

De-Noising Sine and Real Time Audio Signal Using Discrete Wavelet Transform DWT Method *

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Abstract—Most of transmission and receiving signals are often corrupted by noise which can cause severe problems for downstream processing. Therefore, an automated removal of noise would be an invaluable first stage for many signal processing tasks. There are various methods to restore a signal from noisy distortions. In this paper, Discrete Wavelet Transform DWT to be an invaluable accumulation tools and to be enjoyed a rapidly increasing recognition of the signal processing field for the purpose of sine and real audio signal. Wavelet analysis can be compressed or de-noised a signal without appreciable degradation with the SIMULINK/ MATLAB. Wavelet de-noise acts as to remove the noise present in the signal while preserving the signal characteristics, regardless of its frequency content. Moreover, Wavelets is decomposition function that it is a capable method of de-noising. In this paper, according to the analysis of system's performances such as Coiflet5, Daubechies9 and Daubechies10 Wavelets for different values of their order are compared and tested for an audio signal. Further, the variation of threshold values with respective correlation values has been investigated for sine and real audio signal in AWGN channel.

Keywords—De-Noising, DWT, Coiflet, Daubechies, SIMULINK/MATLAB

I. INTRODUCTION

Modeling and removing noise and distortions are at the core of theoretical and practical considerations in communications that limit the capacity of data transmission and that they also affect the accuracy of the results in the signal measurement systems. Another important factor here is that are major problems in applications such as cellular mobile commu-

nication, speech recognition, image processing, medical signal processing, radar and any other application where these desired signals cannot be isolated from this effect [1]. In this paper, it was introduced the consideration methods to reduce noise in a periodic audio signal and sine signal by using wavelet transforms. In solving engineering problems, the use of wavelets in signal and image processing has been found to be very useful tool [2 to 7].

Wavelets are used in a variety of fields including physics from the removal of noise from signals containing information. Wavelets are superior to STFT and Fourier Transform because its simultaneously process time and frequency. Wavelets can be stretched at high frequency which provides fast changing details [7,8]. In the case of low frequency, they are applied to slow changing features. Without using complex numbers, Wavelet can easily represent functions for discontinuities and sharp peaks. The mathematical manipulation that affects synthesis is called Discrete Wavelet Transforms (DWT). In order to synthesize the signal by using Wavelet toolbox and then reconstruct it from the wavelet orders [1].

The number of vanishing points is an important criterion in choosing a Wavelet. If there are 'n' vanishing moments, it means the Wavelet coefficients for nth order polynomial will be zero. This implies that any scale upto (n-1)th order can be drawn completely in scaling space. More vanishing points means that the signal can be represented more accurately. Symmetry considerations are useful for providing knowledge about signal phasing. The regularity of a wavelet is also useful for smoothness of the reconstructed signal. Daubechies Wavelet comprises of a maximum number of vanishing moments and is not symmetrical in nature. Coiflet and Symlet Wavelets are near-symmetrical in nature. The Coiflet Wavelet has vanishing moments in its scaling function. Exact reconstruction is possible in all three Wavelets [7 to 10].

The general procedure for de-noising requires basic three steps are described. Firstly, decompose can be chosen a wavelet. Secondly, it can be chosen a level N and to compute the wavelet decomposition of the signal S. Thresholding are expressed in detail coefficients for each level from 1 to N,

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select a threshold and apply soft or hard thresholding method to the detail coefficients [11,12].

II. CONSIDERATION OF SINE AND AUDIO SIGNAL

To do this, it will start to consider signal by creating a sine wave, which is periodic and presents a well-known behavior. First, it is necessary to define the time interval and to define the angular frequency.

For an original audio file, the first is used wave device to record. It is loaded from audio device to wave file in SIMULINK toolbox. After then, it can be changed the configuration parameter in simulation. The model does not have continuous states; hence it is used the solver 'variablestep discrete' instead of solver 'ode45'. It can be disabled this diagnostic by explicitly specifying a discrete solver in the solver tab of the configuration parameters dialog or setting 'automatic solver parameter selection' diagnostic to 'none' in the diagnostic tab of the configuration parameters dialog. In Figure 1 shows the creation of audio acquire to record in SIMULINK.

