Image Steganography using Non Embedding and Average Technique in Transform Domain

N Sathisha, K Suresh Babu, K B Raja, K R Venugopal

Abstract— The steganography is an art and science of hiding information into a given media to ensurethe security of information over the communication channel. In this paper we propose a Image Steganography using Average Technique in Transform Domain (ISATT). The Lifting Wavelet Transform (LWT) is applied on both cover image and payload. The Diagonal band (CD) of cover image and Approximation band (PA) of payload are segmented into N x N blocks. The N x N matrix of PA is divided by N x N matrix of CD to generate resultant matrix based on Non Embedding Threshold Value (NETV) fixed by key. The average value of N x N resultant matrix is calculated and used to divide PA to generate modified CD. The average value of each N x N block are scale downed by key and embedded into corresponding N x N block of horizontal band (CH) of cover image. The inverse LWT is applied on stego object to derive stego image1. The Peak Signal to Noise Ratio (PSNR) is computed between cover image and stego image1 for different NETV values till maximum PSNR is obtained and the corresponding stego image is considered as final stego image. The capacity and PSNR values are high in the case of proposed algorithm compared to existing algorithms since non embedding and average technique is used in transform domain.

Index Terms— Steganography, Stego image, Payload, Cover Image, Non LSB, LWT.

1 INTRODUCTION

Online banking transaction and resource sharing on the internet communication certainly requires security. Development of security for communication is evolved from long back. The secrecy of confidential information was maintained by writing information on pieces of paper using invisible ink so that the paper appears to be a blank piece of paper for ordinary people. The authorized recipient extracts the confidential information by dipping the paper into the liquids such as urine, milk, vinegar etc., the rapid developments in the digital technology leads to the evolution of security techniques among those cryptography, watermarking and steganography are the most important method. Digital watermark is a perceptually transparent system which is inserted in digital data using an embedding algorithm and key. Digital watermarking is mainly used in copy right protection. Cryptography is the class of information security and associated with scrambling text into cipher text. Steganography is the art and science of hiding secret information by embedding messages within other. In Greek steganography means "covered writing" in modern steganography the confidential information is embedded into digital multimedia files and also at the network packet level. The digital multimedia files may be text, audio, video or images. Images are most widely used because an image consists of more redundant information and human visual system can't detect the variation in luminance of color vectors at higher frequency ends of the visual spectrum. Image steganography is the method of hiding data into cover image and generates a stego image this stego image is sent to the other party trough communication channel where the opponent does not know that this stego image consists of confidential information at the receiving end the confidential information is extracted with or without stego key.

The common image steganography techniques are (i) Least Significant Bit (LSB) insertion: The LSB of the cover image are replaced with the confidential information. (ii) Masking and filtering method: The specific masking algorithms or a mathematical formula is used to select specific pixels to embed the secret information. The secret information looks as an integral part of the cover image after embedding. (iii) Transform techniques: The cover image is converted into transform domain by applying transformation such as Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), Integer Wavelet Transform (IWT), Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), Dual Tree Complex Wavelet Transform (DTCWT) etc., and confidential information.

The important requirements of steganography are (i) Invisibility: - the strength of steganography lies in its ability to be unnoticed by the human eye. (ii) Payload capacity: - the maximum amount of secret information can be embedded into cover image. (iii) Robustness against statistical attacks: - how much the stego image is intact if it pass through transformation such as scaling, filtering, cropping and addition of noises. (iv) Computational complexity: - how much it is computationally expensive during embedding and extracting of a hidden message.

Steganalysis [1] is the reverse process of steganography. The aim of steganalysis process is to break steganography systems. The steganography process starts with a set of suspected information streams. Then the set is reduced with the help of advanced statistical methods. The three main types of steganalysis are (i) visual detection steganlysis:- a set of stego images are compared with original cover images and note the visible difference. (ii) Statistical detection steganalysis:- are powerful and successful because they reveal the smallest alterations in an images. This attack is further classified as passive and active attacks. Passive attack deal with identifying the presence or absence of a covert message or the embedding algorithm used etc. whereas the active attacks is to estimate the embedded message length or the locations of the hidden message or the secret key used in embedding. (iii) structural attacks are based on fact that format of the data files often changes as data to be hidden are embedded, on identifying these characteristic structure changes can detect the existence of image. Applications of steganography are confidential

International Journal of Scientific & Engineering Research Volume 6, Issue 1, January-2015
ISSN 2229-5518

communication and secret data storing, copyright protection of electronic products, Bank Transactions, Healthcare information, Internet security, Authentication and Information assurance etc.

Motivation: Due to increasing demand for privacy and security, a need of various data hiding techniques which lead to the development of several techniques for embedding and extraction. Steganography is powerful method of embedding secret information for covert communication.

Contribution: In this paper non embedding steganography using average technique in transform domain is proposed. The new concept of average value of matrix obtained using division of PA by CD is used to generate stego image. The quality of stego image is improved by using different values of NETV.

Organization: This paper is organized into following sections. Section 2 is an overview of related work. The steganography definitions, proposed embedding model and extraction model are described in section 3. Section 4 discusses the algorithm used for embedding and extraction. In section 5 Performance analysis is discussed and conclusion future work is discussed in section 6.

