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Secret Image Hiding in an Enhanced Steganography Approach using IWT

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ABSTRACT: Steganography is the art and science of writing hidden messages in such a way that no one apart from the intended recipient knows of the existence of the message; this is in contrast to cryptography, where the existence of the message is clear, but the meaning is obscured. Steganography received much significance in the past few years because of the increasing need for delivering secrecy in an open environment like internet. Practically someone can notice the communicated knowledge all around, steganography attempts to cover the existence of the message and make communication undetectable. In this paper we are hiding a secret image by choosing best cover image. Neural network approach is used to train the cover images. Integer wavelet transform (IWT) has been adapted to make our work more secured.

KEYWORDS: Steganography, IWT, Neural Networks.

I. Introduction

The word steganography is initially composed of two Greek words 'Steganos' and 'Graphia', which means "covered writing". The use of steganography dates back to old instances the place it was used by Romans and historic Egyptians. The interest in modem digital Steganography started with the help of Simmons in 1983 when he presented the main issue of two prisoners wishing to escape and being watched by using the warden that blocks any suspicious knowledge communicated between them and passes normal looking one. Any digital file equivalent to image, video, audio, text or IP packets can be utilized to cover secret message. Often the file used to cover data is known as cover object, and the time period stego-object is used for the file containing secret message.

However, the steganogrphic transform based techniques have the following disadvantages; low hiding ability and complex computations [1]. Hence, to recover from these limitations, the this paper proposes an adaptive data hiding procedure joined with the usage integer wavelet transform algorithm to cover information into the integer wavelet coefficients of the cover image in an effort to maximize the hiding capacity as much as possible.

Steganography encompasses methods of transmitting secret messages in this sort of manner that the existence of the embedded message is undetectable. Carriers of such message may resemble harmless sounding text, disks, network traffic and protocols, the way software or circuits are arranged, audio, photos, video, or any others digitally signify code or transmission. These provide nice carriers for hidden understanding and many extraordinary methods.

There are various approaches for hiding information in images. In images, we are able to adjust properties similar to contrast, colours or luminance to hide secret messages. Proposed methods hide information in images with virtually no impact to the human sensor system. When considering the fact that an image in which to hide information, one have got to consider the structure of the image as good as the palette. Essentially the most well known system to hide understanding in the image is least significant bit (LSB) insertion or manipulation. This can be a common and easy approach for embedding information in a cover.

II. Related Work

Sonal Nigam Et al.[1] proposed another picture Steganographic method that installs mystery picture just in the periphery areas of the spread picture while keeping the smoother districts in place. This system of information concealing gives more security. This is because of human visual framework (HVS) that can endure some level of changes in the edges while it is touchy to slight changes in smooth ranges. Edges of the spread picture are ascertained by means of Canny Edge Detection calculation. Installing is connected just in arbitrarily chosen periphery pixels

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instead of all edges. For implanting reason, a pointer channel is chosen from RGB channel. Mystery information bits are implanted to variable no of LSB of other two channels. Pointer is chosen as most extreme force shading channel to give the data about information bits whether they are embedded into that pixel or not. **M. Ravi Shankar Reddy & Sri. J. Swami Naik [2]** have proposed a strategy for the stowing away of instant messages into a computerized picture in spatial space. In our methodology in every pixel two bits of message part is implanted in a manner that the fourth piece place, second piece plane furthermore the minimum huge bits are permitted. Proposed message concealing methodology is vigorous and exceptionally helpful in certifiable applications.

Reyadh Naoum et all [3] described A novel Image Steganography System based on Hybrid Artificial Neural network with Haar-Discrete Wavelet Transform, here enhanced resilient back propagation along with SOM used adapted to choose best cover image compatible with secret image. Firstly secret image is converted to red, green and blue planes. Each layer is processed by applying DWT. The color planes are converted to bit streams. These bits are encrypted using modified FLFSR to increase the security level of the system. **In this paper [4] Mehdi Hussain and M4reed Hussain** compared different stenographic techniques. They have critical analyzed different proposed techniques which show that visual quality of the image is degraded when hidden data increased up to certain limit using LSB based methods.

