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Enhance Audio Signal Watermarking Using Dwt Haar Wavelets

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Abstract*-- Globalization and internet would be the major causes for development associated with investigation as well as sharing associated with details. However, they've already end up being the finest device with regard to malicious consumer to assault and pirate the actual electronic advertising. Therefore copyright laws defence is definitely vital subject nowadays as well as electronic digital watermarking is actually formulated to protect the intellectual properties. Digital watermarking is a technique by which copyright information is embedded into the host signal in a way that the hidden information is imperceptible and robust against intentional and unintentional attacks. In this paper various watermark techniques i.e. existing DWT and proposed DWT using HAAR have been designed and implemented in MATLAB tool. Various performance metrics have been taken for experimental purpose. It has been found that with digital delay attack DWT using HAAR is quite effective technique over others.

Index Terms --**DWT, HAAR, Audio, Watermarking.**

I. INTRODUCTION

The actual increased discussing associated with electronic digital information amongs the numerous customers, allocated within the system necessitates the actual security from the information towards unauthorized copying. A digital watermarking offers acquired reputation because of its importance throughout content material authentication as well as copyright laws protection for digital multimedia data.. Watermarking is imperceptible or hidden information in an audio or an image, or any object of value. A Digital watermarking is very important technique or criteria for copyright protection and integrity authentication in an open network environment. Watermarking is one type of steganographic techniques whose primary goal is to protect the object from its invisibility. The technique consists of two phenomena's:

(i) Embedding (ii) Extraction

In the embedding, the embedded object is known as watermark, the watermark embedding medium is termed as the unique signal or cover subject and also the altered object will be termed as embedded signal as well as watermarked data. In the extraction, watermarking technique that does not utilize the watermark during extraction process. An audio watermarking technique can be classified into two ways. First one includes a time domain and second one uses a frequency domain technique. Frequency domain techniques have been more effective than time-domain techniques since watermarks are in order to chosen locations within the converted area of the host audio tracks transmission, so that inaudibility as well as robustness tends to be taken care of. Inaudibility describes the problem how the inserted watermark shouldn't create audible distortion towards the audio high quality of the original audio signal. Robustness determines the actual resistance of the watermark towards removal or even degradation. These techniques usually use LSB, DCT, or DWT to transform the audio signal to locate appropriate embedding location. This paper proposes an audio watermarking algorithm scheme based on Haar's wavelet transformation. In this paper Discrete Wavelet Transform (DWT) using HAAR. HAAR transform decomposes discrete audio signal into two sub signals of half of its length. One sub signal is a running average or trend or scalling function, the other sub signal is running difference or fluctuation or wavelet function, then watermarks are added to selected regions in the transformed domain of the host audio signal. The technique achieves reliable recovery of hidden data even if watermarked image is subjected to certain attacks.

II. DWT WATERMARKING TECHNIQUE

Discrete wavelet transform (DWT) decompose signals into sub bands with smaller bandwidths and slower sample rates. The discrete wavelets transform (DWT) is capable of giving a time-frequency representation of any given signal and decompose signal into two coefficients the approximated coefficients (A) and the detailed coefficients (D)[14].

$$G_{\varphi}(i,j) = \frac{1}{\sqrt{N}} \sum_n x(n)\, \varphi_{i,j}(n) \quad (1)$$

$$G_{\psi}(i,j) = \frac{1}{\sqrt{N}} \sum_n x(n)\psi_{i,j}(n) \quad (2)$$

"1" and "2" are usually called approximation and detail coefficients, respectively. Where ψ(n)wavelet is function, andφ(n) is scaling function. The complementary inverse DWT is ,

$$x(n) = \frac{1}{\sqrt{N}} \sum_j G\varphi(i,j)\, \varphi_{i,j}(n) + \frac{1}{\sqrt{N}} \sum_j G\psi(i,j)\, \psi_{i,j}(n) \quad (3)$$

The operation of 1-level discrete wavelet transform decomposition is to separate high pass and low pass components. Thus, process involves passing the time-domain signal x(n) through a high pass filter and down sampling the signal obtained yields detailed coefficient (D) and, passing $x(n)$ through low pass filters and down sampling generated approximate coefficients (A). For the multi-level operation the 1-level DWT procedure is repeated by taking either the low frequency components or the high frequency components

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such as 3-Level. After reversing the above procedure signal can be constructed.

