

Comparative Analysis of Image Stenography Techniques for Image Quality & Security

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Abstract— In this paper, discuss about the data hiding using the wavelet approach is better technique in steganography techniques. optimization techniques are better results provides for the data hiding in stenography. In Discrete Wavelet Transform, HAAR Wavelet gives the excellent peak signal to noise ratio (PSNR) and less computation time. In optimization, particle swarm optimization technique is gives excellent better result in case of PSNR ratio. In spatial domain, common useful technique is least significant bit(LSB) gives better result in case of data payload capacity and less computation time. In paper mentioned, all above techniques with compare to other related techniques useful in steganography.

Keywords- Image, Secret information, Discrete wavelet transform(DWT), Particle swarm optimisation(PSO), Least significant bit(LSB), PSNR, MSE

I. INTRODUCTION

Steganography technique is a good technique to keep secure information same as Cryptography. In steganography, all about to information hide/embed in specific objects like, text, image, audio, video, etc. In cryptography, it is about to encrypt secret information[2]. In some application, steganography is seems to be a best idea than cryptography.

The steganography has the advantage that the secret data that is the observer doesn't know the existence of data because of. Whereas in cryptography we feel the existence of data because human visual system can see even encrypted information publicly if it is detected. Steganography useful in many fields, forensics details to transfer, military important information transfer with security, government information to keep secure, etc. Using of stenography has some benefits,

1. In some case, it does not need any key to access secret information.
2. It seems to be a simple transfer sender to receiver.
3. Detector can not observe something is hidden in cover objects. If detector can assume some information is hidden in cover object than also can not find out which methods are applied.

In steganography, information can hide/embed in text, image, audio, video as a cover object. Steganography technique is works on spatial domain in which common method is LSB as least significant bit[2][15]. Other useful technique is in also fourier transform domain technique[15]. LSB is simplest and easy to implemented technique in all methods. For Image cover object, LSB works on pixels to hide/embed information. In LSB technique, Pixel's bits of cover image is replace with secret information pixel's bits[2].

LSB is applied to whole pixel of image to hide data according to secret information size. LSB is data lossless method and data is embed in image with less computation time[17]. In disadvantages of LSB, it is easily prone to attack[6]. If secret

data easily can detect than no meaning of stenography to use for security propose. so, we need to find out other better with LSB techniques which are provides more security.

For example, 24 bits of cover image and 9 bits of secret message[3], After converts in RGB pixels in bits,

Pixel 1: 10010101 00001101 11001001
Pixel 2: 10010110 00001111 11001010
Pixel 3: 10011111 00010000 11001011

Message is 9 bits is, 101101101

LSB work as replace RGB image Upper(last) nibble bits with message bits.

After embedded message bits in cover image bits gets,

Pixel 1: 10010101 00001100 11001001
Pixel 2: 10010111 00001110 11001011
Pixel 3: 10011111 00010000 11001011

After information embedded in image cover object, In 24 bits of RGB pixels each 8 bits Pixel's last bits are replaced with message bits. Image is affected some noise and error. To measure quality of embedded image, peak-signal-to-noise-ratio(PSNR) as parameter present.

1. Peak-Signal –to-Noise-Ratio(PSNR):

$$PSNR=10\log_{10}(\max^2/MSE) \quad \dots(1)$$

Mean square error is a measures average error for cover image. Before apply steganography technique and after applied what is the error between input and output/stego image.

2. Mean Square Error(MSE):

$$MSE=\frac{\sum(\sum((InputImage-ReconstructedImage)^2))}{(M*N)} \quad \dots(2)$$

M is the size of the image N is the size of the reference.

Other many techniques for image steganography is referred as in frequency domain also,

A. Discrete Wavelet Transform

Discrete wavelet transform domain perform on image for spatial domain to convert in Frequency domain in form of low and high frequency sub-bands. Apply one level wavelet transform on image decomposes the cover image into four sub-bands. In, respectively horizontal, vertical and diagonal[1].

