Significance Of Adjustment Method In Watermarking Using DCT Domain And LSB Method

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Abstract- In this paper we are discussing about the watermarking method using adjustment method. Watermarking is the method of embedding the information into other signal. First we capture the audio data and then it is sampled using a sampling frequency of 22050Hz. The sampled audio data is converted into the DCT coefficients. The watermark message is watermarked into the DCT coefficient of the audio data. An adjustment method is carried out in order to increase the accuracy of the watermarked audio signal. We finally extract the message from the watermarked audio signal after performing IDCT to the watermarked signal. We are also doing the watermarking using LSB method. An analysis is carried out for seven audio clips with and without the adjustment method using DCT and LSB method. In the analysis we are calculating the mean squared error between the original and the watermarked signal.

Keywords-**Watermarking, DCT, Adjustment method, LSB**

I. INTRODUCTION

In this paper the watermarking was done in DCT domain and using LSB method. The host signal was an audio signal. In the first method first we recorded the audio signal. Then it was sampled using a sampling frequency of 22050 Hz. Then the audio signal was converted into the DCT (Discrete Cosine Transform) coefficients. The watermark message was then watermarked into the DCT coefficients of the audio signal. Adjustment method was used to get more accuracy for the watermarked signal. The original message was extracted from the watermarked signal after doing IDCT (Inverse Discrete Cosine Transform) to the watermarked signal. In the second method the watermarking was done using the LSB (Least Significant Bit) method. Here also we first recorded the audio data. Then it was sampled as same as in the case of previous methods. We were not performing the DCT here. The watermark message was watermarked into the sampled audio data. The watermarked message was extracted from the watermarked audio signal.

II. WATERMARKING USING DCT

In this method we did watermarking on audio signals. The message which was to be watermarked was the watermark. First we captured the audio data using a microphone. The recording took place for 5 seconds. After the recording was finished, the recorded audio data was sampled using a sampling frequency of 22050 Hz. The sampled audio data was converted into the DCT coefficients using the Discrete Cosine Transformation.

The most common DCT definition of a 1-D sequence of length N is

$$X(k)=\alpha(k)\sum_{n=0}^{N-1} x(n)\cos\left[\frac{\pi(2n+1)k}{2N}\right]$$

For k=0,1,2,…,$N-1$.

The inverse transformation is defined as

$$x(n)=\sum_{k=0}^{N-1} \alpha(k)X(k)\cos\left[\frac{\pi(2n+1)k}{2N}\right]$$

for n = 0,1,2,…,$N-1$.

$$\text{where } \alpha(k)=\begin{cases}\sqrt{\frac{1}{N}} \; for\ k=0\\ \sqrt{\frac{2}{N}} \; for\ k\neq 0\end{cases}$$

It is clear from that for k =0,

$$X(k=0)=\sqrt{\frac{1}{N}}\sum_{n=0}^{N-1} x(n)$$

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

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

for u,v = 0,1,2,…,$N-1$.

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

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,…,$N-1$.

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.

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 xoring is performed between the bits in the ‘bp’ and ‘bits’. The resultant bits are stored into vector ‘S’. The resultant bits after xoring 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.

III. ADJUSTMENT 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’.

IV. EXTRACTION OF MESSAGE

The extraction of message can be done after performing the IDCT to the watermarked signal. We used the property of bitwise xoring 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 xored with the bits stored in the vector ‘bp’. The resultant bits are the message bits and are converted into the message data.

V. WATERMARKING USING LSB METHOD WITH ADJUSTMENT METHOD

In this method the watermarking was done using LSB (least significant bit). Here we did not perform discrete cosine transformation. First we captured the audio data. Then the audio data was sampled using a sampling frequency of 22050 Hz. The message which was to be watermarked into the audio signal was entered into the text box. Each letter in the message was converted into its ascii value. The ascii values were represented by 7 bit binary representation. These binary bits were stored into a column vector. Each bit is bitwise xored with the 2nd bit of sampled audio data. The resultant bits after bitwise xoring were the watermark bits. These watermark bits were watermarked into the 2nd bit of each sampled audio data. In this method we used adjustment method as in the previous case explained.