III. ATTACKS

A. Digital Delay

Digital delays present an extensive variety of options, including a control over the time before playback of the delayed signal. Most also allow an individual to select the overall the entire level of the processed signal in terms of the unmodified one, or the level the amount at which the delayed signal is fed back into the buffer, to be repeated again.

B. Stop Band Filter

Stop band filter is a filter that passes most frequencies unaltered, but attenuates those in a specific range to very low, levels. In this paper stop band filter is taken as attack because it is require altering the audio signal after embedding a watermark. Stop band filter is act as artificial attack, which is that will be use to change the information of audio signal containing watermark.

C. Salt and pepper noise

Salt-and-pepper noises are usually a type of noises at times observed upon images. This presents, because sparsely happening white-colored as well as black pixels. An image containing salt-and-pepper noise will have black pixels inside bright regions. In this paper, salt and pepper noise is imposed to check at what extent the original information get alter.

IV. LITERATURE SURVEY

Ergun Ercelebi et al.(2009) [1] has discussed method of embedding digital watermarks into audio signals in low frequency procedure. The proposed scheme uses the wavelet transform which is constructed by lifting-based wavelet transform (LBWT) in order to represent a fast operation between watermark embedding and extraction parts using binary image (watermark) and audio signal. Vivekananda Bhat K et al. (2010) [2] has proposed a confined, vital, and sightless adaptive acoustic watermarking algorithm based on singular value decomposition (SVD) in the discrete wavelet transform (DWT) field using synchronization system. Vivekananda Bhat K et al. Proposed scheme has elevated payload and superior performance not in favor of MP3 compression compared to the previously audio watermarking schemes. Ravula, R.et al. (2010) [3] has discussed quantization based acoustic watermarking algorithm is depend on both Discrete Wavelet Transforms (DWT) and Discrete Cosine Transform (DCT). The embedding data used is a binary image. Various techniques like Arnold Transform and Linear Feedback Shift Register are used for encrypting image. Various wavelet filters are measured and the output is evaluated. Watermark embedding is performing by mean quantization of DCT values of n^{th} level low frequency components where $n \varepsilon \{3, 4, 5\}$. Low frequency method takes majority of the signals energy, which helps give robustness. Harmonization codes are embedded in the low frequency components of the acoustic signal, and it makes algorithm more healthy against desynchronized attack. Experimental results show that the proposed algorithm is inaudible and healthy against common signal processing techniques. Liu Tianchi et al. (2011) [4] proposed a robust multiple audio watermarking algorithms based on the permutation of modified DWT and LSB. It is used for embed the watermark into audio signal for different purpose and different defense target since this algorithm combines the discrete wavelet transform and the least significant bit theory. The experimental results displays that the algorithm achieve not only good brawl to normal attack except and also to the shear attack. The healthy watermark based with this algorithm shows an brilliant robustness since under strong cropping attack it still may be extract evidently from the host audio. At the same time, the susceptibility watermark is indistinct even under tiny disturbance situations that may be used as a without delay for tempering the data. A.R.Elshazly et al.(2012) [5] has discussed to boost security and robustness of digital audio watermarking algorithms, centered on mean-quantization in Discrete Wavelet Transform (DWT) domain. The watermark can be blindly extracted without understanding of the original signal. To evaluate the performance of the presented audio watermarking method, objective quality tests including bit error rate (BER), normalized cross correlation(NCC), peak-signal to noise ratio (PSNR) are conducted for the watermark and Signal-to-Noise Ratio(SNR) for audio signals. Simulation results show that our approach not only ensures robustness against common attacks, but it also further improves systemic security and robustness against malicious attack. Ankit Chadha et al. (2013) [6] has discussed to develop the data trouncing in all types of multimedia data formats image and audio and to formulate hidden message undetectable, a narrative method for steganography is introduced. It is based on Least Significant Bit (LSB) exploitation and inclusion of unnecessary noise as secret key in the message. This method is functional to data hiding in images. Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) both are used for data hiding in audio. All the results displayed prove to be time-efficient and efficient. Besides the entire algorithm is experienced for dissimilar numbers of bits. For those ethics of bits, Mean Square Error (MSE) and Peak-Signal-to-Noise-Ratio (PSNR) are considered and plotted. Chauhan et al. (2013) [7] has discussed digital audio watermarking technique is a procedure of embedding perceptually apparent digital information into an original acoustic signal. Watermarking can be delicate or non delicate depends upon the user's requirements. The main worry of digital watermarking is to prove rights as well as security of the embedded information. This paper discusses overview of presented acoustic watermarking techniques, their applications and future prediction of digital watermarking. Mr.Munna lal Verma et al. (2013) [8] Digital Audio watermarking is now symbol awareness as a new method of protecting multimedia content from unauthorized copying. Mr.Munna lal Verma et al. Proposes a new watermarking

