A Study of Audio Watermarking Technique in DCT Domain

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***Abstract*— In this time, due to fast improvement in communication technology through a internet accessing is easier. The main disturbance of digital content is to protect distribution and unauthorized copying. Audio watermarking has been proposed as solution to this issue. Audio watermarking is a technique that hides copyright information into audiosignal without affecting original quality of audio signal. In this paper proposes audio watermarking technique to embedding and extraction procedure in DCT domain.**

***Keywords*— Audio watermarking, Copyright protection, DCT, Embedding, Extraction**

I. INTRODUCTION

Now days, there has been large growth in computer networks and more in the internet. This phenomenon, with the rapid increase of computer performance, has facilitated the distribution of multimedia data such as images, audio, video etc. Data transmission is very easy, fast and distributed using the internet. However, one of the main problems associated with transmission of data over the internet is that security problem, i.e., personal data can be stolen or hacked in many ways. Publishers and artists, hence, may be unwilling to distribute data over the Internet due to deficiency of security; copyrighted material can be easily duplicated and distributed without the owner's permission. Therefore, it becomes very important to take data security into consideration, as it is one of the essential factors that need attention during the process of data distribution. [1]

For solving this problem, the watermarking techniques were introduced to provide security ofinformation. In other words, the watermarking is a technique which can embed data in original signal to aware security of information against unauthorized copying, illegal claim of owner and not admitting other things. In recent years, most presented watermarking techniques have been focused on images and video clips, but audio watermarking has become recently an important research that is of interest for many scientists. There are two main reasons that audio watermarking is more complicated than image and video watermarking: First, the Human Auditory System(HAS) has greater sensitivity than the Human Visual System (HVS), because the human ear is capable todetect amplitude and frequency changes of signal, precisely. Second, the size and duration of audio signalsarevery shorter than image files and video clips, and there for, the amount of information embedded in theaudio signals isvery large in comparison with image filesand video clips and consequently this information reduce the audio signal quality. [2]

Audio watermarking techniques reported in literature can be grouped into two types; time-domain techniques and frequency-transform domain techniques

Time-domain techniques include the Least Significant Bit substitution (LSB) and echo hiding techniques, among many others [3]. LSB embeds the watermark information in the least significant bits of the audio sample values by overwriting the original bits. 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. 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. [4]

Frequency domain audio watermarking techniques employ human perceptual properties and frequency masking characteristics of the human auditory system for effective watermarking [5]. 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 the Fourier transform magnitude coefficients over the frequency range from 2.4 KHz to 6.4 KHz are replaced with the watermark sequence since human sensitivity declines compared to its peak around 1 KHz . Moreover, human ears are relatively insensitive to phase distortion, and especially lack the ability to perceive the absolute phase value. [6]

II. DISCRETE COSINE TRANSFORM

This technique is based on the Discrete Cosine Transform (DCT). In this technique, we take the DCT of both the audio signal and the image files. This is followed by zigzag scanning so as to ascertain the low frequency and high frequency DCT coefficients. The high frequency DCT coefficients of the audio signal are replaced with the lowfrequency DCT coefficients of the watermark image file. While transmitting, the IDCT of the final watermarked DCT istaken. This technique involves both an audio signal and animage; hence, we may implement this method using a 1D DCT for the audio signal and a 2D DCT for the image. Equation (1) defines a 1D DCT while, (2) defines a 2D DCT.

Which are defined by following equation. [7]

$$F(u) = \sqrt{\frac{2}{N}} \sum_{i=0}^{N-1} A(i) cos \left[\frac{u(2i+1)\pi}{2N} \right] f(i) \quad (1)$$

Where,

$$A(i) = \begin{cases} \frac{1}{\sqrt{2}} for u = 0 \\ 1 \quad otherwise \end{cases}$$

f(i) is the input sequence.

$$F(u,v) = \sqrt{\frac{2}{N}} \sqrt{\frac{2}{M}} \sum_{i=0}^{N-1} A(i) \cos \left[\frac{u(2i+1)\pi}{2N} \right] \sum_{i=0}^{N-1} A(i) cos \left[\frac{v(2j+1)\pi}{2M} \right] f(i,j) \quad (2)$$

Where,

$$A(i) = \begin{cases} \frac{1}{\sqrt{2}} for u = 0 \\ 1 \quad otherwise \end{cases}$$

$$A(j) = \begin{cases} \frac{1}{\sqrt{2}} for v = 0 \\ 1 \quad otherwise \end{cases}$$

f(i,j) is the 2D input sequence.

III. THE PROPOSED METHOD

In this section, we explain the details of embedding and extraction procedures of the proposed method. [8, 9]

A. Embedding procedure.

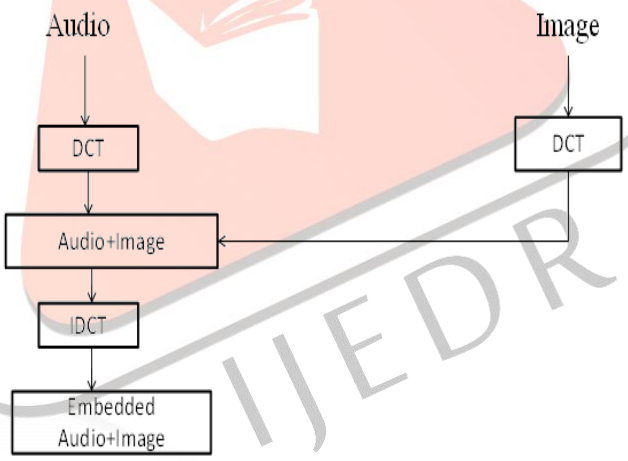

Figure1.Block diagram of the proposed Embedding procedure

The inputs for embedding procedure are combined audio and image. Block diagram of the proposed embedding procedure has been shown in figure 1.In the following, the steps of the proposed embedding procedure.

