ISSN No:-2456-2165

High PSNR based Video Steganography by DWT-BCH Method

Nilam Kumari
Computer science
Rajasthan College of Engineering for Women, Jaipur

Vinod Todwal
Assistant Professor
Rajasthan College of Engineering for Women, Jaipur

Abstract:- Currently, Steganography can be majorly used for the purpose of communicating the data privately. This is the art of hiding all the information in between other carrier like videos, images, graphics and documents for the purpose of getting the stego objects. If we look at the base paper, there are using DWT/IWT technique based Steganography which used for the purpose of communicating the data secretly among receiver and sender. In this research, we are introducing a new methodology in which security of stego-image increase by DWT-BCH technique. As we can see from the results session the value of PSNR is getting increase while the value of MSE is getting decrease.

Keyword: *- Steganography, Fusion Process, BCH, DWT, IWT, Arnold Transform, Color Space.*

I. INTRODUCTION

Recently with the development of Internet and other forms of Technology hacking has become a common process thus requiring people to utilise various techniques to protect their data while passing it through a digital system. One of the most common taking used is steganography which is derived from the Greek word steganos meaning hidden and graphos which means writing. This technique is mainly used to pass the secret data by hiding it within an another image, video, documents or graphics without affecting the originals image to prevent the person from detecting that there is your hidden image available within this data. Only the sender and the receiver will know about the secret data available in the message and no other person would be able to find about it. That's techno graphic technique is of two types namely spatial and frequency[1]. In the first type the hidden data use embedded within the pixels by altering the pixels of the carrier image. In case of frequency domain the original image that is obtained from the spatial domain is transformed into frequency domain by using various methods like domain transformation. Clear the data is initially embedded into the transformed coefficients available in the career image and from the finalized output of stego image[1,2]. This frequency domain is way more better than the other technique with various features like tolerance to external disturbances like cropping, shrinking, manipulation[et cetera 1,2,3]. There are many options available in order to insert the signal within this domain[3]. One of the most common method used is DFT or discrete fourier transform, DCT or discrete cosine transform, DWT or discrete wavelet transform[1,3].

The efficiency of this method can be calculated by using various features like MSE or mean square error, PSNR value and structural similarity index also known as SSIM. The robustness and the capacity of the image along with the safety is also taken into account. Robustness is nothing but the ability of the image to protect itself from the attack of outside forces and security is nothing but the ability of the image to hide the data in such a way that no other person other than the sender and receiver would be able to know about the presence of image in that particular data. At the receiver end by using the technique of steganalysis the secret data can be retrieved successfully. The images are the carriers can be of any kind of file format including a bitmap image or BMP, jPG image and sometimes GIF can also be used to hide the secret data[6]. For our study we have taken bitmap images for sampling. One of the most important. Remember in this method is that the data should be embedded in a place or bit which is of least amount of importance. There are two types of techniques available to insert data. They include and randomly method. In case of a sequential there is a major disadvantage where the presence of an secret data can be easily found by the outsider. In order to improve the quality of image the LSB-DCT threshold is used to hide the data based upon the quality of the threshold[7]. In case of randomly method if the other person finds the particular threshold then the data can be easily extracted. So the chief aim of this paper is to determine a perfect DWT technique that has a higher range of inserting capacity and increase the security with the help of generator called piecewise linear chaotic map(PWLCM)

In order to hide the secret data within an image there are large number of techno graphics methods available, while some of the methods are complex there are some methods which are considerable easy. All of these methods have their own share of pros and cons. Why some methods expect the information to be completely hidden while the other method requires the information to be of Greater size. steganographic technique is mainly based upon the concept of analysing the perceptive qualities of the human and breaking them to understand their psychology and find a method to hide the data in such a way that the human mind would not be able to passive the particular information. This method is called as steganalysis. Steganography hides the data within an another file and the file is encrypted along with the password that would be no only to the receiver who using the password can de-encrypt the message.

ISSN No:-2456-2165

Even though steganography have certain features that are similar to cryptography there is a major difference between the both. In case of cryptography the fact that there is an object being hidden is known to all the people that view the file. But in case of steganography other than the person receiving the file no one else would be able to find out about the fact that there is a hidden message lying within that image. So in case of cryptography anyone can decrypt the message which is not possible in case of steganography where the data is hidden within an image or any other form of data. It is one of the greatest technique available to hide the secret message.

Due to the continuous increase in technology and various techniques for hacking the date of that are being passed through the digital medium or not safer anymore. Show the scientist came up with the idea of embedding the secret data within an another image to pass the information. As a result various technique like cryptography, steganography and coding that being discovered. Among these techniques steganography is one of the most important techniques and the most efficient one.[1] the main aim of steganography is to make the presence of hidden information unknown to all the persons except the receiver. This is one of the major technique in steganography that is not available in any other method. Even the cryptographic method is an efficient one it does not hide the fact of availability of the information. So any person can see the information but they won't be able to encrypt the information until they have the encryption key but with perfect hashing technique they can be easily encrypted. In case of steganography the details that had to be hidden or embedded within an image, video, text messages, music and other forms of sound. Steganography techniques is also used for copywriting to prevent forgery.