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system DWT method using LSB coding for copyright protection of digital inside and noise containment method for watermark improvement. In our proposed watermarking system, the original audio is segmented by DWT transform can be implemented using LSB coding. During the DWT method audio signal transforms to DWT coefficient that are in the two parts first is the unfathomable region and second one is the rarefaction region. Mr. Munna lal Verma et al. take samples of rarefaction region and LSB of rarefaction region are replacing by Watermark data then it becomes a Watermark signal. Inverse DWT are used to extract the watermark text and find the reconstructed signal. Simulation results indicate that the proposed watermarking system is highly Imperceptible not in favor of various kinds of attacks such as noise addition, cropping, re-sampling, re-quantization, and MP3 compression, and achieves similarity value ranging from 3 to 6. In addition, our proposed system achieves high SNR. Dhar, P.K et al. (2012) [9] has proposed an audio watermarking method in transform domain based on singular value decomposition (SVD) and quantization for copyright protection of audio data. In our proposed method, originally the original audio is segmented into non-overlapping frames. Experimental results indicate that the proposed watermarking method resists various attacks such as noise addition, cropping, re-sampling, re-quantization, and MP3 compression. Dhar, P.K et al. proposed method achieves signal-to-noise ratio (SNR) values ranging from 38 to 40 dB, in contrast to conventional methods which achieve SNR values ranging from only 10 to 26 dB. X. Wang et al. [10] proposed a blind and adaptive audio watermarking algorithm which combines the robustness of vector norm with that of the approximation components after the discrete wavelet transform (DWT). In order to improve the robustness and imperceptibility, a binary image encrypted by Arnold transform as watermark is embedded in the vector norm of the segmented approximation components, the count of which depends on depends upon the size of the watermark image, after DWT of the original audio signal through quantization index modulation (QIM) with an adaptive quantization tep selection scheme. Moreover, a detailed method has been designed to search the suitable quantization step parameters. Experimental results indicated that even though the capacity of the proposed algorithm is high, up to 102.4 bps, this algorithm is still able to maintain high quality of the audio signal and tolerate a wide class of common attacks such as an additive white Gaussian noise (AWGN), Gaussian Low-pass filter, Kaiser Low- pass filter, resampling, requantizing, cutting, MP3 compression and echo. Pawar, Kamini, S. K. Parchandekar, and S. G. Tamhankar. (2011) [11] proposed digital audio watermarking technique for embedding additional data along with the audio signal. Embedded data is used for copyright owner identification. Digital audio watermarking techniques include traditional watermarking and zero-watermarking scheme. In this paper, traditional watermarking scheme is compared with zero-watermarking scheme. In traditional watermarking scheme, LSB technique is implemented in wavelet domain. Zero-watermarking scheme is based on steady sign of certain DWT-DCT co-efficients with maximum absolute value. The experimental result shows that the zero-watermarking scheme is more efficient, robust and imperceptible over traditional watermarking scheme. Ghosh, Poulami, et al. (2012) [12] proposed that Due to the rapid growth of internet and technology, protecting digital data is becoming very urgent. In this paper a novel watermarking technique is proposed where both visible and invisible watermarks are embedded in a video. Digital watermarking is a technology to embed additional information into the host signal to ensure security and protection of multimedia data. The video frames contain both the watermarks, so it is more robust to attacks. The watermarking scheme described here deals with embedding and extraction of the watermarks. Discrete Wavelet transform (DWT) is used to embed the invisible watermark and Peak Signal to Noise Ratio (PSNR) is calculated to measure efficiency of this method. Guo, Yuhong, et al. (2013) [13] proposed that Audio mixing greatly degrades the watermarking security. Consequently, it is of importance to introduce mixing-attack-proof audio watermarking algorithms. This article investigates audio mixing attack. First, balanced modulation is introduced to get rid of the host signal interference and improve the correlation score stability. With more stable correlation scores, a randomized pseudo-noise embedding strategy is proposed to decrease the interference among different mixed components and bit error rate. To further improve the synchronization performances, a multiple synchronization strategy which simultaneously synchronizes different mixed components is also proposed. The experimental results indicate that the proposed algorithm shows a strong level immunity to mixing attacks and it can resist the mixing attack with up to 5 mixed components. N.V.Lalitha, Ch.Srinivasa Rao and P.V.Y.JayaSree,(2013) [14] proposed that Digital audio watermarking is adopted for many multimedia applications such as copyright management, music indexing, broadcast monitoring etc. Audio watermarking hides copyright information into the digital audio signal. Simple audio watermarking provides copyright information but authentication/security of the audio can be achieved by using a chaotic sequence in the watermarking process. For which Discrete Wavelet Transform (DWT) along with Arnold Transform is proposed to describe audio watermarking and its authentication. Subjective and objective tests unveil that the proposed watermarking scheme preserves high quality and is simultaneously more robust to different attacks. Performance of the algorithm has been compared with the Discrete Cosine Transform (DCT) and Arnold transform based method.

