RESEARCH ARTICLE OPEN ACCESS

Digital Audio Watermarking Technique through Fused DWT & LSB Technique

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Abstract:

Audio watermarking is more inspiring due to the fact that self-motivated control of hearing ability over the chromatic field.Noise is regularly carried to host audio by common signal processing procedure, and it regularly changes the high-frequency component of an audio signal. So inserting watermark by correcting low-frequency coefficient can rise the robustness of a watermark technique. This work proposed a method which embedding watermark into the maximal coefficient in 3rd Level DWT domain. Biased and unbiased tests reveal that the proposed watermarking technique preserves highly audio quality, and concurrently, the algorithm is highly robust to mutual digital signal processing processes. Experimental replications were achieved to calculate the performance of the audio watermarking technique. Audio watermarking discovers applications in the area of copyright, temper discovery and authentication of music's, military communication, voice activated machines and robots.

Keywords* — *Ausio watermarking technique, DWT, LSB Attacks.

I. INTRODUCTION

Tremendous growth in the World Wide Web (WWW) and digital devices such as mobile phones and personal assistant devices has opened new avenue of business and digital marketing. Comprehensive digital audio files are being offered to increase sales through social media such as facebook, Twitter, Linkedin, email and what's app. Also tools and techniques to manipulate digital media files and documents are being improved to cater the needs of digital marketing. Therefore manipulation and duplication of audios, images and videos is now much easier. A copy of a digital media is identical to the original. By numerical program circulation over World Wide Web, confirmations are extra susceptible than ever due to the prospect of unrestricted copying. A duplicate of a digital media is matched to the original [1] – [3]. Watermarking has been verified to be an effective tools for the security of Intellectual Property Rights (IPR) of program contents. Multimedia forms can be replicated, changed, transformed, and diffused very easily through sophisticated signal and image processing algorithms. In this context, it is important to develop a system for copyright protection, protection against duplication, and authenticationof contents. Digital watermark is a message / data / information which are embedded into digital content (audio, video, images or text) that can be detected or extracted later. Such message/data/information mostly carries the

copyright or ownership information of the content [4] – [7]. The process of embedding digital watermark information into digital content is known digital watermarking. Also watermarked audio are subject to multiple signal processing attacks. For example posting an audio on social media may be resized, manipulated, cropping and compression through JPEG. It may result in partial damage to underlined audio.

For signal processing transformations have respective advantages, some researchers combined good properties of two or three kinds of transformations and embedded watermark into hybrid domain. Making use of the multi-resolution of discrete wavelet transform (DWT) and the energy compression of discrete cosine transform domain(DCT), Wang and Zhao [8] argued embedding the watermark into the hybrid domain. Literature [9] proposed an improved algorithm based on literature [10], which combined characteristics of DWT and histogram. The robustness to MP3 compression and low-pass filter was increased. Literature [11] performed DWT on a frame audio, then, singular value decomposition (SVD) was done on the approximation coefficients, and embedded watermark into the SVD coefficients. Literature [12] segmented audio sample and SVD was performed on each segment, then first SVD coefficient in every block were gathered together and DCT was done, and the watermark was inserted into DCT coefficients. These algorithms all had good robustness.

Number of algorithms have been proposed for audio watermarking and several of them are found to be too complex or require significant time for embedding / ex-traction or vulnerable to several forms of attacks. However complete security to the watermark signal is desirable without measurable distortion in the original audio signal.

In this paper, we present a audio watermarking technique through fused DWT and LSB technique is proposed. The primary idea is to decompose the audio signal into three level DWT coefficients. Noise is repeatedly carried to host audio by common signal processing operation, and it generally vagaries the high-frequency element of an audio signal. So inserting watermark by regulating minimum-frequency coefficient can change the robustness of a watermark techniques. The paper is organized as follows section I introduces to watermarking, section II describes embedding and extraction algorithm in details. Results are discussed in section III and finally concluded in section IV.