The word steganography which is taken from greek word meaning hiding in plain sight. It is the process of hiding a secret information within an another form of data and the main aim of steganography is to prevent others from detecting the availability of a secret data. Even though there are a number of methods to hide data used for several years, the new technique of using digital medium to hide the information and password is highly valuable since there are a lot of information that has been passed through the digital media which are not safe nowadays. They make use of cover images, videos, text, and other forms of audios to hide the information. Initially the data is encrypted and hidden into another file before sending. hence both techniques of steganography and encryption is required to pass the message safely without being identified by other persons. Hence they are way more advantages than the encryption method.

II. DWT-SVD BASED STEGANOGRAPHY

A. DWT Based Steganography

Steganographic method for concealing several pictures within a color picture founded on DWT. The host picture is disintegrated into three different color planes, that is R, G, and B. Separate planes are disintegrated into secondary bands by utilizing DWT. DWT is administered in HH element of every plane. Private information are distributed among the chosen DWT coefficients by utilizing a secret key. Capacity, PSNR, and correlation are principal features in steganography. To be more specific, PSNR is highly needed, though it varies from function to function. PSNR is inversely proportional to capacity, and directly proportional to correlation, and the other way around. During the research, we discovered an issue which is of a correct mixture of PSNR, correlation, and capacity is needed in order for the information to be transmitted via unprotected tunnel without apprehension about third party access. The outcomes in the steganography mostly rely on the private information. The greater value of the private information, the more is the impact on the quality of the stego picture instead of a smaller value of private information.

- *Embedding Process both cover image & secret data by using DWT*

During the suggested insertion procedure, DWT is executed on both the host picture and the private information by utilizing the fusion procedure, we obtain the merged picture. IDWT is administered on the merged picture to obtain a stego picture. 1) Calculation for the suggested insertion procedure:

- Step 1: Interpret the host picture (that is, Video) as C and partition the frame according to the video clip. Transform the host picture's pixel values into a black and white picture as CG.
- Step 2: Administer picture pre-processing and rectification procedure to obtain black and white host picture.
- Step 3: Interpret the private information (that is, Text) as S. Administer picture pre-processing and rectification procedure to obtain a black and white picture as SG.
- Step 4: Administer transform field method into host black and white picture and private black and white picture.
- Step 5: By administering two-dimensional DWT, retrieve the estimation coefficients of matrix LL1 and detail coefficients matrices LH1, HL1, HH1 of stage 1 of the host picture as CG1.
- Step 6: By administering DWT, retrieve the estimation coefficients of matrix LA1 and detail coefficient matrices LH1, HL1, HH1 of stage 1 of the private picture as SG1.
- Step 7: Administer merging operation on a picture CG1 and SG1 and obtain the fused picture. Lastly, execute merged picture with 2-DWT to generate the stego picture as ST.

ISSN No:-2456-2165

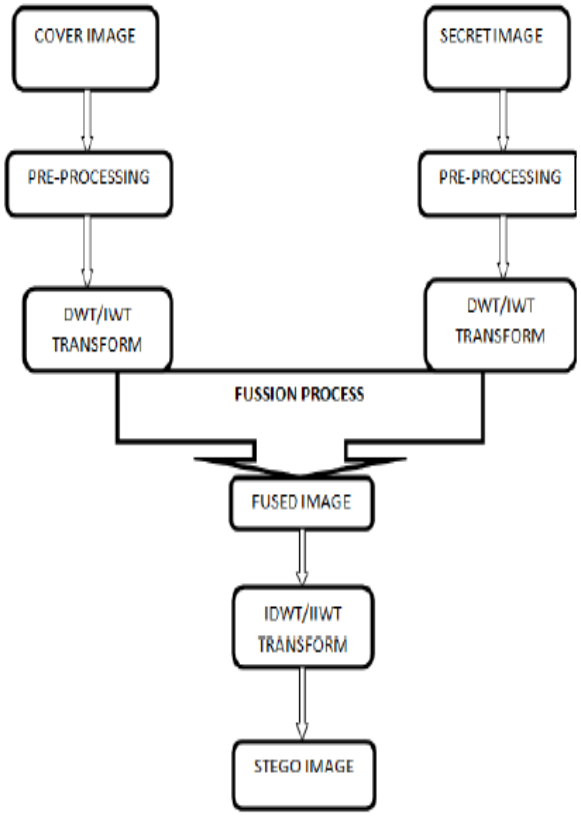

Fig 1:- Block Diagram of Embedding.

➢ *Extraction of Secret Image*

During the suggested retrieval procedure, the extracted stego picture and known host picture were rebuilt with DWT transform field and then the merging procedure. Afterwards, inverse transform IDWT was executed to reconstruct the private information. Lastly, the private information is obtained and it is identical to the initial private picture.

