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RESEARCH ARTICLE

PSNR COMPARISON FOR LSB STEGANOGRAPHY USING GENETIC ALGORITHM OR IMAGE RESTORATION

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ABSTRACT

Steganography science became a challenging developing field used for secure transmission of data and its importance increases as a result of the increasing need to transfer large amounts of various types of data in a secure way, steganography capable to transfers secure data in a carrier medium like image Without draw attention to the presence of confidential information (secret message) are embedding inside the least significant bits of the carrier image As when using LSB Steganography method. This research paper is studied reduction of the noise resulting from embedding secret message in the least significant bits of the cover image in two methods. The first method is to use a genetic algorithm with LSB Steganography method to search for the best sites to hide the secret message data in least significant bits of cover image and thus raise PSNR value of the resulting stego image to get better visual quality. The second method is to use the image restoration to restore the original image quality to the degraded stego image resulting from the use of LSB Steganography, by estimating noise type in the stego image and then select the appropriate filter like adapmedian spatial filter. The PSNR has been used as a standard to measure image quality. Three test images used in this study, Lena .gif, Cameraman.bmp, Pillar. png, the results of both methods were compared and it showed the superiority of using genetic algorithm with LSB Steganography on the use adapmedian filter in image restoration method. The goal of this study is to reduce the noise to improve the visual stego image quality and thus reduces the likelihood of the doubt the stego image.

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INTRODUCTION

Steganography "is the art and science of hiding information by embedding message within other, seemingly harmless messages" [1], its fall under information hiding science. The steganography researchers can do there research in spatial domain or frequency domain, and there are several types of the cover media which include text, audio, image, video. The original information need to be hiding is called the message and it may be text or image. The stegoimage term called to the image after embedding message into the cover image [2]. the idea behind using image to carry hidden messages is to take advantage of the shortcomings of human eye looking at the stegoimage, and therefore steganography can be considered a secure communication to send secret message and difficulty observed. LSB (Least Significant Bit) substitution is one of the spatial domain stenographic techniques, which insert secret message into the cover image, it is a common simplest approach of image steganography and it will modify cover image bit. What happen " in LSB Steganography: first, the cover image is decomposed into bit planes then LSB of bit planes replaced with secret datafit" [3]. In LSB Steganography the substation of secret message in the LSB of cover image bits

will not effect on the appearance of cover image, and stego images have less distortion, in other word less noise image, the hidden secret message will be unnoticed, and the presence of hidden information will be covered and the image doesn't appear as an obvious target for attack. However it can be seen that the embedding in the 4thLSB generates more visual distortion in cover image and it seen as "non -natural" [4], and it is clear to the observant of stego image that there is a slight distortion in the stegoimage. the visual distortion will be more if the secret message will be embedded at the 5,6,7,8 LSB, and there is a direct proportion between the visual distortion in the cover image and embedding secret message bits up to 1,2,3,4,5,.....,8 LSB of cover image bits. The distortion between the original image and stego image is measured by calculating PSNR value (Peak Signal to Noise Ratio). The measured value of PSNR used to refers to stego image quality compared to the original image. To reduce noise in distorted stegoimage we can use genetic algorithm to decrease the noise obtained from inserting hidden information in the LSB of cover image and get a best appearance of the stego image then we can send this stegoimage via communication without visual notice of the observer. That mean for visually distorted stego image we can "using genetic algorithm enables to achieve optimized

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security and image quality" [5]. Image restoration used to recover degraded image, this will be done by knowing the cause of this degradation and using reverse operation to restore original image quality. First it must estimate noise in spatial image and measure the mean m and variance σ^2 of the noise, and then measure a , b to know noise type in specific image, and use a specific filter to reduce noise in noisy image. [6].

Our research is about image steganography where the image is used as a cover medium to carry the hidden information and send it from the sender to receiver invisibly. This paper makes a PSNR comparison between using LSB Steganography by calling the genetic algorithm to reduce noise and to improve the visual quality of the resulting stego image vs using image restoration to recover visual quality of the visually distorted stego image to know the better method.