II Watermark embedding and extraction algorithm

Audio watermark embedding process includes stages as generation of random signal, computing three levels DWT and embedding in wavelet domain. Robustness of the algorithm is enhanced by embedding all DWT coefficients of logo into selected region of audio signal. Whereas computing three levels DWT thereby improves imperceptibility through matching. Fig. 1 demonstrates the stages in watermarking through block diagram and its system is described in this section.

2.1 EMBEDDING ALGORITHM

Let *x[n]* and *w[n]* represent the original input audio signal and watermark signal respectively with *m* number of samples. The steps involved in the embedding of the audio signals are as follows

1. Read *x[n]* of the length *m* from the input audio signal.
2. Generate random watermark signal w[n] of the length 2*m/8 with values zero and one.
3. We apply three level DWT to input audio signal *x[n]*

$$\varphi(t) = \frac{1}{\sqrt{a}}\ \varphi(\frac{t-b}{a}) \quad (1)$$

It is well know that very low frequency and high frequency components are vulnerable to signal processing attacks such as purifying and compression.
Therefore only three level approximate frequency components were used for watermark embedding.

4. These coefficients were converted into IEEE 754 double precision format where N = 64 number of bits per watermark sequence sample.

$$a_i(k) = \{a_i(0),\ a_i(2),\ ---, a_i(N-1)\} (2)$$

5. We have m number of sequences each with 64 bits for watermark embedding.

We now embed watermark bit into the segments of DWT coefficients using (5).

$$wa_{i,k}(0) = a_{i,k}(0)\ xor\ p_i(0) \quad (3)$$

Where i = 0, 1, 2, 3, ---, m-1 and k = 0,1, 2, --- N-1.

6. After obtaining all watermark segments inverse discrete wavelet transform (IDWT) is applied.

The watermarked embedded audio signal is obtained and thus the process of watermark embedding is completed. The resultant audio signal contents watermark whose invisibility is sufficient and robust. The DWT features are invariant with respect to translation and manipulation of audio signal. Thus both provide the much needed robustness to algorithm. Watermarking parameters correlation coefficient between original carrier and watermarked embedded audio was determined to calculate the performance of the projected algorithm.

2.2 EXTRACTION ALGORITHM

The algorithm extracts watermark from the expected audio signal, with the use of original sequence x[n]. Let y[n] is the received watermarked audio signal with or without signal processing attacks.

1. Read y*[n]* of the length *m* from the watermarked input audio signal and x[n] input audio signal.
2. Obtain random watermark signal w[n] of the length 2*m/8 with values zero and one.
3. We apply three level DWT to input audio signal y*[n] and x[n]*

$$\varphi(t) = \frac{1}{\sqrt{a}}\ \varphi(\frac{t-b}{a}) \quad (4)$$

4. These coefficients were converted into IEEE 754 double precision format where N = 64 number of bits per watermark sequence sample.

$$a_i(k) = \{a_i(0),\ a_i(2),\ ---, a_i(N-1)\} \quad (5)$$

5. We have m number of sequences each with 64 bits for watermark extraction

$$ww_{i,k}(0) = x_{i,k}(0)\ xor\ y_i(0) \quad (3)$$

6. Compare watermark extracted ww with original watermark w for correctness of the result.

The whole process of implanting and elimination of audio watermarking is discussed. The watermark signal found after extraction process was relevant for measuring the watermarking parameters such imperceptibility, security and robustness.

III Experimental results

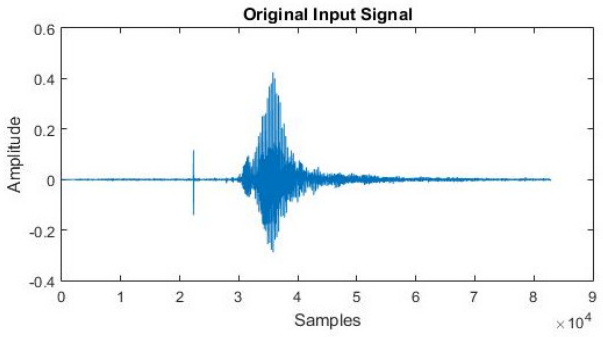
Simulation results are depicted in this section using computer programming language MATLAB. Nine different audio signals were recorded using mobile phone with the sampling frequency of 44KHz. Sound section was manually extracted from the audio and inaudible section was removed. Following types of attacks were applied in the evaluation of the watermarking algorithm.

