*J. Basic. Appl. Sci. Res.*, **3(1)640-645, 2013**
**© 2013, TextRoad Publication**

ISSN 2090-4304
**Journal of Basic and Applied Scientific Research**
*www.textroad.com*

# A Novel Presentation of Audio Embedding Technique Based on CHIRP Signal on WAV Files

**Tahere panahi[1], Saideh naderi[1], Tahere Heidari, Elham Zeidabadi nejad[2], Peiman Keshavarzian[1]**

[1]Department of Computer Engineering, Kerman Branch, Islamic Azad University, Kerman, Iran
[2]Department of Computer Engineering, Sirjan Branch, Islamic Azad University, Sirjan, Iran

## ABSTRACT

In the last decades, Because of great development of communication in the world today, the digital watermarking has loudly proclaimed as a new method to improve communication security and control. The process of steganography is available on the host signal. In this paper, a new method of file steganography with WAV format is presented. Thus, it is designed according to spread spectrum techniques and CHIRP signal. The proposed method is completely compatible with WAV compressing standard and creates a hidden link between the sender and the receiver and accordingly the SNR will be noticeably decreased. The experiments indicate that our proposing algorithm guarantees the imperceptibility of watermarking, as well as high capability of operation and security against attacks.

**KEYWORDS**: Steganography, Audio encryption, CHIRP signal, Spread Spectrum, Digital Watermarking.

## 1. INTRODUCTION

Because of great development of communication in the world today, the necessity of communication security and control is becoming more and more significant. Thus, the digital watermarking with the purpose of designing such systems to protect and control digital information has been proposed (1). Watermarking is a way to create codes on the text, audio and video files. The creation of these hidden codes, makes it a reliable method to protect the copyright, proves the ownership and also it is easy for the expert users to detect the changes. In 1996, the digital watermarking was introduced as the most practical policy for the encryption and is rapidly developing today. In watermarking system, the message to be embedded is called the watermark, and the signal carrying this message is called the host. The existing audio watermarking algorithms have some difficulties, such as meaningless embedded watermark signals and direct watermark embedding on the host audio signal. The use of spread spectrum techniques could be a solution to these problems. The spread spectrum will spread the sending signal power in a frequency spectrum. This method makes the disclosure of the signal complicated and has a high robustness against penetration and noise .in spread spectrum systems, synchronism is a significant issue and the choice of spread spectrum code should favor the synchronism. For the synchronism is crucial, in the case of not being synchronized, the receiving signal will be rejected. The problem of having different routes is desirably solved and its effects are very slight. Spread spectrum audio watermarking saves the information by spreading it in the frequency range. Because of this ability, it produces a firm and imperceptible watermark signal for us. Therefore, this method has been used to cover and embed the communication and accordingly, it will be impossible to distinguish between the original and the watermarked signals (9). To assign the quality of watermarking and embedding techniques, three parameters are considered: resolution, embedding capacity, and robustness. Resolution refers to the quality that causes the encrypted text will not be detected in the message. The embedding capacity refers to the amount of hidden information on the host signal and finally the robustness consists of the vulnerability rate in intentional and unintentional attacks. The most important quality in embedding is the resolution which follows the embedding capacity, while robustness plays a more serious role in watermarking (2). To evaluate the robustness in the audio watermarking, three main criteria, such as bit error rate , signal ratio to noise and angle cosine should be considered.

## 2. THE REVIEW OF PREVIOUS WORKS

The simplest method of audio watermarking is the LSB, least-significant bit. The LSB method has been used in the field of Wav and according to the nature of this method; it has a high capacity of transferring information. The LSB method has been used in the Wav field to safely transfer the information. In the proposed algorithms, the message does not lay on the Wav factor; instead, the message is embedded by implementing another signal at the

***Corresponding Author:** Peiman Keshavarzian, Department of Computer Engineering, Kerman Branch, Islamic Azad University, Kerman, Iran. Tel: +98-341-3201304; E-mail: keshavarzian@iauk.ac.ir

WAV changing output. In (4), the watermarking algorithm robustness has been improved by an audio watermarking system, based on Wav transformation. However, the previous works were done based on the signal processing transformation in the photo field. The use of DCT transformation in the watermarking which is based on WAV transformation is very common as well. In (5), the multi resolution quality of Wav transformation and compressing quality of DCT transformation has been utilized to improve the audio watermarking system quality. Watermarking with the use of Patchwork algorithm is one of other watermarking methods in the Wav field (6).in this method, two subsets of transformation factors are chosen and the message will be put in these two subsets. Generally, the process of designing these systems in Wav transform field is based on the analysis of input audio signal at various stages, and the difference between the algorithms is in the way of analyzing and putting the message in the analyzed bands.