Related Work

LSB Image Steganography

There are many papers on the subject of concealing information (steganography), in particular about hiding the text in the image, this is called image steganography. Also there are many researches that study embedding information in the least important Bit of image to hide. Here mention the most important research on it. It can be created a new LSB Steganography algorithm to reduce noise like in this research [7] Proposing a new algorithm based on steganography algorithm where embedding a series of secret bits to a group of pixels by rearranging portion Pixel locations. It turns out that the proposed scheme greatly reduces Noise-added compared to existing schemes on the basis of statistical restored. Another paper about Information Hiding in image on spatial domain propose a new algorithm as in paper [8] where The proposed theory is enter a compressed text files into all bits of the image and then hide this distorted stego-image in a new image. In another paper different techniques used to hide information such as LSB, and many planning ways to conceal confidential letter in an image. Different parameters such as pixel images, pixel density are also detailed in this paper [9]. In another research there is a proposed method to hide large data in a bitmap image using an algorithm based on the filtering, the MSB bit used for purpose filtering technology development. This technique is a development of LSB image steganography which verifies and check entering and retrieving the message. Author also conducted using the AES algorithm to enhance security, and compares the new method with the traditional and explains disadvantages of the last one [10].

Other research is about showing a new information hiding in image randomly by using two secret keys and makes a comparison with other steganography techniques which hide data in image and use PSNR as a standard for comparison [11]. The research [12] has been proposed two new algorithms the first to keep the statistics of cover image where data hide in. Then propose a new algorithm for the restoration of the first rank statistics of the cover image. the result show the success of the proposed algorithm which provide high security against attacks.

Using genetic algorithm with steganography

Here address some of the research that uses a genetic algorithm with the theme of steganography, the genetic algorithm used in each research for a different purpose.

In [13] paper It has been proposed a technique called DEGGA to hide data using a genetic algorithm to improve security. The Mask selected from the host image and four bits per byte entered in the four right bits per shift Pixel of the original image. The mutation applied to the image after bits embedding by xor. The Authentication process will do with bits embedding. Then DEGGA results comparing with [Ran- Zan algorithm et al.](#) DEGGA give better results than [Ran- Zan algorithm et al.](#) This research [14] uses a genetic algorithm with a single-layer neural network for data protection and encrypted against risks during data transfer and upon receipt of the data is decoded by reversing the use of genetic neural network for the recovery of encrypted data. Another paper talks about the researches that has on the methods concealing information in the images and using genetic algorithm [15]. In this paper [16] the authors create a new genetic algorithm to find the best position in the image data entry as well as the optimization way to improve the embedded image quality, this new algorithm based on Out Guess algorithm, the proposed algorithm aims to secure hiding of data on JPEG images.

MATERIALS AND METHODS

The goal of this research is making a comparison between the results of two methods to improve the visual quality of the stegoimage, first method applying genetic algorithm with LSB Steganography and the second method use image restoration to estimate noise type in stego-image and implement the suitable spatial filters to reduce noise. This entire work is implemented by using Mat lab 8.0 program, the images used are Lena.gif, Cameraman.bmp, Boat.png with a Width and Height 256 x 256 pixel. The Mat lab 8 is implemented for processing LSB Steganography technique, also using genetic algorithm toolbox from the optimization tool in mat lab program for the implementation of the genetic algorithm with LSB Steganography. As well mat lab used to recover the noisy stegoimage by modeling the degradation phenomena and estimate noise and applying appropriate spatial filter to recover the original image quality. Finally the extraction of the embedded secret message will be programmed in mat lab as well.

LSB Steganography

LSB Steganography is the simplest and oldest ways to hide secret information in the original cover image. In LSB substitution the LSB of cover image will substitute with secret information bits to be concealed within the original's cover image. In our work, the embedding method based on the bits substitution of the least significant bit of the original cover image by the secret data bits wants to be hidden in the cover image. Embedding process includes:

Input: The original image and File secret message

Outputs: stego image, the final image containing text.

The original cover image and the secret message read, then both of them convert to the binary system. make matrix for each of them separately. Then bits of the secret message insert in 1-8 least important bits of the original image by substitution. Stego image Convert (final image containing confidential letter) to the ASCII system, determine the value of the PSNR between the final stego image and the original cover image. Finally display the original image and the stego image.

