Secret Technique to Hiding Image after Compression In Cover Image

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Abstract

This paper presents a technique for image compression and hiding in image of a high secret has been applied to wavelet transform and wavelet transform packet first apply two dimensional wavelet transform packet on the cover image was analysis and resorting to (Secret Sub bands level) of the cover image has secret algorithm either the image you want to hide has been compressed using two dimensional wavelet transform and then the application (Hard Thresholding) in order to reduce the values of the image and was also re-sorting to the transactions analysis (Secret Sub-band level) of the secret image(compressed image) Through a secret algorithm and then was minimized transaction values of sub bands level of image want to hide, the key used (random generated Key)to hide the secret, and this system has the property of the secret high in the process of concealment and the distribution of transactions analyzed for the image want to hide After the hit was so secret key and collected(adding) with the sub band level of the cover image on the adoption of the proposal are known algorithm with the secret key for both the sender and the receiver.

Keywords:-Information hiding, Image compression, wavelet transform and wavelet transform packet, Hard Thresholding.

تقنية سرية لإخفاء صورة بعد ضغطها داخل صورة

الخلاصة

يقدم هذا البحث تقنية إخفاء صورة بعد ضغطها داخل صورة ذات سرية عالية حيث تم تطبيق تحويله الموجيه على صورة الغطاء وتم تحليها بمستوين وثم إعادة ترتيب معاملات التحليل (Secret Sub-bands level) لصورة الغطاء بخوارزمية سرية إما الصورة المراد إخفائها تم ضغطها باستخدام تحويله الموجيه وبعدها تطبيق (Hard Thresholding) من اجل تقليل قيم الصورة وكذلك تم إعادة ترتيب معاملات التحليل(Secret Sub bands level) للصورة المضغوطة بخوارزمية سرية وبعدها تم تصغير قيم معاملات الصورة المضغوطة المراد إخفائها وذلك بضربها بمفتاح إخفاء سري(تم توليده عشوائيا) ، وهذا النظام له خاصية سريه عالية في عملية الإخفاء وذلك بتوزيع معاملات المحللة للصورة المراد إخفائها وبعد ضربها بمفتاح السري بحيث تم توزعيها وجمعها مع معامل الغطاء الصوري باعتماد على خوارزمية مقترحه تكون معروف مع المفتاح السري لكل من المرسل والمُستقبل .

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1- Introduction

Information hiding is the science of very old as mankind and the development of modern and sophisticated in computer science and information and communication technology, With the development of Internet technologies, digital media can be transmitted conveniently over the Internet. However, message transmissions over the Internet still have to face all kinds of security problems, Therefore, how to protect secret messages during transmission becomes an essential issue for the Internet Encryption is a well-known procedure for secure data transmission[1].

Two areas of research, which are generally referred to as "Information Hiding". Watermarking that is originated from the need for copyright protection of digital media, whereas Steganography studies ways to make communication invisible by hiding secrets in innocuous message [2]. Steganography is the scheme of hiding the existence of secret information by concealing it into another medium such as image or audio. It originates from the Greek word steganos (covered) and graphs (writing). Steganography is different from cryptography, which is the science of hiding the meaning of information. A cryptographic scheme is considered failed when the information can be successfully decrypted by an unauthorized person. In contrast, a steganography scheme is considered failed the moment an unintended person becomes suspicious of the very existence of the covert data within the host audio [3].

Data hiding techniques are categorized as non-blind or blind techniques. In non-blind data hiding systems, it is assumed that the original host or cover is available at the decoder. In this case, the problem reduces to the classical communications (or data transmission) problem, in which a message has to be transmitted to the receiver in the presence of noise. For blind information hiding systems, the decoder does not have an access to the original cover signal. However, viewing the cover signal as noise disregards the fact that it is actually known to the encoder, who can use this extra information to its advantage. By considering the knowledge of the host signal at the encoder, the data hiding problem can be modeled as communications process with side information about the channel-state at the encoder, Several techniques for blind hiding of the information in images have been presented in the literature. Most of these are intended for watermarking, where the main requirement is a high robustness to ensure survivability even in the presence of intentional removal attacks; in such a scenario, the perceptibility of the embedded message is of no concern as long as it does not degrade the quality of the cover beyond a certain degree. Also, in watermarking the required amount of embedded data is low; indeed as little as one bit may be sufficient (to confirm ownership or otherwise) [4].