2 Related Work

Mehdi Hussain and M Hussain [2] proposed an algorithm to embed the data around the edge boundary of cover image. The cover edge computation is done by sobel or canny edge detector. The stego image is utilized for segmentation process. The technique shows high PSNR with low data capacity. Changcheng Li et al., [3] proposed LSB information hiding algorithm based on Lifting Wavelet Transform Technique (LWT). The preprocessing of secret information is done by LWT. The secret information replaces the random noise using the lowest plane embedding secret information to avoid noise and attacks. Hui-yu hang and shih-hsu chang [4] presented a lossless data hiding method based on quantized coefficients. The subbands obtained after DWT are quantized to generate quantization factors. The secret information is embedded into the successive zero coefficients of the medium – high frequency components of cover image. The algorithm shows high embedding capacity and acceptable stego image quality. Yizhen chen et al., [5] proposed an adaptive steganography algorithm based on block sensitivity vectors using human visual system features. The images is divided into 8 X 8 blocks and analyze the mean, variance and entrophy value of gray scale image for eah block then sensitivity vectors are calculated. The embedding scheme is decided dynamically based on sensitivity vectors.

Mohammad javed khosravi and Samaeh ghandali [6] presented a steganography based on secret sharing method. The cover image is transformed into frequency domain using IWT. The secret image is divided into shares using cryptography and these shares are embedded into coefficients of cover image. Reconstruction of the secret image is done by extracting the shares and rebuilt the extracted shares to generate original secret image. Mehdi Hussain and Mureed Hussain [7] proposed a data embedding method based on pixel intensity. The originality of secret message is modified by applying XOR operation an all bytes with the 8 bit secret key. The modified secret message is hidden into the cover intensity pixels of cover image. S K Mutt and Sushil Kumar [8] presented a image steganography based on slantlet transform and T – codes. The message is encoded using the T codes and the cover image is decomposed into four sub bands HH, HL, LH and LL using slantlet transforms. The encoded message is embedded in high frequency components of cover image.

Hossein Miar Naimi and Bagher Ramazannia [9] presented a steganographic method using Run Length Code (RLC) and Modular arithmetic. The cover image is segmented into blocks of pairs of successive pixels. The run values 0 and 1 are rearranged and run count is obtained. The run counts are embedded in two pixel blocks of cover image which limits the local destruction. Embedding process uses the modular arithmetic. Sara ershadi nasab and Hassan aghaeinia [10] proposed a method of hiding messages in digital images using integer to integer wavelet transform. The image is divided into subbands of 8 X 8 blocks and constructs bit planes of each block. The capacity of each block is caluculated. If the capacity is one the LSB 1/3 used and if capacity is more than one the rounding method for embedding of secret information into digital images is used. Elzbieta zielinska and Krzysztof sozczypiorski [11] developed a steganographic coding scheme using direct sequence spreading technique for IEEE 802.15.4 the embedding of additional content into IEEE 802.15.4 data symbols which ensures a high steganographic data rate by maintaining good performance characteristics. Shivakumar et al., [12] proposed a discrete and integer wavelet transform technique for robust steganography. The cover image is segmented into 4X4 blocks.DWT is applied on each block to obtain 2X2 blocks. The vertical band of 2X2 is considered and IWT is applied to obtain 1X1 block. The DWT and IWT are applied to payload. The payload is is embedded into coefficients of cover image using LSB replacement method. Ahmed A Abdelwahab and lobna A Hassaan [13] developed an image data hiding technique based on DWT. The cover image and secret image is decomposed into four sub images using linear phase two channel integer filter bank. Each sub images are partitioned into 4x4 pixels. The best matched block which has minimum error is searched using the root mean square error method and secret image block is embedded. Cover image by best matched block of minimum error which is searched root mean squared error.

Sunny Sachideva and amit kumar [14] proposed a steganographic method based on JPEG and a Modified Quantization Table [JMQT]. The cover image is divided into blocks of 8x 8 pixels and transformation is applied to generate DCT coefficient matrix each block is quantized using modified quantization table. The encrypted two bits of secret information is embedded into selected quantized block. Entrophy is applied on each block and stego image is generated. Mazhar Tayel et al., [15] proposed a chaos steganography algorithm for hiding the confidential multimedia information. Discrete chaotic dynamic system are used to distribute the confidential image pixels randomly within the lower byte of the cover image pixels then embedded into the LSBs of original image to generate stego image. Wien Hong and Tung shou chen [16] proposed an embedding algorithm based on adaptive pixel pair match-

International Journal of Scientific & Engineering Research Volume 6, Issue 1, January-2015
ISSN 2229-5518

ing. The values of pixel pair is used as reference coordinate and search a coordinate in the neighborhood set of this pixel pair according to confidential message digit. The pixel pair is then replaced by the searched coordinate to hide the digit.

Rong – jian chen and shi – Jinn Horng [17] proposed an antiforensic steganography system using multibit adaptive embedding algorithm with flexible bit locations to achieve large embedding capacity and high image quality. The multibits secret information like logo is embedded into any adjoining k bit of cover image. Septimiu Fabian Mare et al., [18] proposed a steganographic method based on High Dynamic Range [HDR] images. The secret data can be reliably embedded using smart LSB pixel mapping and select the best set of low dynamic range images that will be choosen to be joined later in the resulting HDR. This method combines the quality obtained using smart LSB pixel mapping and data rearrangement technique.

Narasimmalou and joseph [19] proposed image data hiding technique based on discrete wavelet transform. Two different hiding techniques are implemented namely (i) three level wavelet decomposition taking a single plane of the cover image for embedding and processing the image as 4x4 blocks with swapping. (ii) Single level wavelet decomposition. Prabhakar and Bhavani [20] proposed a modified secure and high capacity based steganography method of hiding a large size secret image into a small size cover image. Arnold transformation is performed to scramble the secret image. DWT is applied followed by alpha blending operation. Banoci et al., [21] presented a steganographic method for embedding of secret data in still gray scale JPEG image. The embedding is performed in DCT domain in JPEG file. The method uses modulo operator to achieve characteristics of blind steganography system. The secret message is encrypted by advanced encryption standard Ciphering. Nadeem Akhtar et al., [22] implemented a LSB based image steganography. The bit inversion is applied on stegoimage which is obtaining by LSB technique. The steganography quality is improved using bit inversion technique, particular pattern of some bits of the cover image pixels are inverted to reduce the number of cover image pixel modification. The bit patterns for which LSB's has inverted is stored within the stego image. Nadeem Akhtar et al., [23] presented a data hiding based on a module – based substitution method. Modulus and shifting operations with compression logic is used for hiding secret data. Secret data may be text, image or audio file.

