Wavelets Transform Based Data Hiding Technique for Stegnography

Jayapragash.K,Vijayakumar.P

Abstract— **Stegnography is the art of concealing information in ways that prevent the detection of hidden messages. The goal of stegnography is to avoid drawing suspicion to the existence of a hidden message. LSB stegnography is the simplest stegnography technique used in popular stegnography tools such as S-Tools where embedding is done in the spatial domain. Random or Modified LSB Stegnography is a method in which secret message can be randomly scattered in stego-images. The Discrete Wavelet Transform (DWT) is considered to be an important tool for data hiding techniques. Discrete wavelet transform based stegnography makes use of the wavelet coefficients of the cover image to embed the secret message. Main drawbacks of DWT are lack of shift invariance and poor directional selectivity. The above drawbacks are overcome by Dual Tree Complex Wavelet Transform (DT-CWT). The Dual Tree Complex Wavelet Transform (DT-CWT) is a complex-valued extension to the standard Discrete Wavelet Transform (DWT). An improved stegnography algorithm based on the modified LSB method using Dual Tree Complex Wavelet transforms has been proposed. The secret message is embedded in the insensitive high sub-bands obtained from the cover image after applying this transform. The proposed DT-CWT based embedding algorithm was implemented and simulated. The above simulated results show that performance of PSNR (DT-CWT) was better than DWT.proposed algorithm for modified stegnography is highly secured with certain strength in addition to good perceptual invisibility**

Index Terms— **Stegnography, DWT, DT-CWT**

I. INTRODUCTION

Stegnography or Stegno means, *covered writing* which is derived from the Greek language. Stegnography is defined by Markus Kahn as follow,"stegnography is the art and science of communication in a way which hides the existence of the communication. In contrast to cryptography, where the enemy is allowed to detect, intercept and modify message without being able to violate certain security premises' guaranteed by a cryptosystem, the goal of Stegnography is to hide message inside other harmless message in a way that does not allow any enemy to even detect that is a second message present".

Stegnography is the art of invisible communication. The term invisible is not linked to the meaning of the communication, as in cryptography in which the goal is to secure communications from an eavesdropper; on the contrary it refers to hiding the existence of the communication channel itself. The general idea of hiding messages in common digital contents, interests a wider class of applications that go beyond stegnography. The techniques involved in such applications are collectively referred to as information hiding.

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Throughout history, people have hidden information in different ways. The word 'stegnography' was basically derived from the Greek words with the meaning "covered writing". Soon after, researchers used it for thousands of years in various manners. During the 5th century, the Greek tyrant Histiaeus was taken as a prisoner by King Darius in Susa. Histiaeus needed to send an abstruse message to his son-in-law, Aristagoras, who was in Miletus and in order to do this, Histiaeus shaved a slave's head and tattooed the message on his scalp.

As soon as the slave's hair grew sufficiently to conceal the tattoo, he was sent to Miletus with the message .In ancient Greece, another method was to peal the wax off a wax-covered tablet, then write a message and to have the application of the wax again. The one in charge to receive the message would simply need to get rid of the wax from the tablet to see the message. Invisible ink was another popular form of stegnography. Ancient Romans had their way in writing between the lines by using invisible ink, and by using substances such as fruit juice, urine, and milk. Using Invisible ink, though seems harmless, a letter might reflect a very different message written between the lines. Invisible ink was used as recently as World War II.

II. RELATED WORK

In recent years Stegnography techniques' received much attention from the research world, many researchers have spend considerable effort in designing several Stegnography algorithms.