Discrete wavelet transformed low frequency range pixels are stored in LL sub-band. Some low and high frequency based pixels separate in LH band respectively horizontal dimension. Other pixels in HL and HH sub-bands respectively vertical and diagonal dimensions[1]. All sub-bands are separates in equal image size. For simple DWT perform on image it represent by flow diagram,

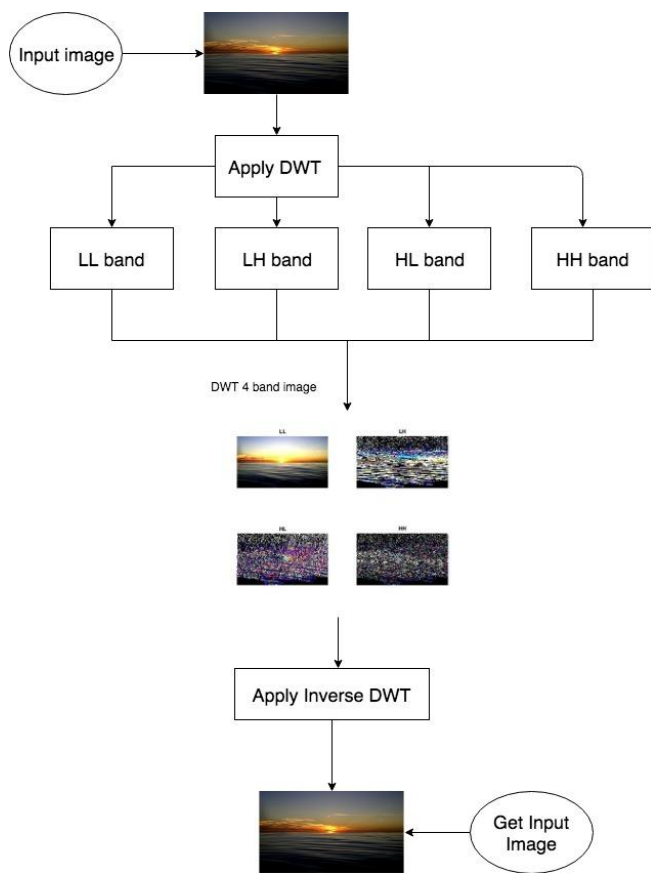


Fig.1 DWT image flow diagram

In frequency domain, applied DWT 2D level on image. To get original image using an inverse wavelet transform. When DWT apply, resultant transformed image is sometimes affected some noise from original image. It is important to quantify signal-noise-to-ratio. Signal-noise-to-ratio (PSNR) measures quality of image[20]. In DWT domain quality of image ratio is increase because of after separated pixels in frequency unnecessary noise is removed from image. DWT is provides good quality of image and improve security for steganography because of frequency based image can not easy to detect compare than spatial domain for steganography[20].

In case of security, wavelet domain is less prone to attack than spatial domain[17]. In comparison survey DWT is good technique with other techniques and provides a multi layer security with good quality of image with more computation time. DWT is trending technique for steganography as a security purpose it is very useful.

B. Discrete Cosine Transform

Discrete cosine transforms(DCT) express a function or a signal with different frequencies. DCT is that the former uses only for cosine functions. DCT is perform in low, high, medium frequency. DCT is similar technique as DWT. It is also perform in 1D and 2D or more levels for compress to image in equal size sub-blocks. Discrete cosine transform provides good security for steganography but less payload capacity than LSB[6]. DCT is a useful in case of security but for limited data information. Feno Heriniaina Rabevohitra and Jun Sang[17] used the PSO and simple LSB substitution based in DCT domain. DCT domain works on image to lossy compression of image[20].

C. Optimisation Techniques:

In optimisation techniques, it is useful to find optimum solution to problems. Generally it uses for the neural network and computer as well as for biological solutions. In optimization techniques like genetic algorithm, particle swarm optimization are provides better solution according to there problems. PSO is particle optimization techniques are newly and trending methods to apply on image steganography to find best position in image for embed data[5]. The cost function is p evaluate the fitness of pixel position. Cost function factors such as entropy, edge, and individual point edge.

PSO is swarm population based algorithm. PSO is perform on particles which are moves to find best position in image for hide information[17]. Particle is a initialise according to there population and moves on one to other places in image by one-by-one generations/iterations and finds best position by pbest and gbest position[17]. Personal best and global best positions of particle's in form of x & y co-ordinates position for embed data in image are updates for each and every iterations. Particles are updates velocity and fitness function value according to their movement for each iterations. PSO is about to search best position by optimizing pixels position. In image which Pixels are best or fit for embed information. PSO algorithm gives final results as optimized image. Optimized pixels values are more nearly with original pixels values and that is provides minimum difference between original image and optimized image. So, it is benefits of PSO, after optimization quality of image is improved.

