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Invisible Watermarking Audio Digital with Discrete Cosine Transform

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ABSTRACT

Security is one of the most important parts now, related to copyright which has a royalty to the content owner, this content are an audio file, invisible watermarking is one of the types of techniques that can be used to solve this case because this technique makes watermarking invisible by the human eye and the methods used for this technique using DCT (Discrete Cosine Transform) which works on the frequency domain digital audio files.
Keywords : Watermarking, Invisible Watermarking, Copyright, Security, Discrete Cosine Transform

I. INTRODUCTION

Since the ever-expanding multimedia network, then the process delivery and access of digital data are also easier, with this ease, of course, everyone can freely exchange the information he or she want. However, on the other hand, it brings new problems regarding ownership of the data as the original image. This time a lot digital data processing methods that can be used to secure the copyright as LSB, MSB, EOF, DWT, and so on.

One method that was developed to approach the problem is digital watermarking. Watermarking is a form of steganography (a technique for hiding information on a medium without any significant changes in the media) [1] [2] [3] [4] [5] [6]. Watermarking Techniques will insert digital information called watermark into a digital data called carrier, the embedded watermark can be plain text, audio, image and video depends on the ability of the host media [1] [2] [3]. The addition of the watermark into a multimedia materials without affecting quality can be used as an authentic proof of ownership of the data [1] [4].

II. METHODS AND MATERIAL

A. Watermark

Basically, the technique watermark is the process of adding an identification code permanently into digital data. The identification code can be text, voice, image, or video. In addition to not damage the protected digital data, an identification code should have a resistance (robustness) against the kinds of advanced processing such as conversion, compression, encryption, etc [1] [2] [6].

B. Characteristic Watermark

There are several desirable characteristics of the use of watermarks on a document, of which can not be detected (imperceptible), robustness, security, fragility, and tamper resistance [7]:

1. Imperceptible: the characteristic watermark so as much as possible should not be seen as or different from the original document. It is intended not to change the status of high-value documents legally and commercially.
2. Robustness: This characteristic depends on the application of the watermark itself. When used as an identification of ownership / copyright, watermark should have resistance to a wide range of modifications that might be done to change / eliminate copyright. If it is used to authenticate the content, watermark as far as possible be fragile, so if it has undergone changes, the watermark will be changed / damaged, so it can be detected any attempt modifications to the contents.
3. Security: Techniques watermark should be able to prevent efforts to detect and modify the watermark

information is inserted into the document. Lock watermark ensure only those eligible are able to do so. However, this aspect can not prevent anyone to read relevant documents.

4. Fraggility: contrary to robust, this concept requires watermarking are fragile. Of course this is done in some specific applications. An example is a physical watermarking given the precious letters are made so that the watermarking will not withstand the process of copying. The goal is of course to maintain authenticity. It looks manufacture of watermarking was deliberately designed vulnerable to some modifications, it is resistant to certain modifications. Type of watermarking is usually not implemented in digital form.
5. Tamper Resistance: This concept requires watermarking resistant to any modifications made to the media signal is carried out with the aim to eliminate watermarking, compared with a robust concept that requires resistance to media signal. Modifications to this kind of purpose is considered successful if it is able to damage the watermarking without degrading the signal quality media drastically. The decline in quality is certainly assessed perceptual watermarking is significant so that if broken, then the signal quality of the media will decline in hearing

Discrete Cosine Transform

DCT (Discrete Cosine Transform) is one method used in performing watermarking is done by mapping the set of values as much as N pieces in the spatial domain into the other set with the same number in the frequency domain. The value of the set of real numbers [1] [2] [3] [7].

The concept used in the DCT method is to replace the DCT coefficients in the image into a new coefficient using discrete cosine wave function [5]. Selection of the replaced coefficients may vary depending on frequency selection. If the selected frequency is a high frequency where the coefficients resulting low value, then the image of the watermark will not change significantly [4], so did not see the changes to the human eye. However, the use of these frequencies causes the image of the weak against the changes, like example cropping, editing and other (low robustness value). If selected was a low frequency, where the coefficients of the resulting image is the coefficient of high value, then the image of the watermarking robust against changes (high robustness values) but the change in the image is easily visible to the human eye [6] [7]. How to get the value of DCT coefficient is to calculate the cosine basis functions. For 1-dimensional matrix of size N, the formula used is:

$$X_k = \frac{1}{2}\left(x_0 + (-1)^k x_{N-1}\right)$$

$$+\sum_{n=1}^{N-2} x_n \cos\left[\frac{\pi}{N-1} nk\right] \qquad k = 0, \ldots, N-1$$

