The Effect of Data Hiding at Various Bit Positions on Audio Stegnography in DCT Domain

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Abstract

This work is related to audio Stegnography and presents the statistical analysis of various quality measuring parameters of audio Stegnography, e.g. signal to noise ratio (SNR), peak signal to noise ratio (PSNR) and mean square error (MSE), for different bit position substitution in an audio cover file in discrete cosine transform (DCT) domain. Interestingly the resulted mean square error (MSE), signal to noise ratio (SNR) and peak signal to noise ratio (PSNR) for each bit position shows a very insignificant variations in the values of the quality measuring.

Keywords: *Audio Stegnography, Discrete Cosine Transform, Signal Processing, Information Security*

1. Introduction

Stegnography is a technique of hidden and secrete writing, the information are hidden in cover media (text, audio, image, video) in both spatial (LSB, VLSB) [1, 2, 3] and transform (DCT, DWT) domain [1]. In spatial domain LSB and VLSB [3, 4] are the most fashionable methods of Stegnography [5]. In transform domain Stegnography has been implemented using Discrete Wavelet Transform (DWT) [6] and Discrete Cosine Transform (DCT) e.g. adaptive DCT based mode 4 Stegnography [8], pseudo-code algorithm [6] and compression [7].

The importance of steganography is increased day by day, and a lot of work is done to enhance this field. kaliappan gopalan proposed an audio steganography algorithm with an encription key for the embedded secret audio file [8]. Mazdak Zamani, Hamed Taherdoost, Azizah A.Manaf, Rabiah B. Ahmad, and Akram M. Zeki work on higher LSB layer of audio file to increased its robustness [9]. Mohammad Pooyan, Ahmad Delforouzi use lifting wavelet transform and calculate the hearing threshold, and according to the threshold data bits are embedded in the least significant bits (LSB) of lifting coefficients [10]. Dimitriy E.Skopin, Ibrahim M.M. El-Emary, Rashad J.Rasras, Ruba S.Diab proposed an algorithm in audio steganography for hiding human speech signal using two methods spectrum shift and spectrum spreading [11]. Masahiro Wakivama, Yasunobu Hidaka, Koichi Nozaki work on wave file as an audio data, and proposed two kinds of new methods of extended low bits coding [12]. Haider Ismael Shahadi, Razali Jidin proposed high capacity audio steganography algorithm based on the wavelet packet transform with adaptive hiding in least significant bits(LSB) [13]. Anupam Kumar Bairagi, Saikat Mondal, Amit Kumar Mondal proposed a method, the message bits are embedded into deeper layer in such a way to increase its robustness [14].

Audio Stegnography is used to hide secret information in audio cover file the secret message is embedded by slightly altering the binary sequence of an audio file. Existing audio Stegnography software can embed message in WAV, AU and even MP3 sound files, in both temporal domain and transform domain. In transform domain Stegnography has been implemented using DWT and DCT etc.

In all previously implemented techniques a specific region/coefficients of the DCT are targeted and data/information are hidden in the least significant bits of specific DCT coefficients. This paper specifically deals with LSB Stegnography using DCT. The main aim of this paper is to find and analyze the effect and contribution of each bit position on SNR and PSNR of Stego image in DCT domain and also to make a comparison with the effect and contribution of each bit position on SNR and PSNR of Stego image in spatial domain.

2. Quality Measuring Parameters

To analyze the effect of data hiding at different bit position in DCT coefficients SNR, PSNR and MSE are used for quality measuring. These parameters are used to compare the resulted Stego file with the original cover file and also with the resulted Stego files for data embedding at different positions.

