International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

An Effective Technique for Hiding Image in Audio

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Abstract: ***This paper introduces an improved technique to hide image in audio. The method used here is to provide more security other than the previous works. In this paper, the secret messages are embedded into the cover audio file by modifying its amplitude. Here the cover audio file is converted from time domain to frequency domain by using FFT. The security of the scheme is increased by using a key to adjust the hiding technique. The image embedded audio is inaudible and this method is suitable for hiding data in audio. If there exist any noise in the stego audio, then also the secret data can be extracted. In this technique, the secret image is embedded in its compressed form and an error correction technique also used to improve the robustness of the system. Finally the original image can be retrieved.***

Keywords: Audio steganography, amplitude modification, fast fourier transform, embedding algorithm, phase, extracting algorithm, compression.

1.Introduction

The various formats of the digital data are essential for the research application to ensure the security. Encryption and watermarking technique are already introduced based on this proliferation of digital data. In today's digital era the malicious attempts to the integrity of digital data are increased, so the need for new techniques and new algorithms to counter constantly-changing malicious attempts has become a necessity.

Steganography is the art or practice of concealing a data within another file, such as message, image, or video. The term steganography combine the ancient Greek words stegans, meaning "covered, concealed or protected".For the steganography technique [1], take a host file A and the secret message M. In steganography scheme, it takes a data hiding function F_h for hiding the secret message M in the host file A and a data extracting function F_e to extract the secret message from the data embedded file. Then the technique can be defined as follows:

$$A' = F_h (A,M,K)$$

$$F_e (A',K) = F_e (F_h (A,M,K), K) = M.$$

Where K is the secrete key used for the steganography technique and A' is the hided or embedded file. That is, F_e can extract the secret message from the host file hidden by F_h. The steganography technique willconceal the existence of the information in the host file; it is easy to distract the opponents. In this paper the host message used is an audio file, and hiding a secret message M as the text data. The embedded file gets after the hiding technique is A', having sounds similar to the original audio file A.

2.Proposed Method

A. The Framework of the Proposed Method

Thiswork is hiding image in the audio. Secrete data hiding in any object is steganography. Here an audio file is used as the cover object to transmit the secret image. The audio file that used for embedding the secret image is converted to frequency domain from time domain by using the FFT method. Before embedding the secret image in the cover audio, the amplitude of the audio should be modified. The amplitude modification of the cover audio is accomplished by the secret key called seed. Amplitude modification is doing for achieving the security of the system. Then by using the embedding algorithm and extracting algorithm, the secret data is embedded at the sender and extracted at the receiver respectively.

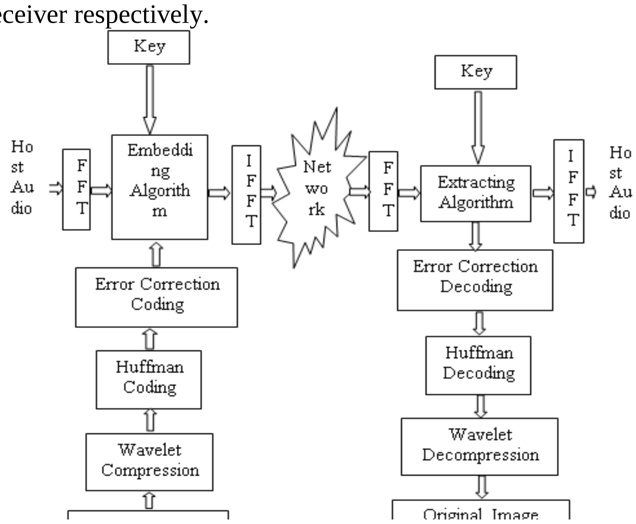


Figure 1: Block diagram

The system hides an image in the audio. Firstly the image is compressed using wavelet compression technique and then converted into the binary form. Before embedding the secret image in the cover audio file, the amplitude of this audio should be modified. The amplitude modification of the cover audio is accomplished by the secret key. Then by using the embedding algorithm, the secret image is embedded at the sender. At sender, the image embedded stego wave is encoded with an error correction code to improve the robustness and sending to the receiver. At the receiver section, all the processes done at the sender will be reversed to retrieves the secret image.

