Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 3, Issue. 7, July 2014, pg.536 – 542

RESEARCH ARTICLE

A DWT and DCT based Hybrid Approach for Audio Watermarking

Lovely Malhotra[1], Neha Gupta[2]

Student, NC College of Engineering[1]
Panipat, Haryana
lovelypanipat@gmail.com

Lecturer, NC College of Engineering[2]
Panipat, Haryana
nehagupta3108@gmail.com

Abstract— To obtain the information security and information authentication one of effective approach is watermarking. In this approach, the data is hide behind some multimedia objects. One of such effective watermarking concept is provided by Audio watermarking. In this work, a hybrid approach is presented to perform audio watermarking by using DCT and DWT approaches. In this paper, the presented research model is presented along with proposed algorithm. The implementation results shows that the presented work has provided effective results. The work is analyzed in case of normal case as well as on noise and compression attacks.

Keywords- Audio Watermarking, DWT, DCT, Noisy, Compression

I. INTRODUCTION

To protect the Audio contents of a DVD, the Copy Protection Technical Working Group (CPTWG), an ad hoc group consisting of the Motion Picture Association of America, the Consumer Electronics Manufacturers Association, and members of the computer industry, examine the digital Audio protection in the form of Audio watermarking. The system was designed basically for the DVD copyright protection. The Audio watermarking provides the Audio protection with better robustness and transparency. In this watermarking system, the watermark convey the information about the copying authority like copy once, copy never, copy freely etc. Another advantage of this mechanism is the cost effectiveness. It provides the higher security and reliability in terms of low false positive rate. This Audio watermarking was defined with MPEG decoder. The

watermark is embedded with in the drive that make it sure that watermark will stay till the multimedia content is available in the DVD. But to include some more features such as cryptography and the authentication over the watermark contents, the application based watermarking come into the picture. This application oriented watermarking scheme gives more flexibility to extend the application as well as the methodology.

Another extension to this Audio marking approach is the inclusion of second watermark. This second watermark scheme is inexpensive and basically used for the compressed Audios. The another watermarking approach is based on tickets that represents a cryptographic counter defined by hash key and this counter is incremented each time the Audio pass to the recorder. Another scheme adopted by Audio watermarking is the scene based watermarking. This scheme basically separate the static and dynamic areas of the Audio frames by using wavelet decomposition. Now these static areas are used to store the watermark objects[6].

Another issue associated with Audio watermarking is the compressed Audio formats. These compressed Audio formats having the compressed bit streams so that full length decoding process cannot be implemented here. These kind of Audio formats increases the complexity as well as delay while performing the watermarking[6].

A) Requirements of Audio Watermarking

Some of the requirements of watermarking are discussed in earlier section. But along with this, the additional requirements of Audio watermarking is given as[7]

(i) Compressed Data Processing

In normal case, the Audio watermarking system must be operated under the compressed domain because most of the available Audio formats are itself in compressed forms. To achieve the robustness, it is required for a watermarking approach to be feasible in compressed, recompressed and decompressed forms.

(ii) Fast Embedding/Detection

Generally, the size of Audio data is quite large so that a Audio watermarking algorithm must be fast enough to process the Audio and to minimize the process delay.

(iii) Blind Detection

In case of Audio watermarking, there is no availability of original Audio while performing the watermark detection. Because of this it is important for Audio watermarking to perform the detection process blink by analyzing the Audio sequences. But the detection process, can have the watermarked object to perform the detection.

B) Watermarking Perspectives

The perceptivity of the watermark actually defines the need of the user or the actual requirement of user. These requirements can be crystal clear, if we get the features of these perspectives. The features of these two classes are listed in Table 2.

Table 2: Perceptive based Classification

	Visible Watermarking
Feature	• Overwrite the Existing media contents • Cannot remove watermarks completely • Used for logos or the trademarks
Advantage	• Direct Confirmation • Comparatively Fast
Disadvantage	• Fragility to Attack • Degrade Quality
	Invisible Watermarking
Features	• Most Commonly used • Necessary for commercial authentication
Advantages	• Not Degrade the contents
Disadvantages	• Can be modified

C) File Format

There are different Audio media formats are available for the Audio content processing. These Audio includes the high and low quality Audios. The low quality Audios are basically the compressed Audios that distort the Audio quality. For the watermarking generally high quality original Audios are preferred. One of such Audio format is WAV that is been used in this research work. It is a special case of the RIFF (Resource Interchange File Format). WAV is defined by Microsoft. It is one of the most usable Audio format in PC. WAV is the Audio standard that provide high quality Audio. Respective to the processing, Matlab has in built commands for the processing of WAV files only. It doesn't support other frequently used Audio formats such as MPEG, DAT etc. These reasons formed the grounds upon which we chose WAV files for Audio Watermarking. We have got many freewares in the net which can convert any movie format to WAV and vice versa. Hence the choice of a particular movie format for this watermarking scheme in no way is a limitation.