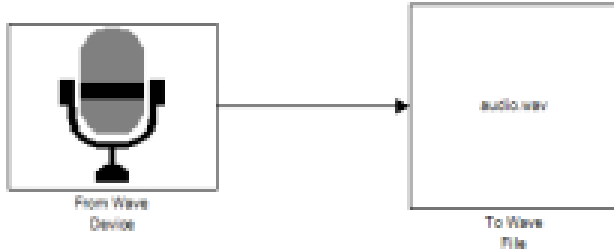


FIGURE I: BLOCK DIAGRAM OF AUDIO ACQUIRE TO RECORD

In Figure 2, it can be realized the source block parameter from wave device. It can be read audio data samples from a standard window audio device in real time. In this block parameter, it can be changed a variety of parameter values such as suitable sample rate in Hertz, sample width (16 bits), queue duration in time in sec and data type system double [13-27]. In Figure 2 shows that the received audio file from microphone speaker.

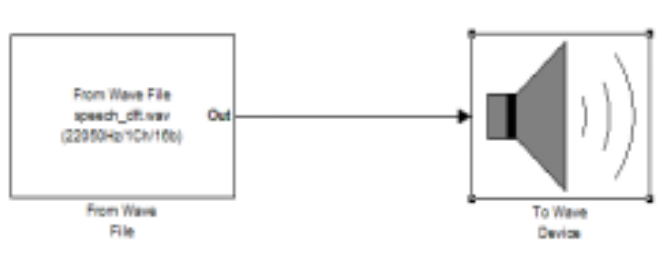


FIGURE II: BLOCK DIAGRAM OF AUDIO ACQUIRE FROM SPEAKER

In Figure 2, it can be realized the sink block parameter To wave file. It can be write audio data samples to a standard window PCM format "WAV" audio file in real time. In this block parameter, it can be changed a variety of parameter values such as sample rate (16) bits and it can be chosen variable source file name.

III. DESIGN OF INVESTIGATION

The performance of a sine signal and real voice or audio signal over digital processing system is also presented.

A. De-noising Process for Sine Signal

To investigate the performance of a sine signal over digital processing system is expressed in Figure 3.

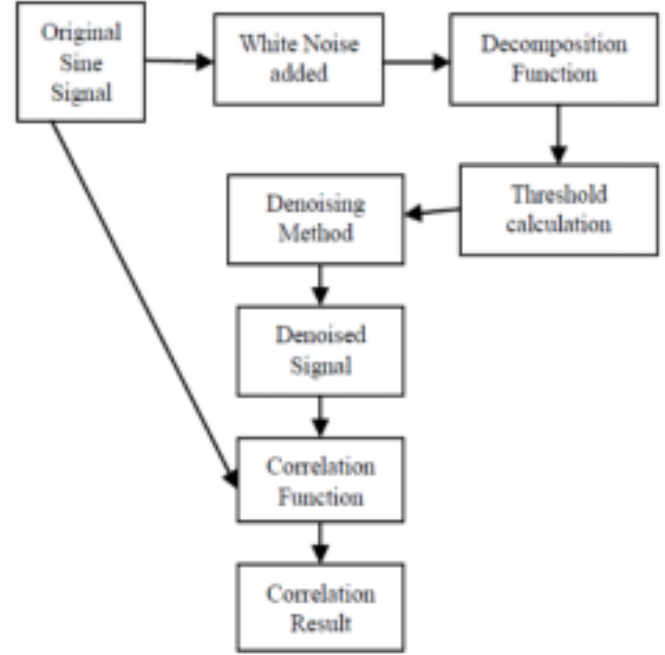


FIGURE III: FLOW DIAGRAM OF DE-NOISING FOR SINE SIGNAL

B. De-noising Process for Audio Signal

To investigate the performance of a real audio signal over digital processing system is expressed in Figure 4.