V. PROPOSED METHODOLOGY

The proposed scheme for audio watermarking is based on HAAR transformation. This scheme involves the

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implementation of DWT using HAAR wavelets so the scheme called as DWHT (Discrete Wavelets Haar Transform). Here 3-level Discrete Wavelet Haar Transform is done. Like all wavelet transforms, the Haar transform decomposes a discrete audio signal into two sub signals of half of its length such as, scalling function and wavelet function. Scalling function and wavelet function of Haar wavelets are also known as approximate coefficients or trend or scaling function and detailed coefficients or fluctuation or wavelet function of Audio signal. The point to point communication is done by simply embedding the coefficient of watermark image (watermark data), into wavelet decomposed coefficients of the Audio signal using secrete key value q, and after that the watermark image (watermark data) is extracted at other point of communication using same key value q.

A. Watermark Injection

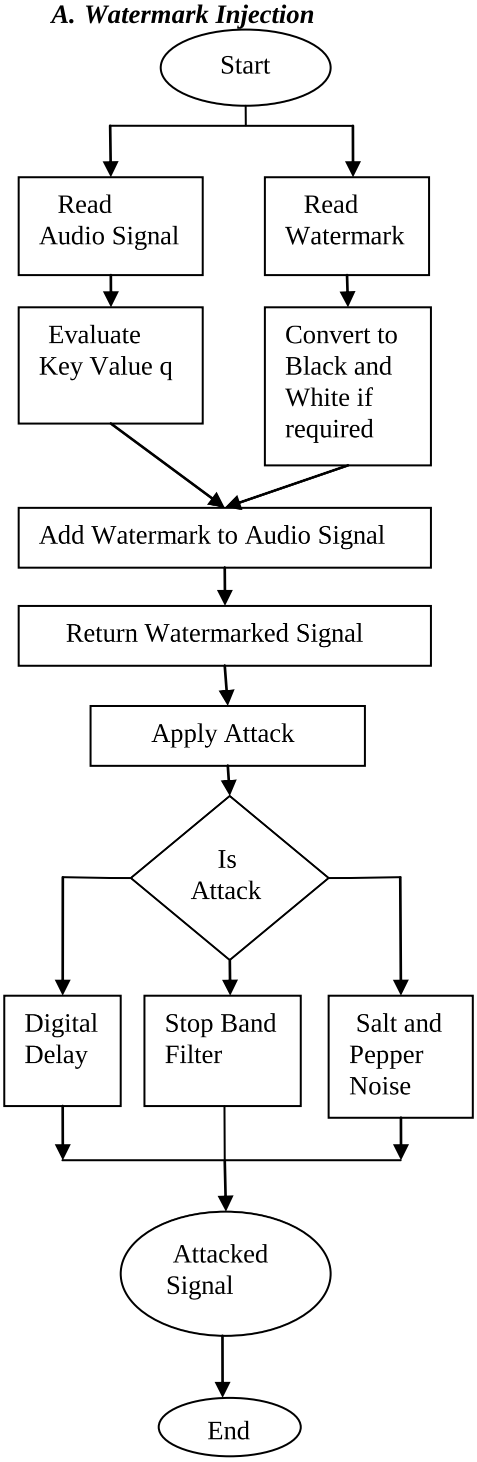

Fig. 1: Watermark Injection

Fig. 1 represents the watermark injection algorithm.

