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Image as a watermark In Digital Audio Using Arnold Transform & DWT

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***Abstract*—** The aim is to get large Capacity embedding watermark in Audio & to improve strength of audio watermarking technique to intelligent attacks and simple signal exploitation attacks in existing digital Audio watermarking, this paper presented a large capacity digital audio watermarking using 24 bit true colour image used as watermark. The image is decomposed into R, G, B Components & Arnold transform is applied to Scramble the Watermark image & DCT for image compression. The compressed scrambled watermark image is prepared, and then a Audio signal is to be selected & sampled with M sample. An audio signal is segmented in small segments.

In our proposed work the watermark is embedded in each segment. Three level DWT is applied for each audio segments for calculating embedding strength. The watermark signal is going to be tested for various tests such as similarity, imperceptibility, Robustness, Security. Thus the aim is to get large Capacity embedding watermark in Audio.
Index Terms— Arnold transfom , Copyright Protection, Color Image, Digital Audio Watermarking, DCT, DWT, Strength,

1 Introduction

Many people download and compress music from the internet, creating exact copies of the original data. It is this ease of reproducing that causes copyright violations and unauthorized distribution. In order to combat theft and unauthorized distribution, many cryptographic algorithms have been implemented. However, encryption techniques are unable to solve this problem completely. The reason is that once the encrypted information has been removed, there is no other data that proves the owner's authenticity. For that reason, composers and distributors are more focused on implementing digital watermarking techniques to protect their material against illegal copying and distribution.

Audio Watermarking is the process of embedding information into the audio signal [2]. Digital audio watermarking is a sub-category of watermarking techniques that attempts to protect intellectual property by embedding watermark data into the audio file and recovering that information without affecting the audio quality of the original data.

Audio Watermarking can be implemented in 3 ways:

- Audio in Audio
- Audio in Image
- Image in Audio

A. Audio in Audio

In this method, both the cover file and the watermark file are audio signals. The watermark signal must have fewer samples as compared to those of the cover audio signal. Further, this method can be implemented with the help of two techniques, namely, Interleaving and DCT.

B.Audio in Image

This watermarking implementation uses DCT for embedding audio file in an image. Here we take DCT of both the cover image and the watermark audio files. The low frequency coefficients of both the DCT" s are taken. The high frequency coefficients of the DCT of the image are replaced with the low frequency coefficients of the DCT of the watermark audio file.

The low frequency coefficients of both the DCTs are taken. The high frequency coefficients of the DCT of the image are replaced with the low frequency coefficients of the DCT of thewatermark audio file. During transmission, the IDCT of the final watermarked DCT is taken. This technique involves both an audio signal (watermark) and an image (host). Hence, we implement this method using a 1D DCT for the audio signal and a 2D DCT for the image.

C.Image in Audio

In this implementation, as deployed previously, DCT is used for embedding an image in an audio file. Here we take the DCT of both the cover audio and the watermark 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 low frequency DCT coefficients of the watermark image file. While transmitting, the IDCT of the final watermarked DCT is taken.

Since this method is similar to the ''Audio in Image'' technique with respect to the parameters involved, i.e., this technique also involves both an audio signal (watermark) and an image (host), hence, we may implement this method using a 1D DCT for the audio signal and a 2D DCT for the image.

The human auditory system (HAS) is more sensitive than the human visual system (HVS), so the amount of information to be embedded in the audio signal is much less than in the visual media. The scope of the proposed work is to increase the capacity of watermark embedding using the encryption techniques & compression algorithm like Arnold transform & DCT.

2 Watermark Embedding

2.1 Image Encryption using Arnold Transform

An encryption technique, which is common in 2-dimensional

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domain, is Arnold transform [6]. It is an image transformation technique used to scatter the pixels of the image. Due to the periodicity of the transform, the image can be recovered from the transform domain information. Let (a,b)Tbe the coordinate of the image pixel coordinate and (a' , b')T be the coordinates after the transform action. The size of the image is (Nl×Nl) Arnold transform is then expressed as

$$\begin{bmatrix} a' \\ b' \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix} \pmod{N_1}$$

This algorithm uses 24 a true color image of 48×48 pixels as the watermarking, the watermarking image is firstly decomposed into R, G, and B three components, as shown in Figure 1, then watermarking image's R, G, and B component respectively carries on the two-dimensional Arnold transform, Figure 2 is scrambled R,G,B component's.

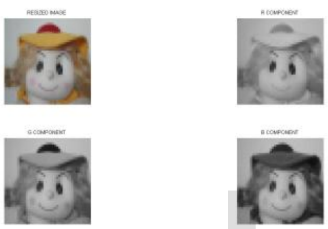

Fig. 1. Original watermarking image & three primary colour R, G, B component

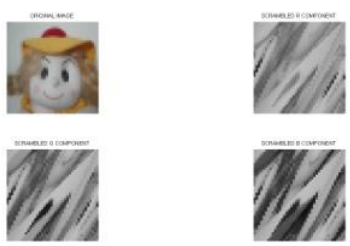

Fig. 2. Original watermarking image & scrambling effect on three primary colour R, G, B component

2.2 Image Compression using DCT

The discrete cosine transform is a technique for converting a signal into elementary frequency components [9]. The DCT can be employed on both one-dimensional and two-dimensional signals like audio and image, respectively.