IndradiP Banerjee et al., [24] proposed a frequency domain image steganography in 4 bit pixel factor mapping method using DCT coefficients. DCT coefficient value for embedding the secret data is selected using pixel selection algorithm. Gabriel Bugar et al., [25] designed a steganography method that uses the properties of Harr transformer coefficients. The secret message is compressed before embedding into cover image to improve capacity. The blind steganography methods do not require an original image in the process of extraction.

Bin Li et al., [26] proposed the process of cost assignment in spatial image steganography. The two phases are (i) determining a priority profile and (ii) specifying a cost value distribution. The cost value distribution determines the change rate of cover elements, when the cost values are specified to follow a uniform distribution, the change rate has a linear relation with the payload, which is a rate property for content – adaptive steganography. Kodovsky and Fridrich [27] presented a paper on how the detectability of embedding changes is affected when the cover image is down samled prior to embedding. The down scaled images are used for steganography, since down sampling changes the strength and character aof dependencies among adjacent image pixels. It also affects steganalysis. The lower image resolution decreases the strength of pixel dependencies due to more rapid changes in the image content. Depending on the image down sampling algorithm the strength of pixel dependencies may increase due to interpolation (averaging). Kuo Chen Wu and Chung –Ming Wang [28] proposed a steganography method using a reversible texture synthesis. The source texture image embds secret messages into cover image through the process of texture synthesis. A texture synthesis process resamples a smaller texture image, whoch synthesizes a new texture image with a similar loca; appearance and an arbitrary size.

3 PROPOSED MODEL

In this section definition of evaluation parameters, embedding model and extraction model are discussed.

3.1 Dfinitions

In this section definition of evaluation parameters has been discussed.

(i) *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. It is calculated using Equation 1.

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

Where:

X_{ij} : The value of the pixel in the cover image.
X_{ij} : The value of the pixel in the stego image.
N: Size of Image.

(ii) *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 measures the percentage of the stegano data to the image percentage. PSNR is calculated using Equation 2.

$$PSNR = 10\log_{10}(255^2 / MSE)\ dB \qquad (2)$$

Capacity: It is the size of the data in a cover image that can be modified without deteriorating the integrity of the cover image. The steganographic embedding operation needs to preserve the statistical properties of the cover image in addition to its perceptual quality. Capacity is represented by bits per pixel (bpp).

$$Capacity = (P_{ij} / C_{ij}) \qquad (3)$$

Where, Pij is the payload image dimensions,
Cij is the cover image dimensions.

International Journal of Scientific & Engineering Research Volume 6, Issue 1, January-2015
ISSN 2229-5518