SP Siva Srinivasan proposed [5] an approach based on Multi-threaded Neural Network approach, he first extracts the features of image embedded information, and then input them into neural network to get the output. The neural network in images is used to overcome the hurdles by way of hiding the info directly into graphical image using neural network algorithm to get cipher bits. The generated cipher bits are then placed the least bit significant bit position of the cover image. A Multi-threaded back propagation algorithm is used in the neural network. Multi-threading in the back propagation algorithm raises the speed of processing in the neural layers and thereby tremendously raises the efficiency.**Preeti Arora, Anupam Agarwal and Jyoti proposed steganographic approach [6]**; their prominent focus was to develop RS-analysis proof design with highest imperceptibility. Optimal Pixel Adjustment process have been adopted to minimize the difference error between the input cover image and the embedded-image and in order to maximize the hiding capacity with low distortions respectively

N Sathisha et al., [7] have proposed Non Embedding Steganography utilizing Average Technique as a part of Transform area (NESATT). The Lifting Wavelet Transform (LWT) is connected on both spread picture and payload picture. The Diagonal band (CD) of spread picture and Approximation band (PA) of payload are fragmented into N x N squares. The PA band of payload is isolated by CD to create resultant grid in light of Non Embedding Threshold Value (NETV) settled by key. The normal estimation of resultant grid is ascertained and used to gap PA to create altered CD. The normal estimation of every squares are scale brought down by key and installed into comparing piece of Horizontal band (CH) of spread picture. The converse LWT is connected on stego object. The limit and PSNR qualities are high on account of proposed calculation.

Ashish Chawla & Pranjal Shukla [8] have proposed a modified secure and high capacity based steganography scheme of hiding a large-size secret image into a small-size cover image. Matrix Rotation is performed to scrambles the secret image. Discrete Wavelet Transform (DWT) is performed in both images and followed by Alpha blending operation. Then the Inverse Discrete Wavelet Transformation (IDWT) is applied to get the stego image. Proposed algorithm for modified steganography is highly secured with certain strength in addition to good perceptual invisibility.**Preeti Chaturvedi et al.,[9]** The proposed paper represents here a image steganography method for hiding secret message in colored images by using integer wavelet transform. Steganography method is provides more security to images that contain secret message. The proposed techniques use the LSB technique. **K. B. Raja et al., [10]** have proposed a novel picture versatile stenographic method in the whole number wavelet change area called as the Robust Image Adaptive Steganography utilizing Integer Wavelet Transform. As per data theoretic solutions for parallel Gaussian models of pictures, information ought to be covered up in low and mid frequencies scopes of the host picture, which have extensive energies.**G.Prabakaran et al.,[11]**presented a novel Steganographic methodology that utilizes 2D wavelet transform and image denoising techniques. This process provides a method for concealing a digital data within a cover image by adjusting a threshold value from denoising methods to propose a high payload (capacity) with very little effect on statistical properties. In this steganography system both cover image and secret data are decomposed into 2 level of wavelet decomposition. By applying a threshold which is calculated from detail coefficients of cover image, embedding points are detected and filled by normalized DWT coefficients of secret message. An experimental result shows that this proposed system gives the high security and capacity. As future extension, we would like to enhance capacity and PSNR rate by level dependent denoising methods.

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Pratap Chandra Mandal et al.,[12] In this paper a survey on the current literature on steganography using Discrete Wavelet Transform. has been done . It presented a background discussion on the major algorithms of steganography deployed in digital imaging. The emerging techniques such as DWT are not too prone to attacks, especially when the hidden message is small. This is because they alter coefficients in the transform domain, thus image distortion is kept to a minimum. Generally these methods tend to have a lower payload compared to spatial domain algorithms. There are different ways to reduce the bits needed to encode a hidden message. This explores how these techniques can be implemented in the fields where security of data is the prime concern. **Hemalatha S et al. [13]** provides a novel image steganography technique that hides both image and key in color cover image using Discrete Wavelet Transform (DWT) and Integer Wavelet Transform (IWT). There is no visual difference between the stego image and the cover image. The extracted image is similar to the secret image. This is proved by the high PSNR (Peak Signal to Noise Ratio),value for both stego and extracted secret image. In their proposed method, the cover image is 256x256 lena color image. The secret information is grey scale image of size 128 x128. To transfer the secret image confidentially, the secret image itself is not hidden, instead a key is generated. Then the key is encrypted .The resultant key is hidden in the cover image using Integer Wavelet Transform (IWT). This improves the security and also the capacity can be improved to some extent since the key is compressed.