- Step 1: Obtain the stego picture. Execute two-dimensional DWT at the stage of both stego picture and known host picture.
- Step 2: Administer merging procedure on both stego picture and host picture to obtain the merged picture.
- Step 3: Partition the wavelet coefficients and use the inverse IDWT of the merged picture to rebuild the private picture.
- Step 4: Choose the four bit secret key to decode the private data.
- Step 5: Compute the statistical parameters like Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Entropy Average, and Capacity of the stego picture.

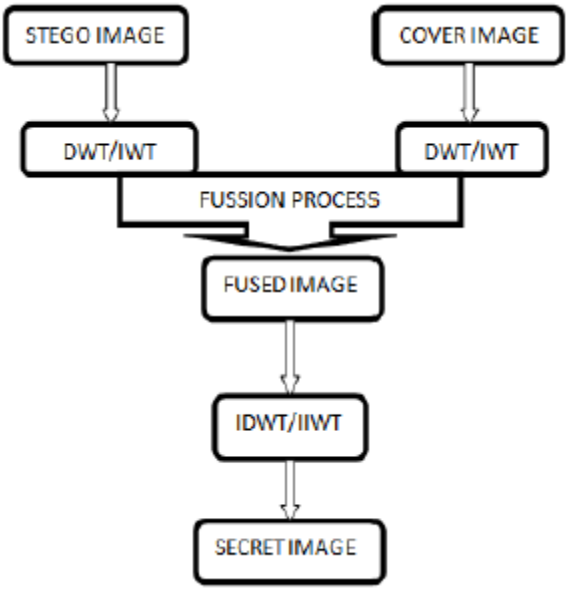

Fig 2:- Block Diagram of Extraction.

B. DWT – SVD based Image Steganography

➢ *Embedding Process*

- Step1- Employ 1-level Haar-DWT to disintegrate the host picture A into four secondary bands (that is, LL, LH, HL, and HH).
- Step 2- Administer SVD to LL secondary bands, that is,
- Step 3- $A = USV^T$
- Step 4- Administer SVD, that is, $S + \alpha W = U_W S_W V_W^T$,
- Where, W is concealed picture and α signifies the scale factor which is utilized to manage the resilience of the concealed picture to be embedded.
- Step 5 – Receive the concealed picture AW by executing the inverse DWT utilizing one group of altered DWT coefficients and three groups of unchanged DWT coefficients.

➢ *Extraction Process*

- Step 1- Utilize 1-level Haar-DWT to disintegrate the concealed (probably contorted) picture A*W into four secondary bands: LL, LH, HL and HH.
- Step 2- Administer SVD to the LL secondary band, that is,
- Step 3- $A_W = US_W V^T$
- Step 4- Calculate $D^* = U_W S^* V^T$,
- Step 5- Recover the concealed picture from LL secondary band.
- Step 6 - $W^* = (D^* – S)/\alpha$.
- Step 7- Finish

III. PROPOSED METHODOLOGY

A basic steganographic technique called video steganography where a specialised algorithm is being used wavelet domain. They depend on KLT tracking technique combined with BCH code (15,11,1). This method of steganography is divided into 4 stages:

A. Secret Message Preprocessing Phase

In our study a text file with a huge amount of data is being used to hide the secret data. The text file is initially processed and then sent into the embedding phase. The various types of characters in the file are changed into ASCII codes to facilitate the generation of binary codes. Later the data is encrypted with a key to increase the security. The key makes the size of the encrypted file similar to the original one. Encryption prevents the data from the hackers.It would be impossible for them to decrypt it. Here the BCH technique is used and as a result the whole data array is split into 11 blocks during encryption and later during encoding they are divided into 15 blocks. Later the size of the secret data is being increased by providing 4 bits to every block. Also with the help of a new key another set of 15 numbers are generated and every number is represented by XORed for each block. Hence Des algorithm uses two major security keys to protect the data and send it in the form of hidden message.

B. Face Detection and Tracking Phase

As per the previous discussion in order to insert the secret data within the facial portion of the video the first step is to separate the facial regions from the video for processing. With the help of the Viola-Jones detector algorithm the first frame is analysed and the face is extracted. Later the KLT tracking algorithm applied for the remaining frames to detect the facial features and extract them.is applied in order to detect the facial region in the first video frame. Then, the KLT tracking algorithm is used throughout the remaining video frames in order to track the facial regions.

C. Data Embedding Phase

In each and every single video frame the facial region is being used as the area for embedding the secret message. They are the cover region and they are removed from each and every single video. In each frame a particular area is chosen and they are processed using the 2D-DWT and they are embedded into the R, G, and B colours of the face creating a variety of sub-bands like LL, L H, HL, and HH. The hidden data is then inserted into the sub bands like LH, HL, and HH available in the face area available in every frame. After this the encryption key and the edges of the box are being embedded in the other areas of the video. The edges are hidden in such a way that they are available in the non facial areas so that it would be difficult for the hackers to find it. Only the sender and the receiver will know the location of the edge box. The face box is nearly 80 bits per frame with both X and Y axis. Also the keys are also hidden within the frame that doesn't involve facial structures. The frames are then reorganised and then sent to the receiver. Through a normal communication channel.