## 3. FULL ACCOUNT

The main purpose of the steganography is a safe connection, in a totally imperceptible method in order to prevent suspicion in the hidden data transfer. Fig.1 describes the basic model of a steganography system which includes the carrier, message, steganography algorithm and the key. K is the common key between the sender and the receiver, M is the audio file with WAV format, R is the Pseudo random function which is responsible to produce a random key, C is the very watermark to hide the audio file. The sender hides the very audio file by the use of C and K and sends it to the receiver in the form of a watermark. By using the K, the receiver extracts the audio file from the watermark for decoding.

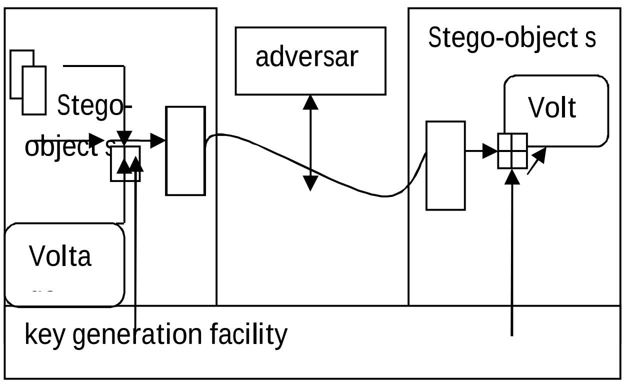


Fig. 1: the basic model of steganography

LSB, phase coding, echo hiding, and spread spectrum are different techniques which are utilized for audio watermarking. The simplest method of audio watermarking is the watermarking method in the Least Significant Bit which is used to embed the data. The LSB method has been used in the Wav field and because of its nature; it has a high capacity of transferring information. The LSB method, in the Wav field in (3), has been used to transfer the information safely. However, if a little change occurs at the LSB signal, the watermarking will be distorted. In coding phase technique, watermarking can be easily omitted because it is spread all over the signal. In echo embedding techniques, the robustness will be raised because of high echo embedding. Thus, if the maximum bar increases, noise will be increased. In spread spectrum, watermark is distributed all over the signal. Among all methods, audio watermarking technique of spread spectrum creates a link masking and has a high robustness, high security and it is also imperceptible.

**2-3 spread spectrum audio watermarking technique: 1.Direct sequence (DS) 2. Frequency hopping (FH)**

To produce watermarked signals, DS and FH techniques need a pseudo random noise producer. But in spread spectrum techniques (CHIRP), to embed the information a CHIRP signal is used instead of a pseudo random noise producer. High robustness and imperceptibility of created watermark by this method will lower the possibility to recognize and identify the original signal. Since this method has significant qualities in comparison with other methods, we use this method to embed the audio files. These qualities are like: low power consumption, low delay, high security, imperceptibility and etc., which can be used in military applications.

**3-3. the proposed technique**

Spread spectrum audio watermarking technique, chirp, is one of spread spectrum techniques which embed CHIRP signal in an audio signal and CHIRP signal can be used as a common key between the sender and the receiver. The watermarked signal is transferred all over the canal so that the adversary is not able to identify the audio signal which is being transferred between the sender and the receiver. CHIRP signal for WAV format can be shown as (8/7):

$$S(t)= a(t) \cos[\theta ( t)] \qquad (1)$$

θ (t) is the phase , a(t) is a cover from CHIRP msignal which is a distance (t) in terms of time. The instantaneous frequency is defined as following:

$$f_m(t) = \frac{1}{2\pi}\frac{d\theta}{dt} \qquad (2)$$

CHIRP rate is defined as :

$$\mu(t) = \frac{df_M}{dt} = \frac{1}{2\pi}\frac{d^2\theta}{dt^2} \qquad (3)$$

It shows the instantaneous frequency rate.