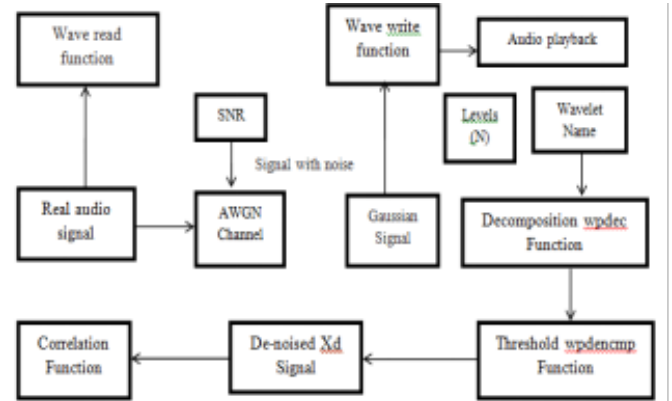


FIGURE IV: BLOCK DIAGRAM OF DE-NOISING FOR AUDIO SIGNAL

IV. TEST AND RESULTS FOR SINE SIGNAL

This section presents not only simulations results that are carried out but also analyze over these results and comments. These simulation modules are implemented taking the standard design parameters are shown in workspace's.

In Figure 5 and Figure 6 for Coiflet5 is considered for original, with Gaussian noise, de-noise signal and correlation curve. After then, Daubechies with order 9 is shown in Figure 7 and Figure 8. The next step, db10 wavelet filter is considered to realize this results. In sinus waveform is taken into the frequency of 250Hz due to real voice is in that range.

To be able to examine the effect of de-noise signal, random white Gaussian noise are added over the AWGN channel in Figure 5 and Figure 6. In most of the research, the simulation are carried out $S/N = 10$ dB which is the better channel situation and very low noise.

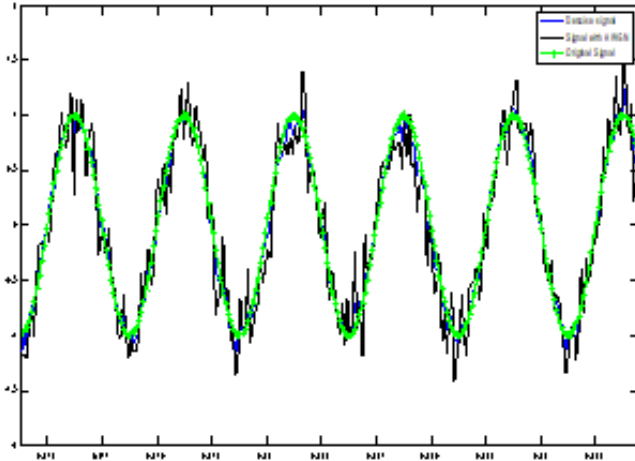


FIGURE V: COIF5'S DE-NOISE SINE SIGNAL

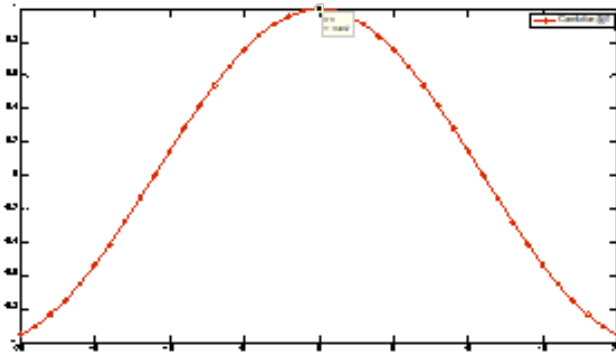


FIGURE VI: COIF5'S CORRELATION @ 0

After running in MATLAB simulation, it is also investigated the effect of cross correlation D between original signal and signal de-noise with data cursor.