D. Data Extraction Phase

The data is encrypted and then they are embedded in the video especially in the frames containing the facial regions. The keys are hidden in the first frame of the database. The edges are placed in the stego box. After reaching the receiver the keys are removed from the first frame initially. Then using the keys the facial frames in which the data is embedded is extracted and then they are processed with 2D- DWT in all the R, G, and B color components in the box. Then the sub bands where the data is hidden is seperated and the data is extracted from the LL, LH, HL, and HH sub-bands. The data is in the binary form and they divided into 15 block initialy. Each of these block are subjected to XORed and processed through the random numbers using the key. Later they are divided into 11 bit blocks again. The removed data is then processed again using the key and decrypted providing real message in the ASCII format.

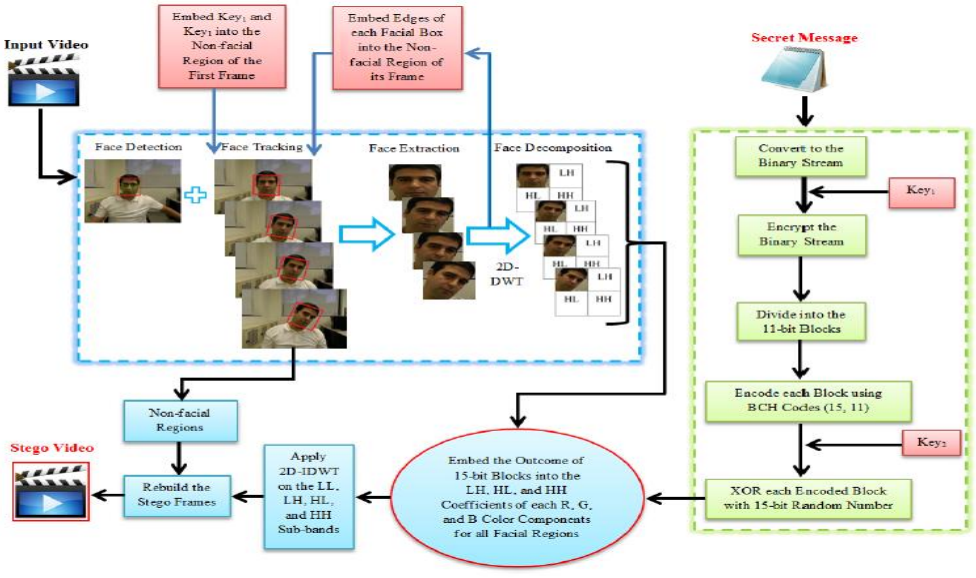

Fig 3:- Block diagram for the data embedding phase.

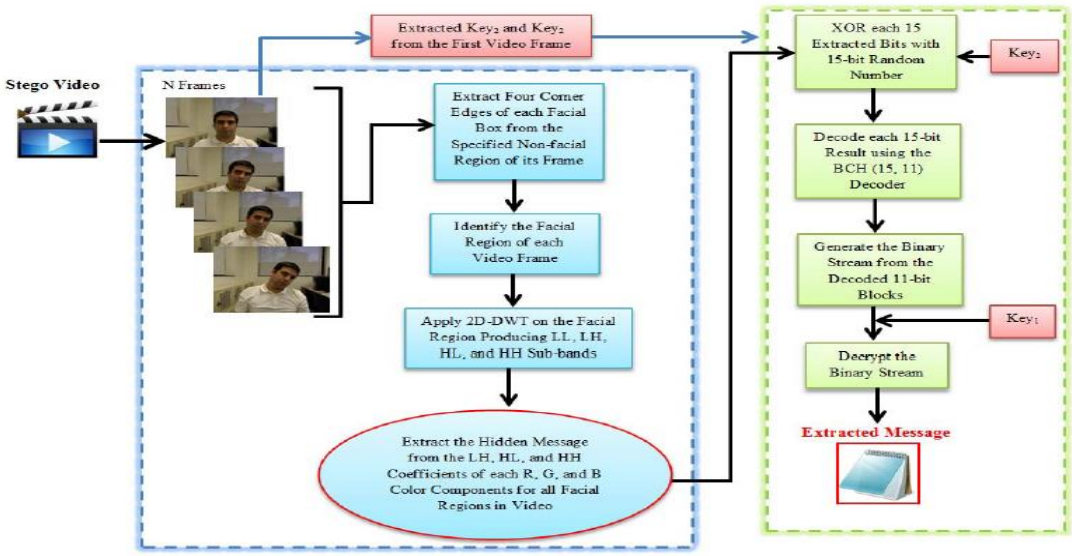

Fig 4:- Block diagram for the data extracting phase.

IV. RESULTS & DISCUSSION

In this chapter, discussing for results of Video Steganography. For perform the operation of Video Steganography, using two methods. These methods are DWT-SVD and DWT-BCH. Proposed Methodology is DWT-BCH method which is using to improve the performance of Video Steganography.

A. Results of DWT-SVD Method

Figure 5 is showing the base image of the steganography process. It is the image in which the stego or hidden image will insert.