Genetic algorithm

Genetic algorithm is a technique that simulates genetic evolution as a model to solve problems. In this research, the purpose was to use LSB Steganography with calling genetic algorithm to improve visual quality and to get the optimal visual quality for the final stego image in order to reduce its noise and raise the value of PSNR to obtain a higher image quality and therefore the image will be in a good visual quality to the person that sees the stego image, and that will lead to less probability of exposure to attack such as statistical analysis because the visual quality of the stego image is better. Soto use geneticalgorithm in this research a File for the function fitness has been used and it includes embedding the secret message to store in bits 1 to 8 of the LSB of cover image and this will be the search locations of geneticalgorithm to find the best combination between the secret message and original cover image, Which consider the ideal locations to hide. This is the key to use the genetic algorithm with LSB Steganography file, the work of genetic algorithm continue to reach the optimal PSNR value of stego image when reaching stopping criteria 50 generation, and calculate the optimal PSNR value.

Fitness function

Fitness function is the objective to be achieved which is in this study obtain the optimal value of PSNR of the stego image. The fitness function is one of the most important steps in the genetic algorithm and leading the search using ga solver in mat lab program toward the best solution.

How genetic algorithm work by using ga toolbox (ga solver)

The ga toolbox was used through mat lab program in APPS tab and chooses optimization Icon, when the ga window open the fitness function put in its place, and then determine the desired options. The initial population size of 20 was selected to start the development process to produce new members and identify the rest of the options, then click the start button, the genetic algorithm was evolving through the use of selected options and continue for the purpose of approaching to get the optimal visual quality of final stego image. It was found through many attempts that following options are best combined to get the optimal PSNR value for the final stego image, the chosen options was: Initial population: 20, Fitness scaling: Rank, Selection: stochastic Uniform, Mutation: adaptive feasible, Crossover: Scattered, Migration: forward, Stopping Criteria: generation: 50. The following is a simple explanation and definitions of the options have been used through a solver window:

1. **Population:** This option specifies the population for genetic algorithm.
2. **Fitness scaling:** chosen factor Rank, Measures the raw goals based on the rank of each individual.
3. **Selection:** it is equivalent to survival of the fittest. The selection function chooses Parents to the next generation. Pick and choose parents in order to produce a new following generation based on the scaled value of the fitness scaling. Chosen factor stochastic Uniform: This identify and draw a line and for each step the algorithm specify father to the line part which lands on it.
4. **Mutation:** enters the random modification and equip the genetic diversity. Chosen factor, adaptive feasible: Generate random directions that adapts to the proportion of the last generation, whether it is successful or not. this supply genetic diversity.
5. **Crossover:** This represents a mating between individuals to form a new individual or a child for the next generation. Choose scattered factor.
6. **Migration:** Is the movement of individuals between the sub population, the better individuals from one sub population often will replace the worst individuals in another population. The control on the migration will be of the following factors: Direction, Forward, Fraction, and Interval.
7. **Stopping criteria:** calculate the reasons that end the algorithm. Generation: The greatest number of generations attempt carried out by the genetic algorithm before stopping.

Image restoration

image restoration process restore the image using prior basic knowledge about the phenomenon of degradation in the degraded image. The restoration technique directs restoration process toward modeling the degradation in the image and applies adverse process to recover the original image quality. The ability to simulate the behavior and the effect of the noise behavior is the basis for image restoration. Determine the noise type in stego image is important and it is a step to choose an appropriate spatial filter to reduce noise in noisy stego image which result from the embedding secret message in the original cover image. The use of the appropriate filter will lead to the ultimate goal which is to improve the appearance of stego image to the observer and retrieved to the quality of the original image and thus reduce the likelihood of attack.

How to determine the type and noise factors in the stego image [6]

- The first step manually pick an area in the stego image to be feature less region back ground as much as possible and this region called the region of interest (ROI). using Roipoly function, which will generate the polygonal ROI by the following code: [B , c, r] =roipoly (f);

The output will be the mask B to determine operations within the area of ROI region.

