Eng. & Tech. Journal, Vol.29, No.2, 2011

Detection of Hidden Object In Speech Based on Fast Fourier Transform Algorithm

Dr. Mahmud k. Kadum *

Received on: 25/10/2010
Accepted on: 5/1/2011

Abstract

In this paper steganalysis technique is proposed on the basis of spectral domain analysis using Discrete Fourier Transform, Fast Fourier Transform Algorithm (DFT_FFTA). The aim from using this algorithm is to provide robust evidence for presence of hidden object in speech segment. The Discrete Wavelet Transform (DWT) is used to decompose the speech segment, 20 seconds in length. The speech is decomposed to the third level. An image of 512x512 pixels embedded in the third level of the speech coefficients. Reverse Discrete Wavelet Transform (RDWT) is applied to get a speech with hidden object (image) called stego-speech. DFT_FFTA is used to analyze the stego-speech to discover an evidence of hidden object in the stego-speech .Experimental results shows that the proposed algorithm is comparable to previously existing techniques and give very clear and strong indication for the existence of stego-object.

Keywords: Wavelet transforms application, speech steganalysis.

كشف المكونات المخفية في الكلام بالاستناد الى خوارزمية تحويل فوريير السريعة

الخلاصة

في هذه البحث تم اقتراح تقنية للكشف عن المكونات المخفية في مقطع من كلام على اساس تحليل المجال الطيفي باستخدام خوارزمية تحويل فوريير السريعة . الهدف من استخدام هذه الخوارزميّة هو تقديم دليل متين على وجود مكون مخفي في مقطع من كلام. حيث استخدمت محولة المويجة المنفصلة لتحليل مقطع من كلام مدته 20 ثانية . حلل الكلام الى المستوى الثالث .استخدمت صورة مكونة من 512x512 نقطة شاشة وضمنت في المستوى الثالث من مقطع الكلام . استخدم معكوس محولة المويجة المنفصلة للحصول على مقطع كلام مضمن (يخفي) صورة . تم استخدام خوارزمية فوريير السريعة لتحليل الكلام المضمن لاكتشاف دليل على وجود مكون مخفي في الكلام .التجارب التي اجريت على استخدام هذه الخوارزمية اعطت نتائج تشير بشكل واضح وقوي الى وجود دليل على وجود جسم او مكون مخفي . النتائج قابلة للمقارنه مع ادبيات الموضوع المنشورة.

1. Introduction

Steganography and steganalysis are new techniques of information security fields. The steganalysis techniques include attacking, detection and cracking technique. The study on steganalysis is focused on detection and attacking technique .There have been quite some efforts in the steganalysis of digital images .During the last decade ,many steganographic and steganalysis algorithms have been proposed [1],[2],[3],[4]. Goode and useful steganography algorithm is the one

* Computer Engineering & Information Technology Department,University of Technology/Baghdad

https://doi.org/10.30684/etj.29.2.16
2412-0758/University of Technology-Iraq, Baghdad, Iraq

which make the difference between the cover file and the stego-file is very hard to be noticeable or detectable by simple way and it is statistically similar to the clean file [5],[6],[7],[8],[9]. The steganography algorithm can be classified in two classes by its embedding domain: spatial domain embedding methods and frequency domain embedding methods .LSB embedding technique is one of the popular spatial domain embedding techniques. Spectra methods are the main of frequency domain embedding methods. They have some advantages and disadvantages with respect to spatial domain's one. Principal advantage is robustness against simple statistical analysis and the principal disadvantage is the limitation of the amount of embedded data [10].

In this paper speech is consider as cover file. After hiding a secret object (image in this work) in the cover file (speech) we get speech with secret message. We call this stego- speech or simply stego which is transmitted to destination through popular communication channels. DFT_FFTA is used to analyze the stego-speech to discover an evidence of hidden object in the stego-speech.