B. Key Generation

In this system, the key is generated by multiplicative congruential generator (MCG), which is a binary string pseudo-random number generator (PRNG) [17]. MCG will generate the secret key (seed, a, m) by the equation:

$$X_{n+1} = (a.X_n) mod m$$

$$R_i = X_i mod 2$$

X_0 is the seed

From this equations, the secrete key (seed, a, m) can be generated. This secrete key is want to be used in the binary format. If the three numbers (7, 5, 37) are using as the secrete key, the X and R valueswill be as in the given table:

Table 1: Binary string values [1]

Vetor	1	2	3	4	5	6	7	8	9	10
X	7	35	27	24	9	8	3	15	1	5
R	1	1	1	0	1	0	1	1	1	1

C. Domain conversion of the sound wave

For the hiding technique, the host file in which the secret message to be embedded is want to select. Here is using an audio steganography technique, so that the host file selecting is the audio file. The audio file used here is given below

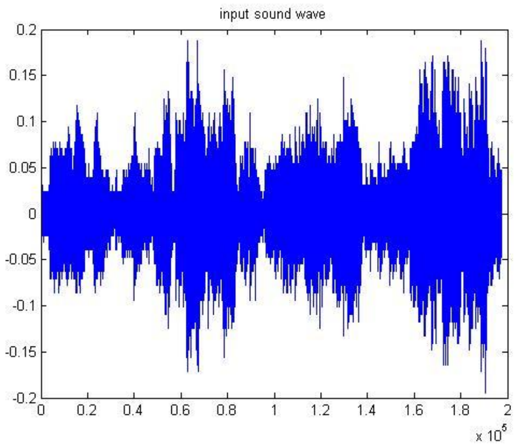


Figure 2: Input sound wave

In this method, the host audio file should be treated in its frequency domain at the time of embedding the secret image data. Fast Fourier Transform (FFT) is used for converting the host audio file from the time domain to frequency domain. Fast Fourier transform (FFT) is an algorithm to compute the discrete Fourier transform (DFT) and it's inverse. Fourier analysis converts time (or space) to frequency (or wave number) and vice versa; an FFT rapidly computes such transformations by factorizing the DFT matrix into a product of sparse (mostly zero) factors[1]. As a result, fast Fourier transforms are widely used for many applications. If A is the host audio file, then it s Fourier transform will be

$$FA=FFT(A)$$

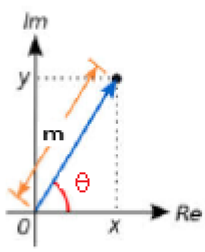


Figure 3: Complex number in polar form [1]

After the FFT, the value of FA is complex numbers. Except for number 0, any complex number can be represented inthe trigonometric form or in polar coordinates [12]. Figure 3 is a graphic illustration of a complex numbers in polar coordinates. z= x + i.y is the trigonometric form of a complex number in formula given.

$$z=m(\cos\Theta+i\sin\Theta)$$

The magnitude m of the complex number z is:

$$m=abz(z)=\sqrt{x^2+y^2}$$

and calculate the phase of the complex number z as in [1].

D. Image Compression

The technology has grown and we are in the digital era now. Dealing with large amount of information will make many difficulties [16]. Wavelet compression is the one of the way to store and retrieve the digital information in an efficient manner.

The steps used for compressing an image are as follows:

- The source image is digitized into a signal s, which is a string of numbers.
- Then decompose the signal into a sequence of wavelet coefficients w.
- Modify the wavelet coefficients w to another sequence w' by using thresholding technique.
- Convert w' to a sequence q by quantization.
- At last do the entropy coding to compress the sequence q into another sequence e.

Figure 4: Input secrete image

Fig 4 shows the secrete image that embedding into the audio file. The above wavelet compression is applied to this secrete image to get compressed version of the image.

E. Huffman coding

Huffman coding is one of the entropy coding to compress the image data [13]. As said in the wavelet compression technique, the quantized integer sequence q is converted into a shorter sequence e in this Huffman encoding. The sequence e contains numbers being 8 bit integers. This conversion of the sequence is made by the entropy coding table. String of zeros are coded by the numbers 1 through 100,105 and 106, while the nonzero integers in q are coded by 101,102,103, 104 and the numbers from 107 to 254. The main idea behindHuffman entropy coding, is to use two or three numbers for coding, with the signal being first with that a large number or long zero sequence is coming. The design of Huffman Entropy coding is that the numbers that are expected to appear the most often q, need the least amount of space in e. Huffman decoding will be the reverse of this process. After all these compression stages, we get the compressed format of the secrete image. This image is converted into the binary format.

