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Performing Image Steganography Using Dual Tree Complex Wavelet Transform (Dtcwt)And Haar Wavelet

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***Abstract*—With the rapid development in the networking technology, information security has become a major problem. Steganography is the art of hiding information in ways that prevent detection. It is a technique of hiding digital information such as data, audio, video file called secrete object or payload behind another digital object called cover image. In this paper, a new embedding and retrieval method is proposed for steganography technique to prevent the detection of secrete object that is present behind the cover object and to prevent data loss of secrete image at receiver end. The discrete wavelet transformation (DWT) transformation is applied on cover image and Dual tree complex wavelet transform (DTCWT) is applied on secrete image. Then merge operation is performed on both the images and inverse DWT is carried out to generate stego image. The retrieval of secrete image is the inverse process of embedding procedure. The proposed approach results in high value of PSNR and low MSE value between cover image and stego image and data loss of secrete image at receiver end is very low.**

Index terms–Dual tree complex wavelet transform (DTCWT), Haar wavelet, stego image, PSNR, PSNR*, MSE

I.INTRODUCTION

The continuous improvements in computer technology and the increase in Internet usage are responsible for the increasing popularity of Network based data transmission. In the field of network security, several techniques are being developed to overcome unauthorized attacks and to protect the secret information during transmission. Secrecy concerns with keeping the information away from the unauthorized users, so that unauthorized users unable to read or understand the information. There are mainly two techniques to achieve secrecy. They are: cryptography and steganography.Steganography is the one of the popular data hiding technique. "Steganography" is a Greek origin word which means “hidden writing”. Steganography word is classified into two parts: Steganos which means “secret or covered” (To hide the secret messages) and the graphic which means “writing” (text). Steganography is the technique for storing any digital object called payload (secret image) behind another digital object called cover image. The cover image with the secret data embedded is called the “Stego-Image”. The most important requirement for steganography is that the length of the cover object must be very high in comparison to payload such that the effect of noise is minimized after the steganography process[2].The main goal of Steganography is to avoid drawing attention to the transmission of hidden information which means the stego image should resemble same as that of cover image.Steganography techniques are mainly divided into two categories. One method consists of embedding the secret object in the image domain or also called as spatial domain. The other method hides the secret object in the transform domain or frequency domain of an image. In transform domain there are many transform that can be used in data hiding, the most widely used transforms are: the discrete cosine transform (DCT), the discrete wavelet transform (DWT) and the discrete Fourier transform (DFT). In the proposed paper work DWT transform is used and the used wavelet is Dual tree complex and Haar wavelet. By using these wavelets, value of mean square error (MSE) is decreased and peak signal to noise ratio(PSNR) value is improved between cover image

and secrete image and PSNR* value is also improved between secrete image at transmitter and receiver end.

II.METHODOLOGY

A. Discrete Wavelet Transform

The discrete wavelet transform describes a multi-resolution decomposition process in terms of expansion of an image onto a set of wavelet basis functions. In DWT method, the image is decomposed based on frequency components into detailed and approximation bands, also called the sub-bands. Detailed band contains vertical, horizontal and diagonal bands. The total Information of the image is present in the approximation band[2][5]. The secrete object is normally embedded in the approximation band and sometimes in the detailed band. Wavelettransforms often have floating point coefficients. Thus, when the input data consists of sequence of integers, theresulting filtered output no longer consists of integers, which does not allow perfect reconstruction of theoriginal image. As a result, the inverse wavelet transform becomes lossy however in wavelet Transform thatmap Integers to Integers and the output can be completely characterized by integers and exact decompressionof the original data is achieved[3].

B. Dual Tree Complex Wavelet Transform (DTCWT)

The complex wavelet transform (CWT) is complex valued extension to discrete wavelet transform. The CWT uses complex value filtering that decomposes signal in real and imaginary parts. These real and imaginary coefficients are used to calculate amplitude and phase information. The dual tree CWT employs two separate real DWTs. The first DWT gives the real part of the transform while the second gives the imaginary part. The two real wavelet transforms use two different sets of filters which is shown in fig 1.These two sets of filters are jointly designed so that the overall transform is approximately analytic. Let $h0(n)$, $h1(n)$ denote the low-pass/high-pass filter pair for the upper FB, and let $g0(n)$, $g1(n)$ denote the low-pass/high-pass filter pair for the lower FB. DTCWT has good directional selectivity as compare to other methods. Also it has reduced shift variant property.

Following are features of DTCWT:

- Approximate shift variant.
- Good directional selectivity.
- Perfect reconstruction.
- Limited redundancy.
- Efficient order n computations.