1.1 Related Work

S. Areepongsa, N. Kaewkamnerd, Y. F. Syed, and K. R. Rao [5] a new approach for image retrieval system is proposed. By utilizing information hiding technique (steganography), the valuable image attributes can be hidden in an image content without degrading the image quality and [6] using discrete wavelet transform embedding watermarking in still images (BMP) true color, this method embedding watermark in large coefficients in high frequency sub-bands

2.Wavelet Transform and Wavelet Packet Decompositions

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 Wavelet Transform provides a time-frequency representation of the signal. It was developed to overcome the short coming of the Short Time Fourier Transform (STFT), which can also be used to analyze non-stationary signals. While STFT gives a constant resolution at all frequencies, the Wavelet Transform uses multi-resolution technique by which different frequencies are analyzed with different resolutions, Wavelet packet decompositions offer the possibility of a flexible time-frequency tiling and are very useful for the analysis of no stationary signals. In audio coding applications these transforms yield high ding gains and a suitable, perceptually adapted distribution of the quantization noise over the time frequency plane [7,8].

Usually, an orthogonal wavelet packet decomposition is implemented by cascading channel Conjugate Quadrature Filter (CQF) filter banks, as shown in Figure (1-a). The hierarchical structure of such a filter bank tree allows an arbitrary combination of time and frequency resolution. In the following shall refer to this transform as cascaded Conjugate Quadrature Filter (CCQF). Wavelet packet decomposition is a more detailed method than wavelet transform. It decomposes the signal into low frequency components and high frequency components at each level. More detailed time-scale analysis can be achieved and more accurate local information can be found in different frequency sub-bands. If the data after wavelet packet decomposition denies are clustered, better clustering results will be got, Wavelet packet decomposition is based on wavelet transform and decomposes a signal with the same widths in all frequency bands [8].

In the first level, the signal is decomposed into two sub bands low frequency sub-bands and high frequency sub-bands. In the next level, the low frequency sub-bands are decomposed into lower and higher frequency parts, the high frequency sub-bands are also decomposed into lower and higher frequency parts (Figure 1-b). The same decomposition goes on repeatedly; wavelet packet is a set with relations between scale function and wavelet mother function. Different orthogonal decomposition results can be obtained which formed the wavelet packet bases which can provide better time-frequency resolution when compared with orthogonal wavelet bases. Then frequency sub-bands can be partitioned to be consistent with the signal features [9].

3-Image Compression

Image compression based on wavelet transform was given more interest in the recent years by those who are working in data compression because of its improvement over the existing methods like high compression efficiency, the ability to handle large images, and progressive image transmission [10].

Wavelet domain techniques are becoming in the development in the wavelet stream in the recent years, Wavelet based compression JPEG2000 compression [6].

There are many known methods for data compression. They are based on different ideas, are suitable for different types of data, and produce different results, but they are all based on same principle, namely, they compress data by removing redundancy from the original data in the source file [6] .

Images require much storage space, large transmission bandwidth and long transmission time. The only way currently to improve on these resource requirements is to compress images, such that they can be transmitted quicker and then decompressed by the receiver, there are many different methods of data compression. This investigation will concentrate on transform coding and then more specifically on Wavelet Transforms. Image data can be represented by coefficients of discrete image transforms. Coefficients that make only small contributions to the information contents can be omitted. Usually the image is split into blocks (sub images) of 8x8 or 16x16 pixels, and then each block in discrete cosine transform (DCT) is transformed separately. However this does not take into account any correlation between blocks, and creates "blocking artifacts", which are not good if a smooth image is required [6].

However wavelets transform is applied to entire images, rather than sub images, so it produces no blocking artifacts. This is a major advantage of wavelet compression over other transform compression methods.

For some signals, many of the wavelet coefficients are close to or equal to zero. Thresholding can modify the coefficients to produce more zeros. In Hard thresholding any coefficient below a threshold λ, is set to zero. This should then produce many consecutive zero's which can be stored in much less space, and transmitted more quickly by using entropy coding compression[11].

There are two thresholding methods frequently used. The soft-threshold function (also called the shrinkage function) is shown in figure (3-a).

$$\eta_T(x) = \mathrm{sgn}(x).\max(|x| - T, 0) \quad \dots (1)$$

Takes the argument and shrinks it toward zero by the threshold T. The other popular alternative is the hard-threshold function is shown in figure (3-b)

$$\psi_T(x) = x\{|x| > T\} \quad \dots (2)$$

Which keeps the input if it is larger than the threshold T; otherwise, it is set to zero. The wavelet thresholding procedure removes noise by thresholding only the wavelet coefficients of the detail sub-bands, while keeping the low resolution coefficients unaltered [11].