II. LITERATURE REVIEW

C. K. Chan et. al [1] presented a data hiding scheme by simple LSB substitution is proposed. By applying an optimal pixel adjustment process to the stego-Audio obtained by the simple LSB substitution method, the Audio quality of the stego-Audio can be greatly improved with low extra computational complexity. The worst case mean-square-error between the stego-Audio and the cover-Audio is derived. Experimental results show that the stego Audio is visually indistinguishable from the original cover-Audio. Sanjeev Manchanda et. al [2] stated that steganography is the science of hiding information in media based data. They present random numbers logic based steganographic methods and layout management schemes for hiding data/Audio into Audio(s). These methods and schemes can be customized according to the requirements of the users and the characteristics of data/Audios. These methods are secure enough to meet the requirements of the users and user can play significant role in selection and development of these methods. Methods can be chosen randomly and implemented dynamically based on inputs, user choices as well as outputs. Experimental results are given to demonstrate the performance of the proposed methods. Xinpeng Zhang et. al [3] said that the pixel-value differencing (PVD) steganography can embed a large amount of secret bits into a still Audio with high imperceptibility as it makes use of the characteristics of human vision sensitivity. However, a loophole exists in the PVD method. Unusual steps in the histogram of pixel differences reveal the presence of a secret message. An analyst can even estimate the length of hidden bits from the histogram. To enhance security, a modified scheme is proposed which avoids occurrence of the above-mentioned steps in the pixel difference histogram while preserving the advantage of low visual distortion of the PVD. The histogram-based steganalysis is therefore defeated. H.-C. Wu, N.-I. Wu et. al [5] proposed a method in order to improve the capacity of the hidden secret data and to provide an imperceptible stego-Audio quality, a novel steganographic method based on least-significant-bit (LSB) replacement and pixel-value differencing (PVD) method is presented. First, a different value from two consecutive pixels by utilizing the PVD method is obtained. A small difference value can be located on a smooth area and the large one is located on an edged area. In the smooth areas, the secret data is hidden into the cover Audio by LSB method while using the PVD method in the edged areas. Because the range width is variable, and the area in which the secret data is concealed by LSB or PVD method are hard to guess, the security level is the same as that of a single using the PVD method of the proposed method. From the experimental results, compared with the PVD method being used alone, the proposed method can hide a much larger information and maintains a good visual quality of stego-Audio. Hwang M.S. et. al [6] proposed that in a (t, n) threshold proxy signature scheme, the original signer delegates the power of signing messages to a designated proxy group of n members. Any t or more proxy signers of the group can cooperatively issue a proxy signature on behalf of the original signer, but $(t-1)$ or less proxy signers cannot. Previously, all of the proposed threshold proxy signature schemes have been based on the discrete logarithm problem and do not satisfy all proxy requirements. In this paper, they propose a practical, efficient, and secure (t, n) threshold proxy signature scheme based on the RSA cryptosystem. They scheme satisfies all proxy requirements and uses only a simple Lagrange formula to share the proxy signature key. Furthermore, their scheme requires only 5 percent of the computational overhead and 8 percent of the communicational overhead required in Kim's scheme.

Chen et. al [7] proposed a new Audio cryptosystem to protect Audio data. It encrypts the original Audio into another virtual Audio. Since both original and virtual Audios are significant, this new cryptosystem can confuse illegal users. Besides the camouflage, this new cryptosystem has three other benefits. First, this cryptosystem is secure even if the illegal users know that the virtual Audio is a camouflage. Second, this cryptosystem can compress Audio data. Finally, this method is more efficient than a method that encrypts the entire Audio directly. Fu, M.S et. al [8] said that in many printer and publishing applications, it is desirable to embed data in halftone Audios. In this paper, they proposed some novel data hiding methods

for halftone Audios. For the situation in which only the halftone Audio is available, they propose data hiding smart pair toggling (DHSPT) to hide data by forced complementary toggling at pseudo-random locations within a halftone Audio. The complementary pixels are chosen to minimize the chance of forming visually undesirable clusters. Their experimental results suggest that DHSPT can hide a large amount of hidden data while maintaining good visual quality. For the situation in which the original multitone Audio is available and the halftoning method is error diffusion, they propose the modified data hiding error diffusion (MDHED) that integrates the data hiding operation into the error diffusion process. In MDHED, the error due to the data hiding is diffused effectively to both past and future pixels. Their experimental results suggest that MDHED can give better visual quality than DHSPT. Both DHSPT and MDHED are computationally inexpensive.