[1] Explained the study of four different image stegnography algorithms based on orthogonal Haar Wavelet Transform and biorthogonal CDF9/7 Transform. [2] combine the features of Cryptography and Stegnography. Stegnography is then applied using Double-Stegging to embed this encrypted data into a cover media and hides its existence.[3] proposed a novel image stegnography technique to hide multiple secret images and keys in color cover image using Integer Wavelet Transform (IWT). [4] proposed a modified secure and high capacity based stegnography scheme of hiding a large size secret image into

a small size cover image.[5] proposed a modified secure and high capacity based stegnography scheme of hiding a large size secret image into a small size cover image. [6]presents the comprehensive study of the various statistical measures and their application in digital image processing at root level. Also Author explored and proposed their importance in some more research area of digital image processing. [7] authors propose an image resolution enhancement technique based on interpolation of the high frequency subband images obtained by discrete wavelet transform (DWT) and the input image. [8] the authors propose a new algorithm to hide data inside image using stegnography technique. The proposed algorithm uses binary codes and pixels inside an image. Based on the PSNR value of each images, the stego image has a higher PSNR value. [9] author explained a modified high-capacity image stegnography technique that depends on wavelet transform with acceptable levels of imperceptibility and distortion in the cover image and high level of overall security.[11] propose a novel method for constructing Hilbert transform (HT) pairs of wavelet bases based on a fundamental approximation theoretic characterization of scaling functions the B-spline factorization theorem.

This paper presents a new method of image stegnography techniques that effectively resist image stegnography against statistical steganalysis. The proposed method based on image stegnography using dual tree complex wavelet transforms. Apply complex wavelet transform to the cover image and embed the secret data into an insensitive frequency coefficient using a new method of pixel substitution

The remaining Chapter of the paper will be organized as follow: Chapter three discuss about DWT, chapter four discuss about proposed method, Chapter five describes the experimental result and analysis of proposed stegnography method and Chapter five gives the conclusion of the paper.

III. DWT

In the general stegnography model consists of cover medium and secret message as the input for the stegnosystem encoder for this encoding and decoding secret key is used to get stegno object then stegno object is transmitted through communication channel then the receiver receives stegno object and stegnosystem decoder decodes stegno object with secret key as shown in figure 1.

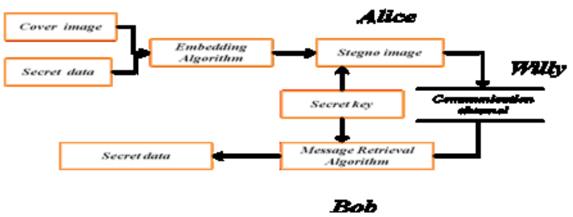

Fig.1 General Stegnography model

Wavelet transform is used to convert a spatial domain into frequency domain. The use of wavelet in image stenographic model lies in the fact that the wavelet transform clearly separates the high frequency and low frequency information on a pixel by pixel basis

Discrete Wavelet Transform (DWT) is preferred over Discrete Cosine Transforms (DCT) because image in low frequency at various levels can offer corresponding resolution needed. A one dimensional DWT is a repeated filter bank algorithm, and the input is convolved with high pass filter and a low pass filter. The result of latter convolution is smoothed version of the input, while the high frequency part is captured by the first convolution. The reconstruction involves a convolution with the synthesis filter and the results of this convolution are added. In two dimensional transform, first apply one step of the one dimensional transform to all rows and then repeat to all columns. This decomposition results into four classes or band coefficients. Figure 2 shown that two dimensional wavelet decomposition. Figure 3 shown that two level DWT decomposition.

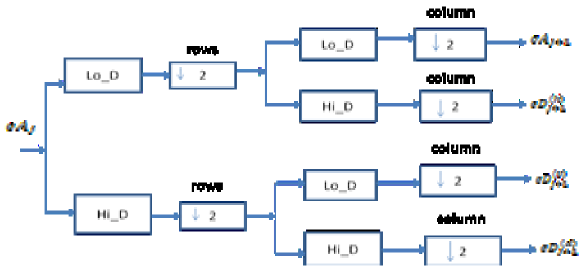

Fig.2 Two dimensional wavelet decomposition.

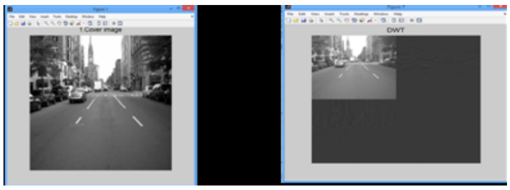

Fig. 3 Two level DWT decomposition

Fig. 4 2-D separable DWT in the spatial domain

The Haar Wavelet Transform is the simplest of all wavelet transform. In this the low frequency wavelet coefficient are generated by averaging the two pixel values and high frequency coefficients are generated by taking half of the difference of the same two pixels. The four bands obtained are approximate band (LL), Vertical Band (LH), Horizontal band (HL), and diagonal detail band (HH). The approximation band consists of low frequency wavelet coefficients, which exists important part of the spatial domain image. The other bands also known as detail bands consist of high frequency coefficients, which involve the edge details of the spatial domain image. Figure 4 shown that 2-D separable DWT in the spatial domain.

