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EMBEDDING TEXT WATERMARK INTO AUDIO SIGNAL USING LSB

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ABSTARCT:

Digital audio watermarking is now drawing attention as a new method of protecting multimedia content from unauthorized copying. This paper proposes a watermarking system using LSB method for copyright protection of digital contents and noise suppression method for watermark recovery. In our proposed watermarking system, the original audio is segmented into non-overlapping frames. Watermarks are then embedded into rarefaction region of signal. Watermarks are extracted by performing the inverse operation of watermark embedding process. Simulation results indicate that the proposed watermarking system is highly imperceptible, robust i.e. noise introduced is minimum and Watermark is extracted successfully.

Keywords: *digital watermarking; copyright protection; security;, LSB; Noise suppression;, Compression & rarefaction region; Embedding and extraction.*

1. INTRODUCTION

The recent growth in computer networks, and more specifically, the World Wide Web, copyright protection of digital audio becomes more and more important. Digital watermarking is a means to identify the owner or distributor of digital data. Watermarking is the process of encoding hidden copyright information in digital data by making small modifications to the data samples. A watermark is designed to permanently reside in the host data. When the ownership of a digital work is in question, the information can be extracted to completely characterize the owner.

Without the correct signature, the watermark cannot be removed. The extracted watermark must correctly identify the owner and solve the deadlock issue when multiple parties claim ownership [2].

Watermarking approach is protection against removal is used for document marking, for embedding information about the author or for embedding a serial number; in other words, copyrights information. In this case, the goal is protection against removal; the watermark might or might not be made visible to the user using a watermarking reader tool.

There are two different techniques for document marking: *watermarking* and *fingerprinting*. Watermarking is the process of embedding marks in digital documents (sounds, images, binaries, etc.) exactly like the watermarks used for example for marking a banknote. Fingerprinting is the process of embedding a serial number into every copy of an object. This serial number can be used to detect the break of a license agreement. In both cases, the information is supposed to be invisible, but it should be very difficult to remove it. The difference between the two processes is that in the former process the objects are all marked the same way, but in the latter process every copy has a different serial number embedded [3].

Several methods exist for hiding data in audio files such as MP3Stego, which effectively hides arbitrary information. The windows wave format lets users hide data using stego-hide [1].

Audio watermarking has been proposed for the protection of multimedia contents, and it has been used for recording media such as MPEG 1 Audio Layer III (MP3) and Microsoft Windows Media Audio. Most of these watermarks are achieved with a non-real-time system, and there are many methods of different approaches in this type of system, e.g. LSB (Least Significant Bit) substitution methods are most fundamental techniques for information hiding, and amplitude modulation or phase shift methods in frequency domain are powerful tools for acoustic watermarking. This type of system uses previously recorded acoustic waveforms as cover data, and therefore, it might not be suitable for embedding watermark in real-time, and it would make difficult to use it for situations like live-performance, where the illegal recording of acoustic sound has easily been made. It is a serious problem, and therefore, real-time watermarking is required [6].

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Data hidden can be classified according to the domain where the watermarking or steganography has been applied. The following sections discus these domains

1.1 *Time Domain Audio Steganography and Digital Watermarking:*

In time domain steganography techniques, watermark is directly embedded into audio signal, where no domain transform is required in this process. Watermark signal is shaped before embedding operation to ensure the robustness. The existing time domain steganography approaches insert the watermark into audio signal by adding the watermark to the signal. Hiding the watermark into time domain engage several challenges related to robustness and inaudibility. Shaping the watermark before embedding enables the system to maintain the original audio signal audibility and renders the watermark inaudible. [1]

1.2 *Frequency Domain Audio Steganography and Digital Watermarking:*

In the Frequency Domain, The input signal should transform to frequency domain in first stage, and then the watermark can embedded. To get the watermarked signal, the inverse frequency transform should be applied. Transforming audio signal from time domain to frequency domain enables steganography system to embed the watermark into perceptually significant components.

The most common transforms used and the fields in which they are used in digital audio steganography are: Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT). Examples of techniques for this domain are Phase coding, Spread spectrum, Echo data hiding. [1]

Audio watermarking should meet the following requirements:

- **Imperceptibility**: the digital watermark should not affect the quality of original audio signal after it is watermarked;
- **Robustness**: the embedded watermark data should not be removed or eliminated by unauthorized distributors using common signal processing operations and attacks;
- **Capacity**: capacity refers to the numbers of bits that can be embedded into the audio signal within a unit of time;
- **Security**: security implies that the watermark can only be detectable by the authorized person.