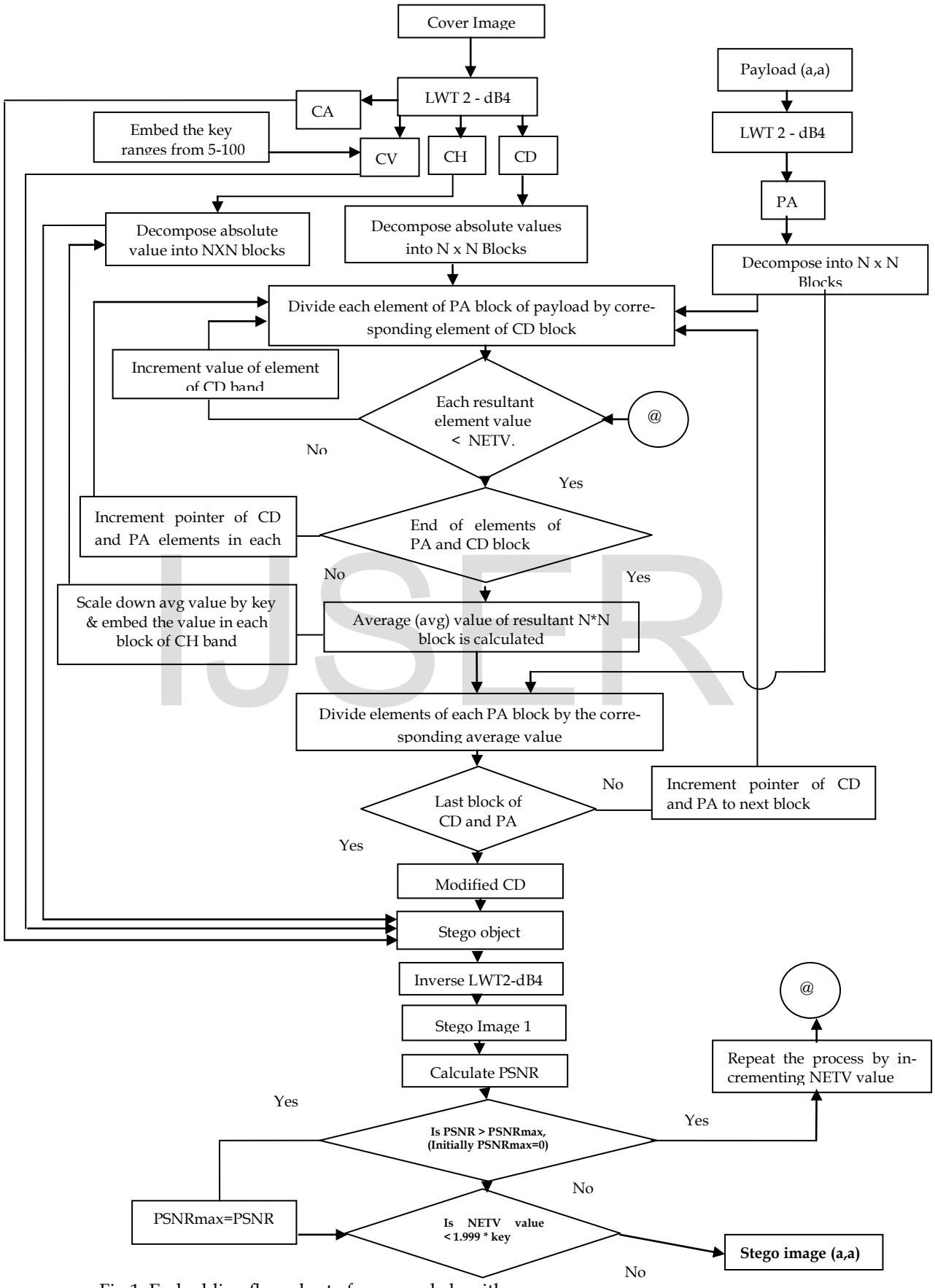


Fig.1. Embedding flow chart of proposed algorithm

International Journal of Scientific & Engineering Research Volume 6, Issue 1, January-2015
ISSN 2229-5518

3.2 Proposed Embedding Model

In the proposed method, the new concept of average value of matrix obtained by division of payload matrix by cover image matrix in transform domain is used to generate stego object. The flow chart of the proposed embedding model is as shown in Figure. 1. Cover image: The cover image is of any size and format is considered to test the performance analysis. The cover image is resized to a square matrix dimensions for embedding payload for better performance.

Payload: The secret image to be transmitted is embedded into cover image to generate a stego image. The payload image is resized to dimension equal to cover image. The payload may be of any format.

Lifted Wavelet Transform 2 (LWT2) *[29]:* The main feature of the lifting scheme is that all constructions are derived in the spatial domain. It does not require complex mathematical calculations that are required in traditional methods. Lifting scheme is simplest and efficient algorithm to calculate wavelet transforms. It does not depend on Fourier transforms. Lifting scheme is used to generate second-generation wavelets, which are not necessarily translation and dilation of one particular function. The lifting scheme of wavelet transform has the following advantages over conventional wavelet transform technique. (i) It allows a faster implementation of the wavelet transform. It requires half number of computations as compare to traditional convolution based discrete wavelet transform. This is very attractive for real time low power applications. (ii) The lifting scheme allows a fully in-place calculation of the wavelet transform. In other words, no auxiliary memory is needed and the original signal can be replaced with its wavelet transform. (iii) Lifting scheme allows us to implement reversible integer wavelet transforms. In conventional scheme it involves floating point operations, which introduces rounding errors due to floating point arithmetic. While in case of lifting scheme perfect reconstruction is possible for loss-less compression. It is easier to store and process integer numbers compared to floating point numbers.

Constructing wavelets using lifting scheme consists of (i) Split phase (ii) Predict phase (iii) update phase as shown in Figure 2.

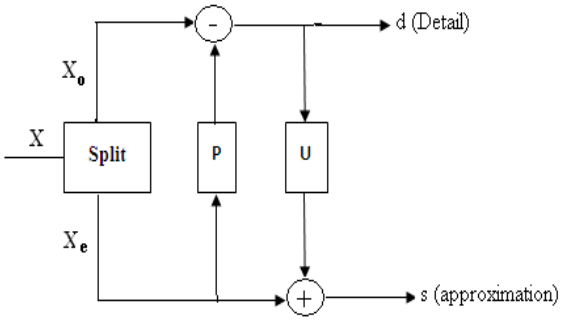


Fig. 2. Lifting scheme implementation

The first step in the lifting scheme is to separate the original sequence (X) into two sub sequences containing odd indexed samples and even indexed samples. This sub sampling is called as lazy wavelet transform

$X_o : d_i \leftarrow X_{2i+1}$

$X_e : s_i \leftarrow X_{2i}$

The prediction phase is also called dual lifting (P). This is performed on the two sequences Xo and Xe which are highly correlated. Hence, the predictor P can be used to predict one set from the other. In this step the odd sample are predicted using the neighboring even indexed samples and the prediction error is recorded replacing the original sample value, thus providing in- place calculations.

$d_i \leftarrow d_i - P\langle S_A \rangle$

Where, $A = \left(i - \left[{}^{N}/_{2}\right] + 1, \ldots\ldots\ldots\ldots\ldots i + \left[{}^{N}/_{2}\right]\right)$

N = number of vanishing moments in d. this sets the smoothness of the P function.

Update phase is the second lifting step also called as primal lifting (U). Here the even samples are replaced with smoothed values using update operator (U) on previously computed details. The U operator is designed to maintain the correct running average of the original sequence, to avoid aliasing.

$S_i \leftarrow S_i + U(d_B)$

Where, $B = \left(i - \left\lfloor {}^{\widehat{N}}/_{L} \right\rfloor, \ldots\ldots\ldots\ldots i + \left\lceil {}^{\widehat{N}}/_{L} \right\rceil - 1\right)$

$\widehat{N}$ is the number of real vanishing moments

The U operator preserves the first $\widehat{N}$ moments in the S sequence, The lazy wavelet is lifted to a transform with required properties by applying dual and primal lifting pair of operations one or more times. Finally, the output streams are normalized using the normalizing factor K.

$d_i \leftarrow d_i - {}^{1}/_{k}\, s_i \leftarrow s_i * k$

The output from the S channel after the dual lifting step provides a low pass filtered version of the input, where as the output from the d channel after the dual lifting steps provide the high pass filtered version of the input. The inverse transform is obtained by reversing the order and sign of the operations performed in the forward transform.

