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A Novel Digital Audio Authentication Technique Using Watermarking

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Abstract: Due to high speed computer networks, the use of digitally formatted data has increased many folds. The digital data can be duplicated and edited with great ease which has led to a need for effective copyright protection tools. With the growth of the Internet, unauthorized copying and distribution of digital media has never been easier. A promising solution to this problem is marking the media signal with a secret, robust, and imperceptible watermark (WM). To enforce Copy rights and to prevent illegal duplication, interpolation and distribution of multimedia data, Digital watermarking is an effective solution Copyright protection, data authentication, covert communication and content identification can be achieved by Digital watermarking. This paper presents a novel audio watermarking algorithm to protect against unauthorized copying of digital audio. In this paper, we propose an Effective and robust audio watermarking algorithm based on Fast Fourier transform (FFT) domain. Experimental results are presented in this paper to demonstrate the effectiveness of the proposed algorithm.

Keywords: Copyright protection Digital watermarking, Fast Fourier Transform

I. INTRODUCTION

Digital watermarking is increasingly used in the copy right protection of documents and digitally distributed media. Watermark information is predominantly used to identify the creator of a digital file, i.e. a picture, a song, or text. Digital watermarking is one of the best solutions to prevent illegal copying, modifying and redistributing multimedia data. Digital watermarking is a technique to embed copyright or other information into the underlying data. The embedded data should maintain the quality of the host signal. The approach of digital watermarking has been employed to protect intellectual property of audio, images and video data [1, 2, 3, 4]. Watermarking is the process that embeds data called a watermark into an image or audio or video. The general watermarking framework is in figure 1.

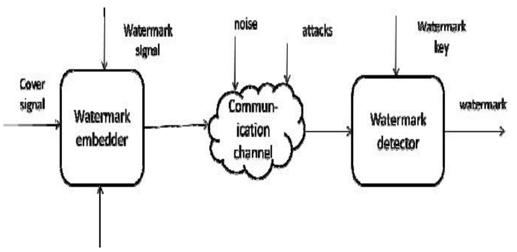

Figure 1 General Watermarking Framework

The watermark can be detected and extracted later from the carrier (cover). It can contain information such as copyright, license, authorship etc. A simple example of a digital watermark is a "seal" on the image to identify the ownership. According to the type of documents to be watermarked, the watermarking techniques can be divided into four types:

a. Text Watermarking,
b. Image Watermarking,
c. Audio Watermarking,
d. Video Watermarking,

An available study on audio watermarking is far less than that of text or image or video watermarking. However, during the last decade audio watermarking studies have also increased considerably. This paper surveys the -the-art of the current watermarking schemes. The paper is organized as follows .In section two; we give a brief description of related works in audio watermarking. In section three, we describe in details the watermarking embedding and extraction procedures of the proposed algorithm. In section four, we evaluate the performance of the algorithm and present simulation results. We conclude in section five with some remarks.

II. RELATED WOKS

Audio watermarking methods can be classified into two main categories consist of time domain based methods and transform domain based methods [5, 6]. The two domains have different characteristics, and thus performances of their techniques may vary with respect to the robustness and imperceptibility (inaudibility) requirements of audio watermarking. Inaudibility refers to the condition that the embedded watermark should not produce audible distortion to the sound quality of the original audio, in such a way that the watermarked marked version of the file is indistinguishable from the original one. Robustness determines the resistance of the watermark against removal or degradation. The watermark should survive malicious attacks such as random cropping and noise adding, and its removal should be impossible without perceptible signal alterations. Time-domain techniques include the Least Significant Bit substitution (LSB) and echo hiding techniques, among many others [7, 8]. LSB embeds the watermark information in the least significant bits of the audio sample values by overwriting the original bits [9, 10].

It takes advantage of the quantization error that usually derives from the task of digitizing the audio signal. On the other hand, echo watermarking attempts to embed information into the original discrete audio signal by introducing a repeated version of a component of the audio signal with small offset, initial amplitude and decay rate to make it imperceptible [11,12]. In general, time-domain audio watermarking is relatively easy to implement, and requires few computing resources, however, it is weak against signal processing attacks such as compression and filtering. Time domain based technique is easier to implement in comparison with transform domain based method and needs less accounting resources. In other words, time domain based watermarking systems are not robust enough against signal processing attacks in comparison with transform domain based systems. AM [13], Echo [14], methods are some kinds of techniques based on time domain. These methods are easy to implement but are not robust enough against attacks. Frequency domain audio watermarking techniques employ human perceptual properties and frequency masking characteristics of the human auditory system for effective watermarking [15]. In these techniques, the phase and amplitude of the transform domain coefficients are modified in a certain way to carry the desired watermark information. Popular transforms include the Discrete Fourier Transform (DFT), the Discrete Cosine Transform (DCT), and the Discrete Wavelets Transform (DWT).In this paper, we propose a new audio watermarking method for embedding watermark sequence based on Fast Fourier Transform (FFT) domain.

L. F. Turner [16] proposed a method for watermarking digital audio signals. He suggested substituting bits of identification code to the insignificant bits of randomly selected audio signal. Bessie et al [17] proposed a time domain method for audio watermarking. They proposed to reduce the distortions resulting from watermark embedding by modulating the original signal and then low pass filtering it. The audio signal is divided into segments and each segment is watermarked separately by embedding the same watermark. An audio watermarking scheme in Fourier domain is suggested BY Arnold [18, 19] in 2001 which uses statistical algorithm. Advantage of this method is that it doesn’t need the original audio signal in the detection process. Y Tang et al [20] proposed a digital watermark algorithm based on wavelet transform and complex cepstrum transform (CCT) which takes advantage of masking effect of human ears. Boney et al [21] suggested the dual domain (time domain as well as frequency domain) watermarking approach based on Human Audio System. The authors suggested shaping the watermark in frequency domain but embedding of the watermark is done in time domain.