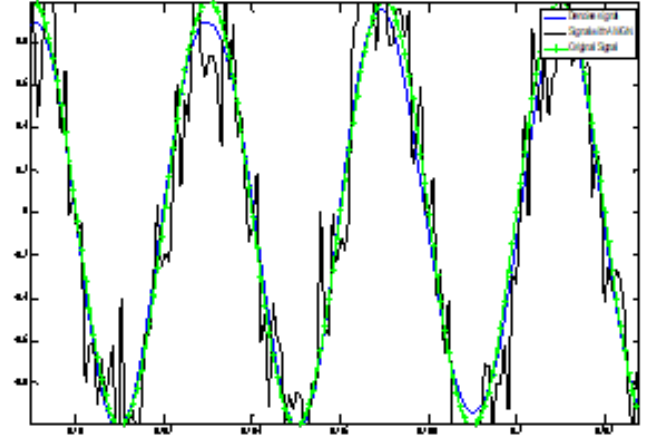


FIGURE VII: DAUBECHIES 9'S DE-NOISE SINE SIGNAL

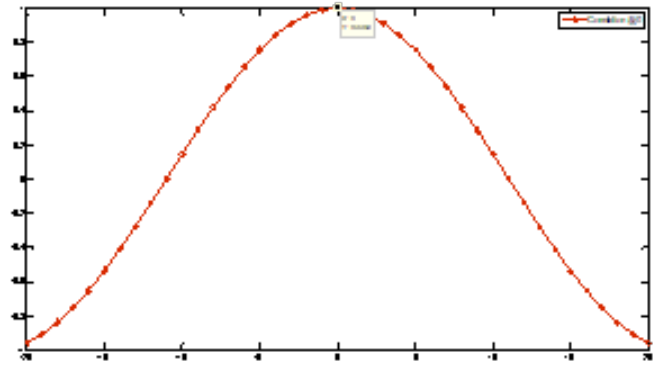


FIGURE VIII: DAUBECHIES 9'S CORRELATION @ 0

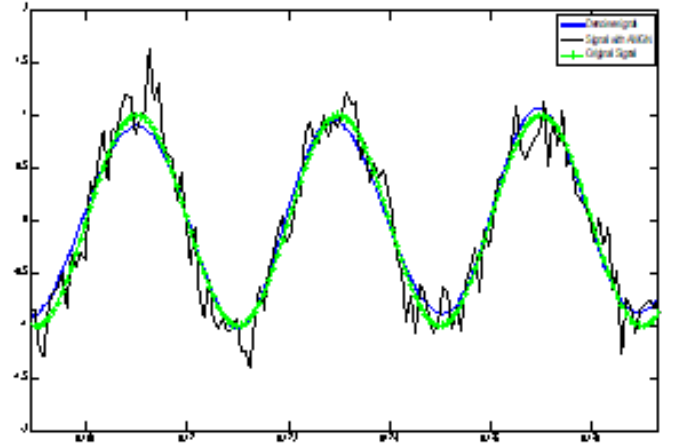


FIGURE IX: DAUBECHIES 10'S DE-NOISE SINE SIGNAL

At the last, it can be concluded that there are some distortion between the white noise sine signal and de-noise resultant sinusoidal function for three wavelet families in Table I. The level of distortion also depends on the detection method on real environment. By analyzing all of results, it can be known the evaluation of threshold values and shows cross correlation to determine the best result in Daubechies9 after noise reduction. Finally, it can be realized that the effects of sine signal are not serious for this analysis.

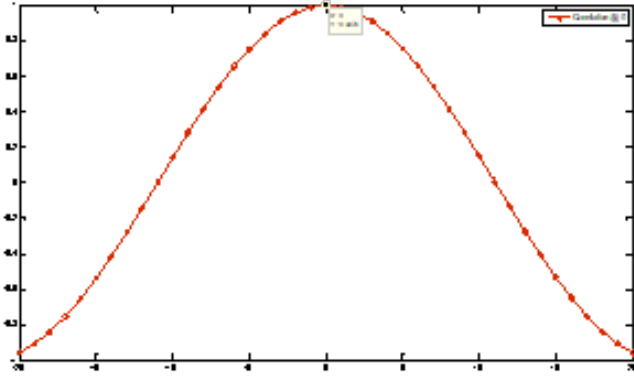


FIGURE X: DAUBECHIES 10'S CORRELATION @ 0

TABLE I: COMPARISON OF SINE SIGNAL

Wavelet Filter	Threshold	Correlation
Coiflet5	0.3598	0.9967
Daubechies9	0.6817	0.9969
Daubechies10	0.5659	0.9976

V. TEST AND RESULT FOR AUDIO SIGNAL

This section presents not only simulations results that are carried out but also analyze over these results and comments.