Step 1 : Audio signal and watermark image is read first of all, during injection process.
Step 2: Now, convert watermark image to black and white image if required, side by side evaluate key value n for the purpose of privacy.
Step 3: Add watermark image to Audio signal.
Step 4: After insertion of watermark image into audio signal, using key value q, return watermarked signal.
Step 5: Now apply attacks, such as Digital delay, Stop band filter and Salt and pepper noise to watermarked signal.
Step 6: At last attacked signal is comes out.

B. Watermark Extraction

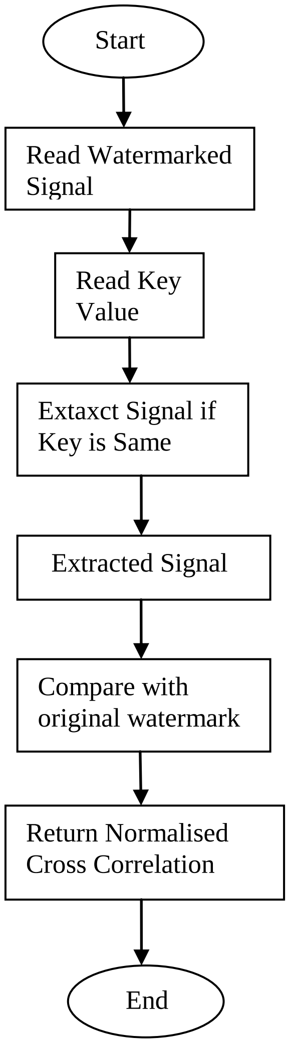

Fig. 2: Watermark Extraction

Fig. 2 represents the watermark extraction algorithm.

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Step 1: During Extraction process, First of all watermarked signal is read at other side of the communication process.
Step 2: Secondly, Watermarked signal having key value q is read, if key value is same then signal is extracted.
Step 3: Then, extracted signal having watermark image is compare with original watermark image.
Step 4: At last, Normalized cross correlation is done between original watermark and extracted watermark to check whether extracted watermark get degrade or not.

VI. RESULTS AND DISCUSSIONS

A. Experimental setup of Existing Work[14]

Fig. 3 represents the input audio signal.

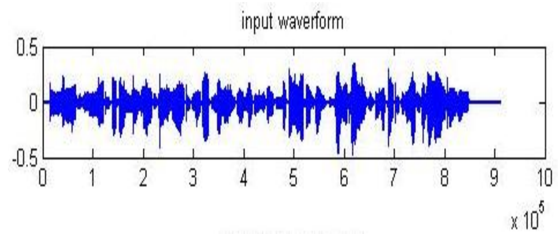

Fig. 3: Input audio Signal

Fig. 4 represents the input watermark i.e watermark image.

Fig. 4: Input watermark

Fig. 5 represents watermarked audio signal i.e Embedded waveform

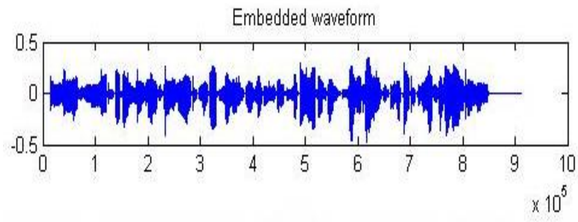

Fig. 5: watermarked audio signal

Fig. 6 represents Extracted watermark..

Fig. 6: Extracted watermark

B. Experimental Setup of Proposed Work

Fig. 7 represents the input audio signal.

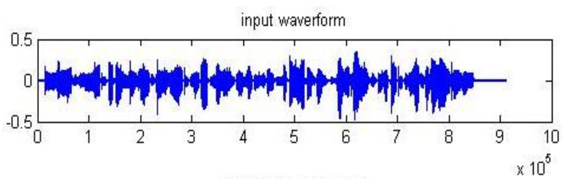

Fig. 7: Input audio signal

Fig. 8 represents the input watermark i.e watermark image.

Fig. 8: Input watermark

Fig. 9 represents watermarked audio signal i.e Embedded waveform

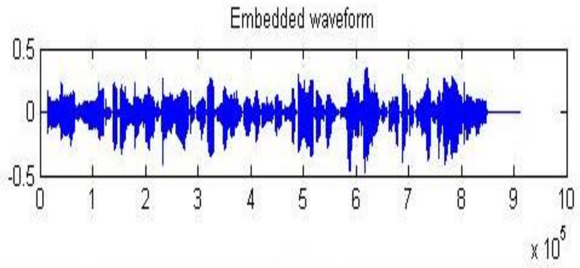

Fig. 9: watermarked audio signal

Fig. 10 represents Extracted watermark.

