Adaptive method for image steganography using genetic algorithm

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Abstract:

Steganography is the art of hiding information in ways that prevent the detection of hidden messages, That a process involves hiding a message in an appropriate carrier e.g., an image, an audio or video file. This research aims to hide a color image in another color image with the same size , depends on substituting the similar blocks of embedding image within the cover blocks by using genetic algorithm for select best match block .This method is robust against the changes and treatments done for the cover image . additional it fast and the stego-images have less distortions. And so , more secure because the positions is send independent from stego- image.

ألخلاصه

الأخفاء هو فن أخفاء المعلومات بطريقه لايمكن اكتشافها، وهذه العمليه تتضمن إ خفاء الرساله داخل وسط حامل مناسب متل ملف لصوره أوصوت او فيديو ، يهدف البحث الى اخفاء صوره ملونه داخل صوره ملونه اخرى وبنفس الحجم بابدال البلوكات المتشابهه بأستخدام الخوارزميه الجينيه لأختيار الحل الأمثل (عن طريق البحث عن افضل بلوك مطابق في صورة الغطاء)اثبتت هذه الطريقة كفاءه عاليه من حيث السرعه والنوعيه مقارنه مع الطريقه التقليديه(بدون استخدام الخوارزميه الجينيه)تم تطبيق النظام باستخدام لغة visual basic

1-Introduction:

Information can be hidden by many different ways in images . To hide information , straight message insertion may encode every bit of information in the image or selectively embed the message in busy areas where it would be less perceptible .A message may also be scattered randomly or repeated several times throughout the image [1].

Some common approaches to information hiding range from least significant bit insertion , to masking and filtering to applying more sophisticated image processing algorithms and transformations . Each of these techniques can be applied , with varying degrees of success , to different image files formats [2,3,4].

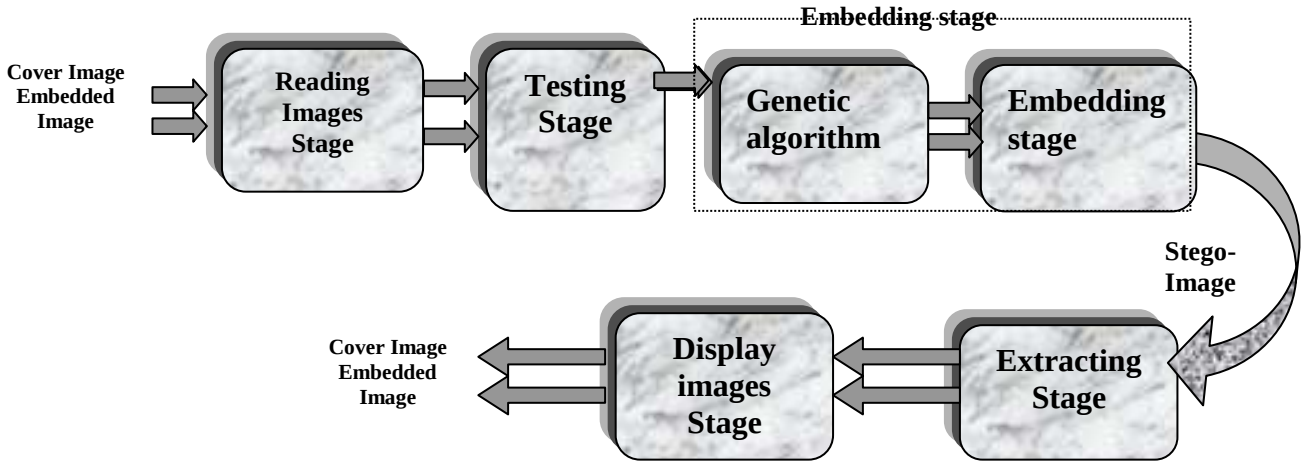
This research produce new method in steganography , depending on substitute the similar blocks (which selected by using genetic algorithm that is the way for search of optimum solutions) between embedding and cover images [5,6,7].

The similar blocks method is more secure and robust comparing with some common methods like LSB method , it consider a weak method because break it is very easy for attacker .

The proposed method consider more resistance against the changes and treatments done for the cover image . The new method include two parts : Embedding part include three stages : reading images stage , testing stage , embedding stage .The second part include extracting stage , display images .

2-the proposed method :

The block diagram below describe the method :



Figure(1):block diagram for proposed method

-Reading images stage : in this stage the both of cover and embedding images will read .