2.Steganalysis Technique [11], [5], [12]

Steganalysis is the complement of steganography. Steganography refers to the science of "invisible " communication. The main objective of steganography is to communicate securely in such a way that the true message is not visible to the observer .In another hand the main goal of steganalysis is to detect the presence of hidden (invisible) object. Most steganalysis techniques search in presence of evidences refer to hidden object and the techniques utilizes to accomplish the process of hiding process. Once the presence of hidden object is detected ,the next goal will be to detect their exact contents. However, this is much harder problem than the detection of the evidence. In general there are two categories of steganalysis algorithms: special methods and universal methods. Special methods are devoted to certain steganographic method. Universal methods are designed for any information hiding schemes. Special methods are more accurate than universal ones, Universal blind steganalysis is even more difficult because analyzers can get no knowledge about the steganographic algorithms Universal steganalysis methods operated in wavelet domain often use statistical properties of wavelet coefficients. Most of them make use of linear prediction errors of wavelet coefficient magnitudes. The weight vectors of linear prediction in existing methods are usually optimized in the sense of statistical average. But in fact ,the weight vectors should be adjusted adaptively for different object , and even for different object regions. Steganalysis performance can be evaluated by efficiency, applicability, practicality and complexity. Efficiency is an important metric which reflects the accuracy of detection. Applicability can be measured by the kinds of steganoghraphy schemes that steganalysis can detect. Practicality reflects the application scope, automation and real time performance. Complexity can be evaluated by resource costs and software- hardware condition.

3. Discrete Wavelet Technique (Dwt)

The transform of a signal is just another form of representing the signal. It does not change the information content present in the signal .The Discrete Wavelet Transform provides a compact representation of a signal in time and frequency that can be computed efficiently. In wavelet analysis, we often speak of approximations and details. The approximations are the high-scale, low-frequency components of the signal. The details are the low-scale, high frequency components [13] The DWT is defined by the following equation:

$$W(j,k) = \sum_j \sum_k x(k) 2^{-j/2} \psi(2^{-j}n - k) \quad (1)$$

Where $\psi(t)$ is a time function with finite energy and fast decay called the mother wavelet [14]. Equation (1) shows that it is possible to build a wavelet for any function by dilating the function $\psi(t)$ with a coefficient, 2^j and translating the resulting function on a grid whose interval is proportional to 2^{-j}[15]. The DWT analysis can be performed using a fast, pyramidal algorithm related to multirate filter banks [16]. In the pyramidal algorithm the signal is analyzed at different frequency bands with different resolution by decomposing the signal into a coarse approximation and detail information. The coarse approximation is then further decomposed using the same wavelet decomposition step. This is achieved by successive high- pass $g[n]$ and low-pass $h[n]$ filtering of the time domain signal and is defined by the following equations [14]:

$$y_{high}[k] = \sum_n x[n]\, g[2k - n] \quad (2)$$

$$y_{low}[k] = \sum_n x[n] h[2k - n] \quad (3)$$

Where $y_{high}[k]$ and $y_{low}[k]$ are the outputs of the high pass (g) and low pass (h) filters, respectively after down sampling by 2. Figure (1) shows the down sampling by 2 for three levels DWT decomposition.

4. Algorithm

First, a segment of speech consist of 26 words (20 seconds) is decomposed by applying DWT. This speech segment is transformed from spatial domain to frequency domain. The transformation and decomposition was performed to the third level (D1, D2 and D3) as shown in fig. (1)

Second, an image of 512x512 pixels (standard Lean see fig .8), where processed and multiplied by key factor then embedded in the third level of speech details D3 so we get the stego-speech.

Third, Reverse Discrete Wavelet Transform (RDWT) is applied to get a speech with hidden object (image) often called stego-speech . The stego- speech cannot be distinguished from the original speech signal. In another words it is impossible to differentiate between the stego-speech and the original speech by the human eye characteristics.