- Step Two: histogram calculation of ROI: Here appoint vectors by the vectors c, r is done by the code: [h, npix] = his troi (f, c, r), to show the his to gram form: Figure, bar (h, 1)
- Step Three: Determine the noise type through observation and comparison between the shapes of the resulting histogram from the second step with reference histogram of noise types.
- Step Four: obtained mean and variance of region masked by B by the following sentence code to estimate the central moments:

[v, unv] = stat moments (h,2);

Then choose appropriate spatial filter such as adapmedian filter and applied on the stego image by this code: Filtered image= adpmedian (stegoimage,7)

D. Extraction process and retrieve the secret message Extract the secret message from stego image is the opposite process to embedding it in cover image. The receiver enters stego image in the extraction algorithm, to extract the secret message and put it in the matrix then converted to the decimal value of the secret message and finally it's converted to characters (plaintext) and display the confidential secret message.

RESULTS AND DISCUSSION

This part of the study shows the results of this research and discusses it.

The programmatic work in this study passed in three stages, the first stage is the LSB Steganography which is the basicstage, and it embedded the secret messagein the original cover image to produce a stego image. The second stage involved using LSB Steganography and genetic algorithm to obtain optimal visual quality of the final stego image and the third phase to improve the stego image produce from LSB Steganography using the image restoration, then compared the results of the latter two stages. The PSNR standard used to measure image quality, where the higher PSNR mean the better visual quality image and low noise, in order to reduce the risk of suspicion and attention to that image due to poor image quality.

First stage: LSB Steganography

Three test images used to embed secret message in its least significant bits, the test images are Lena .gif, Cameraman.bmp, Pillar. png, the PSNR results shown in Table 1.

Table 1 PSNR result of LSB Steganography (first stage) and LSB Steganography + genetic algorithm (second stage)

Title	PSNR LSB Steganography	PSNR LSB Steganography+ Genetic algorithm
Lena .gif	35.3090	77.97051378785375
Cameraman.bmp	34.2237	75.61374429745449
Pillar.png	33.8796	72.8125542844345

Second stage: LSB Steganography + genetic algorithm

In this stage the genetic algorithm used to select the best locations in LSB of cover image to hide the secret message and continue until accessing the optimal PSNR of the resulting

stego image when reaching 50 generation by using ga toolbox (ga solver) in mat lab program where several options chosen to reduce the noise and determine PSNR value for that stego image. Table 1showsThe PSNR results on of stego images processed with genetic algorithm are higher than PSNR values by using LSB Steganography method only, because genetic algorithm will select best sites in the 1-8 in the least significant bits in original cover image. This is a result from the nature of the genetic algorithm work, where the process of succession for generations to come again and again, the selection are choosing the best chromosomes (best LSB sites to hide the secret message) and ignore the rest, and these selected chromosomes will suffer from the cross over and the mutation for the purpose of the production new descendants of the next generation and every generation will be better than the one before, until reached the stopping criteria which are 50 generation. during the generational succession the best sites will choose in each generation for storing secret message bits and this will result a highest PSNR value every time, and whenever the PSNR value had raised the quality of the stego image will be better. Chosen 50 generation as a stopping criterion, give the optimal PSNR value, this lead to achieve the goal of using a genetic algorithm with LSB Steganography. While when using the LSB Steganography method alone the bits of the secret message characters will be stored in LSB bits of original cover image, respectively, sequentially without selecting the best sites.

Third stage: LSB Steganography + image restoration

Here one of the appropriate spatial filters used to process the stego image result from first basic stage to reduce its noise after following number of steps to guess noise type in the stego image. Table2 show the result of estimate noise parameter steps and Histogram ROI figure to compare it with reference histogram and specify noise type in that restored filtered stego image, and it found that a dap mean filter is the best filter according to the PSNR results shown in Table3.

Looking at the results of estimating noise steps involved in in Table 2, we note the importance of selecting the area to be free of features manually in order to give shape mask properly, and then the importance of observation and comparison between the resulting histogram and reference histogram of noise types,. So the results depend on the accuracy of Precision manual of programmer to estimate the noise type. The previous steps necessary to decide and choose appropriate spatial filter to reducing noise in the stego noisy image this will lead to the ultimate goal to improve the appearance of the image to the viewer and restore the visual quality of the original image and thus reduce the likelihood of attack.

The PSNR results in Table3 of using chmean and max filters are less than that resulting from using LSB Steganographyonly, these filters reduced the quality of the stego image instead of improving, as it is applied to the noisy stego image independently to change the properties of the image from one location to another that is mean they are applied regardless of changes in the local's image variation.