In optimization, Kennedy and Eberhart[17], proposed the particle swarm optimisation which is similar to the genetic algorithm. Genetic algorithm has more computation parameters sources as cross over and mutation. It takes more generations than PSO. Genetic algorithm is more complex for steganography compare than PSO[4]. In fig.2 perform PSO algorithm by flow diagram. In PSO, fitness function, velocity, best values are updates till the all iterations perform.

Fitness function is a define how fit image for embed data after optimization.It is difference between original image and optimized image[3],

$$\text{Fitness function} = (\text{original pixel} - \text{optimised pixel})^2 \dots(3)$$

Velocity: velocity is find distance from each particle's current position $X_i(t)$ to updated position $X_i'(t)$.Where t defines time for each iterations[3].

equation is,

$$V_i(t) = X_i'(t) - X_i(t) \dots(4)$$

after each iteration get ,

$$V_i(t+1) = wV_i(t) + X_i'(t) - X_i(t) \dots(5)$$

pBest(personal best): $P_i(t)$ is update as each particle's movements from current position to $4*4$ & $8*8$ neighbourhood directions.which value is best select as $P_i(t)$.

$$\text{For initial, } P_i(t) = X_i(t) \dots(6)$$

after each iteration get ,

$$P_i(t+1) = P_i(t) , \text{ if (Fitness value} < P_i(t)) \dots(7)$$

$$P_i(t+1) = \text{Fitness value} , \text{ if (Fitness value} > P_i(t)) \dots(8)$$

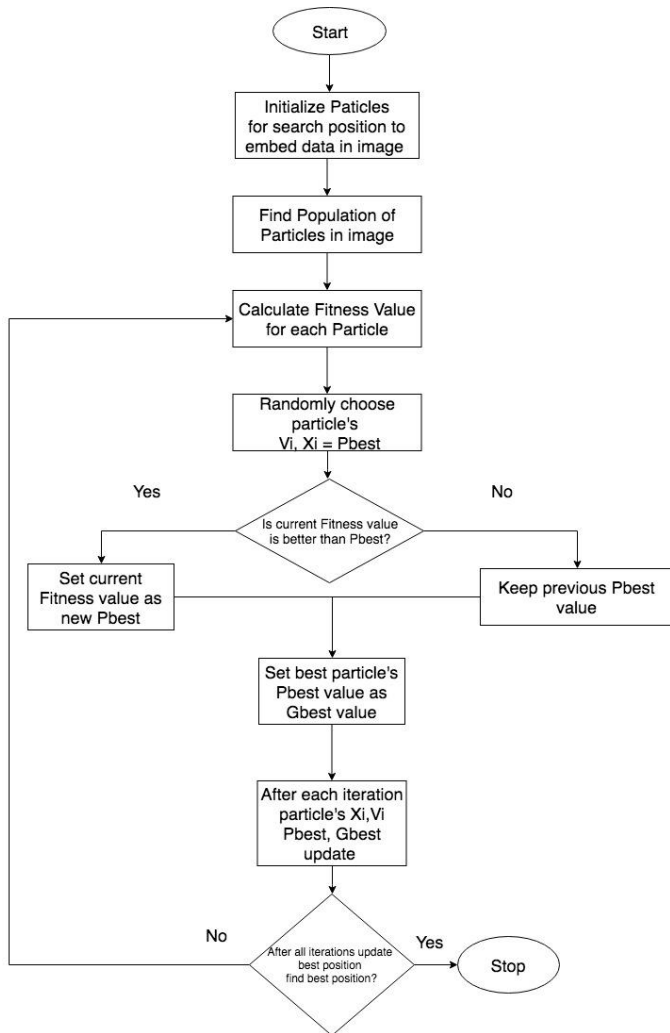


Fig.2 PSO algorithm flow diagram

II. RELATED WORK

Youssef Taouil, EI Bachir Ameer & Moulay Taib Beighiti.[1] is applied method of DWT with LSB for to embed data in wavelet sub-bands using random key.random key is for the find location in image pixels to embed data.where here HL,LH,HH sub-bands.After DWT sub-bands by LSB technique data is embedded in HL,LH,HH sub-bands.DWT with LSB techniques are provides multilayer security for data and PSNR and MSE gives good results using DWT and capacity of information embed is more using LSB.