Fourth, spectral domain analysis using Discrete Fourier Transform (DFT) and Fast Fourier Transform Algorithm (FFTA) is applied to the stego-speech component and the results have been compared with the spectral of the original speech component.

Fifth, many experiments have been conducted using Matlab Package Version 8 to evaluate this approach.

5. Results And Discussions

Fig. 2. Shows the original speech signal and the DWT decomposed components. Three levels of the details, level 1(D1), level 2 (D2), level 3 (D3) and the third level of the approximation A3.

Fig. 3. (3-a) Shows the summation of the original speech details D1, D2, D3 and the third level of the approximation A3. Fig.(3-b) shows the same components of (3-a) except that the third level of the details contain the processed image of 512x512 pixels embedded in this level. If we examine carefully the two figures, we find they are identical in appearance. Figure (3-c and 3-d) contains the same components of fig. (3-a, 3-b) except that the approximations components is removed. Again we can see very clearly that the two figures are identical.

Fig. 4. Shows (a) the original speech signals 20 seconds. (b) Shows the stego–speech. Comparing the two figures we find they are excellently closely identical. The calculated mean square errors are 0.00061. This error is not detectable by the human ears.

Fig. 5. Shows the results of using Discrete Fourier Transform (DFT) ,Fast Fourier Transform (FFTA) Algorithm to analyze the stego-speech . (5-a). Shows the magnitude spectrum of the original speech. (5-b) , Shows the magnitude spectrum of the stego-speech. Comparing these spectrums we find the difference is very clear we can say they are two different spectrums. In (5-b) many frequency components are come out. These components indicating the presence of other information not related to the original speech information. The phase changes depicted in Fig. (5-c, 5-d) are related to the magnitude spectrums of (5-a, 5-b) successively. The differences between the two phases are also clear. The common fact we can get from the magnitude spectrums and phase changes of the original speech and the stego-speech they are strongly different. This means that they are containing two different information. This is the strong evidence of presence hidden object in stego-speech.

Figure 6. (6-a) Shows the power spectrum of the original speech signal. (6-b) shows the power spectrum of the stego-speech. These two figures are completely different in their external appearance and inner content (frequency components). This

is very natural because (6-a) represent the power spectrum of the original speech only, while (6-b) represent the power spectrum of the processed image (512x512 pixels) and the original speech. This difference in internal content and external appearance characteristics again is very strong evidence leaving no doubt that using DFT-FFTA is very efficient in detecting or steganalysis of hidden object in data files.

Figure.7.(a) shows the original image standard image from Matlab. version 8 (Lena 512x512 pixels). (b). Shows the reconstructed hidden image. The calculated peak signal to noise ratio (PSNR) is 49.9251 which is good enough as compared to the published results [17-18].

6. Conclusions.

The technique has been used provide, very strong evidence that it can be successfully employed to detect hidden object in a speech signal. The technique can be applied to any kind of cover file such as image, audio, video and any other files .This is because the technique utilize the frequency components (magnitude and power spectrum) of the stego file as a base for comparison with the original (or clean) file spectrum. Theoretically it is impossible the two files can be identical, this because they are represent different information.

7. References

[1] Yin-Cheng Qi, Liang Ye, Chong Liu "Wavelet domain audio steganalysis for multiplicative embedding model ", Proceeding of the 2009 International Conference on Wavelet Analysis and Pattern Recognition, Baoding, 12-15, July 2009.

[2] Q. Cheng and T. Huang, "An additive Approach to Transform domain Information Hiding and Optimum Detection Structure", IEE Trans. On Image Processing, vol. 12, no.2, pp.221-229, 2003.

[3]] J. Fredric, R. Du and M. Long, "Steganalysis of LSB Encoding in Color Images", in IEEE Int. Conf. on Multimedia and Expo, 2000, 1279-1282.