The discrete cosine transform is the spectral transformation, which has the properties of Discrete Fourier Transformation. DCT uses only cosine functions of various wave numbers as basic functions and operates on real-valued signals and spectral coefficients [8]. DCT of a 1-dimensional (1-d) sequence and the reconstruction of original signal from its DCT coefficients termed as inverse discrete cosine transform (IDCT) can be computed using equations.

In the following, f (i) is original sequence while F(u) denotes the DCT coefficients of the sequence. In the equation for F (u) it can be inferred that for u = 0, the component is the average of the signal also termed as DC coefficient and all the other transformation coefficients are called ac coefficients. Important application of DCT Image compression and signal compression.

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

Where,

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

f(i) is the input sequence.

The most useful application of two dimensional(2-d)DCT are the image compression and encryption 1-d DCT equation can be used to find the 2-d DCT by considering every row as an individual 1-d signal[6]. Thus, DCT coefficients of an M×N two-dimensional signal.

$$F(u,v) = \sqrt{\frac{2}{N}} \sqrt{\frac{2}{M}} \sum_{i=0}^{N-1} A(i) * \cos\left(\frac{u(2i+1)\pi}{2N}\right) * \sum_{j=0}^{M-1} A(j) * \cos\left(\frac{v(2j+1)\pi}{2M}\right) * f(i,j) \quad (3)$$

Where,

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

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

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

DCT has a good characteristics of decor relation & energy concentration [9].In this algorithm three primary colour component R,G,B of the watermarking image which is scrambled by Arnold transform are respectively carried on two dimensional DCT transform. Figure 3 shows the DCT of three components R, G, B respectively [4].

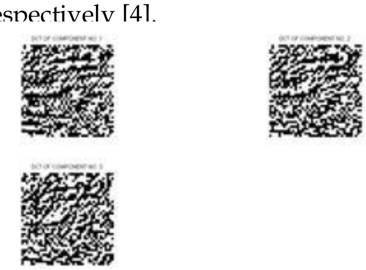

Figure 3. Compressed R component, compressed B component, Compressed G component

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2.3 Audio Signal segmentation using DWT

There are considerable drawbacks in either time domain or frequency domains, which are rectified in wavelet transform. Wavelet Transform provides the time-frequency representation of the signal. Some of the other types of time-frequency representation are short time Fourier transformation, Wigner distributions, etc. There are different types of wavelet transforms such as continuous wavelet transform (CWT) and discrete wavelet transform (DWT) [3]. CWT provides great redundancy of reconstruction of the signal whereas DWT provides the sufficient information for both analysis and synthesis signal and is easier to implement as compared to CWT [5].

A complete structure of wavelet contains domain processing analysis block and a synthesis block. Analysis or decomposition block decomposes the signal into wavelet coefficients [3]. The reconstruction process is the inverse of decomposition process. Here, the block takes the decomposed signal and synthesizes (near) original signal. A view of the wavelet process is shown in Figure. From the figure the original signal is decomposed in the analysis block and the signal is reconstructed using the synthesis block. Filters used in the analysis and synthesis block. A basic block view of wavelet functionality is as shown in figure.

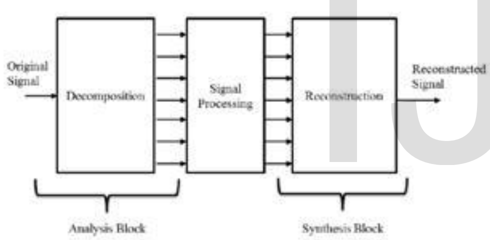

Fig. 4. Basic block view of wavelet functionality

In this algorithm the original audio signal with M sampled data is divided into same segments evenly, embed M1×M2 watermark in each segment of length M1×M2 audio data segments.

2.4 Embedding Phase

1. Carry out 3 level DWT of each audio segment & calculate embedding strength.
2. The decomposition coefficient of the audio data segment is to be carried on wavelet transform, it contain the wavelet coefficients.
3. The low frequency components are modified overall, the watermarking information signal is embedded into the approximate component for the third level of wavelet transform. Modify the wavelet coefficients.
4. The modified wavelet coefficients are carried on the inverse discrete wavelet transform, & obtain the IDWT of the original audio signal.
5. Combine the watermarking signal with IDWT of the decomposition coefficient of original audio signal to get final watermark signal.

3 Watermark Extraction

The Proposed Watermarking extracting process is the reverse of embedding process.
1. The original audio signal and the watermarked audio signals are divided into same segments evenly.
2. The audio data segments and the IDWT of the audio signal are carried on three level discrete wavelet transform. Extracts the low frequency coefficients of each segment, and calculate the extracted watermarking for each segment, combine the extracted value of each segment into one dimensional extracted watermarking signal sequence.
3. Above watermarking signal sequence is decomposed into R,G,B component which are the watermarking signal of the three primary colours & are respectively carried on IDCT.
4. Apply the Inverse Arnold transform on above signal and the results of these are combined into three dimensional arrays, and then may obtain the embedded watermarking image.

4 Result

Watermark signal is image & this image is decomposed into R,G,B component as shown in fig.1, & scrambling effect on three primary colour R, G, B component is shown in fig.2.These signals are compressed using DCT as shown in fig.3.For the Proposed method Test the watermark signal for various tests such as
1. Test for Similarity and Imperceptibility
2. For Bit Error Rate
3. Test for Robustness.

5 Conclusion

All watermarking systems are designed to achieve one goal that is embedding a hidden robust watermark into digital media. This paper focuses an algorithm of digital audio watermarking using image as a watermark; the algorithm is simple & significantly enhances the watermarking information capacity. it may gives the imperceptibility and Robustness is very good.

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