1. Inputs are combined audio and image.
2. Divide audio signal into equal-sized samples.
3. Convert the obtainedsamples to 2-dimention.
4. Apply the DCT transform.
5. Add the audio and the image.
6. Apply inverseDCT.
7. End.

B. Extracting procedure.

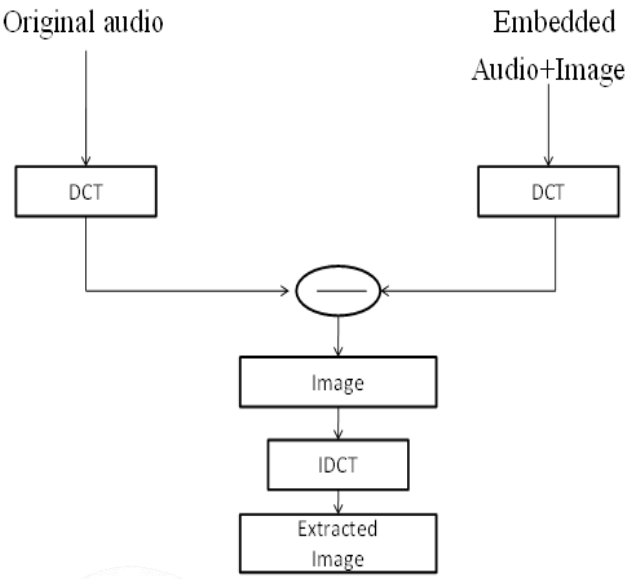

Figure 2. Block diagram of the proposed Extracting procedure

The inputs for extracting procedure are combined original audio and embedded audio+image. Block diagram of the proposed extracting procedure has been shown in figure 2.In the following, the steps of the proposed extracting procedure.

1. Inputs are combined original audio and embedded audio+Image.
2. Apply the DCT transform.
3. Subtract the original audio and the embedded audio+ image.
4. Apply inverse DCT.
5. End.

IV. RESULT

The proposed procedure has been implemented by MATLAB software, completely. In order to evaluate the proposed procedure,audio is 16-bit mono audio signal in WAVE format, sampled at 44100 Hz. The watermark information is an image with size 64×64 bits.

A. Image in audio

The input, i.e., spectrum of the original audio signal and the image is as shown below:

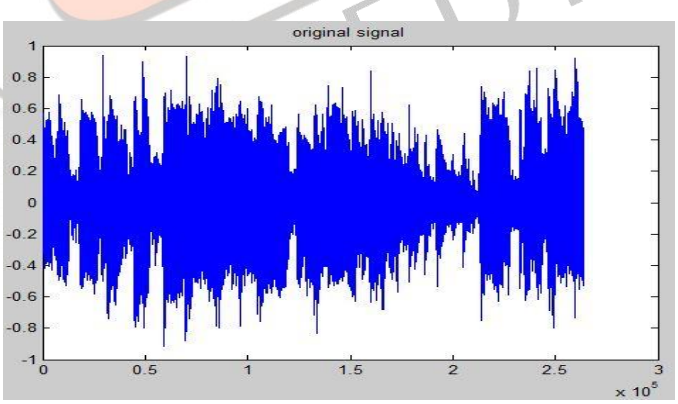

Figure 3. Original audio signal

Figure 4. Original image

The output, i.e., spectrum of the embedded audio signal and the recovered watermark image, obtained by Image in Audio watermarking is as shown below:

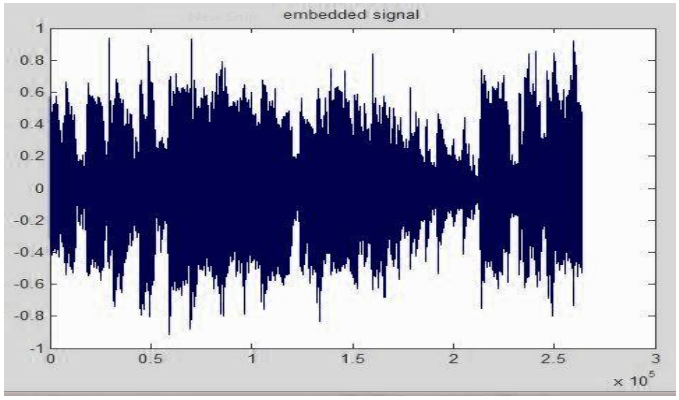

Figure 5. Embedded audio signal

Figure 6. Recovered image

VI.CONCLUSION

This paper presents a new audio watermarking technique in terms DCT transform domain. DCT is an effective and robust algorithm for audio watermarking as the audio signal retrieved is clearly audible.

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