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Data Hiding Technique Using Audio Watermarking

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Abstract: ***Digital watermarking is new method of providing protection to multimedia data and digital content from unauthorized copying. Robust and imperceptible audio watermarking scheme using Discrete Wavelet Transformation (DWT) is presented in this paper. It is effective data hiding technique for audio signal. Algorithm embeds scramble watermark (image) into discrete wavelet transformed audio signal. For scrambling of image Arnold transformation based on best iteration is used. Then embedded watermark must be survived and recovered against different attacks like volume scaling, re-sampling, low pass filtering, re-quantization, random cropping.***

Keywords: Audio watermarking, Discrete Wavelet Transformation (DWT), Arnold transform, SNR.

1. Introduction

Digital watermarking was introduced to provide security of information against intellectual piracy. Now a day's security is main problem as computer performance, use of internet is increasing day by day. Image, audio, video watermarking are the types of digital watermarking based on multimedia data. Audio watermarking technique is more complicated than image and video watermark technique [2][3]. Human auditory system is more complex and sensitive than human visual system as human ear is capable of detecting frequency change in audio signal. Embedded information is large as size and duration of audio signal is shorter than image and video file which degrade the quality of audio signal.

Audio watermarking technique grouped into two types: time domain techniques and frequency domain techniques [1]. In DWT (discrete wavelet transform) audio watermarking technique, watermark is embedded into decomposed audio signal. Embedded watermark in audio signal undergo many signal processing operations like linear filtering, compression, quantization. It does not affect the quality of signal but corrupt the watermark information**.** Embedded watermark must be survived and robust against this various malicious attacks and signal processing operations. Watermark resistance against removal and degradation means robustness. According to IFPI (International Federation of the Phonographic Industry), audio watermarking technique should meet the requirements like robustness, capacity, perceptual quality, security [4].

Robustness is the ability of watermark to survive against different signal processing operation and malicious attacks.

Capacity of audio watermarking algorithm means without degrading the quality of audio signal, algorithm should be able to carry more information. Embedded watermark should not produce audible distortion to original audio is called imperceptibility. Security means only authorized person should detect the watermark or able to make some changes in it.

Time domain techniques of audio watermarking include LSB (Least Significant Bit), spread spectrum, phase coding and echo hiding. Time domain techniques are easy to implement than frequency domain techniques but it is less robust against malicious attacks. Time domain techniques of audio watermarking are unable to give detail information about all frequencies of audio signal. It requires less number of resources. LSB (Least Significant Bit), spread spectrum, phase coding and echo hiding are the time domain techniques of audio watermarking. In LSB information embedded in least significant bit simply by overwriting the original bits. Echo hiding watermark technique embeds information into discrete audio signal.

Human perceptual properties are employed in frequency domain techniques of audio watermarking. Phase and amplitude of the transform domain coefficients are modified to embed information in these techniques. DCT (Discrete Cosine Transform), DFT (Discrete Fourier Transform), DWT (Discrete wavelet Transform), FFT (Fast Fourier Transform) these are the popular transform techniques. DWT preferred over other transform for audio watermarking because it gives time and frequency representation of signal [5].

This paper deals with implementation of efficient audio watermarking technique to prevent copyright infringement of original audio file. Algorithm is based on Discrete Wavelet Transform. Proposed work aims at robust implementation of

audio watermarking that possess ability of watermark to survive against different attacks scaling, re-sampling, low pass filtering, re-quantization, random cropping.

The rest paper is organized as follows section two gives details about discrete wavelet transformation. Section three gives the detail information about scrambling using Arnold transform. Block diagram of proposed work is explained in section. Evaluation parameters such as SNR, PSNR are used to verify robustness of algorithm. Conclusion is in last section.

2. Discrete Wavelet Transform

Discrete wavelet transform is used in DSP applications. It represent signal in both time and frequency domain. The fig.1 shows DWT decomposition of signal. It separate high pass and low pass component of signal. When signal pass through the high pass filter it gives detail coefficient and low pass filter gives approximate coefficient [6]. Approximate coefficients are less vulnerable to noise as they are low pass coefficient. Hence information embedded into approximate coefficients. More level of decomposition of DWT means more accurate representation of signal in time and frequency. Each level is called an octave. High pass component gives details of signal while low pass produces mean. The Haar Wavelet Transform is the simplest of all wavelet transform. It is the basic orthogonal wavelet filter. In inverse DWT process both approximate coefficient and detail coefficient up-sampled then pass through the low pass and high pass filter. By convolving the samples of low pass and high pass filter, reconstructed signal is obtained.