Manisha Boora & Monika Gambhir [14] have proposed a plan for concealing a bigger size mystery picture into littler size spread picture. Arnold Transformation is performed to get mixed mystery picture. DWT is performed on both spread picture and mystery picture and this is trailed by alpha mixing operation. This proposed calculation is exceptionally secured with great perceptual intangibility.

M Vijay et all.,[15] proposed Integer Wavelet Transform is performed on a gray level cover image and in turn embeds the message bit stream into the LSB's of the integer wavelet coefficients of a the image . The main purpose of the proposed work is to focus on improving embedding capacity and bring down the distortion occurring to the stego image. The refinement of the algorithm plays an important role for accomplishing higher embedding capacity and low distortion rate. The experimental results prove that the assessment metric such as PSNR is improved in a high manner. The experimental results show that the algorithm has a high capacity and a good invisibility.

Reyadh Shaker Naoum et al.,[16] proposed multilayer perceptron is prepared utilizing an upgraded flexible backpropagation preparing calculation for interruption identification. So as to build the union speed an ideal or perfect learning variable was added to the weight overhaul mathematical statement. The execution and assessments were performed utilizing the NSLKDD abnormality interruption discovery dataset. The examinations results exhibit that the framework has promising results as far as exactness, stockpiling and time; the planned framework was proficient to arrange records with a recognition rate around 94.7%. Key

In this section, the definitions and proposed model are discussed.

Definitions of performance analysis

Mean Square Error (MSE): It is defined as the square of error between cover image and stego image. The distortion in the image can be measured using MSE. And is calculated using Equation 1.

$$\text{MSE} = \left[\frac{1}{\text{N}}\right]^2 \sum_{i=1}^{N} \sum_{j=1}^{N} (X_{ij} - \overline{X_{ij}})^2 \qquad (1)$$

Where N: Size of images,

X_{ij}: the Value of pixel in the Cover Image,

X_{ij}: The value of pixel in the Stego Image

Peak Signal to Noise Ratio: It is the measure of quality of stego image as compared to cover image, i.e., the percentage of noise present in the cover image is given in an Equation 2.

$$\text{PSNR} = 10\log_{10}\left(\frac{255^2}{\text{MSE}}\right)\text{db} \qquad (2)$$

III. PROPOSED SYSTEM

The proposed work consists of 3 phases, Secret image and Cover image selection, Embedding and Extraction.

A. Secret and Cover Image Selection:

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Cover Image:

Histogram is a graphical representation showing a visual impression of the distribution of data. An Image Histogram is a type of histogram that acts as a graphical representation of the lightness/colour distribution in a digital image. It plots the number of pixels for each value. The selection of the best cover image that will be used to hide the secret image will be conducted using hybrid system built upon two different types of artificial neural networks, the first is SOM neural network which is an unsupervised artificial neural network, and the second network, is the enhanced resilient back propagation neural network, SOM will be trained to obtain the desired outputs of the enhanced resilient back propagation neural network.

The histograms of all the cover images database is obtained first, then they are used as inputs for the SOM neural network. SOM will categorize the histograms into pre-defined classes, ([1 0 0 0], [0 1 0 0], these classes will be used as desired outputs of the enhanced resilient back propagation, whereas the histograms will be used as training patterns.