IV. PROPOSED METHOD

Complex wavelets have not been used widely in image processing due to the difficulty in designing complex filters which satisfy a perfect reconstruction property. To control this, Kingsbury proposed a dual-tree implementation of the CWT (DT CWT), which uses two trees of real filters to generate the real and imaginary parts of the wavelet coefficients separately. Although the outputs of each tree are down sampled by summing the outputs of the two trees during reconstruction, the aliased parts of the signal can be suppressed and approximate shift invariance can be achieved. In this paper CDWT, which is an alternative to the basic DWT the outputs of each tree are down sampled by summing the outputs of the two trees during reconstruction and the aliased components of the signal are suppressed and approximate shift invariance is achieved. The DWT suffers from the following two problems such as Lack of shift invariance and Lack of directional selectivity.

DTCWT is found to possess better properties such as shift invariance and less oscillation compared to the conventional Discrete Wavelet Transform (DWT). Rich source of information on wavelets can be obtained. In DTCWT, shift invariance can be obtained by using two parallel wavelet trees but, they are sub-sampled in a different way, which leads to the lack of frequency localization.

The DWT is obtained by filtering the signal through a series of digital filters. The input sequence is firstly decomposed into low pass and high passes sub bands. Each subband consists of only half the number of input samples with the purpose of providing reduced redundancy. Hence, it is found to be computationally better when compared with the continuous wavelet transform. As already enumerated, DWT is shift variant and real valued. Therefore, it does not consider phase information for analysis. The drawbacks encountered in DWT are circumvented by using Dual Tree Complex Wavelet Transform (DTCWT) which was introduced by Kingsbury. In addition to the wavelet Filter Bank (FB) utilized by the DWT, the DTCWT utilizes a second wavelet FB. It is planned such that its impulse responses are approximately the discrete Hilbert transforms of those of the first wavelet FB. The output of the first FB constitutes the real part of the input coefficients and the second FB output is the imaginary part of the complex transform. For a precise signal, the frequency disintegration provided by the DWT and DTCWT might not be optimal.

A. DUAL TREE COMPLEX WAVELET TRANSFORM

DTCWT is an improvement over the real wavelet transform in possessing shift invariant property. Further, in higher magnitude, it is found to be directionally selective. It is an addition of the standard real transform. It consists of a binary tree structure and is complex valued. It employs two real DWTs. The real and imaginary parts of it are in fact conventional real wavelet transforms. In extension to the magnitude information, phase of CWT coefficients can be leveraged to develop a new effective wavelet based algorithms.

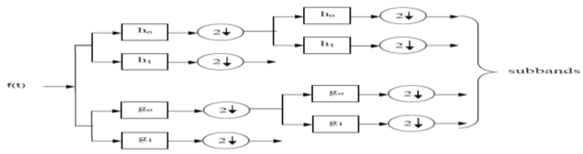

Fig. 5 Analysis of DTCWT

The analysis FB used to implement the DTCWT is shown in Figure 5. The two real wavelet transforms use two different sets of filters, with each satisfying the Perfect Reconstruction (PR) conditions. The overall transform is found to be approximately analytic [106]. In Figure 2.1, h0 & h1 represent the low pass and high pass filter pair for the upper FB. Let g0 & g1 denote the low pass and high pass filter pair for the lower FB. 'h0' gives the approximation coefficients of the upper tree and 'g0' gives the approximation coefficients of the lower tree. Similarly, 'h1' and 'g1' give rise to detail coefficients of the upper and lower tree respectively. The two real wavelets associated with each of the two real wavelet transforms are represented as $\psi h(t)$ and $\psi g(t)$ respectively. Each differs from the other by 900 phase shift, i.e., this form Hilbert Transform pair. The complex wavelet is known by,

$$\psi(t)= \psi h(t) + j\psi g(t) \text{ and } \psi g(t) = H\{\psi h(t)\} \quad (1)$$

where, $H\{\psi h(t)\}$ - Hilbert Transform of $\psi h(t)$.