Here let ‘a’ be the value of original data (sampled audio data), ‘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.

We used the property of bitwise xoring for extraction of message from the watermarked signal. If C= A xor B, then A= C xor B. Hence the 2nd bits of watermarked audio data are bitwise xored with 2nd bits of sampled audio data before watermarking. The resultant bits are the message bits and are converted into the message data.

VI. EXPERIMENTAL RESULTS

The simulation of this concept is carried out using the MATLAB R2010a. 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.

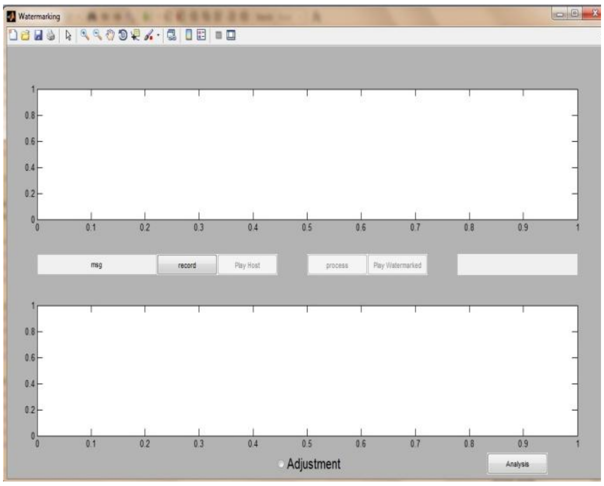

Fig 1: Output window

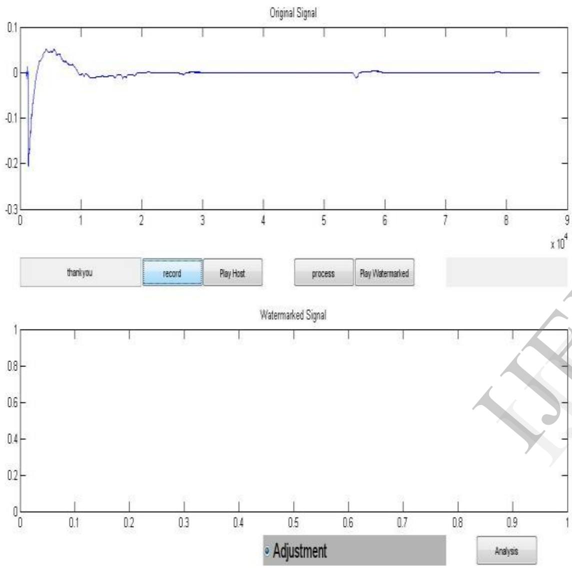

Fig 2: Output window when recording finished

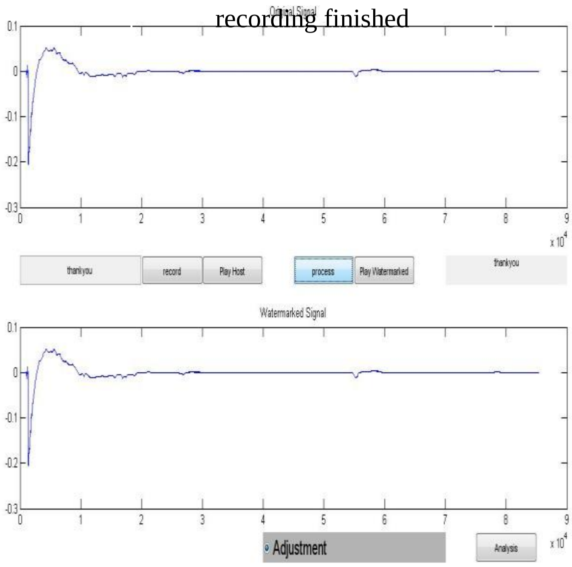

Fig 3: The watermarked signal and extracted message on the output window using the adjustment method in DCT domain