These parameters used to measure the quality and error between cover audio and Stego audio are calculated using the following formulas [15, 16].

$$SNR = 10 * \log_{10}\left[\frac{\sum_{i=1}^{R}\sum_{j=1}^{C}\left[Cov(i,j)\right]^2}{\sum_{i=1}^{R}\sum_{j=1}^{C}\left[Cov(i,j) - Stego(I,j)\right]^2}\right]$$

(1)

$$MSE = \frac{1}{R*C}\sum_{i=1}^{R}\sum_{j=1}^{C}\left[Cov(i,j) - Stego(i,j))\right]^2 \quad (2)$$

$$PSNR = 10*\log_{10}\left[\frac{2^{16}-1}{MSE}\right] \quad (3)$$

3. Implementation

Hiding data in the least significant bits is a common practice in both spatial domain and transform domain. Here in this paper an analysis is made by hiding data at various bits position in the coefficients of discrete cosine transform of an audio cover file. A message audio file is hidden in a cover file in a cover audio file in .WAV format. The message and cover file are read at the sampling rate of 44100 samples/s and 351800 samples are captured almost equal to 3seconds play time.
To made analysis in transform domain DCT is applied on the cover audio file resulting in an array of 2×N size in Matlab. There is a problem of negative values occurring in Matlab and the DCT coefficients are scaled to avoid the negative values and make all coefficients positive. The coefficients are round off to fix the fraction part, by multiplying the DCT coefficient with a suitable number, without any loss. For example after DCT we get a value 0.3528 then we multiply it with 10^4 and get a whole number 3528. By direct rounding off diffidently some will be lost which avoided by the procedure adopted. Then information is hidden in the coefficients by substitution mechanism. The reverse of this process is applied back after hiding data at the specific bit position. The whole process is explained here in block diagram.

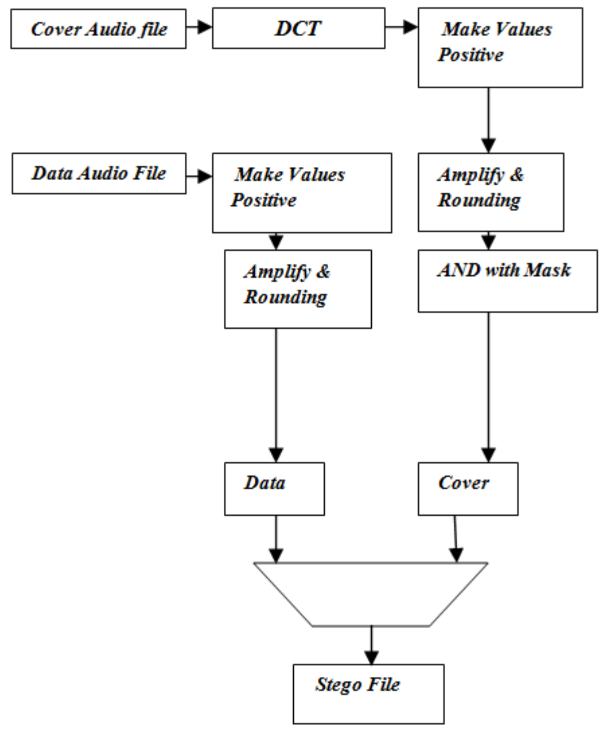

Figure 1: Block diagram Audio Stegnography in DCT domain

The procedure is adopted for data hiding at various bit position and for each position a stego audio file is obtained and MSE, SNR and PSNR are calculated for each bit position.

4. Experimental Results

The procedure given in implementation section is implemented to get stego audio file for data hiding in 1st bit position, 2nd bit position, and 3rd bit position and so on. And for each bit position the MSE, SNR and PSNR are calculated using the expression given in the earlier section. Data hiding at various bit position create almost same, plus minus 1%, results of MSE, SNR and PSNR; quite different from image Stegnography results [15]. The resulted values of MSE, PSNR, SNR, and Capacity are given in table 1. The estimated time elapsed in data hiding proves is also calculated for different bit position and a increasing trend has been observed as shown in table1.