The dB4 LWT is applied on resized cover image to transform from spatial domain to wavelet domain bands such as CA, CH, CV and CD. The CA band has significant information hence CA band is not used for embedding. The CH, CV and CD sub bands are detailed bands and has high frequency components with insignificant information of cover image hence used for embedding. The LWT-dB4 is applied on payload and consider only approximation band PA since it has significant information of payload.

Embedding: The payload in transform domain is replaced in transform domain cover image to generate stego image using new concept called Non Embedding Steganographic Technique in Transform domain. NETV is used to generate stego image with better PSNR given in Equation 4.

NETV = 0.1 to 1.999 * key (4)

Key = 5 to 100.

The approximation band PA of payload is considered and divided into smaller blocks of N x N size. The CD and CH sub bands of cover image are considered and divided into smaller blocks of N x N size. The N x N blocks of PA is divided ele-

International Journal of Scientific & Engineering Research Volume 6, Issue 1, January-2015
ISSN 2229-5518

ment by element by corresponding N x N blocks of CD band. The resultant values of each element is compared with initial values of NETV, if value is greater than NETV, then increment element value of CD and continue till quotient is less than NETV. The average value of resultant N x N block is computed and this process is repeated for complete payload and cover images. The N x N blocks of PA are divided by corresponding average values to convert into modified CD band of cover image. The average values of each N x N blocks are scaled down to one bit by key value and embedded into corresponding N x N blocks of CH band. The intermediate stego object is obtained by combining CA, CV, CH and modified CD bands. The inverse LWT is applied on stego object to generate stego image1.

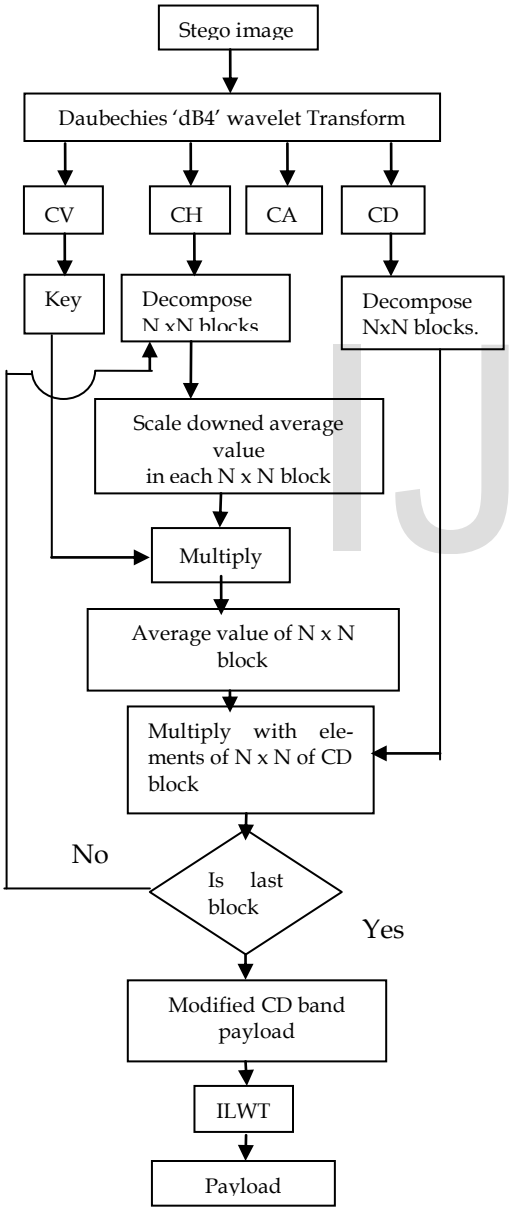


Fig. 3. Extraction flow chart of proposed algorithm

The PSNR is computed between stego image 1 and cover image for different values of NETV till highest value of PSNR is obtained. The stego image with highest PSNR value is considered as final stego image.

3.3 Proposed Extraction Model

In this section the proposed extraction model has been discussed and is shown in Figure 3.
The dB4 wavelet transform is applied on stego image to derive four sub bands viz., CA, CV, CD and CH. The key is extracted from CV sub band. The CH and CD bands are decomposed into N x N blocks. The scale downed average value embedded in each N x N blocks of CH at sending end is extracted and multiplied by key to generate average value for each N x N block. The elements of each N x N block of CD band are multiplied by average value of corresponding N x N block of CH to generate new CD band which results in payload extraction.

4 Algorithm

Problem definition: the secret image is embedded into cover image in transform domain using non LSB technique. In the proposed approach, we use new concept to generate stego image by dividing PA band of payload by CD band of cover image with key and average values.

TABLE I. EMBEDDING ALGORITHM OF PROPOSED MODEL

Input: Cover and payload images of equal size.
Output: Stegoimage

1. Transform cover image by lifting scheme using Daubechies 'dB4' wavelet.
2. Decompose CD band into N x N blocks.
3. Transform payload image by lifting scheme using Daubechies 'dB4' wavelet.
4. Decompose PA band of payload into N x N blocks.
5. The scale down factor value between 5 and 100 acts as key.
6. Embedd 'key' in first 4 elements of CV band of cover image.
7. NETV = 0.1 to 1.999 * key for 1 bit replacement in each CH block of cover image.
8. Divide elements of each PA block by corresponding elements of each CD block.
9. If element value is more than NETV then increment CD element value by 0.1 and repeat 8 else go to step 10
10. Compute average value of each N x N block.
11. Divide elements of each PA block of payload by its corresponding average value to derive modified CD band for stego object.
12. The computed average value is scaled down by key and embedded into corresponding blocks of CH.
13. Repeat steps 8 to 12 for all blocks to obtain final stego object.
14. Apply Inverse lifting wavelet transform to get stego image 1.
15. The PSNR is caluculated between cover image and stego image 1 with variable NETV values to find better PSNR value, which is considered as the final stego image.