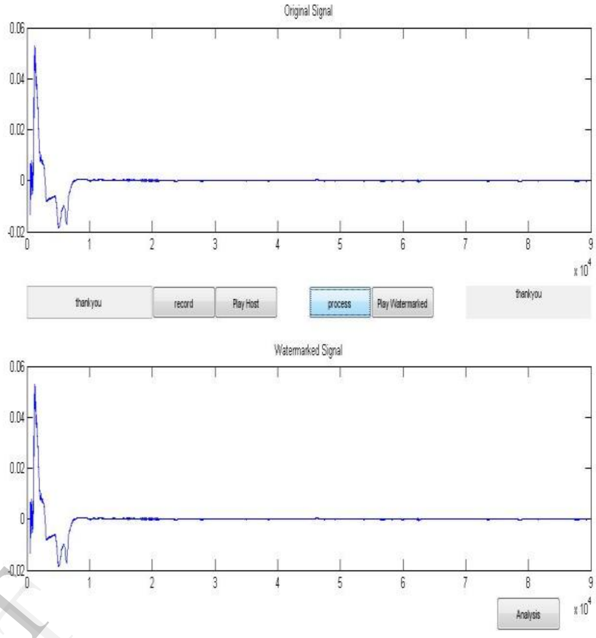

Fig 4: The extracted message and the watermarked signal after watermarking using LSB method

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 and also for the watermarking using LSB 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

In LSB method X(n)-sampled audio data.

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

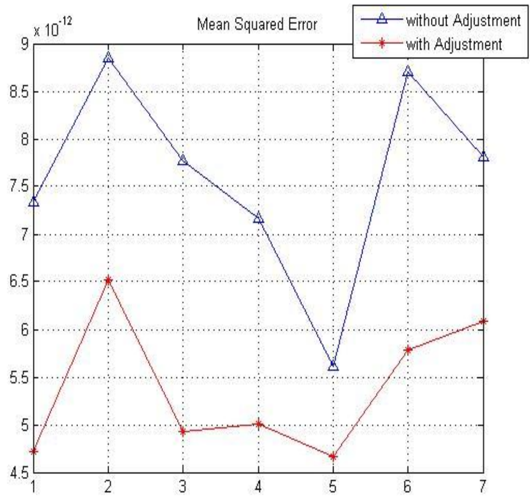

Fig 5: Analysis in DCT domain

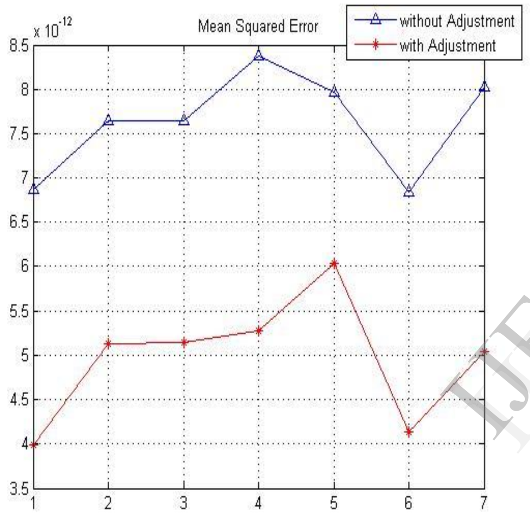

Fig 6: Analysis using LSB method

VIII. CONCLUSION

In this paper we discussed about different watermarking methods. The watermarking was done with and without using the adjustment method. In both the cases the watermarking was performed on the DCT coefficients of the audio data. In addition to these, watermarking using LSB method was also carried out. The adjustment method was used to increase the accuracy of the watermarking. An analysis was carried out for seven audio files using the three watermarking methods. The analysis was carried out by calculating the mean squared error between the watermarked signal and the original signal. From the result we can conclude that the mean squared error is less for watermarking using the adjustment method. The accuracy is therefore more for the watermarking using adjustment method.

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