4- Objective Fidelity Criteria

This fidelity is borrowed from digital signal processing and information theory provided the equations that can be used to measure the amount of error in the reconstructed (decompressed) image.

Commonly used objective measures are the root - mean- square error RMSE), the root-mean-square signal-to-noise ratio (SNR_{RMS}), and the peak signal-to-noise ratio (PSNR). Can be defined the error between an original, uncompressed pixel value and the reconstructed (decompressed)

pixel value as[12]:

error(r,c)=g(r,c)-I(r,c) …. (3)

Where I(r,c): The original image g(r,c): The decompressed image r,c : Row and column

Next, we can define the total error in an (N * N) decompressed image defined as:

$$Total\ \text{error} = \sum_{r=0}^{N-1}\sum_{c=0}^{N-1}[g(r,c)-I(r,c)]^2 \quad ..\ (4)$$

The root -mean-square error is found by taking the square root of the error squared divided by the total number of pixels in the image mean):

$$RMSE = \sqrt{\frac{1}{N^2}\sum_{r=0}^{N-1}\sum_{c=0}^{N-1}[g(r,c)-I(r,c)]^2} \quad .....(5)$$

The smaller the value of the error metrics, the better the compressed image represents the original images. Alternately, with the signal-to-noise (SNR) metrics, a larger number implies a better image. The SNR metrics consider the decompressed image g(r,c) to be "signal" and the error to be "noise.

The PSNR is usually measured in dB and can be defined as

$$PSNR = 10\log_{10}\frac{(L-1)^2}{\frac{1}{N^2}\sum_{r=0}^{N-1}\sum_{c=0}^{N-1}\left[\hat{f}(r,c)-f(r,c)\right]^2} \quad ....\ (6)$$

Where L is the number of the gray levels, f(r, c) is the original image and $\hat{f}(r,c)$ is the reconstructed image [13].

5- Implementation of Proposed system to compressed image and hiding in image algorithm.

The proposed system has two parts as following:-

5-1 The Embedding Algorithm

We proposed the compressed secret image embedding in cover image scheme as shown in Figure (3)

Step1:- Select secret message/image

Applying the two-dimensional wavelets transform.

Step2:- Applying the thresholding methods. The hard thresholding procedure removes noise by hard thresholding only the wavelet coefficients of the detail sub-bands, while keeping the low resolution coefficients unaltered

Step3:- Applying the inverse two-dimensional wavelets transform.

Step4:-Applying the two-dimensional wavelet packets (2 levels decomposition WP).

Step5:- Sorting the secret sub-bands level, set the mapping sub-bands as following in Figure (4-a) the original sorting sub-bands level compressed image and figure (4-b) the modify secret sorting sub-bands level in compressed image.

Step6:- Select the Cover-Image

Applying the two-dimensional wavelet packets (2 level decomposition WP).

Step7:- Sorting the secret sub-bands level, set the mapping sub-bands as following in Figure (5-a) the original sorting sub-bands level in cover image and figure (5-b) the modify secret sorting sub-bands level in cover image.

Step8:- :- Chose (secret key)

Multiplied the modify secret sorting sub-bands level of compressed secret image out of step

5 by secret key(K) was random generated , and adding modify secret sorting sub-bands level cover image output of step 6 and return or Re-sorting to the original sorting sub-bands level in cover image

Step 9:- Applying the inverse two-dimensional wavelet packets (2 levels WP) to the original sorting sub-bands level in cover image.

5.2 The Extracting Algorithm

We proposed the extracting secret image from cover image scheme as shown in Figure (4)

Step1:- Select the Stego-Image:

Applying the two-dimensional wavelet packets (2 levels decomposition WP).

Its sub-bands level is produced. These sub-bands level contain the cover image sub-bands level and secret compressed image sub-bands level.

Step2:- Applying the two-dimensional wavelet packets (2 levels decomposition WP) to the cover image.

Step3:- Subtracting sub-bands level between the stego image and cover image, and then the resulting values will be multiplied by the reciprocal of the secret key (1/K).

Step4:-Re- sorting the sub-bands level in compressed image applying step 5 in the Embedding algorithm then the secret compressed image is out put.