If the signal is $\mu(t)>0$ it is called up-chirps and if $\mu(t)<0$ , down –chirps. In linear chirp, μ(t) is fixed and the then

$f_m(t)$ is a linear function from t and $\theta(t)$ is a second rate function. If the signal is t=0,s(t) can be shown as following:

$$S(t)=a (t) \cos [2\pi f0\, t + \pi\mu\, t^2 + \varphi_0 ] \qquad (4)$$

Where $f_0$ is the central frequency and a(t)=0, if $|t|>T/2$ , bandwidth at instantaneous frequency range can be defined as following:

$$B=|\mu|T \qquad (5)$$

If a chirp signal is confined to an output signal, it has normally one IF at the central frequency of CHIRP. The output signal g(t) is calculated as following:

$$g(t)=h(t) * s(t) = \varphi ss (t) \qquad (6)$$

where φss(t) is an independent function from s(t).

In the proposed technique, the changed signal is modulated with CHIRP signal and a watermarked signal is produced. A modulation of changed signal and CHIRP signal are used to broadcast the audio signal where a high robustness can be achieved. The proposed diagram for spread spectrum audio watermarking by the use of CHIRP signal is shown in Fig. 2. We use this process to transfer watermarked audio file so that he adversary will not be able to distinguish between the original signal and the watermarked. This method causes high reliability and robustness and low power consumption.

To extract the original signal, the receiver does the reverse operation of this process. In the other hand, the receiver modulates the watermarked signal with the CHIRP, that is the modulation. The receiver is able to retrieve the signal just by having the main key. This technique will also cause a hidden link between the sender and the receiver.

To transfer the signal with the low-power consumption, a 1800 MHz band will be used (10). Thus, in this technique the watermarked signal at 1800 MHz band will be transferred to achieve the low-power consumption. One of the main criteria to transfer the signal to the receiver is the signal-to-noise-ratio (SNR). For the evaluation of quality, the watermarked signal is used. If the ratio of signal to noise is high, the watermarked signal will be very similar to the main signal but if the ratio is low, it will be very complicated to distinguish the watermarked signal from the original one.

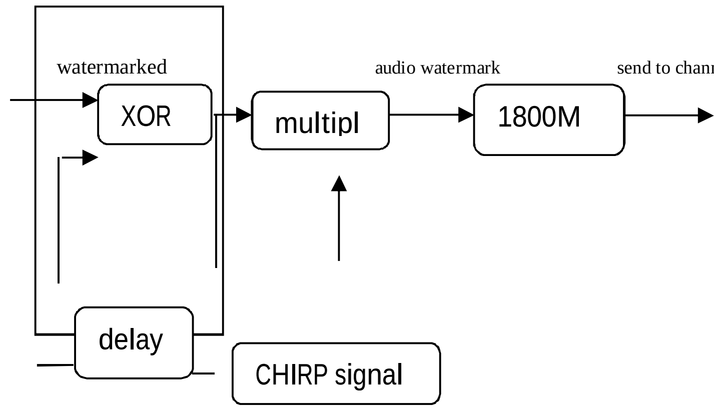


Fig. 2. The diagram of spread spectrum audio watermarking with the use of CHIRP signal

**4-3 the evaluation formulas**

Some formulas are being used to evaluate the effectiveness. Assume that N represents the audio file length T and T' represent two different audio tails and D represents the biggest audio file T. These formulas are shown as following:

**1.BER :**

$$\text{BER}=\frac{100}{N}\sum_{I=0}^{N-1}\begin{cases}1, T'(i) \neq T(i)\\ 0, T'(i) = T(i)\end{cases}$$

**2.SNR :**

$$\text{SNR}=10\cdot \log 10 \frac{\sum_{i=0}^{n-1} t^2(i)}{\sum_{i=0}^{n-1}(T'(i)-T(i))^{2}}$$

SNR is defined as the ratio of maximum possible power of a signal to noise power.