Fig. 10 : Extracted watermark

C. Performance Evaluation

The performance evaluation of extracted audio signals and extracted watermark image is done at receiver side on the basis of parameters such as Normalised cross correlation and Signal-to-noise ratio (SNR) and these observed for existing DWT scheme and proposed DWT using HAAR wavelets

.

I. Normalised cross correlation

Correlation is a measure of similarity of two signals as it depicts the amount by which the signal is deviated from the other signal. Normalized correlation of two binary images can be calculated using eq. 4 below where X and X' are original and extracted watermarks respectively; i and j are indexes of the binary watermark image. The size of X and X' is RxS.

$$NC = \frac{\sum_{i=1}^{R}\sum_{j=1}^{S} x(i,j)x'(i,j)}{\sqrt{\sum_{i=1}^{R}\sum_{j=1}^{S} x(i,j)^2}\sqrt{\sum_{i=1}^{R}\sum_{j=1}^{S} x'(i,j)^2}} \quad (4)$$

Table I. demonstrate the comparison of normalized cross correlation between the original image and watermark image of existing DWT scheme and proposed scheme DWT using HAAR wavelets for different audio signal A,B,C and different images.

II. Signal to Noise Ratio

Signal to noise ratio is a parameter used to know the amount by which the signal is corrupted by the noise. It is defined as the ratio of the signal power to the noise power. SNR can be calculated by eq. 5.

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$$SNR = \frac{Power_{signal}}{Power_{noise}} \quad (5)$$

Table II. demonstrate the comparison of different audio signals A,B,C with extracted audio signal after passing through several attacks, that are observed for existing DWT scheme and proposed scheme DWT using HAAR wavelet

Table I: Normalised Cross Correlation (NCC) Evaluation

Parameter	Audio Signals	Images	Attacks		
			Digital Delay	Stop Band Filter	Salt and Pepper Noise
			Proposed	Proposed	Proposed
Normalised Cross Correlation	A	Image 1	0.9842	0.9535	0.4836
		Image 2	0.9828	0.9473	0.5247
		Image 3	0.9821	0.9485	0.4811
		Image 4	0.9830	0.9468	0.4686
		Image 5	0.9830	0.9479	0.4931
	B	Image 1	0.9916	0.9419	0.5058
		Image 2	0.9871	0.9398	0.5344
		Image 3	0.9884	0.9391	0.4748
		Image 4	0.9894	0.9372	0.4931
		Image 5	0.9894	0.9394	0.4963
	C	Image 1	0.4784	0.5100	0.4974
		Image 2	0.4839	0.5108	0.5108
		Image 3	0.4832	0.5116	0.5410
		Image 4	0.4835	0.5101	0.5399
		Image 5	0.4825	0.5154	0.5154

Table II : Signal-to-Noise Ratio (SNR) Evaluation

Parameter	Audio Signals	Attacks					
		Digital Delay		Stop Band Filter		Salt and Pepper Noise	
		Existing	Proposed	Existing	Proposed	Existing	Proposed
Signal to Noise Ratio(dB)	A	57.5038	83.4659	57.2675	71.7103	3.7896	6.7361
	B	57.2893	87.7973	57.1003	71.9134	3.7968	6.7479
	C	60.2763	92.4271	60.1910	80.7666	9.8931	11.8906

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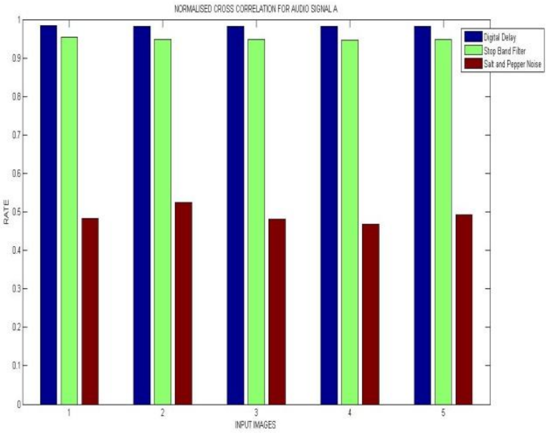