International Journal of Scientific & Engineering Research Volume 6, Issue 1, January-2015
ISSN 2229-5518

Assumptions:
(i) The cover and payload objects are grayscale images with different dimensions.
(ii) The stego image is transmitted over an ideal channel.

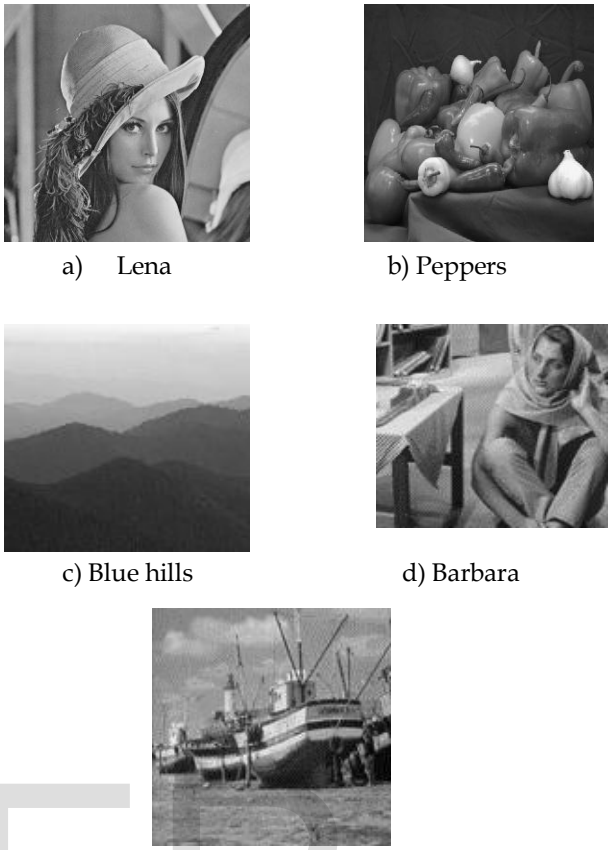
Table I and Table II give the payload embedding in cover image and retrieval of payload from cover image at the destination respectively.

TABLE II. RETRIEVING ALGORITHM

Input: Stegoimage
Output: Payload
1. Transform stego image by lifting scheme using Daubechies 'dB4' Wavelet.
2. Decompose CD and CH bands into N x N blocks.
3. Extract 'key' from CV band.
4. Extract scaled average values from each N x N blocks of CH band.
5. Multiply scaled average value by key to obtain a new Average value
6. Multiply each elements of CD of each block with new Average value to generate payload block.

5 PERFORMANCE ANALYSIS

The several images with different sizes and formats are used to test the performance of proposed algorithm. The few cover and payload images such as Lena, Peppers, Boat, Blue hills, and Barbara are shown in Figure 4.



a) Lena b) Peppers c) Blue hills d) Barbara e) Boat

Figure 4. The sample of cover and payload images.

TABLE III. THE PSNR FOR DIFFERENT SEGMENTED BLOCK

Cover Image	Payload	Size (cover image and payload)	% Capacity	PSNR (dB)		
				Segmented block size of N x N		
				2x2	3x3	4x4
Blue Hills.JPG	Barbara PNG	128X128	100	50.41	48.58	48.66
		256X256	100	52.21	51.77	49.67
		512X512	100	56.16	56.56	49.73
Lena JPG	Lena JPG	128X128	100	35.41	34.06	34.07
		256X256	100	40.20	39.68	39.33
		512X512	100	45.20	50.29	45.09
Peppers.PNG	Lena.PNG	128X128	100	39.77	38.79	38.71
		256X256	100	43.95	42.91	42.44
		512X512	100	55.559	51.62	48.43
Peppers.GIF	Boat.GIF	128X128	100	37.37	36.43	36.41
		256X256	100	41.74	40.94	40.65
		512X512	100	45.05	43.88	44.07

International Journal of Scientific & Engineering Research Volume 6, Issue 1, January-2015
ISSN 2229-5518

The PSNR values for different segmented block sizes with different sizes and formats of cover and payload images are given in Table III.The PSNR values for segmented block sizes such as 2x2, 3x3 and 4x4 of CD of cover and PA of payload images are almost same for different sizes and formats of cover and payload images. It is observed that PSNR value varies between 34 dB to 56.56 dB based on format and size of cover and payload images. The capacity is 100% with acceptable PSNR for different size and formats of cover and payload images.

The advantage of proposed algorithm are (i) payload capacity 100%. (ii) Non embedding technique i e., average value of segmented matrix is used in the proposed technique, hence it is difficult to retrieve payload by eavesdropper and hence more secure to the payload. (iii) The average PSNR value is around 45 dB.

The PSNR values between cover and stego image and Hiding Capacity (HC) for proposed and existing algorithms are compared in Table IV

TABLE IV. THE COMPARISON OF CAPACITY AND VALUE OF PROPOSED ALGORITHM WITH THE EXISTING ALGORITHMS.

Technique	PSNR (dB)	HC (%)
Amitava Nag et al.,[30]	34.17	25
Tataru et al.,[31]	42.17	25
Shivakumar et al.,[32]	39.48	47
Senthooran and Ranathunga [33]	45.05	10.15
Proposed (ISATT)	**56.56**	**100**

It is observed that the PSNR and percentage hiding capacity are more in the proposed algorithm compared to existing algorithms proposed by Amitava Nag et al.,[30], Tataru et al.,[31] Shivakumar et al.,[32] and Santhooran [33]. The PSNR values in the proposed algorithm has high value since averaging of matrix is used to generate stego image along with NETV instead of LSB replacements. The capacity in the algorithm is 100% since the segmented matrix blocks of both cover and payload images are used to compute average value for each segmented block to generate stego image.