**3.SIM :**

$$\frac{100}{N}\sum_{I=0}^{N-1}\begin{cases}1, T'(i) \neq T(i)\\ 0, T'(i) = T(i)\end{cases}$$

## 4. EXPERIMENT RESULTS AND ANALYSIS

The effectiveness of the proposed algorithm has been experimented in this part. We use the 'Voltage-WAV' as a sample of watermarked audio file ( Fig.3-a). Binary audio watermarking, by the use of spread spectrum is shown in Fig.3b. The watermarked audio file by the use of chirp signal is displayed in Fig.3c.

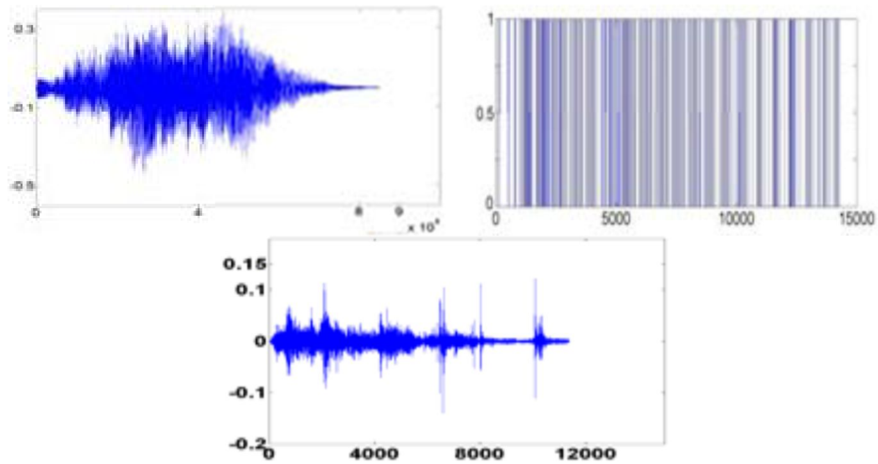


Fig.3.a: audio file watermarking of 'voltage.WAV'  Fig3.b: binary audio watermarking  Fig.3.c: The watermarked audio file with the use of chirp signal

In table 1, The original audio file and the watermarked audio file are compared based on the main criteria of SNR, BER and SIM. It is obvious that BER is less than 4% , SNR more than 30 and SIM more than 0/97 and the audio file get hardly involved in noise.

Table 1. watermarking embedding efficiency with the use of CHIRP signal

| **Parameters** | **Performance** | | |
|---|---|---|---|
| Watermarked audio | BER(%) | SNR(db) | SIM |
| Figure3.b | 3.248 | 37.54 | 0.985 |
| Figure3.c | 3.198 | 38.73 | 0.977 |

In table 2, we evaluate the extracted audio watermark and the embedded original watermark based on three main criteria of BER, SNR and SIM. BER is less than 9% and SNR is more than 3 and SIM is more than 83%. The results are shown in table 2, after extracting the watermarked audio file, voltage-WAV can be easily heard (fig 4). Therefore, the proposed algorithm has a high efficiency to extract the original file.