6- Simulation Results

In this section some experiment founds to prove the efficiency of the proposed system, the software simulated using MATLAB 7.6 in this paper used the cover image size (512×512) shown in figure 6(a, b) and secret image size (512×512) shown in figure 6(c, d).

In the first the compressed the secret image and calculated the RMS, thresholding and compression ratio to secret image (Lemas) shown in figure 7 (a,b,c) and table 1 .Figure 8(a,b,c) show the error, thresholding and compression ratio to secret image (Stonehenge) and table 2 .

figure 9 (a,b) shown the original secret image and compression secret image with best compression and figure 10 (a,b,c,d,e,f) shown the stego image with secret key(K) than calculation the PSNR to the stego and secret image after Extracting shown in table 3 and finished compare the proposal method to the other method shown in table 4.

7. Conclusions

In this paper the implementation of high secret system (more protection) depending on the comparison with other methods where the proposed system was more effective, firstly capacity of proposed system the size of the embedded image is equal of the cover image size (512×512). This capacity is the more interested feature of the proposed system and it is relatively good capacity and secondly the security of proposed system using the wavelet and wavelet transform packet and used secret key in the process of inclusion and distribution algorithm is hidden inside the cover picture, and these attributes have made the system more secure attack effective.

References

[1] A.Nag',S.Biswas,D.Sarkar,P.P. Sarkar "A novel technique for image staganography based on Block-DCT and Huffman Encoding " International Journal of

Computer Science and Information Technology, Volume 2, Number 3, June 2010.

[2] L. Z. Avedissian, "Image in Image Steganography", Ph.D. thesis, computer science dept. University of Technology, Baghdad, Iraq, 2000.

[3] Parul Shah, Pranali Choudhari and Suresh Sivaraman"Adaptive Wavelet Packet Based Audio Steganography using Data History' 2008 IEEE Region 10 Colloquium and the Third ICIIS, Kharagpur, INDIA December 8-10.286.

[4]A. S. Abbass, E. A. Soleit , and S. A. Ghoniemy "Blind video data hiding using integer wavelet transforms" Ubiquitous Computing and Communication Journal, 2007.

[5] S. Areepongsa, N. Kaewkamnerd, Y. F. Syed, and K. R. Rao, Information Hiding in Image Retrieval Systems , ICCS 2000 1/5 Date:10/16/2000.

[6] Dr.Jane J.Stephan, Esraa Jaffar Baker "Image Watermarking using wavelet transform" ,Iraq commission for computer and information 2005,informatics instate for postgraduate studies/Baghdad.

http://www.uop.edu.jo/csit2006/vol1%20pdf/pg157.pdf.

[7] Marcus Purat "A new orthogonal wavelet packet decomposition for audio coding using frequency – varying modulated lapped transforms" Institut fur Fernmeldetechnik, Technische Universitat Berlin Einsteinufer 25, D-10587 Berlin, Germany Proceedings - 19th International Conference - IEEE/EMBS Oct. 30 - Nov. 2, 1997 Chicago, IL. USA.

[8] P.E. Tikkanen and L.C. Sellin " Wavelet and wavelet packet decomposition "Department of Physical Sciences, Division of Biophysics, University of Oulu 2004.

[9] Fecit Science and Technology Production Research Center"Wavelet analysis and application by MATLAB6.5", Electronics Industrial Press, Beijing 2003.

[10] Guangzhao Cui, Xianghong Cao, Yanfeng Wang, Lingzhi Cao, Buyi Huang, Cunxiang Yang "Wavelet Packet Decomposition-Based Fuzzy Clustering Algorithm for Gene Expression Data" Informationed Key Lab of Henan Province Zhengzhou Institute of Light Industry Zhengzhou.

[11] J. L. Strack, F. Murtagh, and A. Bijaoui, "Image Processing and Data Analysis, The Multiscale Approach"Cambridge university press 1998.

[12] K. Lees. " Image Compression Using Wavelets" May 2002.

http://web.cecs.pdx.edu/~mperkows/CAPSTONES/HAAR/u9kvl.pdf

[13] S. U. Umbaugh, "Computer Vision and Image Processing", Prentice Hall 1998.

[14]P.MeenakshidDevi, M.Venkatesan K.Duraiswamy "A Fragile Watermarking Scheme for image Authentication with Tamper Localization Using Integer Wavelet Transform. Journal of computer science 5(11):831-837, 2009 ISSN 1549-3636.