Since DWT provides the following advantages over DTCWT, it has been considered for image fusion application in this work. Such as Good directionality, Shift invariance, Good frequency localization, Better image denoising, Quasi analyticity

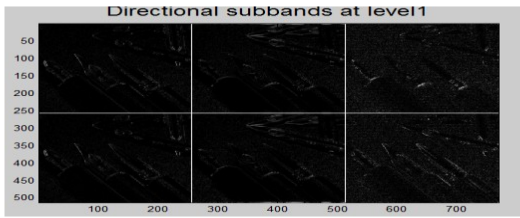

Fig. 6 Directional decomposition using DT-CWT

This operation results in six complex high-pass sub bands at each level and two complex lowpass sub bands on which subsequent stages iterate in contrast to three real high-pass and one real low-pass sub band for the real 2D transform. This display that the complex transforms has a coefficient redundancy of 4:1 or 2m: 1 in m dimensions. In case of real 2D filter banks the three high pass filters have orientations $0^\circ, 45^\circ, 90^\circ$ for the complex filters the six sub band filters are oriented at angles $\pm 15^\circ, \pm 45^\circ, \pm 75^\circ$ This is shown in figure 7.

Fig. 7 Complex filter response showing the orientations of the complex wavelets

B. Algorithm for Embedding

Apply Dual Tree Complex Wavelet Transform to the cover image. Embed the secret data into insensitive frequencies co-efficient. Take inverse Dual Tree Complex Wavelet Transform. Finally get the stego image. Figure8 shown that Flowchart for the Encoding Processes

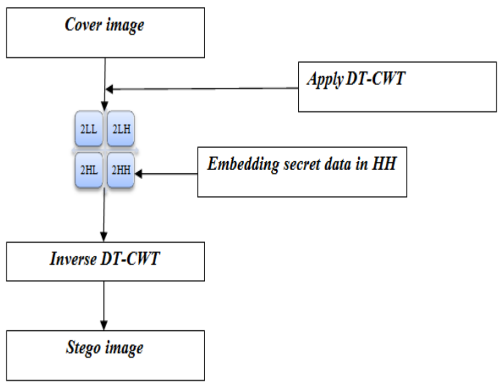

Fig.8 Flowchart for the Encoding Processes

C.Algorithm for Extraction

Apply Dual Tree Complex Wavelet Transform to the stego image.

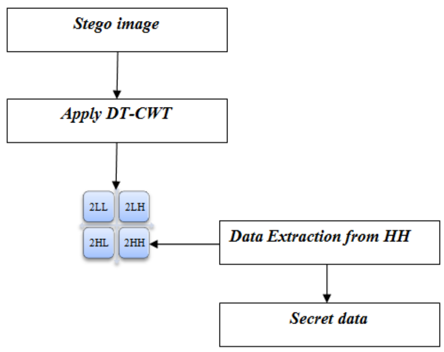

Fig. 9 Flowchart for the Decoding Processes

Extract the secret data from the HH details co-efficient. Finally get the secret data. Figure 9 shown that Flowchart for the Encoding Processes

V. SIMULATION OF PROPOSED METHOD

The proposed modulo based on image stegnography was simulated for both black – n-white and colour image. For black-n-white simulation test image was used as the cover image. For cover image simulation test image was used as cover image. Figure 10 shows Comparison of Cover Image and Stego Image

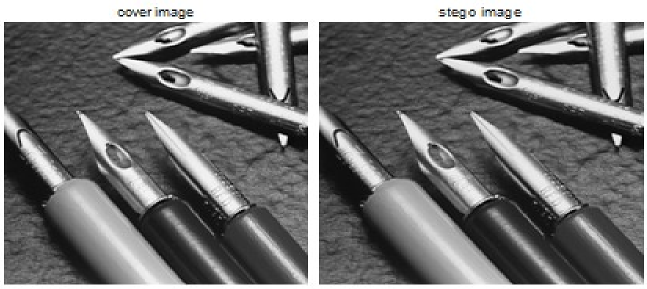

Fig. 10 Comparison of Cover Image and Stego Image

On comparing figure 10 it is inferred that the stego image does not show any changes were after the secret message is embedded.