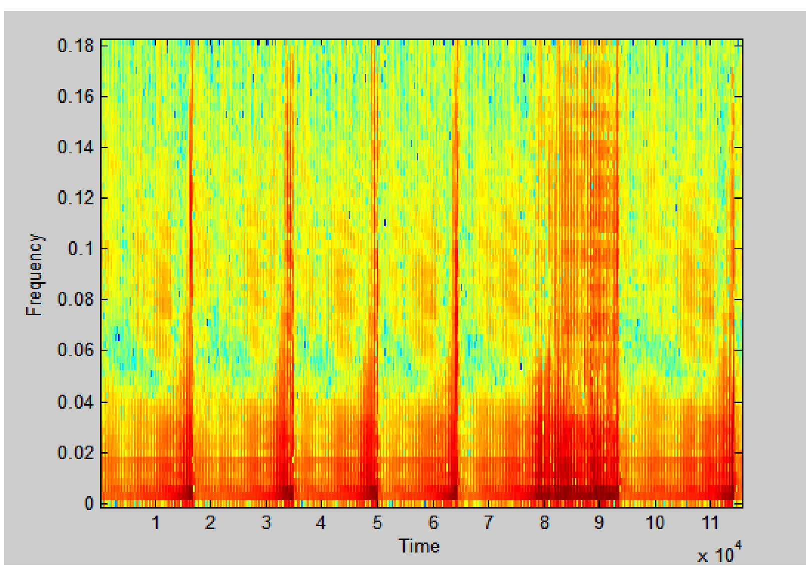


Fig4: extracting the watermarked 'voltage.WAV

Table 2. Watermarking extraction efficiency

| Extracted watermark | | | Watermarking performance and attack parameters | | | |
|---|---|---|---|---|---|---|
| **Embedding watermark** | **Extracted watermark** | **parameter** | **16khz Band** | **Gaussian noise SNR=50** | **1800 Mhz Band** | **WAV** |
| W | W' | BER(%) | 5.611 | 6.453 | 5.522 | 7.426 |
| | | (SNR(DB | 37.11 | 33.14 | 31.25 | 38.05 |
| | | SIM | 0.875 | 0.951 | 0.885 | 0.864 |
| | | (%)BER | 5.765 | 5.981 | 5.515 | 7.926 |
| | | (SNR(DB | 34.12 | 34.51 | 35.76 | 31.17 |
| | | SIM | 0.934 | 0.918 | 0.756 | 0.876 |

## Conclusion

In this paper, spread spectrum signal of CHIRP is proposed for audio watermarking. The proposed technique helps to make a hidden link between the sender and the receiver so that the SNR will be noticeably decreased and the audio watermarking is imperceptible. The embedded watermarking is greatly stable. Thus, the proposed algorithm has some advantages, such as low power consumption, imperceptibility, high robustness, low rate of noise, and the capability of being used in military systems and wireless communications.

## REFERENCES


1. I. J. Cox, M. L. Miller and J. A. Bloom, 2002. Digital watermarking. Academic Press.

2. Petitcolas, F., Anderson, R., & Kuhn, M. (1999). Information hiding-A survey. In Paper presented at the IEEE, Special issue on protection of multimedia content.

3. Dora M. Ballesteros L, Juan M. Moreno A, *August 2012*. Highly transparent steganography model of speech signals using Efficient Wavlet Masking, *Expert Systems with Applications*, *Volume 39*, *Issue 10*: *9141-9149*.

4. Waleed Al-Nuaimy, Mohsen A.M. El-Bendary, AmiraShafik, FaridShawki, A.E. Abou-El-azm, N.A. El-Fishawy, Said M. Elhalafawy, Salaheldin M. Diab, Bassiouny M. Sallam, Fathi E. Abd El-Samie, H.B. Kazemian, *December 2011*.An SVD audio watermarking approach using chaotic encrypted images, *Digital Signal Processing*, *Volume 21*, *Issue 6*: *764-779*.

5. Bai Ying Lei, IngYann Soon, Zhen Li, *August 2011*. Blind and robust audio watermarking scheme based on SVD–DCT,*Signal Processing*, *Volume 91*, *Issue 8*: *1973-1984*.

6. B. PurnaKumari, V.P. SubramanyamRallabandi, *April 2008*.Modified patchwork-based watermarking scheme for satellite imagery, *Signal Processing*, *Volume 88, Issue 4*: *891-904*.

7. P. Karthigaikumar, K. JaralineKirubavathy, K. Baskaran, *May 2011*. FPGA based audio watermarking—Covert communication, *Microelectronics Journal*, *Volume 42*, *Issue 5*: *778-784*.

8. Elias Kougianos, Saraju P. Mohanty, Rabi N. Mahapatra, *March 2009*. Hardware assisted watermarking for multimedia, *Computers & Electrical Engineering*, *Volume 35*, *Issue 2*, *Pages 339-358*.

9. CvejicNedeljko,2004. Algorithms for audio watermarking and steganography, Department of Electrical and Information Engineering, Information Proces- sing Laboratory, University of Oulu.

10. [10] John Pinkney, December 2003. Low complexity indoor wireless data links using chirp spread spectrum, Ph.D. Thesis, University of Calgary.