III. RESULTS AND DISCUSSION

The first step taken before watermarking audio file is read-frequency signal from an audio file as an initial condition after watermarking signal whether different frequencies, the authors use a file with the file name goyang_dumang.MP3. To read the frequency of the signal in the form of waves of cossinus authors use matlab command, the version that I use matlab R2014a, The following is the frequency of the signal from the audio files that are processed using matlab

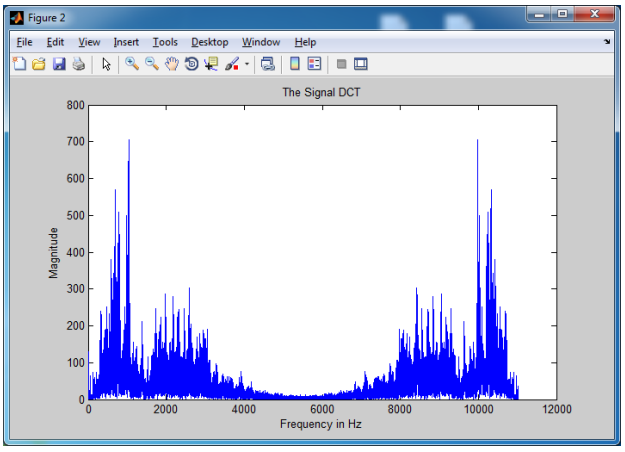

Figure 1. Frequency Audio Files

Now we know the initial signal frequency from MP3 files then the signal is converted into decimal form to make the process easier watermarking using DCT method, prior to the frequency values in a decimal form that is taken in binary form, and the results are as below:

TABLE I
Original Frequency Signals in Binary

BINER		
01000010	10000100	10000001
10001000	11000000	00110000
11000000	10100000	10001000
00010010	10000100	01001000
01100000	00110000	00110000
01000001	00100100	00001001
00101000	00110000	10000001
00010001	00011000	01001000
10001000	01001000	00100010
01000001	00110000	01000100
00100100	00001010	00001100
11000000	00110000	00001100
01001000	01001000	00100100
00001010	00110000	01000100
00001001	00110000	01001000
00000110	01001000	00100001
00000011	10000100	00001100
00001100	01000010	01000001
10100000	00100100	00100001
00100001	01000001	00001001
01000001	00000011	01000001
00001001	10000100	11000000
00001001	00010010	00010100
00000101	00001001	01100000
00100100	11000000	00010001
00011000	00010001	00001100
00001100	10000010	01010000
00100100	00011000	00010001
10001000	01100000	10010000
00101000	00100100	00000101
10000001	01010000	00000110
00101000	01000010	01000100
01000010	01000010	01000100
		01000001

Results binary of the audio file conversion back into decimal form, the results are as below:

TABLE II
Original Matrix Frequency

idx	0	1	2	3	4	5	6	7
0	66	136	192	18	96	65	40	17
1	136	65	36	192	72	10	9	6
2	3	12	160	33	65	9	9	5
3	36	24	129	136	72	48	9	129
4	72	34	132	192	160	132	48	36
5	48	36	48	24	72	48	10	48
6	72	48	48	72	132	66	36	65
7	3	132	18	9	192	17	68	12
8	12	36	68	72	33	12	65	33
9	9	65	192	20	96	17	12	80
10	17	144	5	130	24	96	36	12
11	36	136	40	129	40	80	66	6
12	68	66	68	65				

Let the same matrix size writers erase some value so that the number of rows and columns equal to the size of 8X8, below the results

TABLE III
Original Matrix Frequency 8 X 8

idx	0	1	2	3	4	5	6	7
0	66	136	192	18	96	65	40	17
1	136	65	36	192	72	10	9	6
2	3	12	160	33	65	9	9	5
3	36	24	129	136	72	48	9	129
4	72	34	132	192	160	132	48	36
5	48	36	48	24	72	48	10	48
6	72	48	48	72	132	66	36	65
7	3	132	18	9	192	17	68	12

After getting the decimal value of the audio file, the next is to determine the message watermarking that will be used for watermarking audio files in this study using the word “ROBBIOKE”, the message watermarking is then first converted into decimal form and results in decimal is 82 79 66 66 73 79 75 69, below is a step in the process of watermarking:

1. The first step is reduced 128 original matrix data due DCT method works on a range of -127 to 128, below is a table of the results of the reduction of the original matrix

TABLE IV
Matrix Modification Initial Value

id	0	1	2	3	4	5	6	7
0	-62	8	64	-110	-32	-63	-88	-111
1	8	-63	-92	64	-56	-118	-119	-122
2	-125	-116	32	-95	-63	-119	-119	-123
3	-92	-104	1	8	-56	-80	-119	1
4	-56	-94	4	64	32	4	-80	-92
5	-80	-92	-80	-104	-56	-80	-118	-80
6	-56	-80	-80	-56	4	-62	-92	-63
7	-125	4	-110	-119	64	-111	-60	-116

2. After getting value matrix changes the next DCT is making matrix T and the matrix transpose, to transpose the calculation using the formula

$$T(i,j) = Ci\ Cos\frac{(2j+1)i\pi}{2N},\ Ci = \sqrt{\frac{1}{N}}(i=0), Ci = \sqrt{\frac{2}{N}}(i<0)$$

Then using the above matrix formula can be calculated value matrix T from T (0.0) to T (n, n), for example, initial calculations

$$T(0,0) = \frac{1}{\sqrt{n}} = \frac{1}{\sqrt{8}} = 0.354$$

$$T(0,1) = \frac{1}{\sqrt{n}} = \frac{1}{\sqrt{8}} = 0.354$$

Shown in the above formula to position T (0,0) and Q (0,1) the authors use the divider 8, if the value is less than 0, the divisor used is 8, based on the above formula obtained table matrix transpose matrix T and T as follows:

TABLE V
Matrix T

id	0	1	2	3	4	5	6	7
0	0.354	0.354	0.125	0.354	0.354	0.354	0.354	0.354
1	0.354	0.354	0.354	0.125	0.354	0.354	0.354	0.354
2	0.354	0.354	0.177	0.354	0.354	0.354	0.354	0.354
3	0.354	0.354	1.000	0.354	0.354	0.354	0.354	1.000
4	0.354	0.354	0.500	0.125	0.177	0.500	0.354	0.354
5	0.354	0.354	0.354	0.354	0.354	0.354	0.354	0.354
6	0.354	0.354	0.354	0.354	0.500	0.354	0.354	0.354
7	0.354	0.500	0.354	0.354	0.125	0.354	0.354	0.354

After the matrix T made transposed matrix T, the transpose function to change rows into columns and columns into rows so that from the table above if used as transposed into :

TABLE VI
Matrix Transpose T

Id	0	1	2	3	4	5	6	7
0	0.354	0.354	0.354	0.354	0.354	0.354	0.354	0.354
1	0.354	0.354	0.354	0.354	0.354	0.354	0.354	0.5
2	0.125	0.354	0.177	1	0.5	0.354	0.354	0.354
3	0.354	0.125	0.354	0.354	0.125	0.354	0.354	0.354
4	0.354	0.354	0.354	0.354	0.177	0.354	0.5	0.125
5	0.354	0.354	0.354	0.354	0.5	0.354	0.354	0.354
6	0.354	0.354	0.354	0.354	0.354	0.354	0.354	0.354
7	0.354	0.354	0.354	1	0.354	0.354	0.354	0.354

3. The third step is to perform calculation between matrix transpose T with watermarking message, to perform calculations between matrix transpose T with watermarking message used the formula P = T.Z, where Z is the decimal value of the watermarking message, below is the result of the calculation

TABLE VII
Watermarking Result

0	1	2	3	4	5	6	7
23.01	29.38	29.73	29.02	25.84	27.96	26.55	24.42
23.01	29.38	29.73	29.02	25.84	27.96	26.55	34.5
8.125	29.38	14.86	82	36.5	27.96	26.55	24.42
23.01	10.37	29.73	29.02	9.12	27.96	26.55	24.42
23.01	29.38	29.73	29.02	12.92	27.96	37.5	8.62
23.01	29.38	29.73	29.02	36.5	27.966	26.55	24.42
23.01	29.38	29.73	29.02	25.84	27.96	26.55	24.42
23.01	29.38	29.73	82	25.84	27.96	26.55	24.42

The above table shows that the frequency value after the process of watermarking from message "ROBBIOKE", a value above the value end of the insertion process, while for the extraction process simply reverses the process of Tt Matrix and Matrix T, below is a modified version of the binary signal after insertion