[4] J. Lopez R. Martinez, M. Nakano, K. Yamaguchi, "Detection of BPCS-Steganography using SMWCF Steganalysis and SMV". Proc. of IEEE Int .SYMP. On Information Theory, 2008.

[5] Liang Zhang "Wavelet Domain Steganalysis Based on Predictability Analysis and Magnitude Prediction", 2nd International Congress on digital object identifier Image and Signal Processing, 2009.

[6] Shangping Zhong, Xin Fang, and Xiaggwen Liao "Steganalysis Against Equivalent Transformation Based Steganographic Algorithm for PDF Files" Proceeding of the 2009 Information Symposium on Information Processing (ISIP'09), Huangshan, P.R.China, August 21-23, 2009, PP.075-078.

[7] Gokhan Gul, Faith Kurugollu "detection of watermarking methods using steganalysis" icassp 2008.

[8] J. R. Krenn "Steganography and Steganalysis" January 2004.

http://www.krenn.nl/univ/cry/steg/ article.pdf.

[9] Weihui Dai1, yue Yu , Yonghui Dai, and Xingyun Dai Information , "Hiding System for Online Conversation" ,Proceedings of the International Symposium on Intelligent Information System and Applications (IIA'09) Qingdao ,P.R. China, Oct.28-30,PP.107-110.

[10] A. Hernadez –Chamorro, A. Espejel –Trujillo, J. Lopez Hwrnadez , M. Nakano Miyatake , H. Pere Meana, "A Methodology of Steganalysis for Image", International Conference on Electrical, Communication, and computers.

[11] Sathiamoorthy Manoharan "An Empirical Analysis of RS Steganalysis" ,Third International Conference on Internet Monitoring and Protection ,2008,PP.172-177.

[12] Maxiu ying, Lin Jia jun , "Research on Efficiency Evaluation for Steganalysis", International Conference on Web Information System and Mining ,2009,PP.543-547.

[13] Vimal Krishnan V. R, Babu Anto P, "Features of Wavelet Packet Decomposition and Discrete Wavelet Transform for Malayalam", speech Recognition International Journal of Recent Tends in Engineering ,VOI.1,NO.2,May 2009.

[14] George Tzanetakis, Georg Essl, Perry Cook, "Audio Analysis using the Discrete Wavelet Transform". http://www.cs.princeton.edu/~gtzan.

[15] Maan M.Shaker , "EEG Waves Classifier using Wavelet Transform and Fourier Trasform", International Journal of Biological and Life Sciences 1:2 2005.

[16] M. Misiti, Y. Misiti ,G. Oppenheim ,&J. Poggi, "Wavelet Toolbox, User's Guide", Ver.2.2,the Math Works,Inc.,2002.

[17] Rohini S. Asamwar, Kishor M. Bhurchandi and Abhay S. Gandhi, " Piecewise Lifting Scheme Based DWT to Model Human Vision Interpolation Phenomenon", Proceeding of the Worde Congress on Engineering Vol. 1, July 1-3, 2009, London, U. K.

[18] K.T. Talelel, S. T. Gandhe, A. G. Keskar. "Steganography Security for Copyright Protection of Digital Image Using DWT", International Journal of Computer and Network Security, Vol. 2, No. 4, April 2010.