Table (1) the error, thresholding and compression ratio to secret image (Lemas)

Error	Threshold	Compression ratio	Error	Threshold	Compression ratio
0.2517	0.0000	0	18.6979	7.3727	55.0000
1.4548	1.5227	5.0000	21.1680	7.7142	60.0000
2.6984	2.5200	10.0000	24.0411	8.0636	65.0000
3.9503	3.2839	15.0000	27.4209	8.4177	70.0000
5.1971	3.9185	20.0000	30.7536	8.7212	75.0000
6.6158	4.5287	25.0000	33.8338	8.9712	80.0000
8.1848	5.0918	30.0000	37.3851	9.2332	85.0000
9.9162	5.6172	35.0000	41.4260	9.5000	90.0000
11.7998	6.0986	40.0000	45.9902	9.7672	95.0000
13.9617	6.5654	45.0000	50.0657	9.9794	100.0000
16.1737	6.9719	50.0000			

Table (2): The error, thresholding and compression ratio to secret image (Stonehenge)

Error	Threshold	Compression ratio	Error	Threshold	Compression ratio
0.2510	0.0000	0	20.6803	7.0320	55.0000
1.3972	1.6210	5.0000	23.3224	7.3447	60.0000
2.8767	2.6943	10.0000	25.3622	7.5705	65.0000
4.4076	3.4314	15.0000	27.5593	7.8040	70.0000
6.0541	4.0521	20.0000	29.8162	8.0305	75.0000
7.7760	4.5810	25.0000	32.2361	8.2630	80.0000
9.5450	5.0433	30.0000	35.1588	8.5256	85.0000
11.3227	5.4563	35.0000	38.4150	8.7919	90.0000
13.0135	5.8110	40.0000	42.3633	9.0821	95.0000
15.1844	6.2244	45.0000	45.9579	9.3209	100.0000
18.0143	6.6749	50.0000			

Table (3) PSNR to the stego and secret image after Extracting shown

Cover image (Lenna) and secret image (Lemas)		
Secret Key (K)	PSNR(dB) stego image	Extracting compressed image
0.001	67.65	53.049
0.01	47.62	51.46
0.1	27.6	23.6
Cover image (Lenna) and secret image (Stonehenge)		
Secret Key (K)	PSNR(dB) stego image	Extracting compressed image
0.001	63.08	52.92
0.01	43.08	50.76
0.5	9.1	23.5
Cover image (Babban) and secret image (Lemas)		
Secret Key (K)	PSNR(dB) stego image	Extracting compressed image
0.001	63.08	43.40
0.005	49.11	40.65
0.5	9.2	21.4
Cover image (Babban) and secret image (Stonehenge)		
0.001	63.90	43.45
0.01	47.67	41.8
0.55	12.26	24.6

Table (4) PSNR and capacity comparison with the other method [14]

	Other Method		Proposed Method	
Cover Images	Size	PSNR(dB)	Size	PSNR(dB)
Lenna	256×256	60.91	512×512	67.65
Babban	130×130	59.59	512×512	63.90
Camera	256×256	60.23	512×512	63.08
Peppers	512×512	69.59	512×512	67.88