TABLE VIII
Modification Frequency Signals in Binary

BINER		
0 0 0 0 1 1 0 0	1 0 0 0 0 1 0 0	0 1 0 0 1 0 0 0
0 1 0 0 0 1 0 0 1	0 1 0 0 0 1 0 0	0 1 1 0 0 0 0 0
1 0 0 0 0 0 0	0 0 0 1 0 0 0 1	0 1 0 0 1 0 0 0
0 0 0 0 0 0 1 1	0 0 0 0 0 1 1 0	0 0 1 1 0 0 0 0
0 0 0 1 0 1 0 0	0 0 1 0 1 0 0 0	0 1 0 0 0 1 0 0
0 0 0 0 0 0 1 1	1 0 1 0 0 0 0 0	0 0 0 0 0 0 1 1
0 1 0 1 0 0 0 0	0 1 0 0 0 0 0 1	0 0 0 0 1 1 0 0
0 0 0 1 1 0 0 0	0 1 0 0 0 1 0 0	0 0 0 0 0 1 0 1
0 0 0 1 0 1 0 0	1 0 0 0 1 0 0 0	0 1 0 0 0 0 0 1
0 0 1 0 0 1 0 0	1 0 0 0 1 0 0 0	0 0 1 0 0 0 0 1

0 0 0 1 0 1 0 0	1 0 0 0 1 0 0 0	0 0 0 0 0 1 1 0
0 0 0 0 0 1 1 0	0 1 0 0 1 0 0 0	0 0 0 0 1 0 0 1
0 1 0 0 1 0 0 0	0 1 0 1 0 0 0 0	0 1 0 0 1 0 0 0
0 0 0 0 0 0 1 1	0 0 0 0 0 1 0 1	0 0 0 0 0 0 1 1
0 1 0 0 0 0 0 1	0 0 0 0 0 0 1 1	1 0 0 0 0 1 0 0
0 1 0 0 0 1 0 0	0 0 1 0 1 0 0 0	0 0 1 0 0 0 1 0
0 0 0 1 1 0 0 0	0 0 0 0 1 0 0 1	0 0 1 0 0 0 0 1
1 0 0 1 0 0 0 0	0 0 0 0 0 0 1 1	0 1 0 0 0 1 0 0
0 0 0 0 0 0 1 1	1 0 0 0 0 0 1 0	0 1 1 0 0 0 0 0
0 0 0 1 0 1 0 0	0 1 0 0 0 0 1 0	0 0 0 1 0 0 1 0
0 0 0 1 0 1 0 0	0 1 0 0 0 0 1 0	0 0 0 0 0 1 0 1
0 0 1 0 0 0 0 1	0 0 0 0 1 1 0 0	0 0 0 0 0 0 1 1
0 1 0 1 0 0 0 0	0 0 1 0 0 1 0 0	0 0 1 0 0 1 0 0
1 0 0 0 1 0 0 0	0 0 0 1 0 0 0 1	0 1 1 0 0 0 0 0
0 1 0 0 1 0 0 0	0 0 0 1 1 0 0 0	0 0 0 1 1 0 0 0
0 1 0 0 0 0 1 0	1 0 1 0 0 0 0 0	0 0 0 0 1 1 0 0
1 0 0 0 0 1 0 0	0 0 0 0 0 1 0 1	0 0 0 1 0 0 1 0
0 0 1 0 0 0 1 0	0 0 0 0 0 1 0 1	1 0 0 0 0 1 0 0
0 1 0 0 0 0 0 1	1 0 0 0 0 0 0 1	1 0 0 0 0 1 0 0
0 0 1 0 1 0 0 0	0 1 0 1 0 0 0 0	0 0 1 0 0 1 0 0
0 1 0 0 0 1 0 0	0 0 0 0 0 1 0 1	0 0 0 0 0 0 1 1
0 0 0 1 0 0 0 1	0 0 0 0 1 0 0 1	0 0 1 0 0 0 1 0
0 0 1 0 0 0 0 1	0 0 1 0 0 0 1 0	0 0 0 0 1 0 0 1
0 0 0 0 0 1 1 0		

IV. CONCLUSION

Watermarking process the audio file by delivering text messages using Discrete Cosine Transform algorithm successfully performed well, giving watermarking signal frequency will be difficult for a layman to know the watermarking and for expert also takes time to eliminate the existing watermarking

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