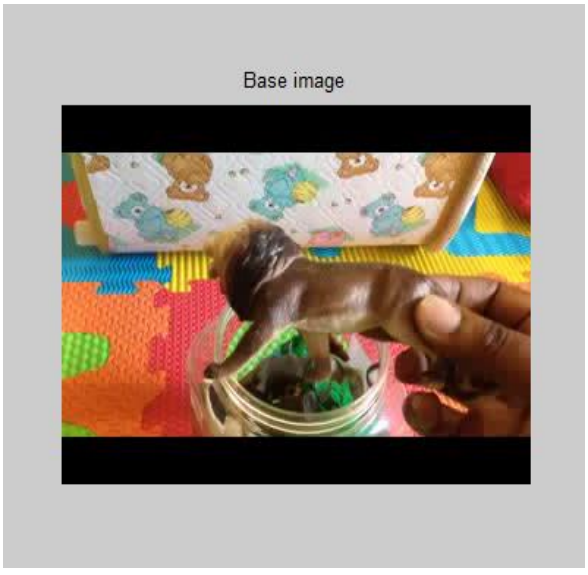

Fig 5:- Base Image

Figure 6 is showing the hidden image. This hidden image will be insert into base image by use DWT-SVD steganography method. We can use any another image also which we want to hide by steganography method.

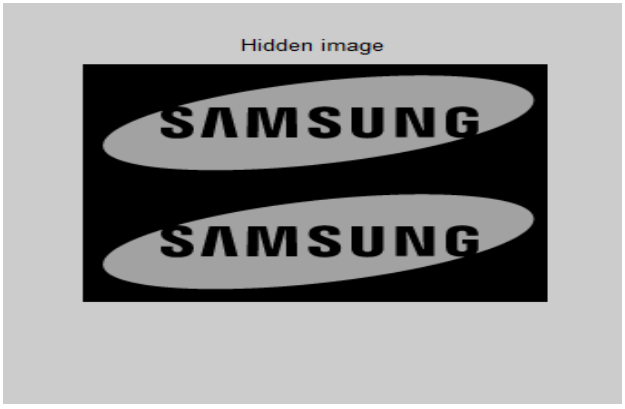

Fig 6:- Hidden Image

Figure 7 is showing the steganography image which comes out after apply steganography method. For perform steganography method, using DWT-SVD method. In the image 5.3, hidden image has been hide and final outcome image is figure 5.3.

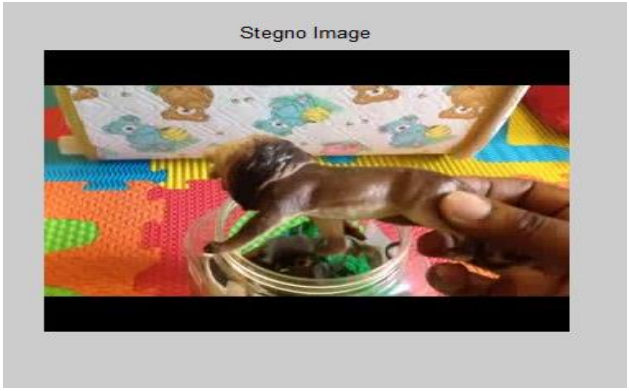

Fig 7:- Steganography Image

Figure 8 is showing the extracted output image which is decode by use DWT-SVD method. In the Steganography process, we need to follow to process, embedding and extraction. Figure 7 is outcome of embedding process while figure 5.4 is outcome of extraction process.

ISSN No:-2456-2165

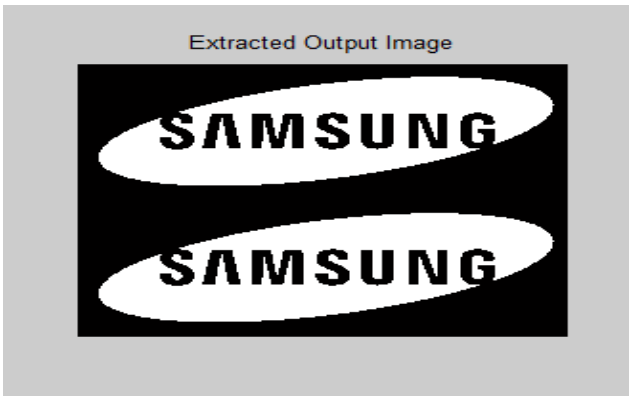

Fig 8:- Extracted Image

Frame Number	MSE	PSNR
1	0.0050	49.46
20	0.0134	45.31
30	0.0092	46.89
40	0.0102	46.47
50	0.0226	43.12

Table 1:- Comparison table for MSE and PSNR

B. Results of DWT-BCH Method

Figure 9 is showing the base image of the steganography process. It is the image in which the stego or hidden image will insert.

Fig 10:- Base Image for DWT-BCH method

Figure 11 is showing the hidden image. This hidden image will be insert into base image by use DWT-BCH steganography method. We can use any another image also which we want to hide by steganography method.