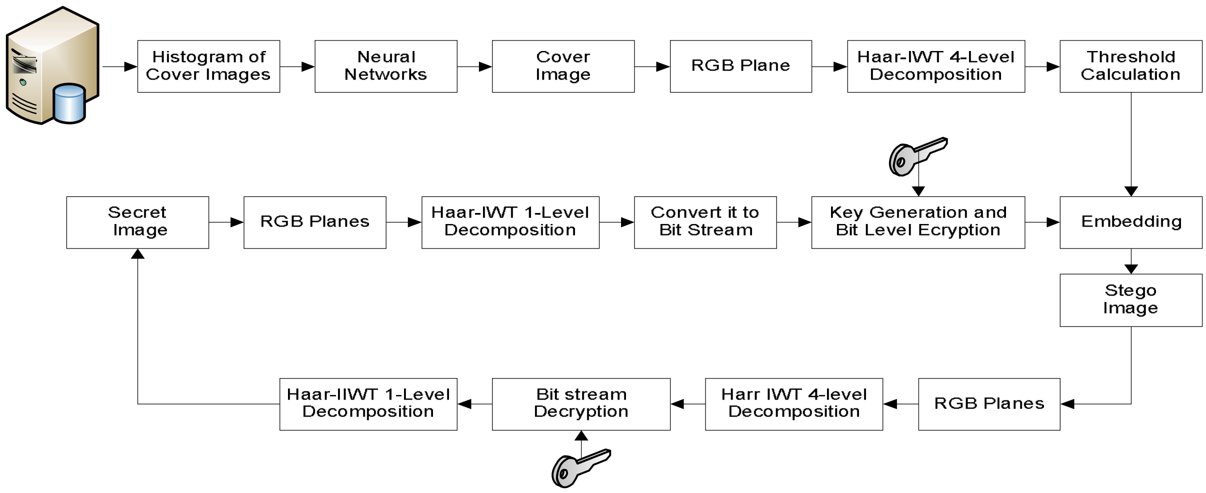

Figure 1: Proposed Architecture

Once the cover images are trained, user picks a cover image which compares features that are trained if it matches one of the trained image, system will guide you for the further operation. If not system asks you to pick good one. After the best cover image is chosen then it can be divided into its (R,G,B) layers shown in fig 2

Fig 2 : Conversion of image to RGB plane

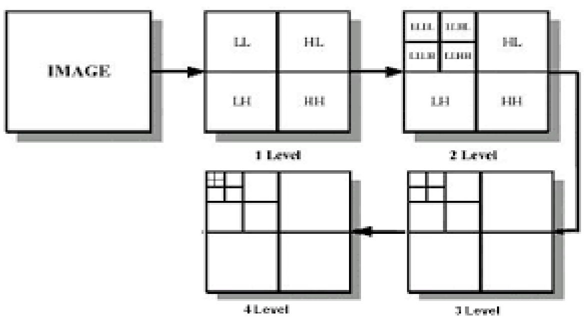

Fig 3: four level wavelet decomposition

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After the cover image and secret image has been divided into three color layers (R,G,B) then the next step is to apply 4 level-Discrete Wavelet transform individually to each colour layer. Every channel (R, G, B) of cover-image will be decomposed into four stages and each and every level with more than a few multi-decision sub bands (Approximate, Horizontal, Vertical and Diagonal), using Haar function as mother wavelet. The aim of decomposition is to separate the low frequency accessories, which has essentially the most energy of the image (Approximation), from high frequency accessories (important points) fig 3.

Secret Image:

In this stage user has to choose secret image manually form the database. The chosen image will be embedded in to cover image. As a first step, red, green and blue planes of image are separated. Once the layers are obtained, apply first level integer wavelet transform to each color bands. After applied IWT to secret image, each layer is processed separately. Each color bands get converted to 4-bit stream, where each coefficient is transformed into 16 bits and the bits of all coefficients of a sub band are concatenated to compose the whole bit stream. As soon as the bit stream of each and every sub band is available, the encryption step begins. The encryption will cipher the bit stream using key produced through modified “Fibonacci Linear feedback Shift Register ”. Initial state of the register is set using the first pixel of each color layer, and this 8-bit pixel is viewed the seed worth of the register, where a separate seed is used for every color layer, so there is a separate encryption key for each colour layer and this increases the safety level of our proposed process. Then the operation of shifting every time produces new bit key. The key bits are generated key bits as much as needed to form a stream of ciphering key matches in length of sub band bit stream.