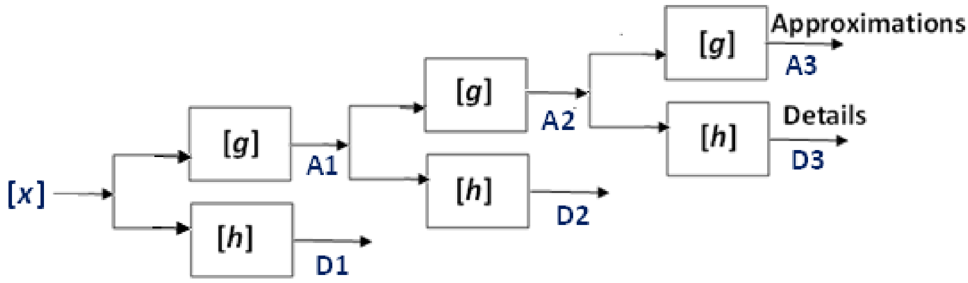


Figure (1) Three level discrete wavelet transform decomposition

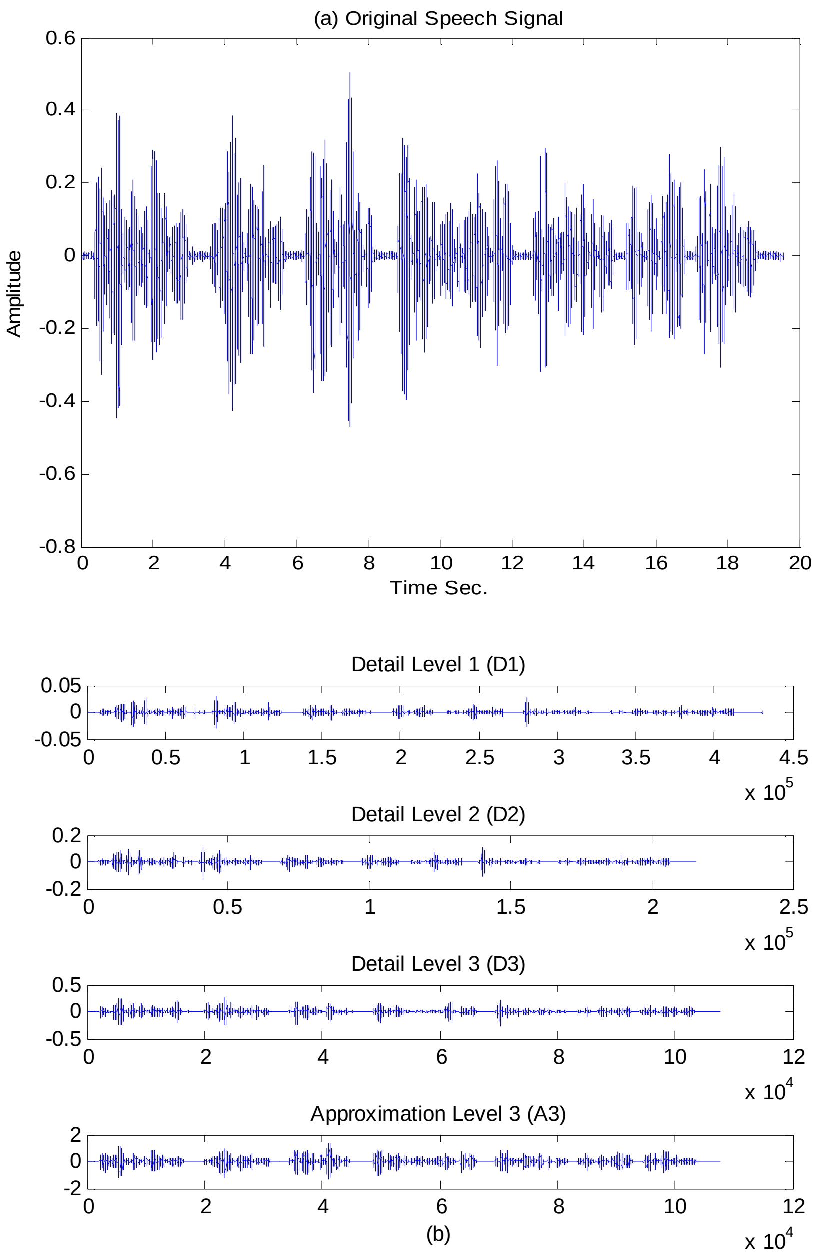


Figure (2) Original speech and the three levels coefficients details D1, D2, D3, and the third level of the approximations A3.