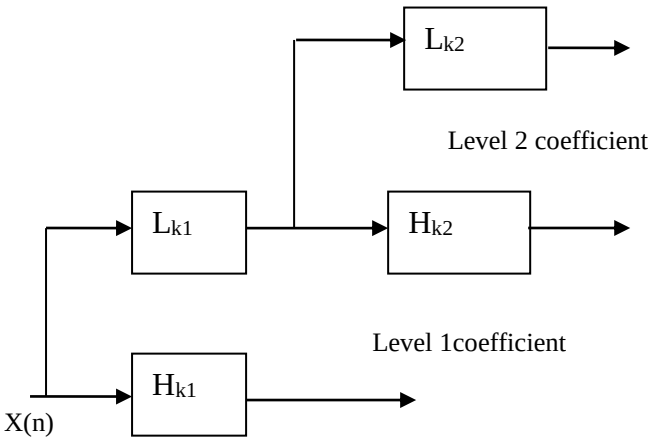

Figure1: DWT decomposition

3. Arnold Transform

Arnold transformation is one of the methods of scrambling digital signal. It is based on iteration. Scrambling means formation of meaningless image to increase its security. Digital watermarking techniques used this scrambling to improve robustness of watermarking. Security of digital image in transmission has become very important issue. Digital image is made up of number of image points called pixels. Pixels represent position or gray level. F(x, y) is two dimensional function of image, where x and y represent the co-ordinate and F is the gray level. Digital scrambling means original media loses its meaning and hard to recognize [7].

Arnold transform defines as follows, Let original pixel position of image is (x, y) and its new position after scrambling is (X, Y). It moves to (X, Y) by following equation

$$\begin{bmatrix} X \\ Y \end{bmatrix} = \begin{bmatrix} 11 \\ 12 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} \bmod l \qquad (1)$$

L is length of unit square. It is the biggest drawback of Arnold transformation. To get original image back inverse Arnold transformation is used as Arnold transformation is invertible. (X, Y) is new position of pixel (x, y) in scrambled image to move back it to its original position (x, y) equation is as follow:

$$\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 2 & -1 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} X \\ Y \end{bmatrix} \bmod l \qquad (2)$$

It is called 2D Arnold transformation. It has many applications like scrambling. Arnold transformation can be applied only on square image. Fig 2 shows original image, fig 3 is Arnold means scramble image and fig 4 shows again original image means inverse Arnold image.

Figure 2: Original binary image

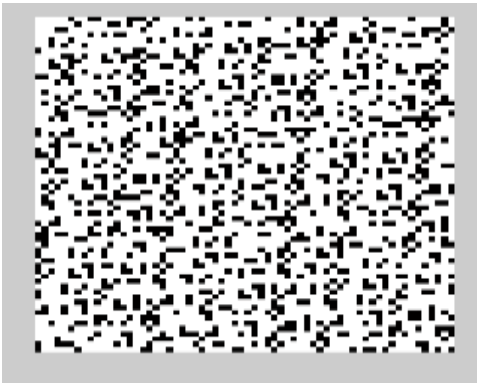

Figure 3: Arnold image (scramble)

Figure 4: Inverse Arnold image (original)

4. Proposed Approach

DWT based audio watermarking algorithm approach is presented in this paper. Audio watermarking is divided into two parts embedding and extraction of watermark. In embedding process, information is added into decomposed audio signal, while extraction is used to remove that information without distortion.

A. Embedding of Watermark:

There are two main steps of embedding process:

a. Watermark preprocessing:

Binary image of 64×64 is used to embed as a watermark. Steps for watermark preprocessing are mentioned bellow.

1. RGB to gray conversion of image.
2. Apply Arnold transform to scramble the image
2. Express binary image as a 64×64 two dimensional matrix.
3. Convert it into one-dimensional vector.

Then one dimensional vector of image is embedded into decompose audio signal.

b. Audio decomposition:

Audio signal is decomposed using DWT. It gives two coefficient low frequency coefficient and high frequency coefficient when signal pass through low pass filter and high pass filter respectively. To achieve robustness watermark processed in first step embed into approximate coefficient. After embedding watermark into low frequency coefficients portion combine it with the high frequency component portion by applying inverse DWT. The output signal is the audio signal with watermark. It is also called as watermark signal.

B. Watermark Extraction:

Extraction process is exactly the inverse of embedding process. Block diagram for watermark extraction is as shown in fig. 6. There are four main steps in watermark extraction process:

a. Wave decomposition.
b. Compute watermark vector.
c. Watermark image formation.
d. Apply inverse Arnold to get back original image.