B. Embedding:

Our proposed embedding and extraction algorithm depend on using identical threshold value in both embedding and extraction levels without using further locations in the IWT coefficients to store the indices of the locations that used to store the bit streams of secret image sub bands. It is proposed to use the learning power of the enhanced resilient back-propagation neural network to approximate the appropriate best threshold parameter that fits our proposed embedding algorithm. Our resilient back-propagation neural network was once trained using the Normalized IWT coefficients as inputs and the excellent threshold worth as the desired output for each layer of the cover images, the high-quality threshold value (T) is set after multiple of trials and errors to determine the best threshold for each and every cover image of database contains cover images. The embedding threshold determines the size (the space) of the redundancy in the best cover image coefficients that can be used to embed the secret image. And this embedding threshold can be obtained analytically by using statistical equation (3),

$$T = \frac{\alpha}{N}\sum_{i=0}^{N}|C_i| \quad (3)$$

Where N:size of the image

Ci: Value of pixel in the each plane

α:constant = 1

Once the result coming out of pre-embedding levels being ready, then the embedding section can take place. In this phase, the bit stream of each and every sub band in the secret image will probably be embedded in the (IWT) coefficients of the cover image such that, the coefficients of one layer are embedded within the secret image in the corresponding layer in the cover image and the bit circulation of one sub band within the secret image will likely be embedded in the corresponding sub band in the cover image. Now, the coefficients of every sub band in the cover image are converted to a vector that composed of the coefficients popping out of all phases and in a concatenated way. Each and every coefficient is compared with the embedding threshold (T). If it is better than threshold, then it is neglected and it's going to not be involved in the embedding approach, however if the value of the coefficient is lower than or equal to the embedding threshold (T), then the coefficients is changed to 16 bits binary quantity and then the least four significant bits (LSB) of this binary stream are used to store 4 bits block coming out the bit movement of secret image. After the substitution is finished, the coefficient that used in embedding is transferred to its float value once again. After the entire bit stream of secret image sub bands is embedded in the available coefficients that lies under threshold of cover image then “Inverse Integer Wavelet Transform (IIWT)” is used.

C. Extraction:

Extraction stage helps us to separate the stego image into its colour layers (R, G, B) and then each colour layer shall be processed individually to get the color layers of secret image, then these color layers will likely be combined together to get the full (RGB) recovered secret image and that is regarded the first protection layer of our proposed system. Then

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each and every color layers of Stego image is decomposed into 4 stage/ IWT to get the stego image sub bands that conceal the secret image bit streams. Establishing with the approximate sub band, the place the secret key which includes embedding threshold is extracted; seed value and secret image size that are embedded in the first three coefficients of approximate sub band coefficients vector.

Each and every coefficient is compared with the extracted embedding threshold; if the coefficient is larger than the threshold, ignore it. If it is less or equal to threshold then convert it to binary number and extract the 4 least significant Bits. This procedure is repeated for each and every coefficient much less or equal to the threshold unless the entire bit stream of secret sub bands is extracted. Now, the identical operation is performed for the other sub bands where each and every sub band bit streams of secret image is hidden in its corresponding sub bands of the cover image and this add a another safety stage to our proposed approach. Now, there are four encrypted bit streams of the secret image sub bands and must be decrypted. The decryption is performed within the equal steps acknowledged above in the embedding phase. Hiding the encrypted bit streams of the secret image is considered an additional safety layer for our proposed system. Once the encrypted bit streams are got decrypted, then it'll be divided to sixteen-bit blocks and they're converted again to vectors of float numbers. One level IIWT is applied to get one color layer of the recovered secret image and then repeat the same approach above to get the other layers. Subsequently, the color layers are combined together to get the full color (RGB) secret Image.