-Testing stage : in this stage the cover image will testing in order to know if it suitable to be as cover for embedded image , or no . To do that we used two measures : similarity and dissimilarity depending on histogram [8]; as illustrated in the following two equations :

$$S\{H(E),H(C)\}=\frac{\sum_{j=1}^{n}\min\left\{h_j(E),h_j(C)\right\}}{Nc\times Mc} \qquad \ldots\ldots (1)$$

$$D\{H(E),H(C)\}=\sum_{j=1}^{n}\left|\frac{h_j(E)}{Ne\times Me}-\frac{h_j(C)}{Nc\times Mc}\right| \qquad \ldots\ldots (2)$$

where the equation (1) give the similarity between the histogram of cover image (C) and histogram of embedded image (E) , $h_j(E)$ is the number of pixels of color j in embedded image (E) , $h_j(C)$ is the number of pixels of color j in cover image (C) .

For measure the difference between two histogram we use the equation (2) ,where $Me\times Ne$ is the embedded image size .

Also ,we use the Goodness of fit in the testing stage as follows [9]:

$$S=\frac{\sum_{i=1}^{n}(C_i-E_i)^2}{C_i} \qquad \ldots\ldots..(3)$$

Where E_i is the embedded image and C_i is the cover image .

-Embedding stage :in this stage both the cover and embedded images will divided into blocks ,after that we begin to search a bout the similar blocks between two images ,so this process need a time .Because that we use genetic algorithm to accelerate this process and obtain best decision.

Process of genetic algorithms

Genetic algorithms are search algorithms based on the mechanics of natural selection and natural genetic. In this work the search process depends on genetic algorithm by using feature extracted from each block of embedded blocks (we reduce the number of blocks and hide only one

block from similar blocks) and every block of cover blocks in order to find the block that is similar to embedded block then substitute it .

This work used simple genetic algorithm sGA that proposed by Holland [6] as follows:

Algorithm sGA

Initialization (population);
Evaluation (population);
Gen ← 0;
Do
Selection (population, Selected _parents);
Crossover (Selected _parents, Created _ offspring, Crossover prob.);
Mutation (Created _ offspring, mutation prob.);
Population ← Created _offspring;
Evaluation (Population);
Gen ← Gen +1;
While (not Stop_ criteria);
End sGA

In genetic algorithm the length of chromosome was equal to the total number of blocks in the embedded image and each gen is represent the block number in the embedded image .

Fitness evaluation

Each gen in the chromosome contains the number of block and this block will mapping to the block in covered sequentially and compute goodness of fit function (3) ,and the fitness function was computed for average of that result (of computing goodness of fit function for mapping blocks) .

Selection

After we evaluate population's fitness, the next step is chromosome selection. Embodies the principle of 'survival of the fittest' .Satisfied fitness chromosomes are selected for reproduction .Poor chromosomes or lower fitness chromosomes may be selected a few or not at all [6,7].

Stop criteria when reach zero fitness and that chromosome will be the result, each number of block in one gen of chromosome will mapped to cover by the matching block in covered image.

Using GA for searching of best matching block between the cover image and embedded image give more secure to the method because break it is very difficult for a taker, and so this method is more robust in which the result image has high quality.

The representation of image with feature or few number of features have enough information to distinguish , where convert the low level of image representation (image pixels) into high level of data representation (few number of digital values)and these values refer to term of "features" , which use to pattern recognition .

The Normalized Cross-Correlation (NCC) as similarity measure between the cover and embedded images as follows [10]:

$$NCC(W1,W2)=\frac{(w1-\overline{w1})\bullet(w2-\overline{w2})}{\left\|w1-\overline{w1}\right\|\ \left\|w2-\overline{w2}\right\|} \qquad \text{.....(4)}$$

Where w1 and w2 are treated as vectors (blocks) for cover and embedded images . $\overline{w1},\overline{w2}$ for the mean value of the vector pixels $\left\|\overline{w1}\right\|,\left\|\overline{w2}\right\|$ for the 2-norm of vectors w1,w2 .

Also ,we use the goodness of fit in the matching process ,where E_i refer to block from embedded blocks , C_i refer to block from cover blocks . This equation gives best results because

the matching perform between every pixel in embedded blocks with opposite pixel in cover blocks .for 256 color-images the palette of embedded image can be hidden in LSB of the stego-image.
The next scheme describe the embedding Algorithm:

Embedding Algorithm

Input : The cover-image and the embedding-image.
Output : The stego-image.
Step 1:Select the embedded-image and the cover-image.
Step 2:Calculate the histogram of both embedded and cover images.
Step 3:Perform Equation (1) or (2) or (3).
Step 4:If the result is true go to step 5 ,otherwise return to step1 to select new cover-image.
Step 5:Split the embedded-image and cover-image into blocks with size (N×N).
Step 6:Reduce the number blocks of embedded-image by remove the identical blocks and save one of them.
Step 7:For I=1 to No. of embedded-image blocks ,do
-Select emb-block[I] from embedded-image blocks.
-For j=1 to No. of cover-image blocks ,do
-Select cover-block[j] and perform genetic algorithm, search for greater match, and substitution it with emb-block[I].
End for
-Save the block number in an array ”positions”.
End for
Step 8:If the embedded-image is 256 color then go to step9, else go to step10.
Step 9:Hide the embedded-palette in the LSB of the stego-image.
Step 10:End.