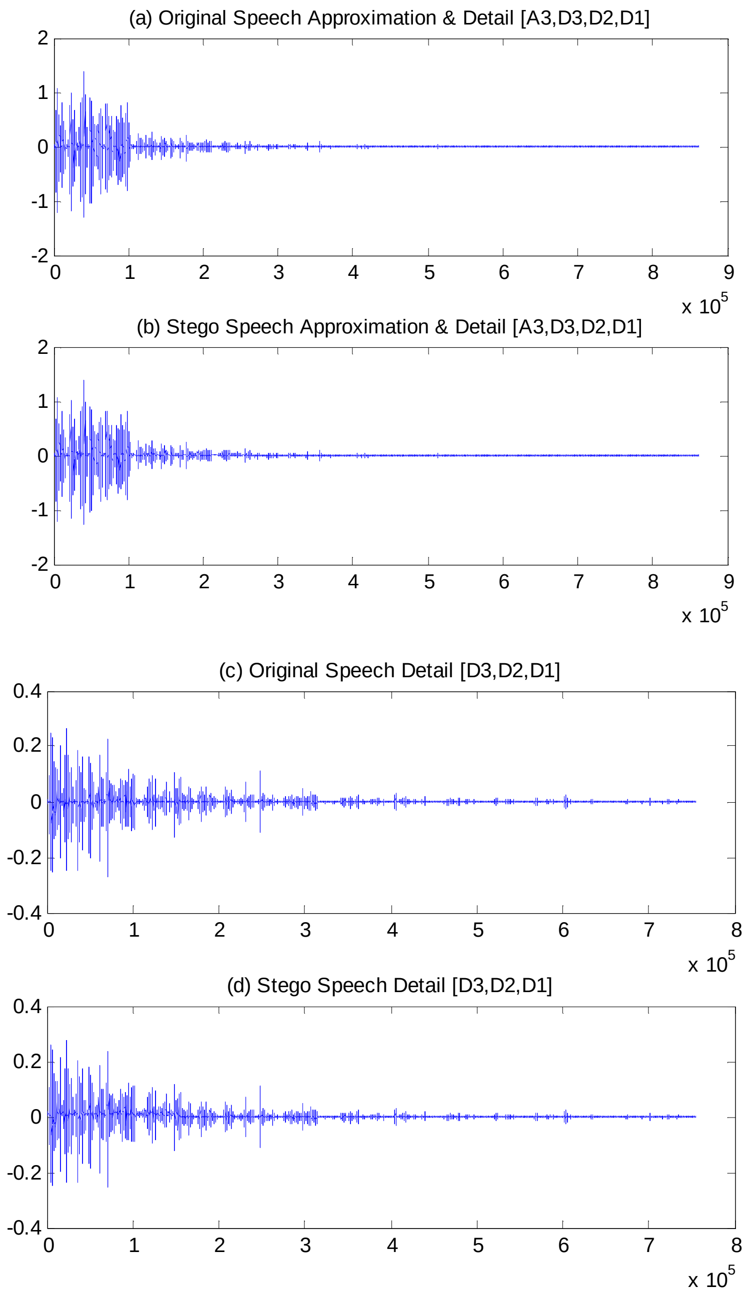


Figure (3) (a) original speech components A3,D1,D2,and D3. (b) Stego-speech components A3,D1, D2 andD3. (C) original speech components D1,D2,and D3.(D) Stego-speech components D1,D2 and D3.