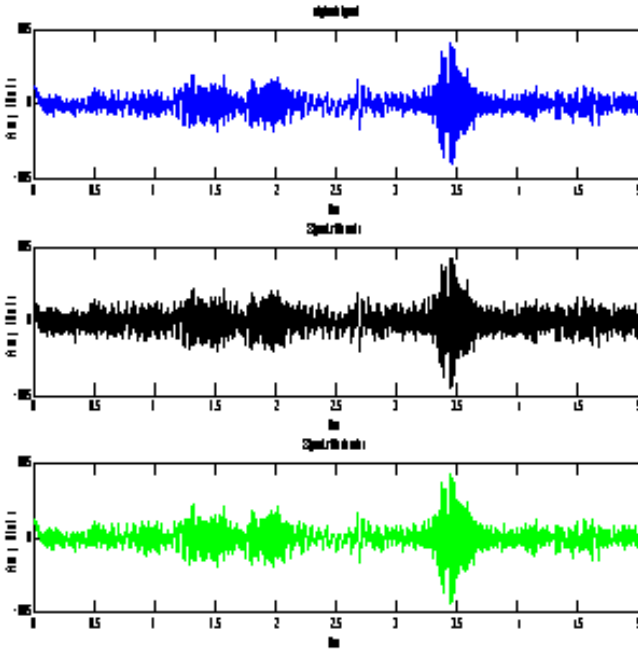


FIGURE XI: COIF5'S DE-NOISE AUDIO SIGNAL

These simulation modules are implemented taking the standard parameters are taken for Coiflet5 and db9. The next step, db10 wavelet filter is considered to realize as shown in Figure 12 to Figure 16. This paper is taken into the frequency of 250Hz. According to the simulation result, de-noise signal can be compared with the original sine function. In these comparison, sine function has less interference than real voice over AWGN channel. Thus, it can be clearly seen that the Coiflet wavelet filter is reliable for this audio signal.