All these requirements are often contradictory with each other. However, it should satisfy the important properties such as imperceptibility and robustness.

In this paper, we propose a new watermarking system using LSB for audio copyright protection and extraction with noise suppression method. The watermarks are embedded into the highest prominent peak of the magnitude spectrum of each non-overlapping frame. Experimental results indicate that the proposed watermarking system provides strong robustness against several kinds of attacks and extracted watermark.

2. LITERATURE REVIEW:

A significant number of watermarking techniques have been reported in recent years in order to create robust and imperceptible audio watermarks. Lie et al. [7] propose a method of embedding watermarks into audio signals in the time domain. The proposed algorithm exploits differential average-of-absolute-amplitude relations within each group of audio samples to represent one-bit information. It also utilizes the low-frequency amplitude modification technique to scale the amplitudes in selected sections of samples so that the time domain waveform envelope can be almost preserved. In [8], authors propose a blind audio watermarking system which embeds watermarks into audio signal in time domain. The strength of the audio signal modifications is limited by the necessity to produce an output signal for watermark detection. The watermark signal is generated using a key, and watermark insertion depends on the amplitude and frequency of audio signal that minimizes the audibility of the watermarked signal. Ling et al. [9] introduce a watermarking scheme based on non-uniform discrete Fourier transform (NDFT), in which the frequency points of embedding watermark are selected by the secret key. Zeng et al. [10] describe a blind watermarking system which embeds watermarks into DCT coefficients by utilizing quantization index modulation technique. In [11], the authors propose a watermarking

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system which embeds synchronization signals in time domain to resist against several attacks. Pooyan et al. [12] introduce an audio watermarking system which embeds watermarks in wavelet domain. The watermarked data is then encrypted and combined with a synchronization code and embedded into low frequency coefficients of the sound in wavelet domain. The magnitude of quantization step and embedding strength is adaptively determined according to the characteristics of human auditory system. Wang et al. [13] proposes a blind audio watermarking scheme using adaptive quantization against synchronization attack. In addition, the multi resolution characteristics of discrete wavelet transform (DWT) and the energy compression characteristics of discrete cosine transform (DCT) are combined in this scheme to improve the transparency of digital watermark. Watermark is then embedded into low frequency components by using adaptive quantization according to human auditory system. In [14], authors propose a watermarking system in cepstrum domain in which a pseudo-random sequence is used as a watermark. The watermark is then weighted in the cestrum domain according to the distribution of cepstral coefficients and the frequency masking characteristics of human auditory system. Liu et al. [15] propose a blind watermarking system which takes the advantages of the attack-invariant feature of the cepstrum domain and the error-correction capability of BCH code to increase the robustness as well as imperceptibility of audio watermarking. In Cox's method [16] watermarks are embedded into the highest m DCT coefficient of the whole sound excluding the DC component.

3. LOW–BIT ENCODING METHOD OF AUDIO WATERMARKING*:*

Low-bit encoding considered as the earliest techniques to add information into digital audio signal. It is the simplest technique to embed data into other data structures such as data of audio in image file or data of image in audio file. Low-bit encoding can be done by replacing the LSB of each sampling point by a coded binary string [1].

In LSB coding, the ideal data transmission rate is 1 kbps per 1 kHz. In some implementations of LSB coding, however, the two least significant bits of a sample are replaced with two message bits. This increases the amount of data that can be encoded but also increases the amount of resulting noise in the audio file as well [3].

One should consider the signal content before deciding on the LSB operation to use. For example, a sound file that was recorded in a bustling subway station would mask low-bit encoding noise. On the other hand, the same noise would be audible in a sound file containing a piano solo.