Fig.11 Screenshot for Encoding and Decoding of Secret message

Figure 11 shows the screen shot of the embedding process with stego key. After the recipient gets the stego image, decoding process was done with stego key so as to retrieve the hidden data. Figure 11 shows screenshot of the decoded secret message

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A. Histogram Analysis

The histogram analysis plays a vital role in image stegnography. The histogram analysis was performed on the cover image and stego image. The stego image shows the minimum changes in the histogram when compared to the cover image histogram. This shows that a steganalyst will not be able to find out the hidden message. The proposed method histogram was found to be almost alike to the cover image. Figure 12 show Compare histogram of the cover image and stego image. Figure 13 shows Directional Decomposition of Cover Image with Secret Image.

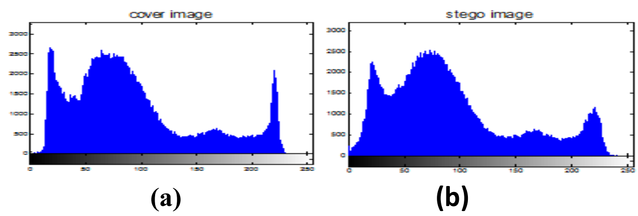

Fig. 12 Comparison of Histogram with (a) Cover Image (b) Stego Image

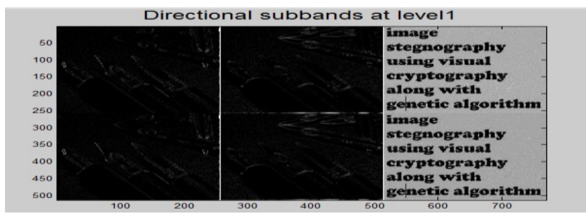

Fig.13 Directional Decomposition of Cover Image with Secret Image

B.Statistical Analysis

Statistical analysis was also performed on proposed stego image. The simulated results show that the scheme has the same insertion capacity and improved Peak Signal to Noise Ratio (PSNR) when compare to the existing DWT stegnographic techniques.
Statistical parameter like mean, variance, maximum difference and average difference are calculated from the image before and after encoding of secret message. Then the value are tabulated and compared with existing DWT method. Figure 13 represents comparison between Stego Image of DTCWT and DWT.

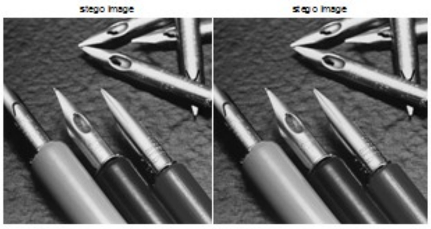

Fig.14 (a) Stego Image of DTCWT (b) Stego Image of DWT

TABLE-I

COMPARISON STATISTICAL ANALYSIS RESULTS

	Original (Test) Image	**Encoded Image with Existing DWT Method**	**Encoded Image with Proposed DTCWT Method**
Entropy	7.4808	7.5738	7.5638
Mean	92.1173	92.2449	92.1188
Variance	57.3330	57.6067	57.5748
PSNR in dB	-	32.8100	33.6231
Structural Similarity	-	0.8406	0.8987

From table I, the stego image values of DWT and the stego image values of DT-CWT were compared. The change in the value will inferred that something was hidden in the image.