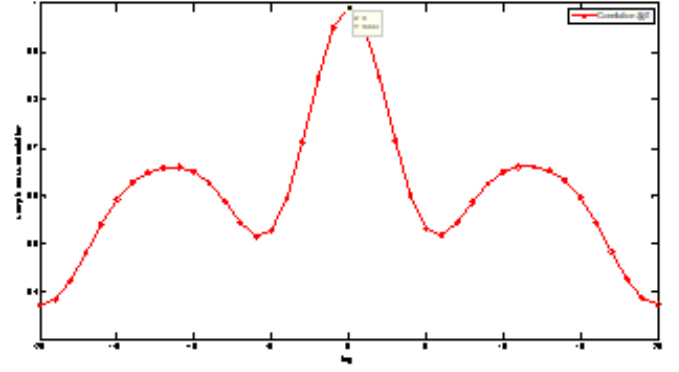


FIGURE XII: COIF5'S CORRELATION @ 0

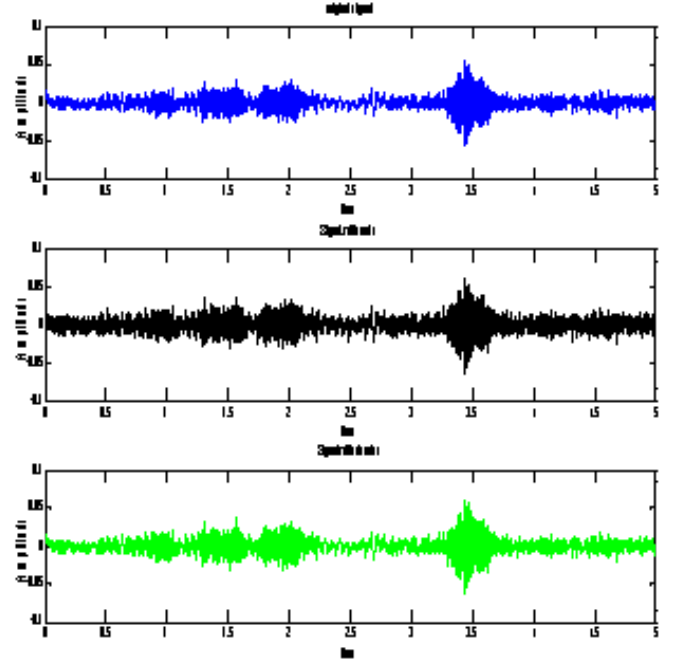


FIGURE XIII: DAUBECHIES 9'S DE-NOISE SIGNAL

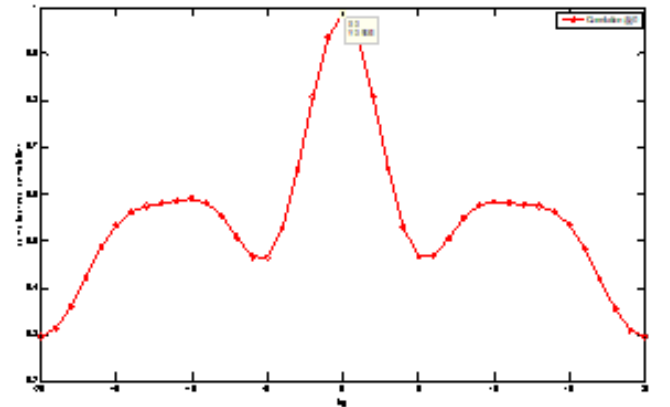


FIGURE XIV: DAUBECHIES 9'S CORRELATION @ 0

The Daubechies 9's filter can be seen over Gaussian noise signal. By comparison performance the above Coiflet5 noise signal's figure, there is no significant plot of result.

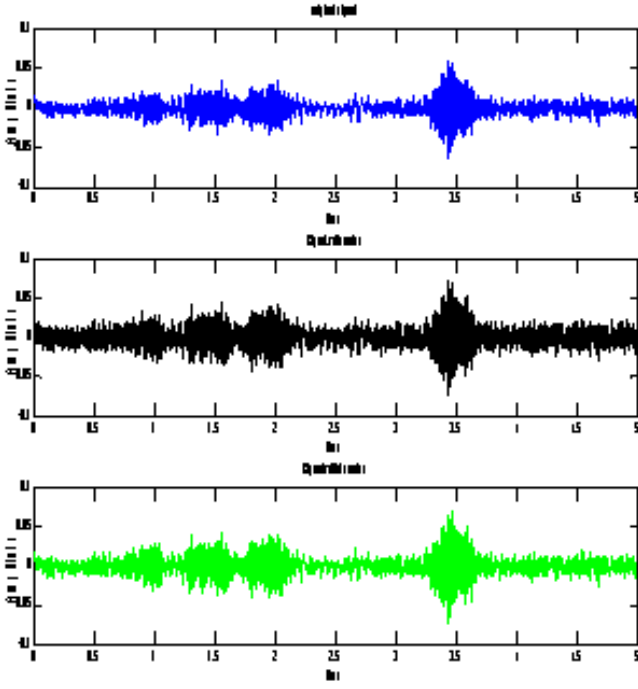


FIGURE XV: DAUBECHIES 10's DE-NOISE SIGNAL

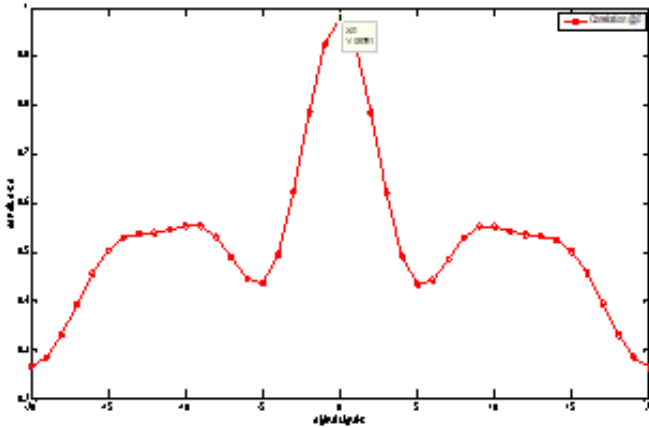


FIGURE XVI: DAUBECHIES 10's CORRELATION @ 0

At the last, it can be concluded that there is some distortion between the white noise voice signal and de-noise resultant sinusoidal function for two wavelet families. The level of distortion also depends on the detection method on real environment. By analyzing all of results, it can be known the evaluation of threshold values and shows cross correlation to determine the best result after noise reduction. Finally, it can be realized that the effects of voice signal are not serious for this analysis.

