dual Tree Discrete Wavelet Transform" ,MIT International Journal of Electronics and Communication Engineering, ,Jan 2011.

[8] Olawuyi, N.J." Comparative Analysis of Wavelet Based Denoising Algorithms on Cardiac Magnetic Resonance Images" Afr J Comp & ICT Olawuyi et al - Comparative Analysis of Wavelet-Based Denoising Algorithm Vol 4. No. 1. June 2011

[9] Zhu Youlian, Huang Cheng, "An Improved Median Filtering Algorithm Combined with Average Filtering" Third International Conference on Measuring Technology and Mechatronics Automation, IEEE, 2011.

[10] J Xia, J Xiong, X Xu and Q Zhang, "An efficient two-state switching median filter for the reduction of impulse noises with different distributions", 3rd International Congress on Image and Signal Processing (CISP), Vol No. 2, pp.639–644, 2010.

[11] Francisco Estrada. and Allon Jepson. Stochastic "Image Denoising". ESTRADA, FLEET, JEPSON, 2009.

[12] Umesh Ghanekar "A Novel Impulse Detector for Filtering of Highly Corrupted Images " World Academy of Science Engineering and Technology, Vol No.14, pp No. 352-355, 2008.

[13] Rafael C. Gonzalez, Richard E. Woods, ―Digital Image Processing‖, 3rd edition, 2008.

[14] S.Kother Mohideen., Dr. S. Arumuga Perumal. and Dr. M. Mohamed Sathik,"Image Denoising using Discrete Wavelet Transform", IJCSNS International Journal of Computer Science and Network Security. VOL, January 2008

[15] Pei-Eng Ng and Kai-Kuang Ma, "A switching median filter with boundary discriminative noise detection for extremely corrupted images", IEEE Transaction on Image Process. 2006.

[16] Zhou Wang, Alan C. Bovik,"A Universal Image Quality Index", IEEE Signal Processing march 2002.

[17] Mitsuji Muneyasu, Taltahiro Mae& a,nd Taltao Hinainoto "A New Realization of Adaptive Weighted Median Filters Using Counter Propagation Networks" 1999 IEEE.

[18] Scott E Umbaugh, "Computer Vision and Image Processing,Prentice Hall PTR",1998

[19] Astola. JandKuosmanen.P, "Fundamentals of Nonlinear Digital Filtering", 1997.

[20] Bhupal Singh Classification of Brain MRI in Wavelet Domain International Journal of Electronics and Computer Science Engineering, Volume1,Number 3.

[21] Sattar, F., L. Floreby, G. Salomonsson and B. Lovstrom, 1997. Image enhancement based on a nonlinear multiscale method. IEEE Trans. Image Process.

[22] Myung-Sin Song, Wavelet Image compression, 1991

[23] Neeraj Saini, Pramod Sethy "Performance based Analysis of Wavelets Family for Image Compression-A Practical Approach", International Journal of Computer Applications.

Authors Profile

Latha Rani G.L is currently pursuing M.Phil. Degree in computer science in Sadakathullah Appa College, Tirunelveli. She has completed MCA degree, 2013 in National Engineering College, Kovilpatti graduated under Anna University Chennai. She has completed B.Sc. (Computer Science) in 2010 in Rosemary College of Arts Of Science graduated under Manonmaniam Sundaranar University, Tirunelveli. Her area of interest is image denoising.

Jannath Firthouse P, received the M.sc degree in Computer Science from MS University in 2015 and B.sc degree in Computer Science from MS University in 2013. She is currently pursuing the M.Phil degree in Computer Science under the guidance of Shajun Nisha. Her Research interest are mainly include domain of Medical Image Denoising

Shajun Nisha S, Professor and Head of the Department of Computer Science, Sadakathullah Appa College, Tirunelveli. She has completed M.Phil. (Computer Science) and M.Tech. (Computer and Information Technology) in Manonmaniam Sundaranar University, Tirunelveli. She has involved in various academic activities. She has attended so many national and international seminars, conferences and presented numerous research papers. She is a member of ISTE and IEANG and her specialization is Image Mining.