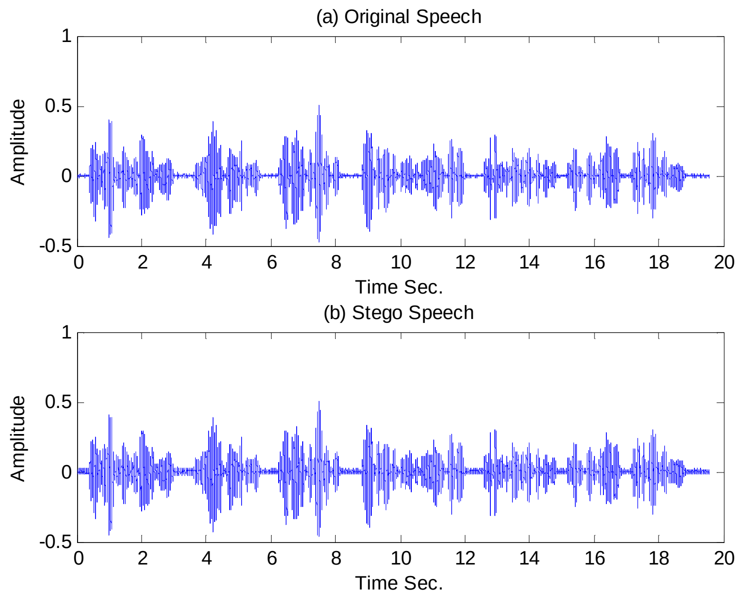
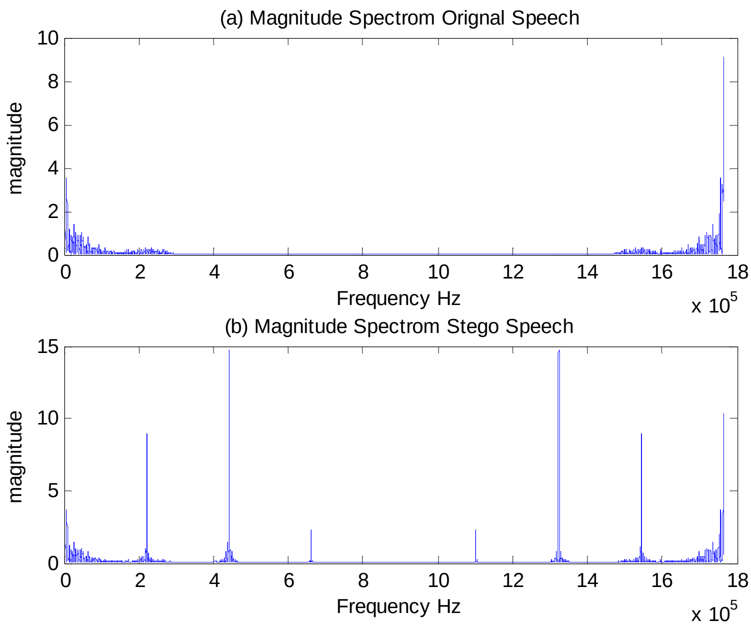