F. Error correction coding with cyclic code

Cyclic code is a block code, where the circular shift of each codeword gives another code word that present in the code. These are the error correcting codes with algebraic properties that are convenient for efficient error detection and correction [14]. Let C be a linear code over a finite field GF(q) of block length n. This linear code C is called a cyclic code if, for every code word $c=(c_1, c_2,\ldots\ldots c_n)$ from C, the word $(c_n, c_{1,}\ldots.,c_{n-1})$ in $GF(q)^n$ obtained by a cyclic right shift of components is again a cyclic code. Because n-1 cyclic left shifts is equal to one right shift, so that a cyclic code can also be defined with cyclic left shifts. So the linear code C is cyclic precisely when it is invariant under all cyclic shifts. Cyclic codes have some additional structural constraint on the codes. These codes are based on Galois fields because of their structural properties they are very useful for controlling the errors. This structure of cyclic code is strongly related to Galois fields because of which the encoding and the decoding algorithms for cyclic codes are computationally efficient.

G. Embedding algorithm

The embedding algorithm uses host audio file A, secret key (seed, a, m) and the secret image are in binary form [1]. The algorithm is

- Using the secretkey (seed, a,m) to generate the binary vector R.
- Read the host audio file A to get the audio samples. Do the FFT on each segment to convert A from time domain to frequency domain: FA= FFT (A).
- Take audio samples with amplitude>=15.Modify each segment according to the bit to be embedded[1].
- Do the IFFT on each segment FA to convert FA from frequency domain to time domain.
- Write A to the stego-audio file H'.

H. Extracting Algorithm

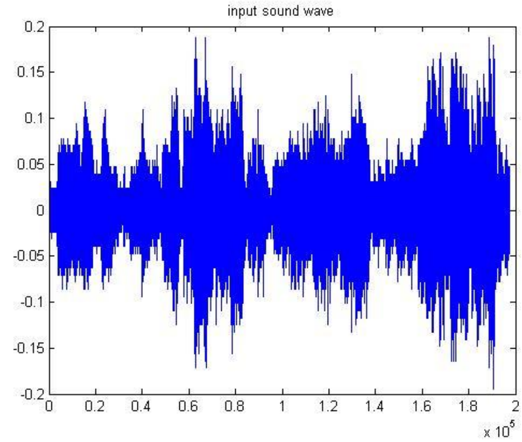
The extracting algorithm uses stego-audio file H', secret key (seed, a, m) [1].

- Read the stego-audio file H' to get the audio samples A.
- Using the secret key (seed, a, m) to generate the binary vector R.
- Do the FFT on each segment to convert Afrom time domain to frequency domain: FA= FFT (A).
- For each segment FA, findFA'swhich amplitude>=15 and for each FA get 1 bit [1].
- Return Message bits M.

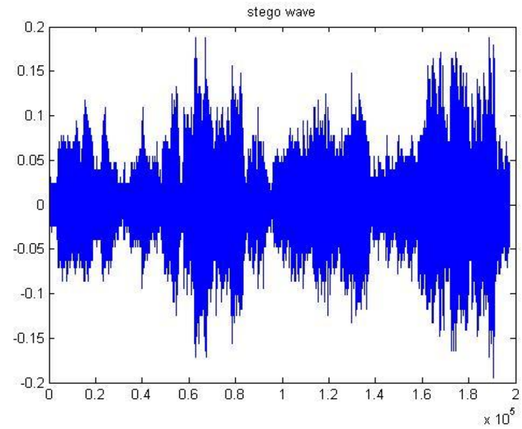
Now we get all the bits embedded at sender. From those bits retrieve the original secrete image by doing all the inverse process done at the sender.

3.Experimental Results

In this experiment, an input image shown in the Fig 4 is embedded in the cover audio file (Fig 2). The image is compressed using wavelet compression with compression ratio 3.8764. The forth coming compressed image is converted to binary form to embed in the cover audio file. The stego audio file getting after the embedding process will be same as the cover audio file. Then a cyclic error correction code is applied to it. At the receiver section, the original secret image is reconstructed successfully. The PSNR value of the image in the system is 32.84.



(a)



(b)

(c)

Figure 5: (a) Cover audio file, (b)Stego audio file, (c) Extracted secret image

4.Conclusion

In this paper, the secret image is hiding in the cover audio file. The image is embedded in its compressed form by wavelet compression. Also an error correction coding with the cyclic code is done to improve the robustness of this technique. The bit embedding process in the cover audio file is done by modifying the audio amplitude according to the bits of the secret image. At last the embedded secret image is retrieved from the stego wave successfully.

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