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Copyright Protection Using Digital Audio Watermarking- an Overview

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Abstract:- **Every day, thousands of audio files are being uploaded and downloaded through the internet. Therefore, audio copyrights become an important issue for the authors to protect the intellectual property of these files. In this paper, some of the methods of audio watermarking are discussed.**

Keywords: Audio, watermarking, copyright protection.

1. Introduction:

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]

2. Methods for audio watermarking:

Different methods used for audio watermarking age discussed below with their advantages and disadvantages.

2.1 Low–bit Encoding:

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:

I). High watermark channel bit rate

II). Low computational complexity of the algorithm compared with others techniques

III). No computationally demanding transformation of the host signal, therefore, it has very little algorithmic delay

The major disadvantage is that the method is:

I). Low robustness, due to the fact that the random changes of the LSB destroy the coded watermark.

II). It is unlikely that embedded watermark would survive digital to analogue and subsequent analogue to digital conversion.

2.2Phase Coding:

Phase Coding watermarking works by substituting the phase of an initial audio segment with a reference phase, this phase represents the hidden data. The phase of subsequent segments is adjusted in order to preserve the relative phase between segments.

The major advantage of Phase Coding is:

I). Basic technique

The major disadvantage is that the method is:

I). Phase coding method is a low payload because the watermark embedding can be only done on the first block.

II). The watermark is not dispersed over the entire data set available, but is implicitly localized and can thus be removed easily by the attackers.

2.3 Spread Spectrum Technique:

Spread spectrum (SS) is technique designed to encode any stream of information via spreading the encoded data across as much of the frequency

spectrum as possible even though, there is interference on some frequencies, SS allows the signal reception,

The major advantage of Spread Spectrum is:

I). Difficult to detect and/or remove a signal.

II). Provide a considerable level of robustness.

The major disadvantage is that the Spread spectrum is:

I). Spread spectrum technique used transform functions (e.g. Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT), or Discrete Wavelet Transform (DWT)) with appropriated inverse transform function, which can cause a delay.

II). Spread spectrum is not a visible solution for real time applications.

2.4 Echo technique:

Echo technique embeds data into a host audio signal by introducing an echo; the hidden data can be adjusted by the two parameters: amplitude and offset, the two parameters represent the magnitude and time delay for the embedded echo, respectively. The embedding process uses two echoes with different offsets, one to represent the binary datum "One" and the other to represent the binary datum "Zero".

The major advantage of Echo is:

I) The main advantage of echo hiding is that the echo detection technique is easy to implement.

The major disadvantage is that the echo hiding technique is:

I) More complicated computation is required for echo detection.

II) Echo hiding is also prone to inevitable mistakes, such as the echo from the host signal itself may be treated as the embedded echo.

III) If the echo added has smaller amplitude, then the cestrum peak would be covered by the surrounding peaks to make the echo detection an arduous task to perform.

2.5 Noise Gate Technique:

Noise gate technique is designed to be an alternative solution for the weakness in the previous approaches, this technique implanted in the time domain. This technique maintains a high quantity of data hidden side by side with robustness. Noise Gate Technique involve two steps approach, the first step, noise gate software logic algorithm has used to obtain a desired signal for embedding the secret message of the input host audio signal. In the second step, standard i th LSB layer embedding has been done for this desired signal by simply replaces the host audio signal bit in the ith layer with the bit from the watermark bit stream, if 16-bit per audio sample used, where (i=1,...,16).
The major advantage of Noise Gate Technique is:

I) High watermark channel bit rate
II) Low computational complexity of the algorithm compared with others techniques
III) No computationally demanding transformation of the host signal, therefore, it has very little algorithmic delay
IV). Add level of complexity against Stego-Only Attack and Known Message Attack.

The major disadvantage is that the method is:
I). Fair robustness
II). Noise Gate technique is weak against Known Cover Attack, Known Chosen Cover or Chosen Message and Known Stego Attack.[1]

2.6 Patchwork Coding:

Patchwork Coding considered as one of the earliest generation for digital watermarking schemes. Patchwork Coding can be done via embedding the watermark in the audio using time domain or frequency domain. In the literature, several approaches of Patchwork Coding have been proposed on frequency domain using linear transformations, such as Discrete Wavelet Transform (DWT), Discrete Fourier Transform (DFT) and Discrete Cosine Transform (DCT). Frequency or time domain watermarking schemes directly tinker with sample amplitude of audio to embed the watermark.

The major advantage of Patchwork Coding is:

I) Patchwork based watermarking scheme has been confirmed as an valuable to those common signal processing operations, such as low-pass

filtering, image/audio compression, and so on.

The major disadvantage is that the Patchwork is

I) An attack called "curve-fitting attack" has been successfully implemented for patchwork watermarking scheme.
II) Patchwork watermarking scheme is sensitive to various synchronization attacks.

2.7 Singular Value Decomposition Audio Watermarking:

The Singular Value Decomposition mathematical technique provides an elegant way for extracting algebraic features from a 2-D matrix. The main properties of the matrix of SVs can be exploited in audio watermarking. When a small perturbation happens to the original data matrix, no large variations occur in the matrix of SVs, which makes this technique robust to attacks.

The main advantages are:

I) A robust audio watermarking method with a higher degree of security.
II) The SVD audio watermarking does not degrade the quality of the watermarked audio signal.

The major disadvantage is

I) This method is based on the chaotic Baker map, which is permutation-based but permutation based algorithms are more immune to noise.[4]

3. Requirements:

Audio watermarking should meet the various requirements listed as follows:

a) Imperceptibility: The most important requirement of audio watermarking is that the quality of the original signal has to be retained after the embedding of watermark. The digital watermark should not affect the quality of original audio signal after it is watermarked.

b) Robustness: The embedded watermark data should not be removed or eliminated by using common audio signal processing operations and attacks. The detection rate of watermark should be perfect.

c) Capacity: It refers to the number of bits that can be embedded into the audio signal within a unit of time. A user should be able to alter the amount of information embedded depending upon the applications.

d) Security: It implies that the watermark can only be detected by the authorized person.

e) Speed: The watermark embedding and extracting processes have to be fast enough depending upon the application.
The main challenge in digital audio watermarking is to achieve the good tradeoff between the robustness and high watermark data rate[5].

To function as a useful and reliable intellectual property protection mechanism, the watermark must be: i) *embedded* within the host media;

ii)*perceptually inaudible* within the host media;

iii) *statistically undetectable* to ensure security and unauthorized removal;

iv)*robust* to manipulation and signal processing

operations on the host signal, e.g., noise, compression, cropping, resizing, D/A conversions, etc. and

v) *readily extracted* to completely characterize the copyright owner.[2]

4. Conclusion:

With the advancement of technology and growth in computer networks & internet, a large amount of data is transferred and copied. The issue of information security has gained extensive attention. Digital watermarking has been proved as an appropriate solution for copyright protection and to enforce the intellectual property rights. In this paper we reviewed different techniques which are developed for information protection, and described with some advantages and disadvantages of these techniques.

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