III. PROPOSED APPROACH

In this present work, a hybrid DWT and DCT based approach for Audio Watermarking approach is presented. The presented research algorithm is shown here under

Table 2 : Proposed Algorithm

```
Algorithm(Audio,Watermark)
/* Here Audio is the input Audio that will work as cover object and watermark is the object information that we have to hind behind the audio content*/
{
1.  Perform the segmentation over the audio object to extract the audio features
2.  Divide the audio datablock in N segments
3.  For I=1 to length(AudioSegment)
    {
4.  Set Audio=AudioSegment(i)
5.  Perform the audio information and identify the cut point
6.  Divide the input audio in two sections so that partial hiding will be performed
7.  Obtain Section I, and implement the data encoding in synchronous way.
8.  Obtain section II, and implement the hybrid decomposition using DWT and DCT
9.  Obtain the watermark and perform encoding using DWT and DCT.
10. Perform Inverse DCT and Inverse DWT to obtain the data back in encoding form
11. Perform Ex-oring on section I and section II data to generate the watermark segment
}

}
```

The concept defined in this paper is based on DWT and DCT approaches. These two approaches are defined here under

A) DCT

DCT is one of the impotent approach that first separate the video frames in smaller parts and assign the weightage to these parts under the quality analysis. The concept of DCT is similar to the Fourier transformation so that the signal is identified under the spatial domain and the frequency analysis on these frames will be done effectively.

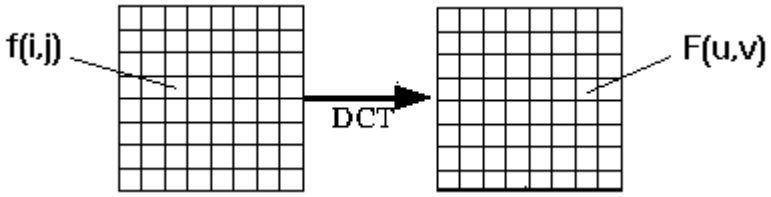

Figure 1 :DCT Encoding

The basic process defined by DCT is given as under

- As the video frames is accepted by the DCT, it split the frame in smaller windows of size nxm.
- Extract the intensity from different window forms at position (I,j)
- Define the coefficient for each row and column under the DCT coefficient matrix.
- The extraction of low frequency areas from the frame that will be used as the key area for storing the data over the image
- The compression will be performed effectively by neglecting the non visible areas so that no visible distortion will be done.
- Define the DCT array of integer so that the gray level scaling will be done.
- The matrix contents will be retrieved under different formats such as horizontally, vertically, in zig-zag motion.

B) DWT

The DWT is one of the fundamental processes in the JPEG2000 image compression algorithm [4]. The DWT is a transform which can map a block of data in the spatial domain into the frequency domain. The DWT returns information about the localized frequencies in the data set. A two-dimensional (2D) DWT is used for images. The 2D DWT decomposes an image into four blocks, the approximation coefficients and three detail coefficients. The details include the horizontal, vertical, and diagonal coefficients. The lower frequency (approximation) portion of the image can be preserved, while the higher frequency portions may be approximated more loosely without much visible quality loss. The DWT can be applied once to the image and then again to the coefficients which the first DWT produced. It can be visualized as an inverted treelike structure. The original image sits at the top. The first level DWT decomposes the image into four parts or branches, as previously mentioned. Each of those four parts can then have the DWT applied to them individually, splitting each into four distinct parts or branches [5].