Aman Arora, Prateek Thakral.[2] is used LSB technique to hide information with encryption algorithm like AES.Data is encrypted by AES, plain text converts into cipher text.Cipher text data is embedded in image by LSB.Data is replaced with RGB model pixels as red, green and blue pixels bits.Secret Data using this methods can embed maximum size.In grey scale and colour image are used but colour image gives good average PSNR than grey scale image.

S.M.Masud Karim, Md. Saifur Rahman, Md. Ismail Hossain.[3] is a proposed method using LSB with any secret key to embed data in image. In paper, randomly "sohel" selected as a secret key to convert in binary image to 1D array with XOR to embed data in RGB model of cover image.In extraction phase of data, using secret key is need to know for get secret data.If secret key is loss or detector know key then data can easily detect. In result, LSB technique gives good results in PSNR with 53 db or can be improve.

Rafael Lima de Carvalho, Warley gramacho da silva.[4] is a proposed work on PSO optimization techniques applied to hide data in cover image. After optimization of image data is embed in optimized pixels. Optimized pixels are nearest with original image pixels and quality of image is improved. PSO with genetic algorithm also compared. Optimization is good option now and trending method for steganography.

Dr.P.Rajeswari, Ms.P.Shwetha, Dr.S.Purushothaman.[5] is a combine methods like DWT, PSO and LSB.DWT is applied on secret information as a image perform 5 levels of sub bands and resultant output get with $8*8$ matrix image. On $8*8$ image applied PSO method to find best location with 100 iterations. Maximum iterations get good quality of image. Best location in image of coefficients are select to embed secret data using LSB technique.Using three methods are provides more security and increase quality of image .In future to calculate PSNR and MSE for this methods. In future it can possible to measures text based secret information embed using methods.

Ms Rashmi N, Dr Jyothi K.[19] is a proposed method, encryption and reversible data hiding(RDH) techniques applied with LSB method to compare there PSNR ratio and MSE.For encryption, AES algorithm used.Encrypted data using RDH method and LSB technique embedded in image.Perform good for only grey scale image not for colour image.

TABLE I. COMPARISON ANALYSIS

Techniques	Advantage	Disadvantage	Comparison	Outcomes
LSB	Simple, robust, lossless	Easy to detect ,prone to attack	Good image quality, capacity, less computation time	PSNR=30 to 50 db MSE=0.0021 to more
DWT	High security, robust	More computation time	Good image quality, more computation time take than LSB,better than DCT	Increase security , PSNR=50 db or more
DCT	Less prone to attack	Less payload capacity	Less prone to attack than LSB, Less payload capacity than DWT	Increase security , PSNR 35 db or more
PSO	Simple, fast, easy	Sometimes not find exactly solution for all problems	Highly increase quality, decrease error for image	PSNR= avg. 50 to 70 db MSE = 0.0001
Genetic algorithm	Simple, fast	More computation parameters	GA has more parameters & generations than PSO	PSNR = avg. 40 to 60 db MSE = 0.0012 34

TABLE II. COMPARISON ANALYSIS

Techniques	Advantage	Disadvantages	Comparison	Outcomes
LSB with PSO	Improve quality of image, security	Sometimes easy to detect depend on image	Increase quality and Capacity	PSNR=60db to mor MSE= 0.0021 to more
LSB with DCT	Increase security	More computation time for cosine function	Increase quality	PSNR=30 db or more
DCT with PSO	Less prone to attack, improve highest quality	Less payload capacity	Less prone to attack with DCT, increase quality image with PSO	PSNR= 60db to more
DWT with PSO	Simple, fast, easy	DWT takes more computation time	Highly increase quality, decrease error for image	PSNR=70db to more MSE = 0.0001
Cryptography with steganography	Multilayer security	Not sufficient for all image cryptography for increase quality	Good with steganography techniques but not in all case	PSNR =30 to 40db, MSE = 0.0012

CONCLUSION

In Image steganography, many techniques are presents according to survey but some few techniques are in trending to improve results for quality of image and security purpose ,like DWT,PSO and LSB or more.In spatial and frequency domain uses to improve security for less detection. Which are gives good performance.LSB in spatial domain and DWT or DCT in frequency domain can improve results. PSO is optimization method perform with good quality results with DWT and LSB.In final outcomes, LSB is useful for more capacity, less computation time and DWT method for less detection, PSO useful for increase quality of image.In future, try to implement of three methods DWT,LSB and PSO combine for steganography. According to methods what will get outcomes for that happy to publish it through our next paper.

