Audio Watermarking Using Adjustment Method

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Abstract— In this paper we are discussing watermarking on audio signals. In this method the recorded audio data is first sampled using a sampling frequency of 22050 Hz. The sampled audio data is then transformed into Discrete Cosine Transform domain. Then the watermark message is watermarked into the DCT coefficients of the audio signal. In this method the adjustment is done to increase the accuracy of the watermarked signal. Finally we extract the message from the audio data after performing Inverse Discrete Cosine Transform to the watermarked audio signal.

Keywords— **Watermarking, DCT, Adjustment method**

I. INTRODUCTION

In this paper we are discussing watermarking on audio signals. In this method the recorded audio data is first sampled using a sampling frequency of 22050 Hz. The sampled audio data is then transformed into Discrete Cosine Transform domain. Then the watermark message is watermarked into the DCT coefficients of the audio signal. In this method the adjustment is done to increase the accuracy of the watermarked signal. Finally we extract the message from the audio data after performing Inverse Discrete Cosine Transform to the watermarked audio signal.

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II. DISCRETE COSINE TRANSFORMATION

Transform coding constitutes an integral component of contemporary image/video processing applications. A transformation is defined to map this spatial (correlated) data into transformed (uncorrelated) coefficients. The Discrete Cosine Transform (DCT) attempts to decorrelate the image data. After decorrelation each transform coefficient can be encoded independently without losing compression efficiency.

The 2-D DCT is a direct extension of the 1-D case and is given as

$$C(u,v)=\alpha(u)\alpha(v) \sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\cos\left[\frac{\pi(2x+1)u}{2N}\right]\cos\left[\frac{\pi(2y+1)v}{2N}\right]$$

for $u,v = 0,1,2,\ldots,N-1$.

$$\text{Where } \alpha(u), \alpha(v)=\begin{cases}\sqrt{\frac{1}{N}}\ for\ u,v=0\\ \sqrt{\frac{2}{N}} for\ u,v\neq 0\end{cases}$$

The inverse transform is defined as

$$f(x,y) = \sum_{u=0}^{N-1}\sum_{v=0}^{N-1}\alpha(u)\alpha(v)C(u,v)\cos\left[\frac{\pi(2x+1)u}{2N}\right]\cos\left[\frac{\pi(2y+1)v}{2N}\right]$$

for $x,y = 0,1,2,\ldots,N-1$.

The 2-D basis functions can be generated by multiplying the horizontally oriented 1-D basis functions with vertically oriented set of the same functions.

III WATERMARKING

The DCT coefficients are fractional values. So these are multiplied by a higher value. The DCT coefficients are represented by 16 bits. The message which is to be watermarked into the audio signal is entered manually in the text box provided. The default message in the text box is 'msg'. Each letter in the watermark message is first converted into its ASCII values. The ASCII values are represented by 7 bits. The message bits are represented by a column matrix. Now we are taking 16 bit audio DCT coefficients. The number of DCT coefficients selected should be same as the total number of message bits. The 2nd bits of DCT coefficients are stored into a vector 'bp'. The message bits are stored in a vector 'bits'. The bitwise XOR is performed between the bits in the 'bp' and 'bits'. The resultant bits are stored into vector 'S'. The resultant bits after XOR are the actual watermark bits. These bits are embedded into the 2nd bit of each DCT coefficients of audio signal. The resultant signal is the watermarked audio signal. The accuracy of the watermarked signal is improved by using adjustment method.

IVADJUSTMENT METHOD

In the adjustment method let 'a' be the value of original data (DCT coefficient), 'b' be the value of watermarked data. Then we choose a value 'c' as the watermarked data such that it is very close the value of ‘a’ and the watermark bit should remain as that of the watermarked data ‘b’. If a > b, then b ≤ c < a or if a < b, then a < c ≤ b.