6. CONCLUSION AND FUTURE WORK

The secret information is transmitted through communication channels in a secured manner using steganography. In this paper non embedding steganography using average technique in transform domain is proposed. The LWT is applied on cover image and payload to generate wavelet domain sub bands. The CD and PA are segmented into smaller blocks of N x N size. The N x N of PA is divided by N x N block of CD to generate resultant N x N block based on NETV. The average values of resultant N x N matrix is computed and scale downed by key and embed into corresponding N x N blocks of CH band of cover image. The key is embedded into CV band of cover image. The N x N blocks of PA are divided by corresponding average values to generate stego CD. The inverse LWT is applied to derive stego image in spatial domain. The quality of stego image is improved by changing the values of NETV. It is observed that the capacity of proposed algorithm is hundred percent with better PSNR values compared to existing algorithms. In future the proposed technique can be verified with spatial domain.

REFERENCES

[1] Vladimir Banoci, Gabriel Bugar and Duskan Levicky, "A Novel Method of Image Steganography in DWT Domain," Twenty first International Conference on Radioelektronika, pp. 1 – 4, 2011.

[2] Hussain M and M Hussain, "Embedding Data in Edge Boundaries with High PSNR," Seventh International Conference on Emerging Technologies, pp. 1 – 6, 2011.

[3] Changcheng Li, Wei Xu, Liang Meng, Baojun Liu, Yongjiang Wang and Lin Wu, "Realization of a LSB Information Hiding algorithm Based on Lifting Wavelet Transform Image," International Conference on Mechatronic Science, Electric Engineering and Computer, pp. 1015 – 1018, 2011.

[4] Hui-Yu Huang and Shih-Hsu Chang, "A 9/7 Wavelet-based Lossless Data Hiding," IEEE Symposium on Computational Intelligence for Multimedia, Signal and Vision Processing, pp. 1-6, 2011.

[5] Yi-zhen Chen, Zhi Han, Shu-ping Li, Chun-hui Lu and Xiao-Hui Yao, "An Adaptive Steganography Algorithm based on Block Sensitivity Vectors using HVS features," Third International Congress on Image and Signal Processing, pp. 1151 – 1155. 2010.

[6] Mohammad Javed Khosravi and Samanen Ghandali, "A secure joint wavelet based steganography and secret sharing method," Seventh International Conference on Information Assurance and Security, pp. 222 – 227, 2011.

[7] M Hussain and Mureed Hussain, "Pixel intensity based high capacity data embedding method," International Conference on Information and Emerging Technologies, pp. 1 – 5, 2010.

[8] S K Mutt and SushilKumar, "Secure Image Steganography Based on Slantlet Transform," Proceeding of International Conference on Methods and Models in Computer Science, pp. 1 – 7, 2009.

[9] Hossein Mair Naimi and Bagher Ramazannia, "New Image Steganographic Method Using RLC & Modular Arithmetic," IEEE International Conference on Signal Processing and Communications, pp. 744 – 747, 2007.

[10] Sara Ershadi Nasab and Hassan Aghaeinia, "A New int2int High Capacity Robust Steganography method with LSB 1/3 and Rounding Method for Embedding Message," Nineteenth Iranian Conference on Electrical Engineering, pp. 1 – 6, 2011.

[11] Elzbieta Zielinska and Krzysztof Szczypiorski, "Direct Sequence Spread Spectrum Steganographic Scheme for IEEE 802.15.4," Third International Conference on Multimedia Information Networking and Security, pp. 586 – 590, 2011.

[12] K B ShivKumar, Khasim T, K B Raja, Sabyasachipattnaik and R K Chhotaray, "Dual Transform Technique for Robust Steganography," International Conference on Computational Intelligence and Communication Networks, pp 310 – 314. 2011.

[13] Ahmed A Abdelwahab and Lobna A Hassaan, "A Discrete Wavelet Transform based Technique for Image Data Hiding," National Radio Science Conference, pp. 1 – 9, 2008.

[14] Sunny Sachdeva and Amit Kumar, "Colour Image Steganography Based on Modified Quantization Table," Second International Conference on Ad-

International Journal of Scientific & Engineering Research Volume 6, Issue 1, January-2015
ISSN 2229-5518

vanced Computing & Communication Technologies, pp. 309 – 313, 2012.

[15] Mazhar Tayel, Hamed Shawky and Alaa El Din Sayed Hafez, "A New Chaos Steganography Algorithm for Hiding Multimedia Data," 14th International Conference on Advanced Communication Technology, pp. 208 – 212, 2012.

[16] Wien Hong and Tung-Shou Chen, "A Novel Data Embedding Method Using Adaptive Pixel Pair Matching," IEEE Transactions on Information Forensics and Security, pp. 176 – 184, 2012

[17] Rong-Jian Chen and Shi-Jinn Horng, "Multi-bit Adaptive Embedding Algorithm for anti forensic Steganography," International Symposium on Biometrics and Security Technologies. pp. 82 – 89, 2012.

[18] Septimiu Fabian Mare, Mircea Vladutiu and Lucian Prodan, "HDR based Steganographic Algorithm," 17th International Symposium for Design and Technology in Electronic Packaging. pp. 333 – 338. 2011

[19] T Narasimmalou and Allen Joseph R, "Discrete Wavelet Transform based Steganography for Transmitting Images," International Conference on Advances in Engineering Science and Management, pp. 370 - 375, 2012.

[20] Prabakaran G and Bhavani R, "A Modified Secure Digital Image Steganography based on Discrete Wavelet Transform," International Conference on Computing, Electronics and Electrical, pp. 1096 – 1100, 2012.