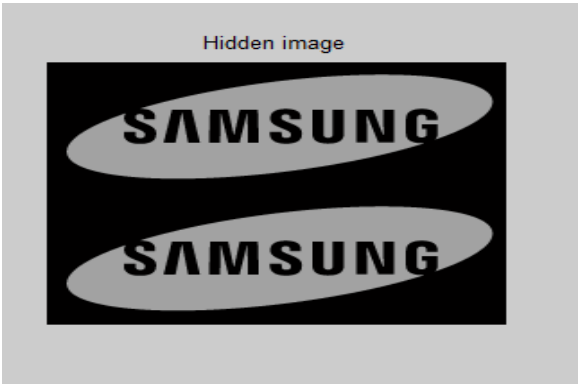

Fig 11:- Hidden Image

Figure 12 is showing the steganography image which comes out after apply steganography method. For perform steganography method, using DWT-BCH method. In the image 11, hidden image has been hide and final outcome image is figure 11.

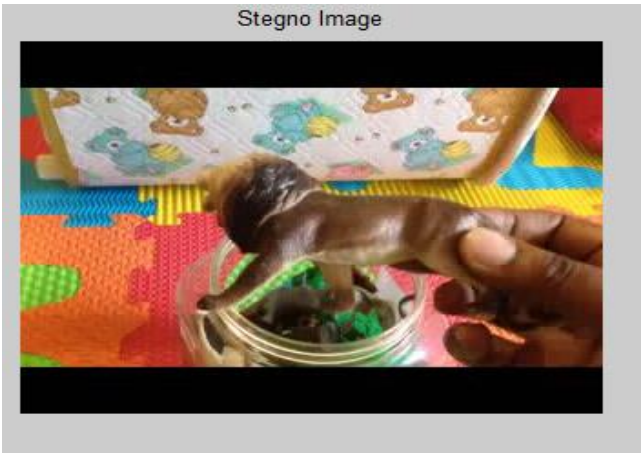

Fig 12:- Base Image for DWT-BCH method

Figure 13 is showing the extracted output image which is decode by use DWT-BCH method. In the Steganography process, we need to follow to process, embedding and extraction. Figure 12 is outcome of embedding process while figure 13 is outcome of extraction process.

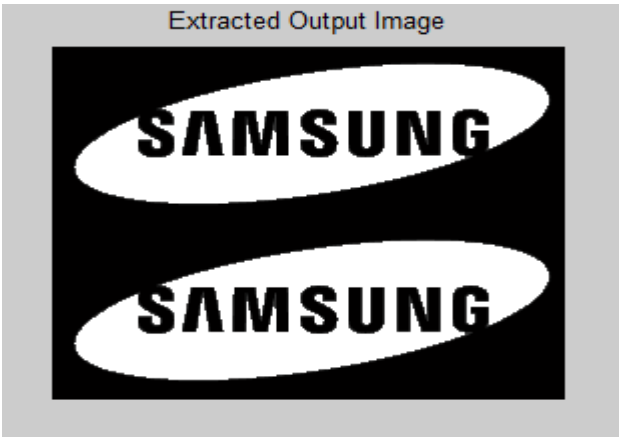

Fig 13:- Extracted Output image for DWT-BCH method

Frame Number	MSE	PSNR
1	0.0027	50.7919
20	0.0026	50.8163
30	0.0026	50.8176
40	0.0026	50.8288
50	0.0026	50.8323

Table 2:- Comparison table for DWT-BCH method with MSE and PSNR comparison

V. CONCLUSION

Image steganography technique is useful for security of confidential data over Internet. In this proposed work a new concept of Steganography has been introduce. Previous method will create difficulty for an unauthorized

person to determine presence of secret massage. Using DWT-DCH method, stego image is generated. For improve the performance, comparing two parameters which are PSNR and MSE. As we can check from results chapter, PSNR is getting increase for DWT-BCH method while MSE is decreasing for DWT-BCH method.

FUTURE WORK

In the future , we can work for the Research Limitation. According to the limitations , we are working only for Image Steganography. In the Future we can work at Audio and Video based Steganography. According to the Second limitation , we are working for PSNR , Correlation and Contrast parameters only . In the future we can work for the MSE parameter also . According to the third limitation , in this Research we are working only at gray Scale image. In the Future , we can work for the Color images also .