TABLE II: COMPARISON OF AUDIO SIGNAL

Wavelet Filter	Threshold	Correlation Values
Coiflet5	0.0033	0.993
Daubechies9	0.0042	0.9861
Daubechies10	0.0097	0.9791

The two wavelet families have been evaluated in case of audio signal in Table II. For Coiflet5, Daubechies9 and Daubechies10 are considered the result of performance. By studying this simulation result, the correlation value is maximum in the case of at Coiflet5 at lag0 is followed by

Daubechies9 and Daubechies10. Therefore, the theoretical values and simulated values of threshold are matched for the kinds of wavelet filters.

VI. CONCLUSION

In Coiflet5 Wavelet and Daubechies9 and 10 Wavelet, it has been found that the performance of Coiflet Wavelet is the best is followed by Daubechies10 and then Daubechies9 Wavelet. When it is observed that the value for Coiflet5 Wavelet, the pattern observed for threshold value is the best fit. The maximum value of correlation is found at Daubechies10, followed by Coiflet5 and Daubechies9. There is no significant difference in the correlation values is very minimal for Coiflet5 and Db10. Thus, it has been found to be the best for de-noising purposes. De-noising of audio signal has been achieved successfully using wavelets. This provides a practical approach on how noisy audio in wavelet form incorporated with white Gaussian noise can be de-noised. A high correlation value above 99 percent for sine signal with two wavelet families Coiflet5, db9, db10 and above 99 percent for real audio signal with two wavelet families Coiflet5 and db10 at lag value of zero has been achieved.

COMPETING INTERESTS

The authors declare no competing interests.

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ETHICAL STATEMENT

In this article, the principles of scientific research and publication ethics were followed. This study did not involve human or animal subjects and did not require additional ethics committee approval.

DECLARATION OF AI USAGE

No AI tools were used in the creation of this manuscript.

REFERENCES

- [1] Adrian E. Villanueva-luna, Alberto Jaramillo-Nune z, et.al. 10, October 2011. De-Noising Audio Signals Using MATLAB Wavelets Toolbox. Mexico. www. Intechopen.com. ISBN 978-953-307-656-0.
- [2] Javed Ahmed and Roopali Goel. May 2013. Contrast of Wavelets Order Behavior for Sine Signal. International Journal of Innovative Technology and Exploring Engineering (IJEAT). ISSN: 2278-3075, Volume-2, Issue-6.
- [3] Florian Luisiera, Thierry Blua, Brigitte Forsterb and Michael Unsera a Biomedical Imaging Group (BIG), Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland Centre for Mathematical Sciences, Munich University of Technology (TUM), Munich, Germany. Which Wavelet bases are the best for image denoising ?