TABLE 1: EMBEDDING ALGORITHM

Input: cover image and secret image Output: stego image 1.select best cover image using trained neural network 2.convert the cover image to RGB data to separate the planes 3. Apply IWT to each plane to obtain the co-efficient of sub bands LL, LH, HL and HH. 4. Select the secret image and separate RGB planes . 5. Apply IWT transform for each plane. 6. Convert the coefficients of each plane to binary and loop for every bit and perform XOR with key and encrypt the secret bands. 7.Calculate the threshold of cover image plane to find the redundancy bits in each plane and embedded the MSB bits of secret image in LSB of the cover image in respective planes 8.Apply IIWT to obtain stego image

TABLE 2: EXTRACTING ALGORITHM

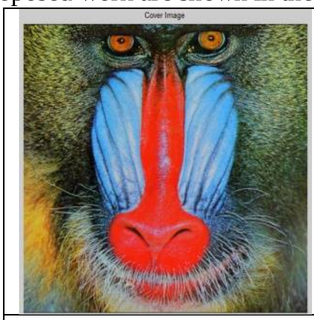
Input: Stego image. Output: extracted secret image. 1. Read the stego image. 2.extract the RGB plane from embedded image 3. Apply IWT on each colour plane of stego image to generate MSB coefficient of secret image. 4. By using threshold and LSB technique extract the MSB bits embedded in the RGB planes. 5. Decrypt the message bits by using key used during the embedding process. 6.Concatinate all the three planes RGB obtain the secret image

Significance of IWT:

The lifting scheme allows for the efficient implementation of integer wavelet transforms. It is not restricted to one-dimensional signals. Red-Black wavelets are less anisotropic than tensor product wavelets. The principle of the Red-Black wavelet transform is not restricted to a quincunx lattice. It can also be extended to triangular or hexagonal regular grids.

IV. RESULTS AND DISCUSSION

Experimental results of our proposed work are shown in the figure below.



(a) Cover Image

(b) Secret Image

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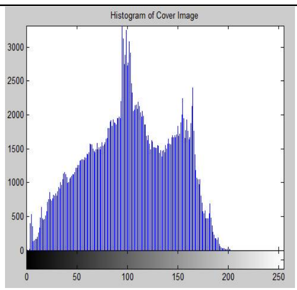
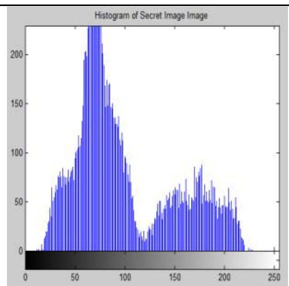
	
(c) Histogram of Cover Image	(d) Histogram of Secret Image

Fig. 5 Initial Process Diagrams

As we mentioned in the figure, secret image is embedded into IWT coefficients of cover image. Using the threshold value secret image will be embedded into cover image. Histogram of cover image Embedded image are shown. To highlight the important characteristics of our proposed system, a histograms comparison between the resulted stego image and the cover image is presented now. The histogram test shows that the modified image (stego image) is not affected by the hidden image. The histogram of the cover image is approximately the same as the histogram of stego image The histogram test is also applied to the secret image and recovered secret image. In the extraction stage, the experimental results show that the recovered secret image has almost the same histogram of the original secret image.

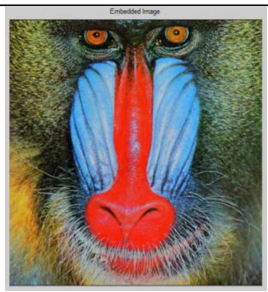
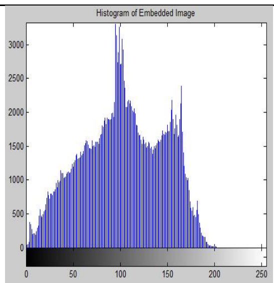
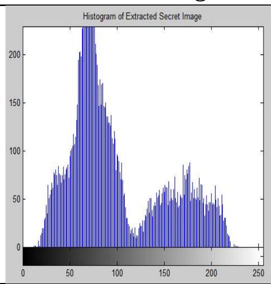
	