1. Low pass filtering (LPF): low pass filter with 12 KHz cut off frequency are applied to watermarked signal.
2. High pass filtering (HPF): high pass filter with 100 Hz cut off frequency are applied to watermarked signal
3. MP3 attack (Compression): layer III compression was performed on watermarked signal.
4. Noise attack (NA): random noise of signal to noise ratio of 20dB was added to watermarked signal.
5. Amplitude attack (AA): amplitude of the watermarked signal was improved by 1.25 times.

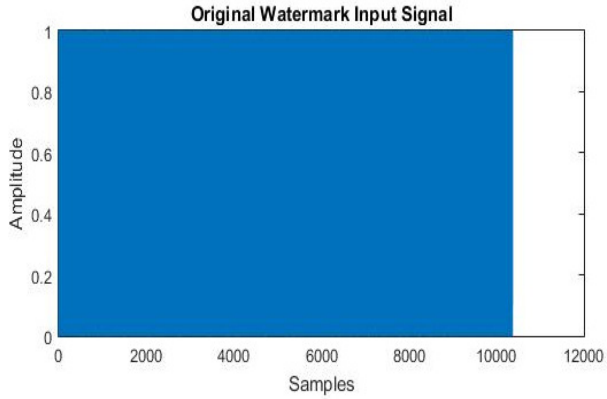
The strength of the watermarking procedure was measure using extraction rate (ET) given as (11)

$$ET = \frac{correctly\ extracted\ watermark}{total\ embedded\ watermark}\ x\ 100\ (\%) \quad (11)$$

Table 1 shows the measured ET for all the nine audio signals under various signal processing attacks. Fig. 3 shows the three audio signals already watermark inserted.



audio signals already watermark inserted.



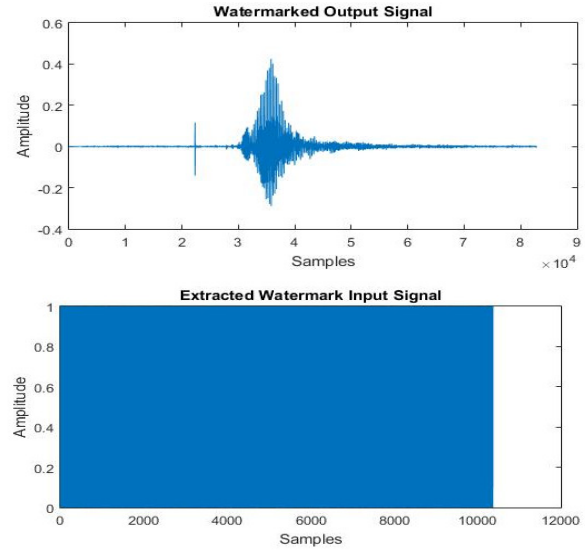


Figure 1. Audio signals

Iv Conclusion

This work proposed a technique which inserting watermark into the best coefficient in 3rd Level DWT domain. Biased and unbiased tests expose that the suggested watermarking technique preserves highly audio quality, and simultaneously, the algorithm is very robust to common digital signal processing processes. Experimental simulations were performed to calculate the performance of the audio watermarking system. Experimental results clearly indicates suitable extraction rate for various types of attacks. The simulation was done using MATLAB software on Intel i5 processor with 3 GHz speed and 4 GB RAM.

Table 1.Extraction rate

Audio signal / Attacks	**Extraction rate (ET) %**								
	A1	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**
LPF	89	87	85	86	84	83	89	84	87
HPF	98	99	96	95	94	93	97	98	96
MP3	97	96	97	96	95	94	95	96	97
NA	92	93	91	92	94	91	90	91	92
AA	98	99	99	99	98	99	98	97	98

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