A New Data Hiding Method based on Lévy Flight Technique

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Abstract

Many data hiding methods and techniques were introduced in the literature, most of them by well recognized researchers that have undisputable impact on the scientific society, yet the focus was on using a general algorithm that apply the same parameters and guidelines each and every time on different data. Sometimes it yields good results in term of robustness of imperceptibility but many times it is a sacrifice of one to the favor of the other. Nature-inspired algorithms (NIAs) recently gained a significant amount of attention, regarding problem solving of complex problems in the field of optimization where an actual solution is hard to obtain due to vast number of parameters. In this paper an attempt is intended to enforce a certain NIA algorithm with goals of maximization of robustness, capacity and imperceptibility and minimization of distortion measured by some signal distortion detection parameters.

Keywords: Information hiding, data security, nature inspired algorithms, lévy flight.

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1. Introduction

A stereographic video file has a various of properties that can be misused to performance by means of a host for secret data, one of these characteristics i.e. the dual-channel video stream will be focused, utilizing Anaglyph 3D as the name given to the stereoscopic 3D impact accomplished through method for encoding every eye's image utilizing channels of various colors, regularly red and cyan. Anaglyph 3D images contain two distinctively separated filtered colored images, one for every eye. At the point when seen through the "color coded" "anaglyph glasses", each of the two images achieves one eye, uncovering a coordinated stereoscopic image[1]. The visual cortex of the brain fuses this into view of a three dimensional scene or arrangement. These color channels are used to hold the embedded data and the recovery data in case of damage or degradation occurrence due to intentional or accidental attacks such as recompression or standard image transformations. any embedding process will affect the quality of the stereoscopic video namely each frame that holds a certain data, for this reason we will select the best embedding locations in the video frame which has minimum impact on the visual data represented by that frame. The selection is done using one of the most efficient and advanced nature inspired algorithms (NIAs) namely the cuckoo algorithm[2].

2. Related works

Recently, the naturally evolving techniques that are found in the study of biological creatures' behaviors to optimize the data embedding methods. There are some issues need to be addressed in data embedding, namely strength parameters selection, these issues gained the focus of many researches for a quiet time. In [3][4], the Genetic Algorithm (GA) was responsible for finding the appropriate positions for the watermark injection inside a cover image. Whereas in[5][6], this heuristics process is used to detect the strength factors for the best watermark in digital image watermarking. Using both DWT besides DCT embedding pattern enhanced through heuristics process is suggested in[7]. In another view, the operation implemented through a two level DWT, then the HL_2 coefficients in the sub-band is separated into block of 4×4, then and there the DCT was achieved on every of these blocks. This heuristics process is utilizing to discover which 4 central bands of coefficient of block

DCT are utilize to insert the data and to discover the finest value of gain factor. In[8], Particle Swarm Optimization is utilizing to choice the finest coefficients for the implanting in adaptive way. Whereas in [9], the effective of embedding data in diverse blocks is adaptive through perform PSO procedure. In[10], proposed a new image watermarking by adaptive technique, in which DCT sub-band is chosen by GA as well as watermark strength is selected intelligently over PSO. GA functions well at discovering a large exploration space besides it chooses the appropriate sub band for data embedding.

3. Cuckoo Search Algorithm

The fact is that this cuckoo is just about the most fascinating wild bird fond in the wilderness these birds have their own nests, instead they lay their eggs within some others nests, where they hatch and been looked after by other hosting birds[11].

The hatched cuckoo will be then fed by the hosting birds until it's fledged. To accomplish that, the hatched cuckoo egg within the nest is not notice from the host bird. For that reason, the common phrase "Someone placed a cuckoo inside the nest" is used commonly. The hosting female bird consciously adopts the newly hatched cuckoo, but still there might be a problem of existing host's eggs. Once the cuckoo's eggs hatch this newly hatched Cuckoos will get rid of the host eggs and attempt to become the only bird inside the nest, eliminating the completion for food resources form the nurturing bird[11].