Other Test Cover Images are considering. Fig. 15 Shows other Test Cover Images

Fig. 15 Other Test Cover Images

TABLE-II

STATISTICAL ANALYSIS RESULT FOR BLACK-N-WHITE IMAGE

Cover image	Test Image2	Test Image3	Test Image4	Test Image5
Cover image size	512*512	512*512	512*512	512*512
Secret image size	256*256	256*256	256*256	256*256
PSNR (dB)	33.6044	33.6984	33.5483	33.5612
Entropy (Cover)	6.7135	7.5463	7.4486	7.2367
Entropy (Stegno)	6.8739	7.5585	7.5622	7.4167
Mean (Cover)	178.0162	108.5003	152.692	111.6399
Mean (stegno)	178.0163	108.5468	115.3910	111.6393
Variance (Cover)	46.2491	49.7932	53.6816	47.6347
Variance (Stegno)	46.5470	49.9151	53.9119	47.9038
Structural Simlarity	0.8638	0.9260	0.9176	0.9052

From table II, the stego image values and the original cover image values are compared. The change in the value will inferred that something was hidden in the image.

VI. CONCLUSION

An improved stegnography algorithm based on the pixel substitution method using Dual Tree Complex Wavelet transform has been proposed. The secret message was embedded in the insensitive high sub-bands obtained from the cover image after applying this transform. The proposed DT-CWT based embedding algorithm was implemented and simulated. The above simulated results show that performance of PSNR (DT-CWT) was better than DWT. Histogram and statistical analysis performed on the stego image proved that the proposed method can effectively resist statistical stanalysis.comparing the statistical values like mean, variance, entropy, average differences and PSNR for proposed method with existing DWT stegnography method was also carried out.

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REFERENCES

[1] Sushil Kumar and S.K.Muttoo," Image Steganogaraphy Based on Complex Double Dual Tree Wavelet Transform," *International Journal of Computer and Electrical Engineering,* Vol. 5, No. 2, April 2013

[2] Nadiya, P.V and Imran, B.M, "Image Stegnography in DWT Domain Using Double-Stegging With RSA Encryption," *International Conference on Signal Processing Image Processing & Pattern Recognition*, pp. 283 - 287, February 2013

[3] Hemalatha, U Dinesh Acharya, Renuka A and Priya R. Kamath,"A Secure and High Capacity Image Stegnography Technique,"*International Journal on Signal & Image Processing*, vol.4, no.1, February 2013.

[4] Prabakaran and G, Bhavani, R., "A Modified Secure Digital Image Stegnography Based on Discrete Wavelet Transform,"

International Conference on Computing, Electronics and Electrical Technologies, pp.1096 – 1100, March 2012.

[5] Adriaan Barri, Ann Dooms and Peter Schelkens ," The Near Shift-Invariance of the Dual-Tree Complex Wavelet Transform Revisited," *Journal of Mathematical Analysis and Applications*, Volume 389, Pages 1303-1314, May 2012.

[6] Vijay Kumar and Priyanka Gupta,"Importance of Statistical Measures in Digital Image Processing,"*International Journal of Emerging Technology and Advanced Engineering*, vol 2, August 2012.

[7] Demirel, Hasan and Anbarjafari.G, "Image Resolution Enhancement by Using Discrete and Stationary Wavelet Decomposition," *IEEE Transactions on Image Processing*, vol: 20, pp. 1458 - 1460, May 2011.

[8] Rosziati Ibrahim and Teoh Suk Kuan," Stegnography Algorithm to Hide Secret Message inside an Image," *International Journal of Computer Technology & Applications2***,** pp.102 – 108, 2011.

[9] Ali Al-Ataby and Fawzi Al-Naima,"A Modified Capacity Image Stegnography Technique Based on Wavelet Transform," *International Arab Journal of information technology*, vol. 7, no.4, October 2010.

[10] S. K. Muttoo and Sushil Kumar, "Data Hiding in JPEG Images," *International Journal of Information Technology*, vol. 1, no. 1, July 2009

[11] K.N. Chaudhury and M. Unser, "Construction of Hilbert transform pairs of wavelet bases and Gabor-like transforms," *IEEE Transactions on Signal Processing*, vol. 57, no. 9, pp. 3411-3425, 2009.

[12] W. Selesnick, R. Baraniuk, and N. G. Kingsbury, "The Dual-Tree Complex Wavelet Transform: A Coherent Framework for Multiscale Signal and Image Processing," *IEEE Signal Processing Magazine*, pp.123-151, June 2005.

[13] R.Gonzalez and R.Woods ,Digital image processing,2nd ed., New Delhi: prentice Hall,2006

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