- [4] A. K. Verma, Neema Verma. A Comparative Performance Analysis of Wavelets in Denoising of Speech Signals, National Conference on Advancement of Technologies – Information Systems Computer Networks (ISCON – 2012) Proceedings published in International Journal of Computer Applications® (IJCA).
- [5] Nathaniel A. Whitmal, Janet C. Rutledge, and Jonathan Cohen. Reducing Correlated Noise in Digital Hearing Aids.
- [6] Dr. Parvinder Singh, Dinesh Singh, Deepak Seth. Reduction of Noise from Speech Signal using Haar and Biorthogonal Wavelet, ISSN: 2230-7109(IJECCT Vol. 2, ISSN : 2230-7109(Online) — ISSN : 2230-9543(Print) Issue 3, Sept. 2011.
- [7] Rajeev Aggarwal, Sanjay Rathore, Jai Karan Singh, Mukesh Tiwari, Vijay Kumar Gupta, Dr. Anubhuti Khare. Noise Reduction of Speech Signal using Wavelet Transform with Modified Universal Threshold, International Journal of Computer Applications (0975 – 8887) Volume 20– No.5, April 2011
- [8] Ritesh Jain and Suraiya Parveen. April 2013. Analysis of Different Wavelets by Correlation . International Journal of Engineering and Advanced Technology (IJEAT). ISSN: 2249-8958, Volume-2, Issue-4.
- [9] R.J.E. Merry, Prof. Dr. Ir. M. Steinbuch, Dr. Ir. M.J.G. van de Molengraft. Wavelet Theory and Applications A literature study, DCT 2005.53.
- [10] A. K. Verma, Neema Verma. A Comparative Performance Analysis of Wavelets in Denoising of Speech Signals, National Conference on Advancement of Technologies – Information Systems Computer Networks (ISCON – 2012) Proceedings published in International Journal of Computer Applications® (IJCA).
- [11] Roopali Goel and Ritesh Jain. March 2013. Speech Signal Noise Reduction by Wavelets. International Journal of Innovative Technology and Exploring Engineering (IJITEE). ISSN: 2278-3075, Volume-2, Issue-4.
- [12] Anonymous. No date. MATLAB Digital Signal Processing Technique Graphics. Cardiff University.
- [13] Tun, H. M., Moe, W. K., Naing, Z. M. (2017). Analysis on ECG data compression using wavelet transform technique. Int. J. Psychol. Brain Sci, 2(6), 127.
- [14] Tun, H. M. (2021). Photoplethysmography (PPG) scheming system based on finite impulse response (FIR) filter design in biomedical applications. Int. J. Electr. Electron. Eng. Telecommun, 10(4), 272-282.
- [15] Tun, H. M., Moe, W. K., Naing, Z. M., Min, Z. (2015). Analysis of computer aided identification system for ECG characteristic points. Int J Biomed Sci Eng, 3(4), 49-61.
- [16] Phyto, A., Tunand, Z. M., Tun, H. M. (2015). Wireless patient monitoring system using point to multi point Zigbee technology. International Journal of Scientific Technology Research, 4(6), 267-274.
- [17] Tun, H. M., Naing, Z. M., Moe, W. K., Latt, M. M. (2018). Analysis of heart rate variability based on quantitative approach. MOJ Proteomics Bioinform, 7(2), 131-141.
- [18] Zar, W. T., Tun, H. M. (2022, February). Non-contact Heartbeat Detection Using Viterbi Algorithm Based on Distribution of Difference of Two-Adjacent RR Intervals. In Proceedings of the 11th International Conference on Robotics, Vision, Signal Processing and Power Applications: Enhancing Research and Innovation through the Fourth Industrial Revolution (pp. 405-411). Singapore: Springer Singapore.
- [19] Nwe, M. S., Tun, H. M. (2017). Implementation of Multisensor Data Fusion Algorithm. International Journal of Sensors and Sensor Networks, 5(4), 48-53.
- [20] Tun, K. M. M., Khaing, A. S. (2014). Implementation of lung cancer nodule feature extraction using digital image processing.
- [21] Wah, T. N. (2018). Hla Myo Tun, "Analysis on Detection of Chalkiness for Myanmar Rice Using Image Processing,". Machine Learning Research, 3(2), 33-48.
- [22] Aung, S. T., TUN, H., NAING, Z., MOE, W. K. (2017). Analysis of Speech Features Extraction using MFCCs and PLP Extraction Schemes. International Journal of Scientific Engineering and Technology Research, 6, 2969-2973.
- [23] Soe, K. A., Myo, T. H., San, M. (2016). Detecting Leg Bone Fracture In X-Ray Images. International Journal Of Scientific Technology Research, 5.
- [24] Tun, H. M. (2009). Analysis of neural network based photo to caricature transformation using MATLAB. Bahria University Journal of Information Communication Technologies (BUJICT), 2(1).
- [25] Zar, W. T., Tun, H. M., Win, L. L. Y., Naing, Z. M. (2024). Innovative non-contact rr intervals estimation using viterbi algorithm with Squared Branch Metric (VSBM). Jurnal Pendidikan Teknologi Kejuruan, 7(1), 32-43.
- [26] Tun, K. C., Tun, H. M., Win, K. K. K. (2024). Human Motion Recognition Using Temporal Foot-Lift Features Extracted from a Small Number of Skeleton Data Frames and Multi Classifiers. Engineering Journal, 28(7), 41-51.
- [27] Oo, N., Tun, H. M., Pradhan, D., Win, L. L. Y., Aye, M. M., Oo, T. (2024). Implementation of the Process for Contamination in Electromyography (EMG) Signal by Using Noise Removal Techniques. Journal of Novel Engineering Science and Technology, 3(03), 94-98.
- [28] Tuna, Khin Cho and Tunb, Hla Myo (2024) "An Efficient Method for Recognition of Human-in-motion Action Based on Foot-lift Features," ASEAN Journal on Science and Technology for Development: Vol. 41: No. 3, Article 2.