PSNR values in Table 3 showing the advantage of adpmedian filter on other multiple spatial filters to remove noise, also it

show the importance of select the appropriate filters to improve the visual quality of noisy stego image and reduce its noise. note that PSNR value of using adpmedian filter are higher than those resulting from the use of chmean and max filters and PSNR result of LSB Steganographystage, because this filter is able to adapt based on the properties of the image applied on it, where it's change his behavior based on using local statistical parameters in the mask region.

Table 4 is considered the main table which showing important final desired results. It display PSNR values of the images resulting in the three stages for each one of the three test images selected for this study, finally it shows if the secret message can be recovered from final stego image result for each one of the three test images. table4 shows that PSNR values of using genetic algorithm higher than that for using

Table 2 Image restoration step result

Image	V	unv	The mask	Histogram ROI
Lena.gif noise : Rayleigh	1.0e+03 * 0.1091 3.4051	1.0e+08 * 0.0003 2.2141		
Cameraman noise: lognormal	1.0e+03 * 0.0846 5.2261	1.0e+08 * 0.0002 3.3982		
pillar.png Gaussian noise	unv = 1.0e+07 * 0.0023 2.4611	unv = 1.0e+07 * 0.0023 2.4611		

Table 3 Comparison PSNR value of using multiple filters in tests image

Image	PSNR after LSB Steganography	PSNR After using adpmedian	PSNR After using max	PSNR After using chmean
Lena.gif	35.3090	41.7627	25.4544	28.5254
Camera man.bmp	34.2237	40.9623	28.5254	30.2023
pillar.png	33.8796	42.8338	26.4854	30.2276

Table 4 PSNR value for different host image (cover image) showing psnr value result from three methods

Title	Host image	Embedded Image LSB Steganography	Filtered Image adpmedian filter image restoration after LSB Steganography	Stego Image after LSB Steganography + genetic algorithm
Lena .gif				
PSNR		35.3090	41.7627	77.97051378785375
Cameraman.bmp				
PSNR		34.2237	40.9623	75.61374429745449
Pillar.png				
PSNR		33.8796	39.1343	72.8125542844345
secret message retrieved short text	text : life is beautiful	the whole secret text retrieved	the whole secret text retrieved	the secret text retrieved but there is some change in some character
secret message retrieved long text (Figure 1)		the whole secret text retrieved	the whole secret text retrieved except change in few character	the secret text retrieved but there is some change in some character

adapmedian filter (second stage) and LSB Steganography (first stage), The difference between using genetic algorithm on the use of the adapmedian filter, because adapmedian filter focuses on the pixels of the noise And replaces it with median of its neighborhoods pixels while genetic algorithm will choose the best sites to hide and the development process continue with succession generations until stopped and reaching the best result which is the highest PSNR value for the fitness function. Also in Table 4 there is two step in extraction process and retrieve the secret message, first step for short secret message and second for long secret message , first step show that in LSB Steganography alone and LSB Steganography +genetic algorithm recovering is complete while for using adapmedian filter there is few change in character , in second step , the result show that in LSB Steganography alone recovering is complete, while LSB Steganography +genetic algorithm and using adapmedian filter there is few change in character and this show Superiority of using genetic algorithm on using adapmedian filter.

1. LSB steganography,
2. LSB+adapmedian filter,
3. LSB+ga

CONCLUSION

- using genetic algorithm with LSB Steganography showed better result in de noising stego image than using adapmedian filter in image restoration method.
- using genetic algorithm will nested with LSB Steganography to produce an optimal visual quality of stego image while in image restoration method the adapmedian spatial filter used to restore the quality of degraded stego image result from LSB Steganography.
- Genetic algorithm focuses on the search for the best sites in the LSB of cover image to hide the secret message data, while adapmedian filter the focus on how to adapt with the properties of the stego image.
- -There is no effect observed of different extension images type on results in both methods.
- Image restoration method requires manual precision of the programmer to estimate the noise type while fitness function is important in using genetic algorithm gatoolbox.
- in using genetic algorithm appeared the effect of the options which is: Fitness scaling: Rank, Selection: stochastic Uniform, Mutation: adaptive feasible, crossover: Scattered, migration: forward, while In image restoration method the adapmedian filter show a better result .

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