Figure (4) (a). The original speech. (b). The stego-speech



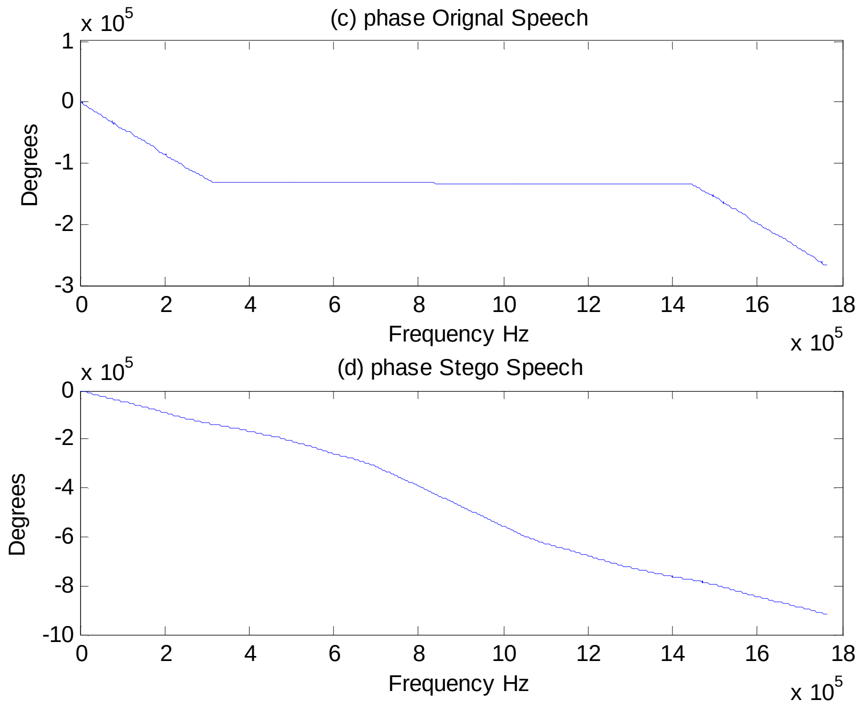


Figure (5) (a). Magnitude spectrum of the original speech. (b) Magnitude spectrum of the stego-speech. (c) Phase change of the original speech. (d) Phase change of the stego-speech.

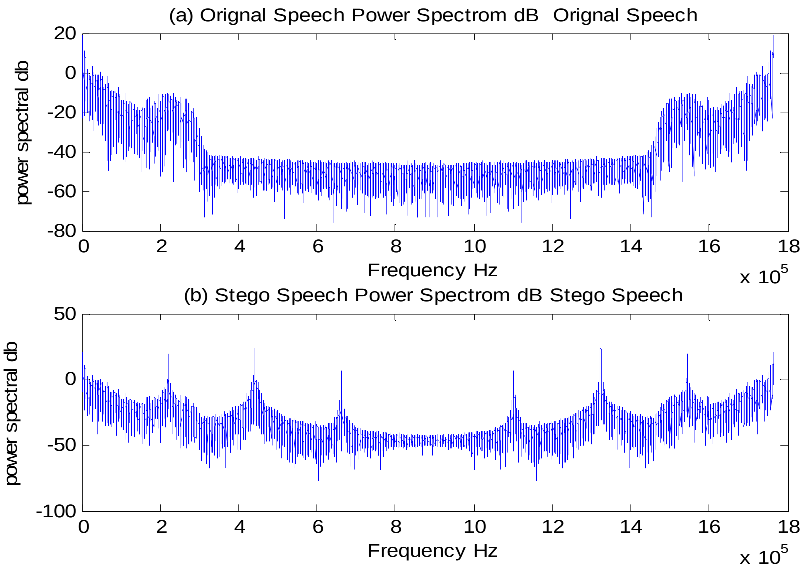


Figure (6) (a) Power spectrum of the original speech. (b).power spectrum of stego- speech

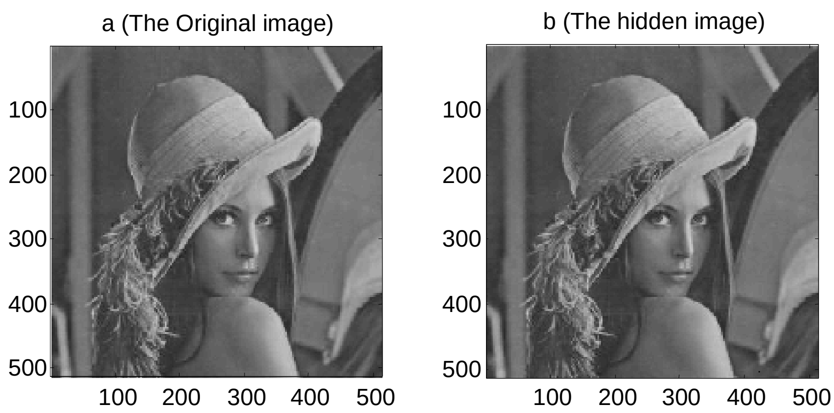


Figure (7) (a) The original (standard Lina) image. (b) The reconstructed (from the hidden) image.