REFERENCES

[1]. S. Bhattacharyya,. "A survey of steganography and steganalysis technique in image, text, audio and video as cover carrier." Journal of global research in computer science 2, no. 4 (2011).
[2]. S. Saejung, A. Boondee, J. Preechasuk, and C. Chantrapornchai, "On the comparison of digital image steganography algorithm based on DCT and wavelet," in Computer Science and Engineering Conference (ICSEC), 2013 International, 2013, pp. 328–333.
[3]. M. Tayel, H. Shawky and A. E. S. Hafez, "A New Chaos Steganography Algorithm for Hiding Multimedia Data," 14th International Conference on Advanced Communication Technology, pp. 208 – 212, 2012.
[4]. N. Sathisha, G. N. Madhusudan, S. Bharathesh, K. B. Suresh, K. B. Raja and K. R. Venugopal, "Chaos based Spatial Domain Steganography using MSB", International Conference on Industrial and Information Systems(ICIIS), pp. 177-182, 2010.
[5]. N. Raftari and A.-M. E. Moghadam, "Digital Image Steganography Based on Assignment Algorithm and Combination of DCT-IWT," in 2012 Fourth International Conference on Computational Intelligence, Communication Systems and Networks (CICSyN), 2012, pp. 295–300.
[6]. N. Sathisha, K. Suresh Babu, K. B. Raja, K. R. Venugopal and L. Patnaik, "Embedding Information In DCT Coefficients Based On Average Covariance" International Journal of Engineering Science and Technology (IJEST), 3 (4), 3184-3194. 2011.
[7]. A. Danti, and P. Acharya. "Randomized embedding scheme based on DCT coefficients for image steganography." IJCA Special Issue on Recent Trends in Image Processing and Pattern Recognition (2010).
[8]. D. Neeta, S. Kamalapur and D. Jacobs, "Implementation of LSB Steganography and Its Evaluation for various Bits" in Digital Information Management, 2006 1st International Conference on. 06/01/2007; DOI: 10.1109/ICDIM.2007.369349
[9]. N. Kafri and H. Y. Suleiman, "Bit-4 of frequency domain-DCT steganography technique," in First International Conference on Networked Digital Technologies, 2009. NDT ,09, 2009, pp. 286–291.
[10]. J. M. Rodrigues, J. R. Rios, and W. Puech. "SSB-4 System of Steganography using bit 4." In 5th International Workshop on Image Analysis for Multimedia Interactive Services. 2004.
[11]. B. Bakhache, J. M. Ghazal, and S. E. Assad, "Improvement of the Security of ZigBee by a New Chaotic Algorithm," IEEE Syst. J., vol. Early Access Online, 2013.
[12]. S. Li, X. Mou, Y. Cai, Z. Ji, and J. Zhang, "On the security of a chaotic encryption scheme: problems with computerized chaos in finite computing precision," Comput. Phys. Commun., vol. 153, no. 1, pp. 52– 58, Jun. 2003.
[13]. S. Tao, W. Ruli, and Y. Yixun, "Perturbance based algorithm to expand cycle length of chaotic key stream," IEEE Electron. Lett., vol. 34, no.9, pp. 873–874, Apr. 1998.
[14]. E. Walia, P. Jain, Navdeep, "An Analysis of LSB & DCT based Steganography", Global Journal of Computer Science and Technology, April, 2010, Vol. 10, pp. 4-8.
[15]. S. K. Mutt and S. Kumar, "Secure image steganography based on Slantlet transform," in Proceeding of International Conference on Methods and Models in Computer Science, 2009. ICM2CS 2009, 2009, pp. 1–7.
[16]. Y. Wang and P. Moulin, "Optimized Feature Extraction for Learning- Based Image Steganalysis, "IEEE Trans. Inf. Forensics Secur., vol. 2, no. 1, pp. 31–45, Mar. 2007.
[17]. D. Caragata, S. El Assad, B. Bakhache, and I. Tutanescu, “Secure IP over Satellite DVB Using Chaotic Sequences”. Engineering Letters journal. Volume 18, number 2, 2010, pp. 135-146.
[18]. Nitin Jain, Sachin Meshram, Shikha Dubey ," Image Steganography Using LSB and Edge – Detection Technique ", International Journal of Soft Computing and Engineering (IJSCE) , Volume-2, Issue-3, July 2012.
[19]. Kazi Azizuddin Rafiuddin1, Chetan Kumar," Improvement in LSB Image Steganography using Message Partitioning ", International Journal of Recent Research and Review, Vol. VI, Issue 3, December 2013.
[20]. Amanpreet Kaur, Sumeet Kaur," Image Steganography Based on Hybrid Edge Detection and 2k Correction Method ", International Journal of Engineering and Innovative Technology (IJEIT) Volume 1, Issue 2, February 2012.
[21]. Sarabjeet Kaur and Sonika Jindal ," Image Steganography using Hybrid Edge Detection and First Component Alteration Technique ", International Journal of Hybrid Information Technology Vol.6, No.5 (2013).