Table1. MSE, PSNR, SNR, Capacity and Processing Time vs. Variable Bit Position

Bit position	*MSE*	*PSNR (db)*	*SNR (db)*	*Capacity (%)*	*Processing Time (sec)*
1st	73.3746	89.7153	33.8824	5.8824	125.925
2nd	73.3734	89.7154	33.6424	5.8824	128.963
3rd	73.3722	89.7155	33.6423	5.8824	139.250
4th	73.3657	89.7158	33.6419	5.8824	152.423
5th	73.3650	89.7159	33.6419	5.8824	130.895
6th	73.3554	89.7164	33.6413	5.8824	156.153
7th	73.3363	89.7176	33.6402	5.8824	139.082
8th	73.2320	89.7238	33.6340	5.8824	149.940

The resulted MSE, PSNR, SNR and time elapsed are also shown in figure 2, figure 3, figure 4 and figure 5 respectively for comparison.

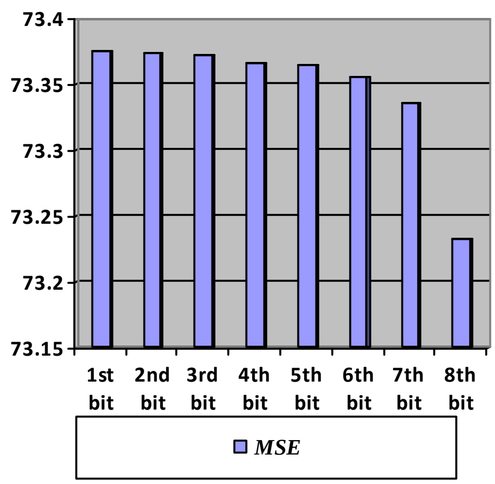

Figure 2: Analysis of mean square error (MSE)

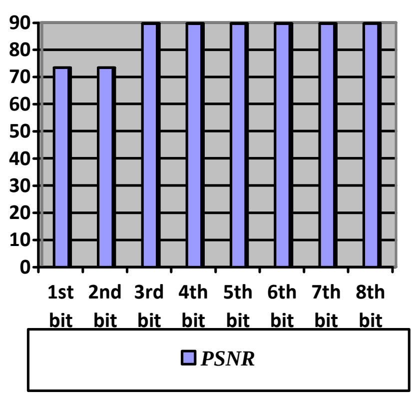

Figure 3: Analysis of peak signal to noise ratio (PSNR)

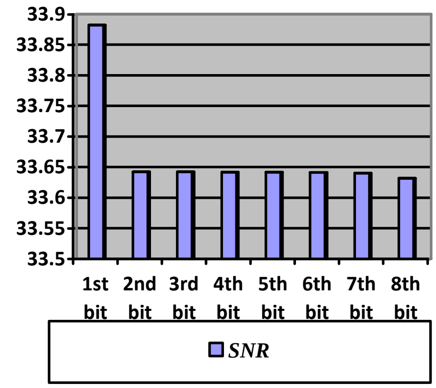

Figure 4: Analysis of signal to noise ration (SNR)

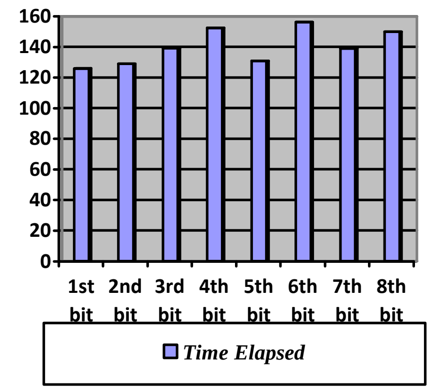

Figure 5: Analysis of Time elapsed

5. Conclusion

In this paper data is hidden at variable bit position in DCT coefficients of an audio cover file and the effect of each bit position is analyzed in term of MSE, SNR and PSNR. A very insignificant change with higher position occurs in the Stego file. Hiding data in DCT coefficients create a very significant noise in Stego file but the variation in SNR, PSNR and MSE is very insignificant as compared to that of Stegnography in DCT domain. For the same amount of noise as at 1st least significant bit position data can be hidden at 8th bit position.

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