REFERENCES

- [1] Aman arora,prateek thakral,“Image stengography using enhanced LSB technique.” 2016 fourth international conference on parallel,Dstributed and Grid computing,"978-1-5090-3669-1/16/\$31.00 2016 IEEE.
- [2] S.M.Masud karim,Md.Saifur Rahman,Md. Ismail Hossain, new approach for LSB based image stegnography using secret key",987-1-161284-908-9/11/\$26.00 @2011 IEEE.
- [3] Rafael Lima deCarvalho, Warley gramacho da silva,“Optimizing Image Steganography using Particle Swarm Optimization Algorithm”International Journal of Computer Applications (0975 - 8887) Volume 164 - No.7, April 2017.
- [4] Dr.P.Rajeswari,Ms.P.Shwetha,“Application of Wavelet an Particle Swarm Optimization in Steganography”,978-1-5090-5814-3/17/\$31.00 ©2017 IEEE
- [5] http://www.uobabylon.edu.iq/eprints/paper_1_2264_649.pdf
- [6] Alaa A. Jabbar Altaay,Shahrin bin Sahib,Mazdak Zamani,2012 international conference on advanced computer science application and technologies"An introduction to Image stegnography techniques".978-0-7695-4959-0/13 \$25.00 © 2013 IEEE .
- [7] "New image stegnography method used on haar dicrete wavelet transform",@Springer international publishing AG 2017,in information and communication technologies ,advances in intennigent system520,DOI 10.1007/978-3-319-46568-5_30.
- [8] Harpreet kaur,“Comparision of different image using LSB image stengography",978-1-5090-5838-9/17\$31.00@2017 IEEE.
- [9] Jigar Makwana, S.G Chudasama,“Dual image based LSB stegnography”.987-386-2976-5/18/\$31.00@2018 IEEE.
- [10] International journal of scientific research in computer science,engineering & information technology,@2018 IJSRCSEIT|volume 3 |ISSN : 2456-3307"An approach to hide information using wavelet based method".

- [12] Tanusree Podder, Purbani Kar, Lalita Kumari, "An Approach to Hide Information Using Wavelet Based Method", International Journal of Scientific Research in Computer Science, Engineering and Information Technology © 2018 IJSRCSEIT | Volume 3 | Issue 1 | ISSN : 2456-3307
- [13] J. K. Mandal, A. Khamrui, "A Data Embedding Technique for Gray scale Image Using Genetic Algorithm (DEGGA)".
- [14] Suchitra. B, Priya. M, Raju. J, "Image Steganography Based On DCT Algorithm for Data Hiding". International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 2, Issue 11, November 2013. ISSN: 2278 – 1323.
- [15] C.P. Sumathi, T. Santanam and G. Umamaheswari, "A Study of Various Steganographic Techniques Used for Information Hiding". DOI : 10.5121/ijcses.2013.4602
- [16] Ratnakirti Roy, Suvamoy Changder, Anirban Sarkar, Narayan C Debnath, Evaluating Image Steganography Techniques: Future Research Challenges. 978-1-4673-2088-7/13/\$31.00 ©2013 IEEE
- [17] E Divya, P. Rajkumar, "Steganographic Data Hiding using DWT and Particle Swarm Optimization". International Journal of Computer Applications (0975 – 8887) Volume 117 – No.14, May
- [18] 2015. P.M. Siva Raja and E. Baburaj, "An Efficient Data Embedding Scheme for Digital Images Based On Particle Swarm Optimization with LSBMR"
- [19] Ms Rashmi N, Dr Jyothi K, "An Improved Method for Reversible Data Hiding Steganography Combined with Cryptography". 978-1-5386-0807-4/18/\$31.00 ©2018 IEEE.
- [20] https://en.wikipedia.org/wiki/Discrete_cosine_transform.
- [21] https://en.wikipedia.org/wiki/Discrete_wavelet_transform