(a) Stego Image	(b) Extracted Secret Image
	
(c) Histogram of Stego Image	(d) Histogram of Extracted Secret Image

Fig.6. Embedding and Extraction Results

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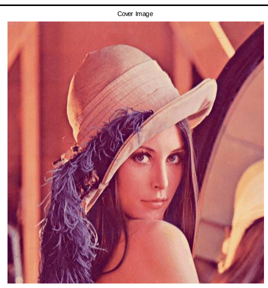
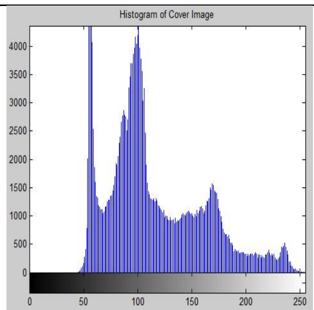
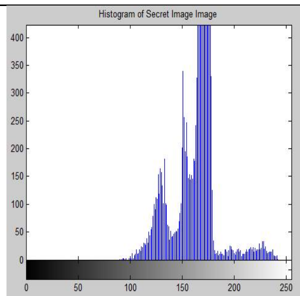


(a) Cover Image

(b) Secret Image

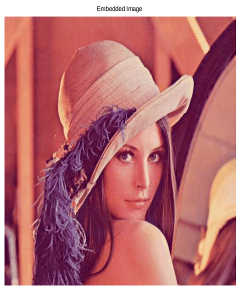


(c) Histogram of Cover Image



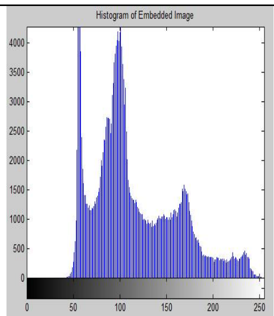
(d) Histogram of Secret Image

Fig.7 (Test Case 1) Initial Process Secret Image and Cover Image

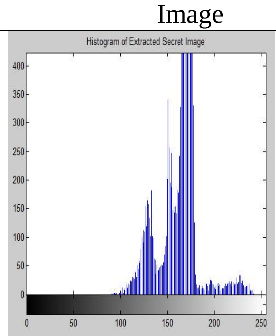


(a) Stego Image

(b) Extracted Secret Image



(c) Histogram of Stego Image



(d) Histogram of Extracted Secret Image

Fig.8 Process of Extraction

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TABLE 3: PSNR variations for different secret image formats with cover image lena.bmp (512X512)

Secret image format(128x128)	PSNR at Embedding stage	PSNR at Extraction stage
Bmp	41.0344	82.7417
Jpg	41.0611	82.7417
Png	41.1267	78.4186
Tif	41.2431	82.6372
Gif	41.1428	82.4412

TABLE 4:PSNR variations for different cover image formats with secret image cameraman(64X64)

Cover Image format(512x512)	PSNR at Embedding stage	PSNR at Extraction stage
Bmp	41.0162	81.6143
Jpg	41.0019	79.8611
Png	41.9145	82.7417
Tif	41.2345	81.6143
Gif	41.0065	81.6120

TABLE 5: Comparisons of PSNR for existing and proposed Technique

Methods	PSNR
Hemalath s et al[13]	44.7
Vijay M et al [15]	42.4
Preeti chaturvedi[9]	60.21
Proposed	82.74

V. CONCLUSION

In this paper we proposed an efficient methodology to transmit the secret image over network using multiple enhanced approaches. Initially an RGB layer of secret image is converted to bit stream, which is embedded to the coefficients of integer wavelet transform of cover image. Apply inverse integer wavelet transform to get the original secret image. The outcome guaranteed the adequacy of proposed plan as far as high estimations of PSNR and low estimation of MSE. Part the secret and cover picture into (R, G, B) shading layers and diverse level IWT decay prompted high perceptual quality in both embedded and extraction stages. The proposed framework shrouds the mystery picture in the spread picture taking into account Haar-IWT gives great extrcated secret picture quality which prompted build the intangibility of the framework. Changing the sub groups of secret picture into bits streams and concealing it at all critical bits of the IWT coefficients of spread picture brought about high PSNR and littler MSE in both inserting and extraction stages. The proposed mix amongst steganography and cryptography enhanced the security layers of our work to focused levels in contrasted and existing present day Steganographic frameworks. So it is hard to know the first concealed picture since it is encoded before inserted.

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