[22]. S. N. Rekha1, Y. Manjula2, M.Z. Kurian ," A Secured Lsb Image Steganography System Using Edge Detection, Low Compression And Hybrid Encryption Methods ",International Journal Of Advanced Technology In Engineering And Science.
[23]. Vijaypal Dhaka , Ramesh C. Poonia, Yash Veer Singh ," A Novel Algorithm for Image Steganography Based on Effective Channel Selection Technique ", International Journal of Advanced Research in Computer Science and Software Engineering , Volume 3, Issue 8, August 2013.
[24]. Aishwary Kulshreshta , Ankur Goyal," Image Steganography Using Dynamic LSB with Blowfish Algorithm ", International Journal of Computer & Organization Trends –Volume 3 Issue 7 – August 2013.
[25]. Keerthi K M ," A Novel Steganographic Method based on Edge Detection and Adaptive Multiple Bits Substitution ", International Journal of Computer Applications (0975 – 8887) Advanced Computing and Communication Techniques for High Performance Applications (ICACCTHPA-2014).
[26]. Navneet Kaur1 and Sunny Behal ," Audio Steganography Using LSB Edge Detection Algorithm ", International Conference on Communication, Computing & Systems (ICCCS) 2014.
[27]. Tamanna , Ashwani Sethi," Steganography: A Juxtaposition between LSB DCT, DWT ", International Journal of Computer Applications (0975 – 8887) Volume 126 – No.11, September 2015 .
[28]. Anuradha Goswami1, Sarika Khandelwal," Hybrid DCT-DWT Digital Image Steganography ", International Journal of Advanced Research in Computer and Communication Engineering Vol. 5, Issue 6, June 2016.
[29]. Blossom Kaur1, Amandeep Kaur2, Jasdeep Singh ," Steganographic Approach For Hiding Image In DCT Domain ", International Journal Of Advances In Engineering & Technology, July 2011.
[30]. Sumeet Gupta1, Dr. Namrata Dhanda," Audio Steganography Using Discrete Wavelet Transformation (DWT) & Discrete Cosine Transformation (DCT) ", IOSR Journal of Computer Engineering (IOSR-JCE), Volume 17, Issue 2, Mar – Apr. 2015.
[31]. Gurmeet Kaur* and Aarti Kochhar ," Transform Domain Analysis of Image Steganography ", International Journal for Science and Emerging Technologies with Latest Trends" 2013.
[32]. Stuti Goel, Arun Rana,Manpreet Kaur ,"ADCT-based Robust Methodology for Image Steganography ", Image, Graphics and Signal Processing, 2013.
[33]. Mamata J, Poornima G," Comparative Analysis of Embedding Data in Image using DCT and DWT Techniques ", International Journal of Science and Research (IJSR),2012.
[34]. Prabakaran G, Dr. Bhavani R, Sankaran S, "Dual Wavelet Transform in Color Image Steganography Method", IEEE International Conference on Electronics and Communication System (ICECS - 2014), pp. 193-197, 6-7 March 2014.
[35]. Praneeta Dehare, Padma Bonde, "Implementation of Image Steganography in Image by using FMM nested with LSB Substitution", International Journal on Recent and Innovation Trends in Computing and Communication, Vol. 2, No. 11, pp. 3663 – 3667, November 2014.
[36]. Della Baby, Jitha Thomas, Gisny Augustine, Elsa George and Neenu Rosia Michael, "A Novel DWT based Image Securing Method using Steganography" Proceeding of International Conference on Information and Communication Technologies (ICICT 2014), Vol. 46, pp. 612-618, 3-5 December 2014.
[37]. Vijay Kumar Sharma and Vishal Shrivastava, "A Steganography Algorithm for Data Hiding in Image in Image in Image by Improved LSB substitution by Minimize Detection" , Journal of Theoretical and Applied Information Technology, Vol. 36, No. 1, pp. 1-8, 15 February 2012.
[38]. Saeed Sarreshtedari and Shahrokh Ghaemmaghami, "High Capacity Image Steganography in Wavelet Domain", IEEE 7th Consumer Communications and Networking Conference (CCNC), pp. 1-5, 9-12 January 2010.
[39]. S. M. Masud Karim, Md. Saifur Rahman and Md. Ismail Hossain, "A New Approach for LSB Based Image Steganography using Secret Key", IEEE 14th International Conference on Computer and Information Technology (ICCIT), pp. 286-291 , 22-24 December 2011.
[40]. Nadeem Aktar, Shahbaaz Khan and Pragati Johri, "An Improved Inverted LSB Image Steganography", IEEE International Conference on Issues and Challenges in Intelligent Computing Techniques (ICICT), pp. 749-755, 7-8 February 2014.
[41]. Shabir A. Parah, Javaid A. Sheikh and G.M. Bhat, "High Capacity Data Embedding using joint Intermediate Significant Bit (ISB) and Least Significant Bit (LSB) Technique" , Journal of Information Engineering and Applications, Vol. 2, No.11, pp. 1-11, 2012.
[42]. Nilanjan Dey, Anamitra Bardhan Roy and Sayantan Dey , "A Novel Approach of Color Image Hiding using RGB Color planes and DWT", International Journal of Computer Applications, Vol. 36, No. 5, pp. 19-24, December 2011.
[43]. Zhenjun Tang and Xianquan Zhang, "Secure Image Encryption without Size Limitation Using Arnold Transform and Random Strategies", Journal of Multimedia, Vol. 6, No. 2, pp. 202-206, Apr 2011.
[44]. Tushina Bedwal and Mukesh Kumar, "An Enhanced and Secure Image Steganographic Technique Using RGB-Box Mapping" IET Confluence 2013: The Next Generation Information Technology Summit (4th International Conference), pp. 385-393, 26-27, September 2013.