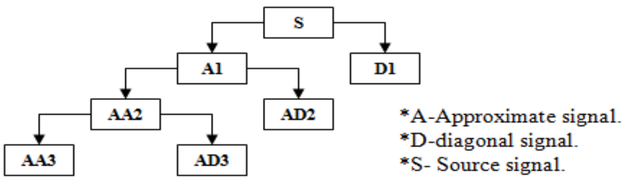


Figure (1-a) N layer decompression of wavelet transforms

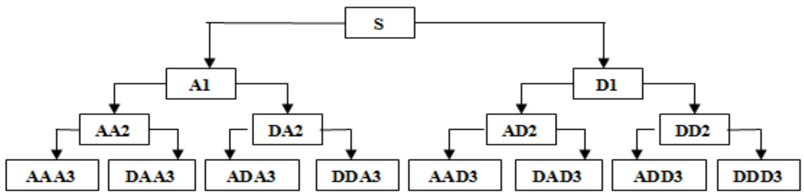


Figure (1-b) wavelet packet decompression

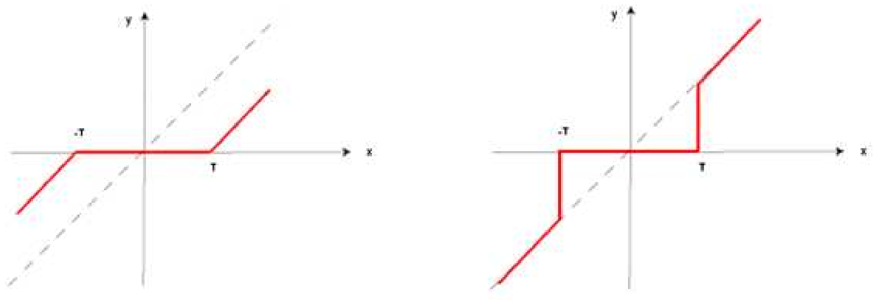


Figure 2: (a) Soft Thresholding (b) Hard Thresholding

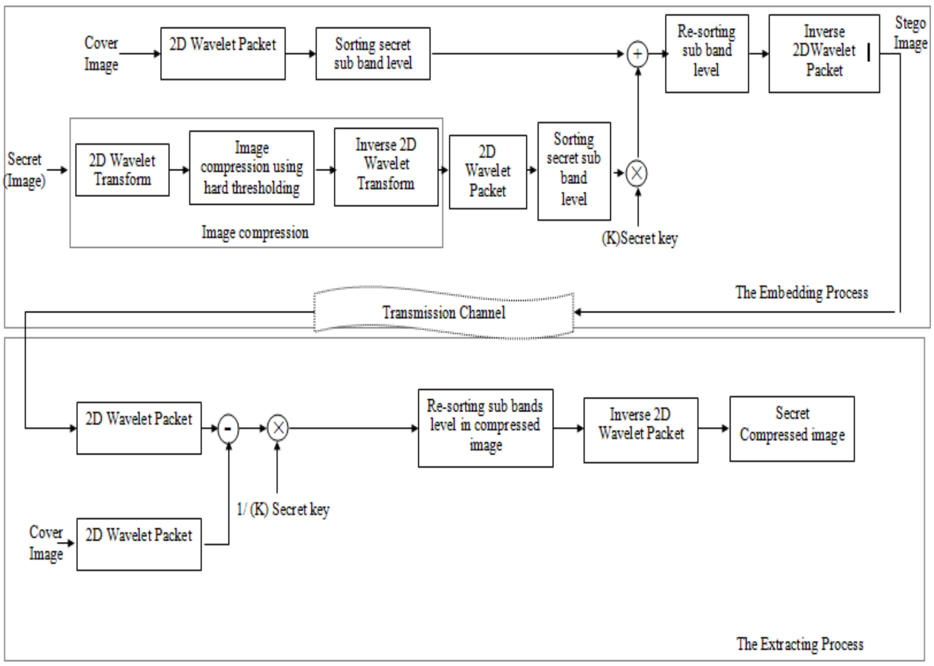


Fig (3) The Proposed Information hiding

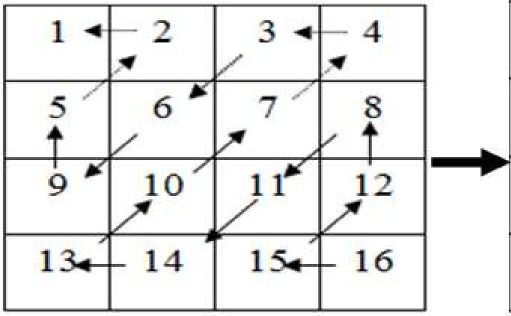


Figure (4-a) original sorting sub-bands level in compressed image

16	15	12	8
11	14	13	10
7	4	3	6
9	5	2	1

Figure (4- b) modify secret sorting sub-bands level compressed image

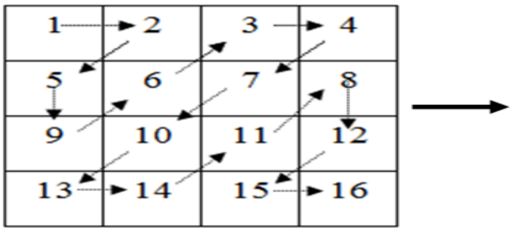
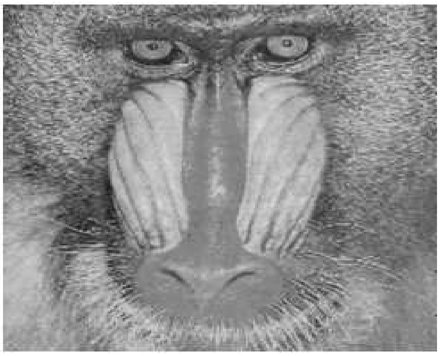