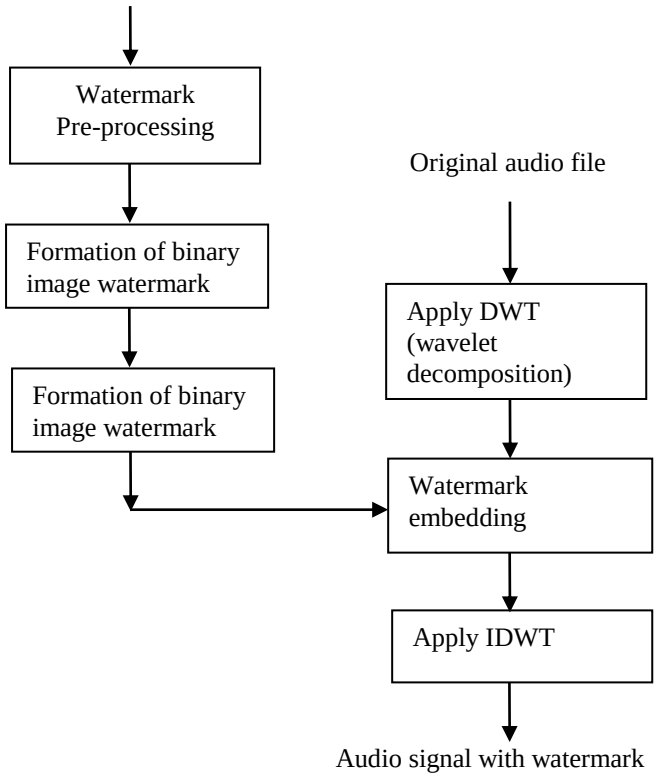

Figure 5: Block Diagram of watermark embedding procedure

Output of embedding process that is audio signal with watermark used as input signal for extraction process to get watermark back. Hence DWT is applied to watermark signal to decompose it into low frequency and high frequency component. As low frequency portion of signal contain watermark information into it compute watermark vector. That obtained watermark vector is in the one dimensional form. Convert that vector into two-dimensional matrix. Two-dimensional matrix is nothing but scrambled binary image. To get back original image apply inverse Arnold transformation.

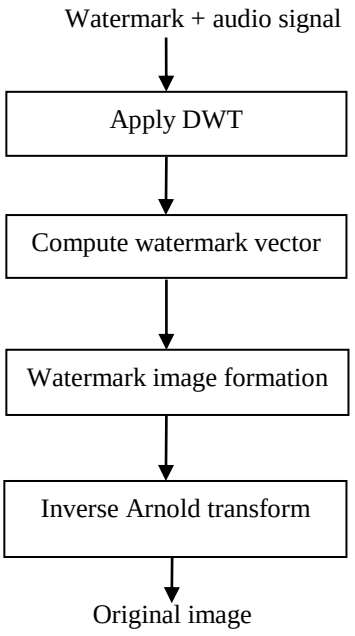

Figure 6: Block Diagram of watermark extraction

Input original image

5. Evaluation Parameters

To extract watermark without distortion is the main aim of effective audio watermarking algorithm. Watermark must survive against different attacks like volume scaling, re-sampling, low pass filtering, re-quantization, random cropping. Absolute robustness is difficult to achieve. There are two main evaluation parameter SNR (signal to noise ratio), PSNR (Peak signal to noise ratio). SNR and PSNR both are objective evaluation parameter.

A. Signal to noise ratio:

According to IFPI SNR must be more than 20 dB to satisfy the condition of robustness. It is the ratio of signal power to noise power. It used as measure to check audio quality. The amount by which signal corrupted by noise is obtained using SNR.

$$SNR=10\log_{10}\left[\frac{1}{N}w(i)-w_r(i)\right]dB$$

Where w (i)= original audio signal

$w_r(i)$= watermark audio signal

b. Peak signal to noise ratio:

PSNR is related to mean square error. It is related to the watermark quality.

$$PSNR=10\log_{10}\left(\frac{255\times 255}{MSE}\right)$$

MSE = mean square error.

6. Conclusion

This paper proposes a efficient data hiding technique for audio watermarking based on Discrete Wavelet Transform is proposed. As compared to time domain technique transform domain technique for audio watermarking shows more robustness. Arnold transformed is used to provide more security for watermark in transmission. DWT is efficient algorithm. Using DWT audio signal without distortion is obtained after extraction of watermark. SNR, PSNR are used as evaluation parameter which verify robustness of algorithm. SNR must be more than 20 dB which satisfy IFPI requirements. DWT audio watermarking approach is useful in copyright protection and authenticity verification.

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