[21] Vladimir Banoci, Gabriel Bugar, Duvan Levicky and Zita Klenovicova, "Histogram Secure Steganography System in JPEG File based on Modulus Function," 22nd International Conference Radioelektronika, pp. 1-4, 2012.

[22] Nadeem Akhtar, Ambreen Bano, faraz Islam, "An improved module based substitution steganography method," Fourth International Conference on Communication Systems and Network Technologies (CSNT), pp. 695-699,2014

[23] Nadeem Akhtar, Shahbaaz Khan, Pragati Johri, "An improved inverted LSB image steganography," International Conference on Issues and Challenges in Intelligent Computing Techniques (ICICT), pp. 749 – 755, 2014..

[24] Indradip Banerjee, Souvik Bhattacharyya, Gautam Sanyal,. "Robust image stenography with pixel factor mapping technique." International Conference on Computing for Sustainable Global Development (INDIACom), pp.692 – 698, 2014.

[25] Gabriel Bugár, Vladimir Bánoci, Martin Broda, Dusan Levický, Denis Dupák, "Data hiding the still image based on blind algorithm of steganography," 24th International Conference Radioelektronika (RADIOELEKTRONIKA), pp. 1 – 4, 2014

[26] Bin Li Shanquan Tan, Ming Wang and Jiwu Huang, "Investigation on Cost Assignment in Spatial Image Steganography," IEEE Transactions on Information Forensics and Security, Vol. 9, No. 8, August 2014.

[27] Jan Kodovsky and Jessica Fridrich, "Effect of Image sampling on Steganographic Security," IEEE Transactions on Information Forensics and Security, Vol. 9, No. 5, May 2014.

[28] Kuo – Chen Wu and Chung – Ming WAng, "Steganography using reversible texture Synthesis," IEEE Transactions on Image Processing, Vol. 24, No. 1, January 2015.

[29] W Sweldens, "The Lifting Scheme: A Construction of Second Generation Wavelets," SIAM Journal in Math. Analysis, vol. 29, no. 2, pp.511 – 546, 1998.

[30] Amitav Nag, Siwati Ghosh, Sushanta Biswas, Debasree Sarkar and partha pratim sarkar, "an average steganography technique using X-Box mapping," IEEE - International Conference on advances in Engineering Science and management, pp. 709 – 713, March 2012.

[31] R L Tataru, D Battikh, S Elassad and H Noura, "Enhanced adaptive data hiding in spatial LSB domain by using chaotic sequences," Eighth International Conference on Intelligent Information hiding Multimedia Signal Processing, pp. 85 – 88, 2012.

[32] K B ShivaKumar, K B Raja, Chhotaray R K and Pattnaik S, "Coherent steganography using Segmentation and DCT," IEEE International Conference on Computational Intelligence and Computing Research, pp. 1 – 6, 2010.

[33] V Senthaooran and L Ranathunga, "DCT Coefficient Dependent Quantization Table Modification Steganographic Algorithm," IEEE International conference on Networks and Soft Computing, pp. 432 – 436, 2014

N Sathisha received the BE degree in Electronics and Communication Engineering from Bangalore University and the M. Tech degree in Digital Communication and Networking from Visvesvaraya Technological University Belgaum. He is pursuing Ph.D. in Computer Science and Engineering of Bangalore University under the guidance of Dr. K Suresh Babu, Associate Professor, Department of Electronics and Communication Engineering, University Visvesvaraya College of Engineering. He is currently an Assistant Professor, Dept. of Electronics and Communication Engineering, Govt. SKSJ Technological Institute, Bangalore. He has over 9 research publications in refereed International Journals and Conference Proceedings. His research interests include Computer and information security, computer networks, Image processing and Communication Engineering. He is a life member of Indian Society for Technical Education, New Delhi. He is a life member of Institute of Electronics and Telecommunication Engineers, New Delhi.

K Suresh Babu is an Associate Professor, Dept. of Electronics and Communication Engineering, University Visvesvaraya College of Engineering, Bangalore University, Bangalore. He obtained his BE and ME in Electronics and Communication Engineering from University Visvesvaraya College of Engineering, Bangalore. He was awarded Ph.D. in Computer Science and Engineering from Bangalore University. He has over 20 research publications in refereed International Journals and Conference Proceedings. His research interests include Image Processing, Biometrics, Signal Processing,

K B Raja is an Associate Professor, Dept. of Electronics and Communication Engineering, University Visvesvaraya College of Engineering, Bangalore University, Bangalore. He obtained his BE and ME in Electronics and Communication Engineering from University Visvesvaraya College of Engineering, Bangalore. He was awarded Ph.D. in Computer Science and Engineering from Bangalore University. He has over 126 research publications in refereed International Journals and Conference Proceedings. His research interests include Image Processing, Biometrics, VLSI Signal Processing, computer networks

K R Venugopal is currently the Principal, University Visvesvaraya College of Engineering, Bangalore University, Bangalore. He obtained his Bachelor of Engineering from University Visvesvaraya College of Engineering. He received his Master's degree in Computer Science and Automation from Indian Institute of Science, Bangalore. He was awarded Ph.D. in Economics from Bangalore University and Ph.D. in Computer Science from Indian Institute of Technology, Madras. He has a distinguished academic career and has degrees in Electronics, Economics, Law, Business Finance, Public Relations, Communications, Industrial Relations, Computer Science and Journalism. He has authored 27 books on Computer Science and Economics, which include Petrodollar and the World Economy, C Aptitude, Mastering C, Microprocessor Programming, Mastering C++ etc. He has been serving as the Professor and Chairman, Department of Computer Science and Engineering, University Visvesvaraya College of Engineering, Bangalore University, Bangalore. During his three decades of service at UVCE he has over 275 research papers to his credit. His research interests include computer networks, parallel and distributed systems, digital signal processing and data mining.