Figure (5- a) original sorting sub-bands level in cover image

1	2	5	9
6	3	4	7
10	13	14	11
8	12	15	16

Figure (5- b) modify secret sorting sub-bands level cover image

(a) Lenna



(b) Babban

(c) Lemas

(d) Stonehenge

Figure (6) Cover image and secret image

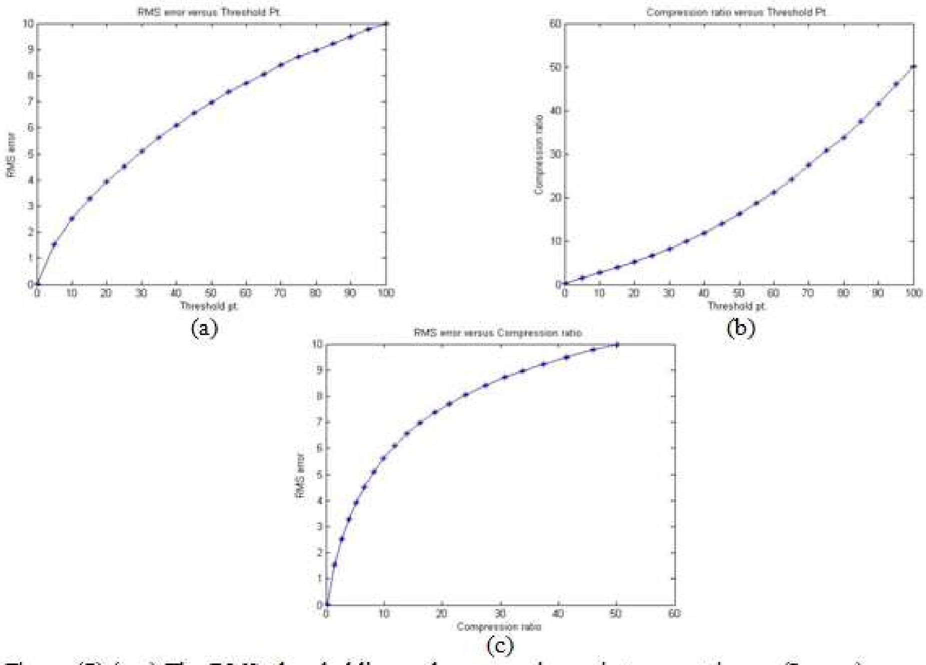


Figure (7) (a-c):The RMS, thresholding and compression ratio to secret image (Lemas)

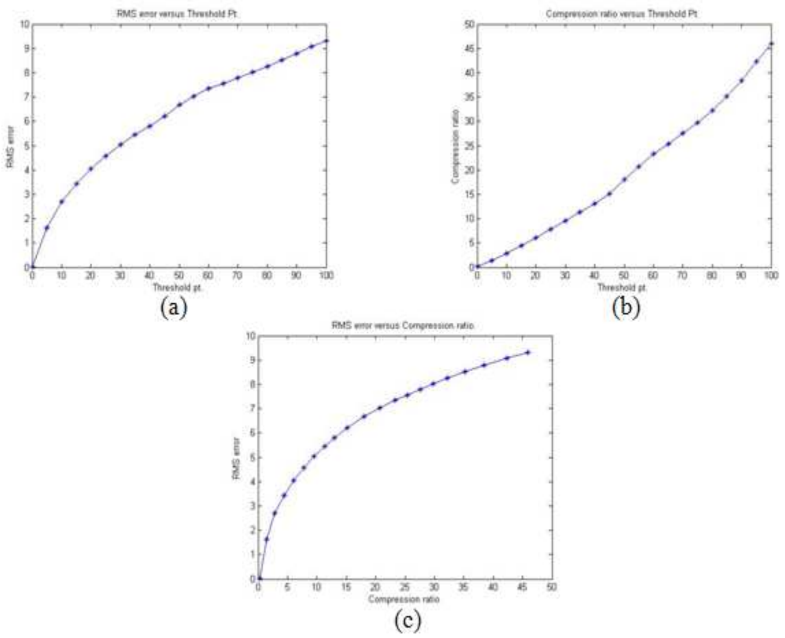


Figure (8) (a-c) :The RMS, thresholding and compression ratio to secret image (Stonehenge)