For example, consider an 8 bit representation. Let the 3rd bit is to be watermarked by a watermark bit ‘1’. Let ‘a’=‘00001011’ (11d) be the DCT coefficient of audio signal. After watermarking ‘a’ will become ‘b’= ‘00001111’ (15d). This watermarked data is adjusted to a new value ‘c’= ‘00001100’ (12d). Here ‘c’ is very close to ‘a’ and the watermark bit remains same as that of ‘b’ ie; ‘1’. Hence now we select the watermarked data as ‘c’.

a=00001011=11d
b=00001111=15d
c=00001100=12d

V EXTRACTION OF MESSAGE

The extraction of message can be done after performing the IDCT to the watermarked signal. We are using the property of bitwise XOR for extraction of message from the watermarked signal. If C= A XOR B, then A= C XOR B. Hence the 2nd bits after IDCT are bitwise XOR with the bits stored in the vector ‘bp’. The resultant bits are the message bits and are converted into the message data. This method is more accurate. The original message can be obtained more accurately after extraction.

VI EXPERIMENTAL RESULTS

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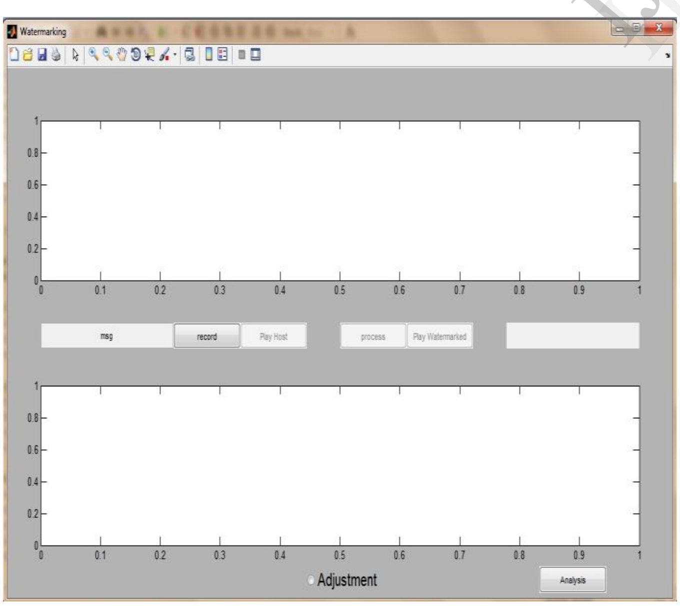


Figure 1 Output window

The output window consists of push buttons ‘record’, ‘Play Host’, ‘process’ and ‘Play Watermarked’ and the edit text box for typing the message. The edit text box contains ‘msg’ as default watermark message. When we select the pushbutton ‘record’, the recording takes place for 5 seconds of time. The extracted message will be displayed in the text box provided for it.