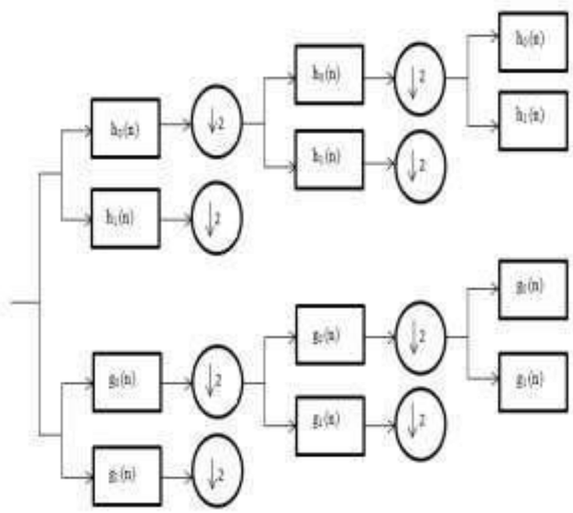

Figure 1.Filter bank (FB) of Dual tree complex wavelet transform

C. Haar Wavelet

Haar wavelet usually decomposes the signal into two sub-signals of half its length:Running average and Running difference [4]. To understand how haar wavelets work, consider a simple example. Assume a 1D image with a resolution of four pixels, having values [9 7 3 5]. First average the pixels together, pair wise, is calculated to get the new lower resolution image with pixel values [8 4]. Clearly, some information is lost in this averaging process. We need to store some detail coefficients to recover the original four pixel values from the two averaged values. In our example, 1 is chosen for the first detail coefficient. This number is used to recover the first two pixels (9 and 7) of our original four-pixel image. Similarly, the Second detail coefficient is -1, since 4 + (-1) = 3 and 4 - (-1) =5. Thus, the original image is decomposed into a lower resolution version and a pair of detail coefficients. The decomposition to lower resolution values using haar wavelet is shown in Table 1

Resolution	Averages	Detail coefficients
4	[9 7 3 5]	
2	[8 4]	[1 -1]
1	[6]	[2]

Thus, for the one-dimensional Haar basis, the wavelet Transform of the original four-pixel image is given by [6 2 1 -1].

III.PROPOSED STEGANOGRAPHIC MODEL

A. Embedding Method

The block diagram of proposed embedding method is shown in fig 2.

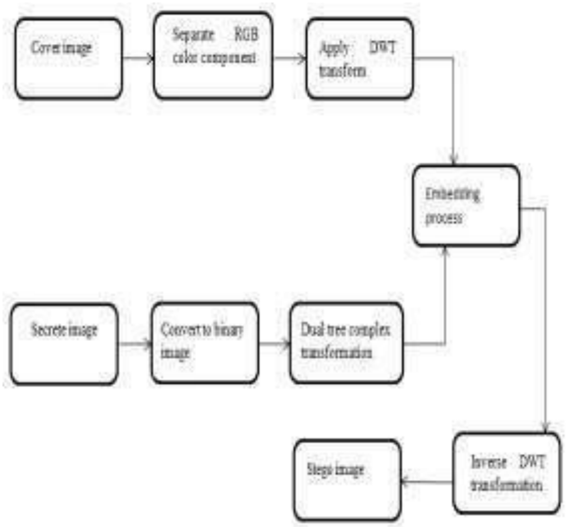

Figure 2.Block diagram of proposed embedding method

1. Read the cover image and resize the image so that number of rows and columns in the image should be equal. The cover image should be in .jpg format
2. Separate the RGB color components from the cover image.
3. Apply three level DWT transform to any of the color component and finally obtain four subbands LL3, LH3, HL3 and HH3.
4. Read the secrete image and also resize it so that number of rows and columns in the image should be equal.
5. Size of secrete image should be smaller than cover image and the secrete image should also be in .jpg format
6. Convert the secrete image into binary image and apply dual tree complex wavelet transformation.
7. DT-CWT reduces the noise in the secrete image and produces a image with good resolution and resultant secrete image isembedded in the anyone subband of the cover image.
8. Now carry out inverse DWT transform to generate stego image. The cover image with the secret data embedded is called the StegoImage.
9. Then stego image is sent to receiver end where extraction of secrete image from cover image is carried out.

B. Retrieval Method

The block diagram of proposed retrieval method is shown in fig 3.