To extract a message from an LSB encoded sound file, the receiver needs access to the sequence of sample indices used in the embedding process. Normally, the length of the message to be encoded is smaller than the total number of samples in a sound file. One must decide then on how to choose the subset of samples that will contain the message and communicate that decision to the receiver. One trivial technique is to start at the beginning of the sound file and perform LSB coding until the message has been completely embedded, leaving the remaining samples unchanged. This creates a security problem, however in that the first part of the sound file will have different statistical properties than the second part of the sound file that was not modified. One solution to this problem is to pad the message with random bits so that the length of the message is equal to the total number of samples. [3]

The major advantage of Low-bit encoding is:

- High watermark channel bit rate
- Low computational complexity of the algorithm compared with others techniques
- No computationally demanding transformation of the host signal, therefore, it has very little algorithmic delay.

The major disadvantage is that the method is:

- Low robustness, due to the fact that the random changes of the LSB destroy the coded watermark.
- It is unlikely that embedded watermark would survive digital to analogue and subsequent analogue to digital conversion.

4. PROPOSED ALGORITHM

4.1 *Embedding Watermark:*

(1) Select the PCM encoded wave file.

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(2) Sample the wave file.
(3) Select a watermark text .
(4) Convert watermark text in binary format.
(5) Select a frame from rarefaction region of wave file.
(6) Take one sample of above selected frame.
(7) Embed the first bit of text in place of LSB of selected sample.
(8) Repeat the steps 6 and 7 until all the bits of watermark text have been replaced.
(9) Reconstruct the audio wave file

4.2 *Extraction of watermark:*

(1) Take the PCM encoded wave file.
(2) Sample the wave file.
(3) Select a frame from rarefaction region of wave file.
(4) Take one sample of above selected frame.
(5) Read LSB of selected sample.
(6) Take next sample and read least significant bit of that sample.
(7) Repeat above steps till all the massage bits are retrieved.
(8) Convert binary message bits into text format.

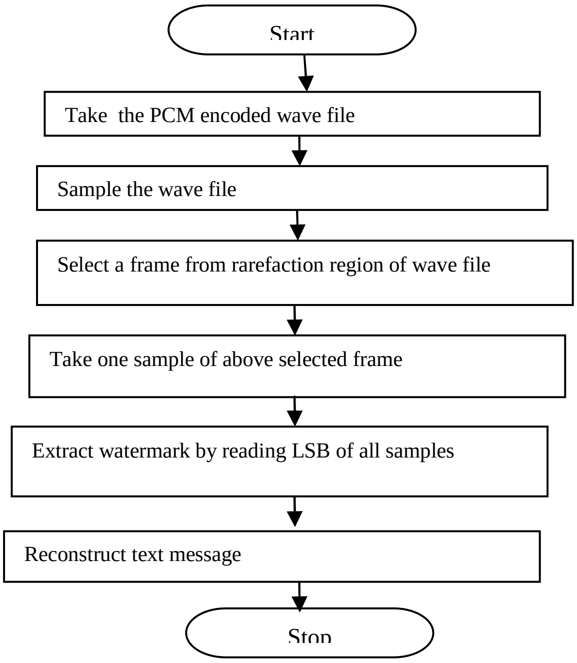

Fig 1. Watermark Embedding Flowchart

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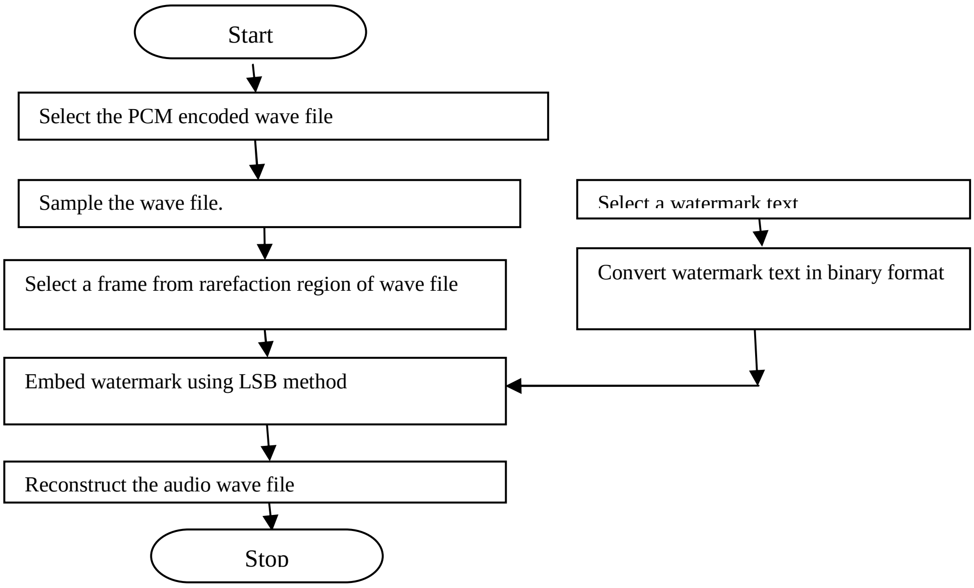