Fig. 11: NCC Audio signal A

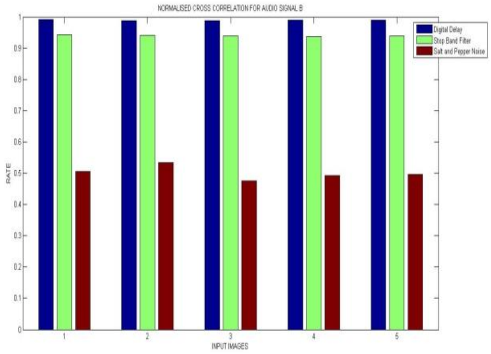

Fig. 12: NCC Audio signal B

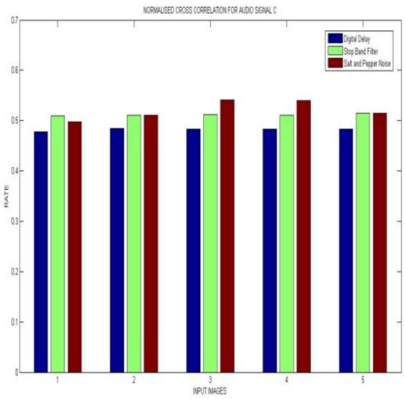

Fig. 13: NCC Audio signal C

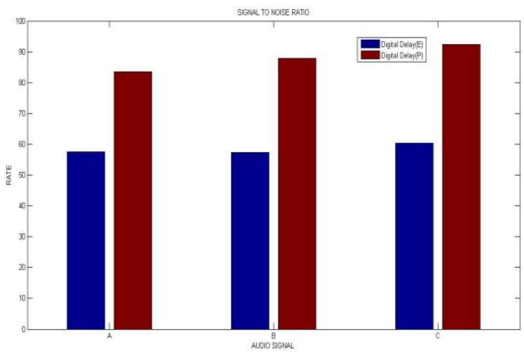

Fig. 14: SNR Analysis for Digital Delay Attack

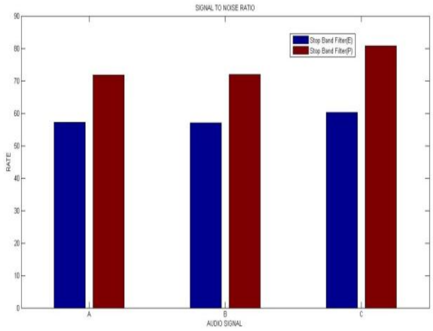

Fig. 15: SNR Analysis for Stop Band Filter Attack

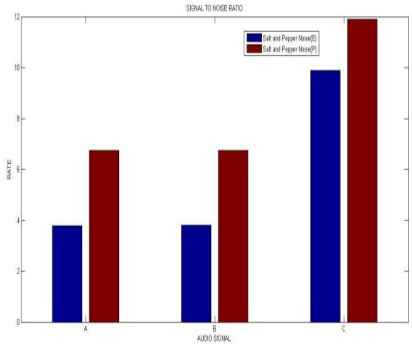

Fig. 16: SNR Analysis for Salt and Pepper Noise Attack

VII. CONCLUSION AND FUTURE SCOPE

In audio watermarking technology it is possible to implant supplementary information in an audio track. Audio digital watermarking technology has found to be the new way of audio reproduction, which can pre-implant the particular data as a watermark to the audio signal which exceed the information on behalf of the owner distinctiveness and verify the user's authenticity. After comprising the existing and proposed technique for audio watermarking, it is noticeable that the proposed technique i.e DWT using HAAR wavelet will show better result on the basis of parameters Normalised cross correlation and Signal to noise ratio, when different audio signals pass through different Attacks. Audio watermarking technology thus affords an opportunity to generate copies of a recording which has been supposed by listeners as identical to the original but which may differ from one another on the basis of the embedded information. Audio watermarking has found to be most popular technique to secure images when they are containing useful information. One can also use audio watermarking for copy right protection for robustness and inaudibility. The various watermark techniques DWT and DWT-HAAR have been designed and implemented in MATLAB tool. In near future some more attacks will also be considered. However no modification is done in existing algorithm in near future we will integrate two existing audio watermarking algorithms. Also one can also effort to hide audios in audios for more secured transmission of the digital audios especially some secured voice messages.

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