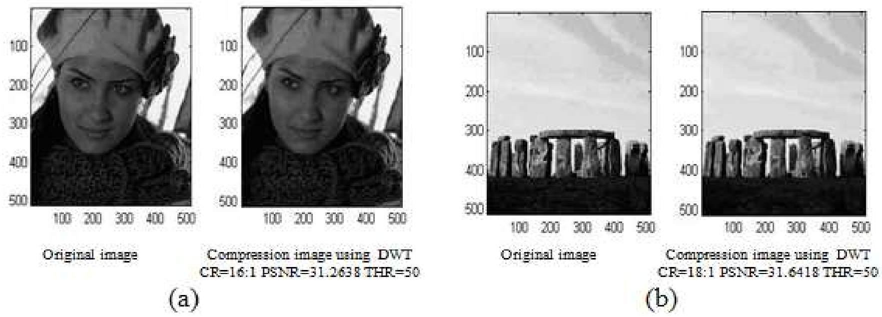


Figure 9:The original secret image and compression secret image with best compression (a) Lemas, (b) Stonehenge

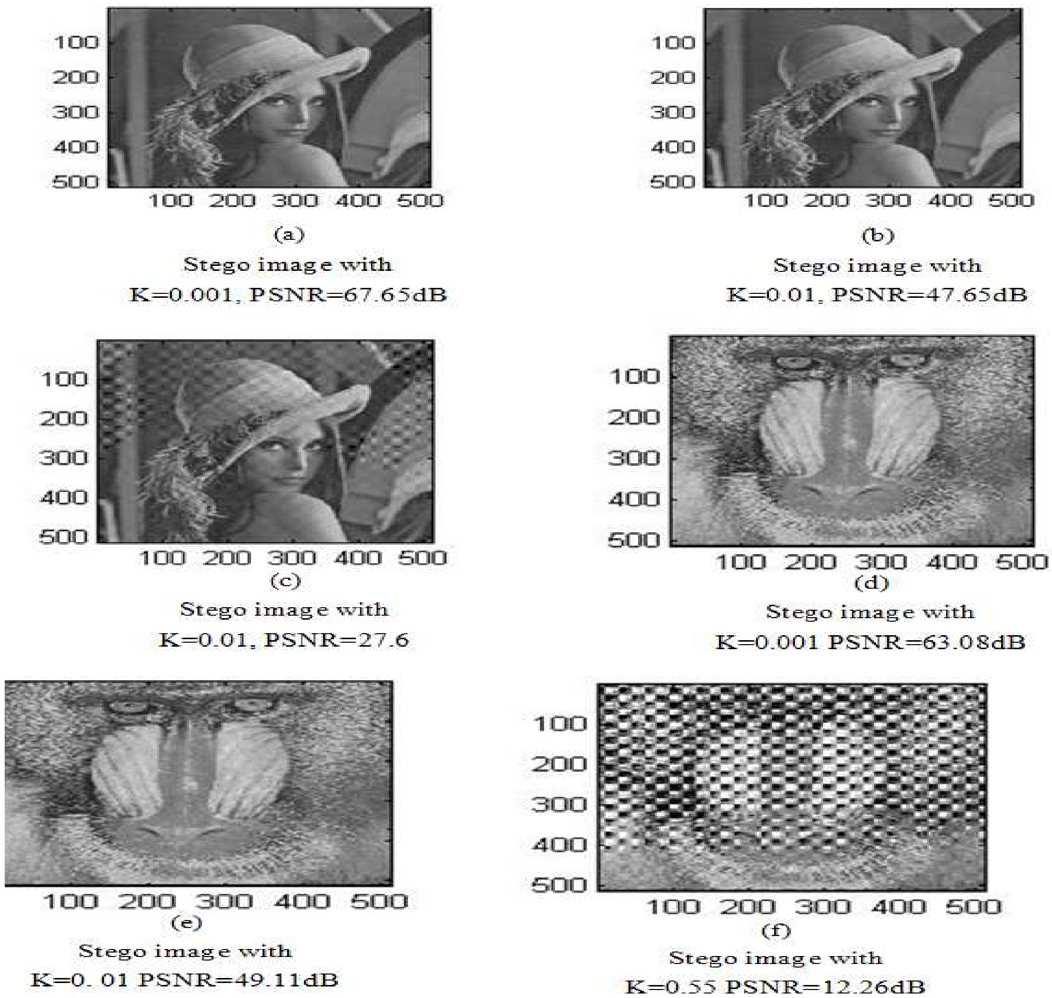


Figure (10) PSNR to the stego image and secret Key