-Extracting stage : in this stage we extract every block of embedded blocks from the stego-image .This process need to know the positions of blocks . (embedded positions) , therefore these positions keep in split file and transmit independence from stego-image . The receiver can not able to extract the embedded–image without know the embedded positions , therefore this method is more secure.
The next scheme describe the extracting algorithm :

Extracting Algorithm

Input : The stego-image ,the array ”positions” and block size, No.of embedded –image blocks.
Output : The embedding-image.
Step 1:Extract the embedded-palette from LSB of the stego-image.
Step 2: For I=1 to No. of embedded-image blocks ,do
-From an array ”positions” get the pos [I]
-Extract the emb-block from stego-block.
End for
Step 3:End.

3- testing the proposed method :

To standing on performance of the proposed method ,applied many types of images with different complexities . also , we use two criteria in the comparing process[11,12,13] :

- Peak signal to noise ratio (PSNR).

- Root mean square error (RMSE).

(A) Hide color image in color image :

we have tested the proposed method without using genetic algorithm on a number of color images , and the figure (2) shows the results on (128 x 128) color image with bock size 4X4:

Embedded image

Cover image

Extracted image

Stego image

Figure (2) :experimental results without using genetic algorithm.

The experimental result is PSNR for cover image and stego –image equal (29.62 db), and RMSE equal (5.41). while for embedding image and extracted image the PSNR is (22.91 db) , and RMSE is (9.79) .

The figure (3) explains the proposed method with using genetic algorithm on the same sample of images with bock size 4X4:

Embedded image

Cover image

Extracted image

Stego image

Figure (3) :experimental results of the proposed method .

For the cover and stego- images the PSNR is (44.35 db), and the RMSE is (1.74).The PSNR for embedded and extracted images is (42.54 db) and RMSE is (1.97),with pc is (0.8) and pm is (0.01), where population size is (30) and length of chromosome is (324) and number of cycle is (22),the following table explain that results:

Criteria	without using GA		with using GA
RMSE	embedded & extracted	9.79	1.97
PSNR	embedded & extracted	22.91	42.54
RMSE	cover & stego	5.41	1.74

PSNR	cover & stego	29.62	44.35

4-The conclusions:

It appears from the observation of results of the mentioned experiments that the proposed method success in the embedding/extracting process and get the best results for the images that have great similar in the color levels . The method applied on color images, once using genetic algorithm in searching of best blocks and the same method without using genetic algorithm, so that we can standing on the results :

For color images without using genetic algorithm the PSNR rang (29.62 -22.91 db) .For gray scale image the PSNR rang (44.35 -42.54 db) .

Additionally , the testing stage is very important for embedding process because that select the suitable cover make the embedding process imperceptibility and we get excellent results for images that low color scales .

References

[1] N . F. Johnson , Z . Duricand and S.Jajodia , **Information Hiding : Steganography and Watermarking-Attacks and Countermeasures ,** Kluwer Academic Publishers , Boston / Dordrecht / London , 2001.

[2] J .Fridrich ,**Applications of Data Hiding in digital Images** , Tutuorial for the ISPACS '98 conference in Melourne , Australia , (1998) .

[3] N . F . Johnson and S . Jajodia **, Exploring Steganography :Seeing the Unseen** , IEEE ,computer , **31** , 26 , (1998) .

[4] F . Queirolo ,**Steganography in Images** ,Communications Report , (2001) .

[5] K. Deb, 'Genetic Algorithm in Search and Optimization: The Technique and Applications, Proceedings of International Workshop on Soft Computing and Intelligent Systems,Calcutta,58,1998.

[6] D. E. Goldberg.' Genetic Algorithms in Search optimization and Machine Learning',Addisson_Wesly,Massachusetts,1989.

[7] D. Quagliarella, J. Periaax, C. Poloni, G. Winter,' Genetic Algorithm in Engineering and Computer Science', Wlley & Son, John(1997)

[8] T . Y .Kim and J. Han , **Partial Image Matching by Measures from Connected Color Regions**,Technical Report Supported by Minstry of Education of Korea , (1999) .

[9] R . Johnson and G .Bhattacharyya ,**Statistics Principles and Methods** , John Wiley & Sons ,INC,1985 .

[10] S.M. Chaudhry, **Introduction to statistical Theory** , Kutub Khana, Lahore , Pakistan , 1984.

[11] R .C . Gonzalez , R . E. Wood and A . Wesley , **Digital Image Processing** , Addision Wesley publishing Company INC. ,1992.

[12] S . E . Umbaugh ,**Computer Vision and Image Processing** , Pretice Hall , London ,1998 .

[13] D . Salomon ,**Data Compression** ,Springer-Verlag NewYork ,1998.