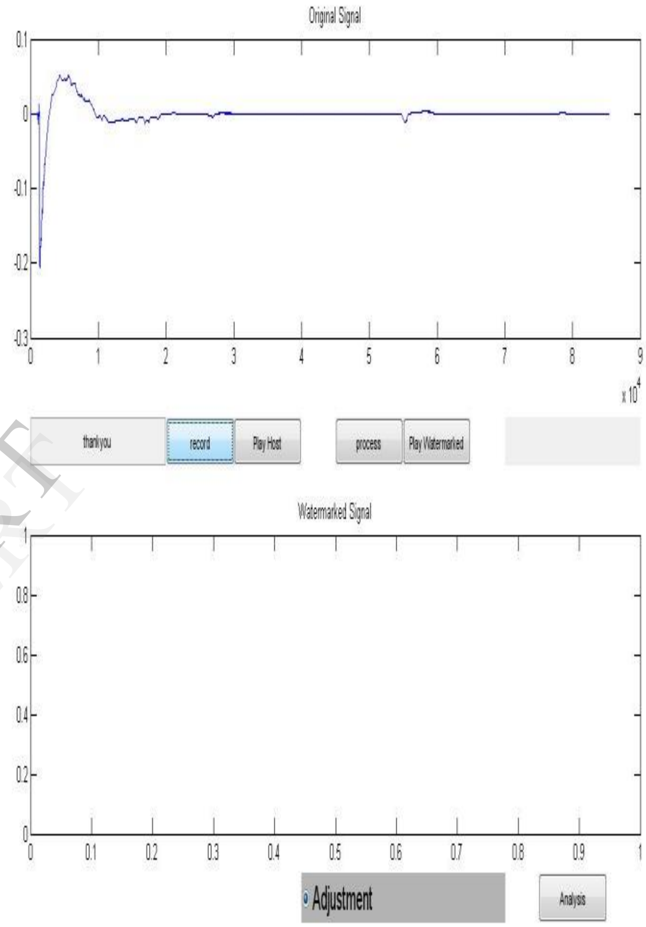


Figure 2 Output window after recording finished

The original audio signal will be displayed after the recording finished. We can check the recorded audio data by selecting the 'Play Host' push button.

WATERMARKING USING ADJUSTMENT METHOD

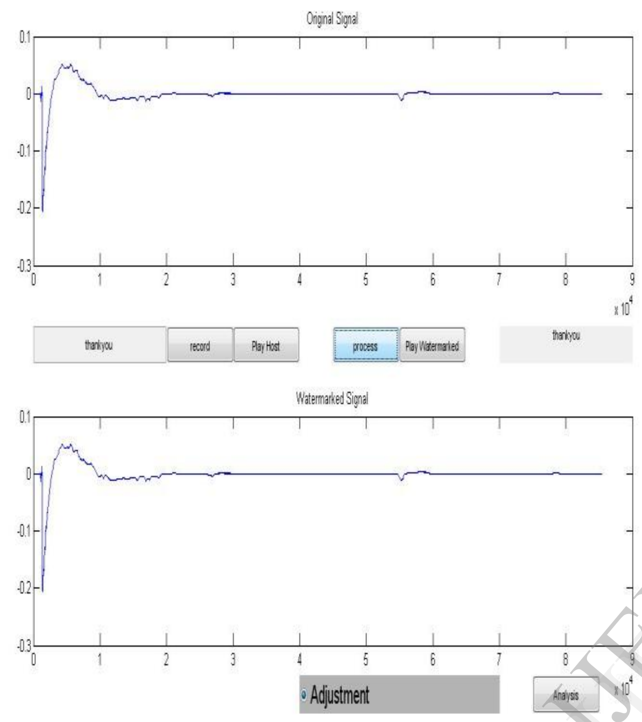
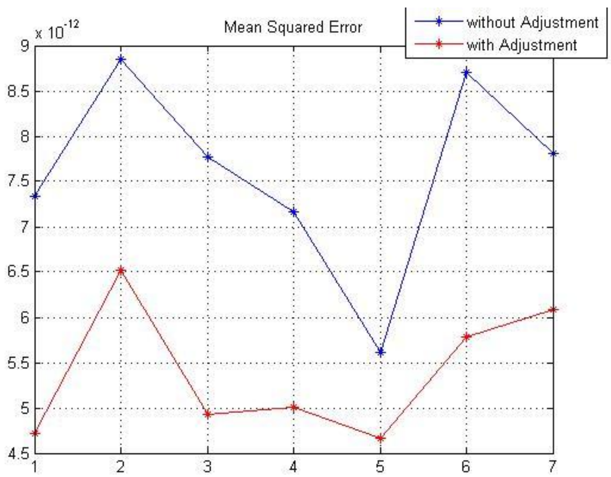


Figure 3.The watermarked signal and extracted message on the output window while using the adjustment method

VII ANALYSIS



The mean squared error between the original signal and the watermarked signal is calculated for both the watermarking methods with and without using the adjustment method. The mean squared error can be calculated as follows.

$$\text{Mean squared error} = \frac{1}{N}\sum_{n=0}^{n=N-1}[Y(n) - X(n)]^2$$

Where N-total number of data taken
Y(n)-watermarked data
X(n)-original audio data after DCT.

The mean squared errors for both the cases are calculated for 7 audio test files. It can be seen that the mean squared error is higher for the watermarking method without using the adjustment method.

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