III. PROPOSED METHOD

A. Watermark Embedding Process:

The proposed watermark embedding process is shown in Figure 1.

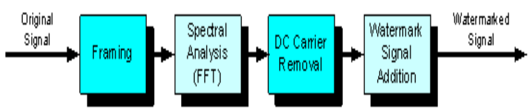

Figure 2 Watermark embedding process

The embedding process is implemented in the following seven steps

Step: 1 Read Audio-file and determine available watermark size

Step: 2 Read black and white watermark image and scale watermark image to fit the audio file length such that the watermark image is of even side lengths

Step: 3 Save the watermark image in to vector of size equal to that of audio file

Step: 4 Watermark embedding

a. Divide the audio file in to blocks of equal size

b. Select a frequency range of audible spectrum .let the value be wmpeak.

c. For each block in steps of 2 for two channels of stereo signal do

i. Let x be an audio data block and y be the Fast Fourier transform of x (y=FFT(x))

ii. Search peaks with different absolute values beginning at wmpeak

iii. Search for a location in the block x to store the watermark byte

If abs(y(n))>abs(y(n+1)) then watermark byte black is embedded

if abs(y(n))<abs(y(n+1)) then watermark byte white is embedded

iv. Perform inverse transform of the watermarked fft block

end

B. Watermark Detection Process:

The proposed watermark detection process is shown in Figure 2.

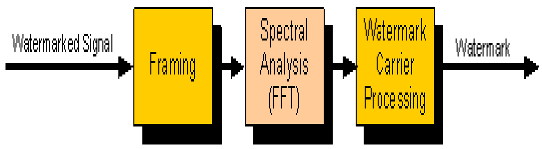

Figure 3 Watermark Detection process

Watermark Detection process is implemented in following steps

Step: 1 Read Watermarked Audio-file and determine available watermark size

Step: 2 preset all watermark pixels to white

Step: 3 Watermark detection

a. Divide the audio file in to blocks of equal size

b. Select the frequency range of audible spectrum applied during insertion process .let the value be wmpeak.

c. For each block in steps of 2 for two channels of stereo signal do

i. Let x be an audio data block and y be the Fast Fourier transform of x

(y=FFT(x))

ii. Search peaks with different absolute values beginning at wmpeak

iii. Search for a location in the block x to store the watermark byte

If abs(y(n))>abs(y(n+1)) then the byte is decoded as black pixel

if abs(y(n))<abs(y(n+1)) then byte is decoded as white pixel

end

IV. SIMULATION RESULTS

In this section, we evaluate the performance of our watermarking method for different types of stereo audio signals sampled at 44.1 KHz , represented by 16 bits per sample, and ten seconds in length. The watermarking algorithm was implemented in MATLAB 7.0 under Windows on an Intel Pentium PC running at 166 MHz. A original audio file in wave format is fed into the system, where it is subsequently framed, analyzed, and processed, to attach the inaudible watermark to the output signal. For a track with 44100 samples per second block size of 8820 is taken which corresponds to a duration of 0.2 s therefore we have a fft frequency resolution of 5 Hz. Since audio tracks often start with a few seconds of silence we leave First Block as empty (about 6 s) .Low Frequency peaks (5Hz) are chosen for the embedding the watermark signal. Selected Amplification factor for the watermarked spectral value is 10. The watermark Image and the extracted watermark are shown in figure 4 and figure 5

Figure 4 Watermark Image

Figure 5 Extracted Watermark Image

In order to evaluate the performance of the proposed watermarking method in terms of watermark detection, the watermark image and the extracted watermark image are compared in terms of single-sided amplitude spectrum of the "noise", which is brought into the audio file by watermarking and the new quantization of the samples as a consequence to it the spectrum of the difference signal .Single sided amplitude spectrum of the difference signal between watermarked image and extracted watermark is shown in figure 5

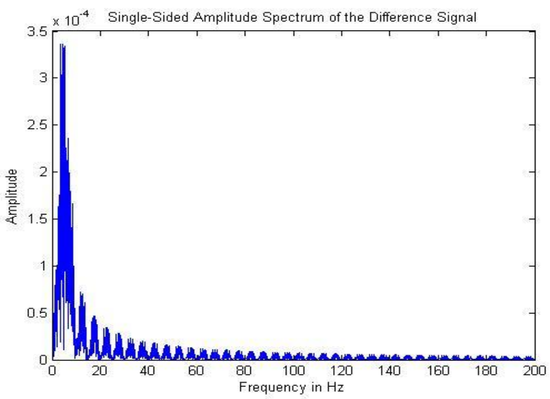

Figure 6 Single sided amplitude spectrum of the difference signal

In our proposed method, watermarks are embedded into the selected prominent peaks of highest energy segment which provides high robustness against different kinds of attacks as well as good SNR values for watermarked audio signals

V. CONCLUSION

In this paper, we propose a new method for audio signal watermarking to embed a watermark sequence based on FFT methods.. Water mark is embedded into wave file after reducing noise and random carrier is chosen instead of fix carrier. This embedding scheme adapts the watermark so that the energy of the watermark is maximized under the constraint of keeping the auditory artifact as low as possible. Experimental results showed that our watermarking scheme is robust to common signal processing attacks, such as mix down, amplitude compression, and data compression. Moreover, our proposed method achieves PSNR values ranging from 13 dB to 24 dB for different watermarked sounds. These results demonstrate that our proposed watermarking method can be a suitable candidate for audio copyright protection

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