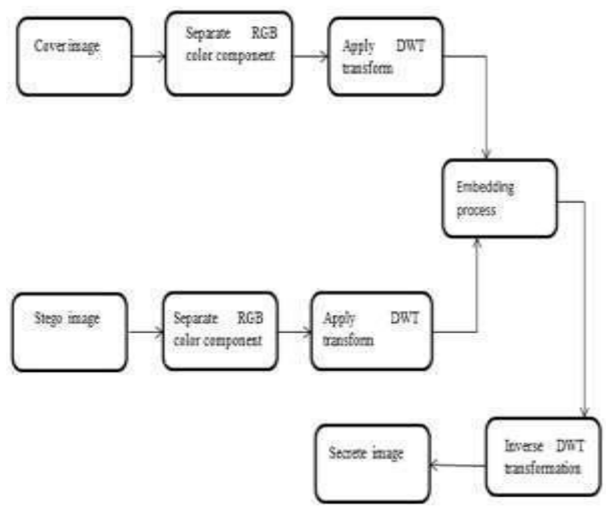

Figure 3.Block diagram of proposedretrieval method

1. The retrieval procedure of secrete image from the stego image is the inverse procedure of embedding method.
2. To the stego image, the three level DWT transform is applied to the particular color to which the secrete image is embedded.
3. Once again to the cover image the three level DWT transform is applied to the particular color to which the secrete image is embedded.
4. Then reconstruct the secrete image from stego image and cover image. By using corresponding subband of stego image and cover image the secrete image is recovered back.
5. For a good retrieval procedure the data loss to the secrete image should be very less and the secrete image should resemble same as that of original secrete image.

IV. RESULTS AND DISCUSSION

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Cover Image: Flower image is used as cover image, of size 512×512. The image is in .jpg format.

Secrete Image: The secrete image (medical image) of size 64×64 used as data to be hidden in cover image. The image is in .jpg format.

Stego Image: After embedding the secrete images in cover image, stego image is obtained.

The cover image, secrete image and stego image is shown in fig4, 5 and 6. The retrieved secrete image is shown in fig 7.

Figure 4. Cover image

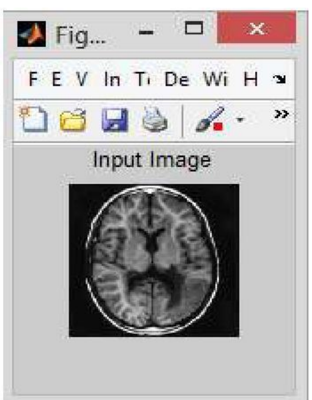

Figure 5: Secrete image

Figure 6.Stegoimage

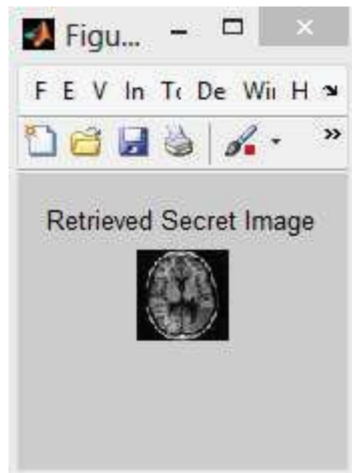

Figure 7. Retrieved secrete image

There are some metrics which can be used to check the performance of proposed approach. The commonly used metrics are MSE, PSNR and $PSNR^*$.

Peak Signal to Noise Ratio (PSNR):It is the measure of quality of the image by comparing the cover image with the stego image, i.e., it is the measure of the difference between the cover image and stego image.

$$PSNR=10 \log 255^2/MSE$$

For a good steganography technique PSNR value should be high. The proposed approach results with a PSNR value of 53.2.

$PSNR^*$: It is the measure of loss of secrete image by comparing the secrete image at transmitter end with steganography technique PSNR* value should be high. The proposed approach results with a PSNR* value of 14.5.

Mean square error(MSE): It is defined as the square of error between cover image and stego image. It is calculated by:

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Where f (i, j) is the original image and f' (i, j) is the stego image. For a good steganography technique MSE should be low. The proposed approach results with a MSE value of 0.4.

Comparison of proposed approach with similar existing approaches is shown in table 2

Approach	PSNR
ThanhHai Thai., et al.	47.3
ElhamGhasemi. et al	42.4
Victer Paul P., et al	45.28
Allen Joseph., et al	33.1
Kumar K. B. S., et al	46.50
Harish Rohil., et al	48.10
Bhattacharya T., etal	27.39
Proposed approach	**53.2**

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Table 2: Comparison of Proposed Approach with Similar Existing approaches

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