IV. RESULTS

The presented work is implemented in matlab environment and tested on different audio files. The results obtained from the work is presented here under

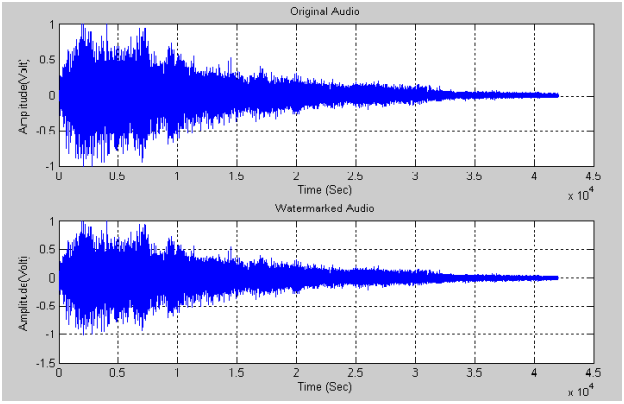

Figure 2 : Encoding Results

Here figure 2 is showing the encoding results of presented approach. Here the upper part of image is showing the input audio signal and low part is showing the signal generated after the watermarking process.

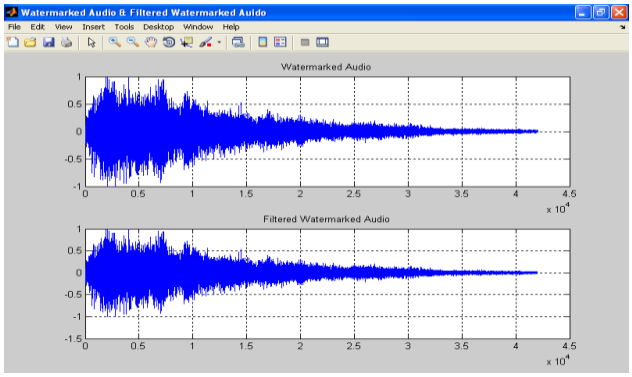

Figure 3 : Filtered Watermarking Result

Here figure 3 is showing the results of watermarking. As shown in figure, the upper part of image is showing the watermarked audio and the lower part is showing the reterived signal. As we can be see, after recovering the signal from audio file, no data loo is obtained and the signal is transformed to the original format.

The presented work is also analyzed under different attacks. The attacks considered in this work are the noise based attack and the compression based attack. The signal obtained in these two cases is shown in figure 4 and figure 5.

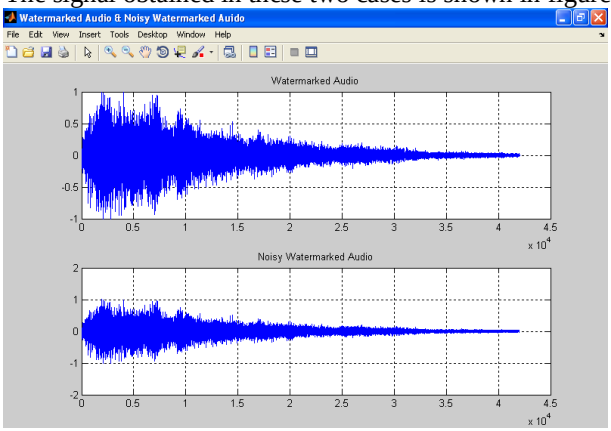

Figure 4 : Noisy Watermarked Audio

Here figure 4 is showing the results obtained in case of noise attack over the watermarked audio. Here upper part of image is showing the input watermarked audio and lower part is showing the noisy watermarked audio.

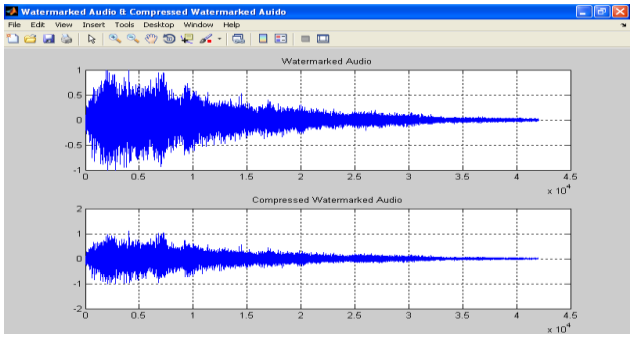

Figure 5 : Compressed Watermarked Audio

Another attack considered in this work is the compression attack. Here upper part of image is showing the watermarked audio and lower part is showing the compressed watermarked audio.

The results show that the presented work is able to perform the effective watermarking and recovery in normal case as well as in case of different attacks.

V. CONCLUSION

In this paper, an effective approach is defined to perform the audio watermarking using DCT and DWT based hybrid approach. The presented work is also tested for different attacks. The obtained results from the system are effective and showing the effective data watermarking and recovery in normal cases as well as in case of attacks.

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