Fig 2.Watermark Extraction Flowchart

5. RESULT ANALYSIS:

In this section, we evaluate the performance of our watermarking system for 16 bit audio signals sampled at 300 Hz.

- A song with name 'a.wav' is considered as input wave file.
- This waveform is plotted.
- It is sampled at 300 Hz.
- After sampling watermark text from file 'new11.txt' is embedded using LSB method.
- Resultant wave file is plotted and saved with name 'nm.wav' as shown in Fig 3

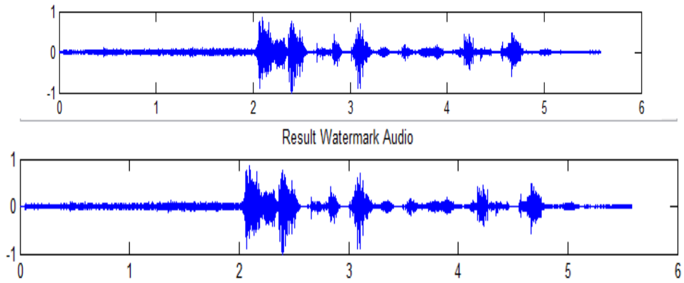

Fig 3 Input and output waveforms

- Embedded watermark text is extracted correctly by reverse process.
- Noise inserted during embedding process is found to be minimum.

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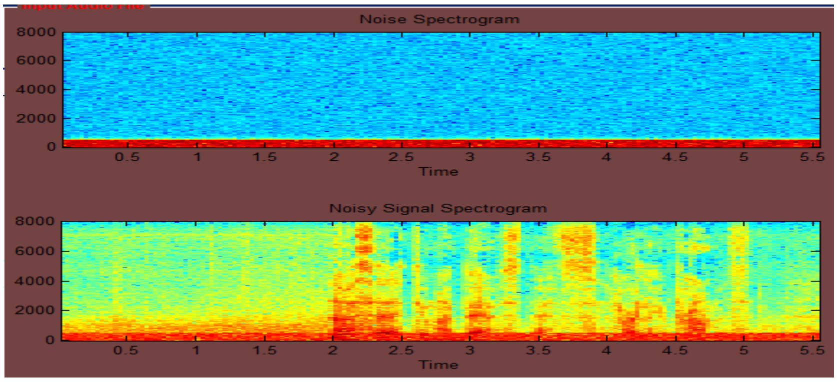

Fig 4 Noisy spectrogram in resultant audio file.

- Listening using head set reveals that the watermark embedded into the original audio using the proposed watermarking system does affect the quality of the sound which ensures the imperceptibility of the embedded watermark.
- The most commonly used measure is SNR which define the overall error between the original audio & watermarked audio signal. Signal to noise ratio (SNR) using the following equation.

$$SNR = 10log_{10}\frac{\sum_{n-1}^{N} w^2(n)}{\sum_{n-1}^{N}[w(n) - w^*(n)]]^2} \quad (1)$$

Where w(n) & w*(n) are original audio signal & watermarked audio signal respectively.

- So in following *table 1* different audio wave file are selected and text watermark is embedded and it is found that SNR obtained is 10 to 37db.

.Table 1 SNR values for different Waveform and size of watermark

Audio file name	Audio file Size	Watermark text size	SNR	Watermark Extracted Successfully
a.wav	174 KB	(New11.doc)7 bytes	37	Yes
a.wav	174	(New.doc)992 bytes	10	Yes
2_1.wav	47.6 Mb	(a.m)137 bytes	23	Yes

6. CONCLUSION:

In this paper, we have presented an watermarking system using LSB with noise suppression for copyright protection of sound contents. Experimental results indicate that the proposed watermarking system is highly imperceptible, robust i.e. noise introduced is minimum and Watermark is extracted successfully.

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