For the convenience[12] in describing this algorithm, the three standard instructions are referred to some assumption such as Each individual in this paper represent as cuckoo bird lays one egg in the host's nest, and deposits this egg in haphazardly selected nest; second assumption present that the finest nests by a high quality egg will defer to be considered in the succeeding generations; finally the number of obtainable host nests is constant, besides the probability of a placed egg to be discovered through the host bird is pa $\in$ [0, 1]. In this situation, the host bird whichever throws the egg or wildness the nest, and construct a new nest[13].

Depend on the above assumption, the cuckoo search can be described as follows

Algorithm *Cuckoo Search*
Input : *Population of solution nests*
Output: *Best nest in the population*

Start
Set cost function f(y), y = $(y_1, y_2, ..., y_d)^T$;
Create initial population of *m* host nests y_i *(i = 1, 2, ..., m)*.
[termination step] **While** (t less than Max-Generation) or (stop condition)
Pick a cuckoo haphazardly through Lévy flights;
Estimate its fitness *Fi*;
Pick a nest between *m* (*say, j*) haphazardly.
If *(fi* greater than *fj)*,
Substitute *j* through the new explanation;
End
Discover (*pa*) of worse nests, where nest is uncontrolled besides new one is build;
Preserve the finest solutions (or nests with quality solutions);
Rank the solutions then discover the present best.
End while
End

Each host nest *n* is considered a container for a simple egg *x.* As soon as generating new solutions *y(t+1)* for a cuckoo *i*, a Lévy flight is achieved.

$$(t+1)=(t)+\alpha \oplus Lévy(\lambda) \quad (1)$$

Wherever *α* greater than zero is the size of step which must be related to the problematic of attention scales, so it can be pick to one in most states. Equation (1) is essentially the stochastic equation for haphazard walk, which is a Markov chain where the succeeding position only based on the present position, besides the transition probability, which are the first plus second term correspondingly. The invention $\oplus$ denotes the entry wise multiplication, which is similar to those used in particle swarm optimization.

In terms of discovering the space of search, haphazard walk through Lévy flight is further effective as its step length is much longer in the long run[13]. The haphazard step length of Lévy flight, which essentially offers a random walk, is consequent from a Lévy distribution with an infinite variance in addition to infinite mean.

$$Lévy \sim u=t-\lambda, \ (1<\lambda\leq 3) \qquad (2)$$

At this point, the steps basically form a haphazard walk procedure with a power-law step-length distribution with a heavy tail. Certain of the new solutions should be generated through Lévy walk about the best solution found so far, this will speed up the local exploration. Yet, a substantial fraction of the new solutions should be produced via far field randomization and whose positions should be far enough from the present finest solution[14]. Figure 1 demonstrations examples of Lévy flight in a 2D plane.

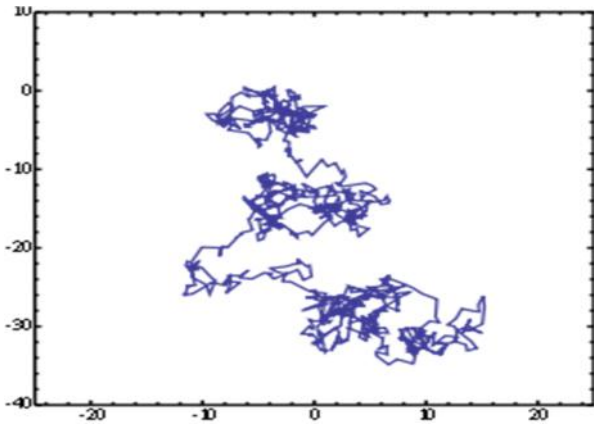


Figure 1: Lévy flights.

Because CS algorithm is considered relatively new, a little number of articles employed on optimize the embedding of digital image, the objective of the cuckoo search method to the data embedding problematic will be indicated for discovering the best scaling issues and compare it to the well-known genetic algorithm used for the same purpose[15].

4. Data Embedding Process

The embedding organization uses the cyan channel to embed the real secret data since the cyan color distinction is hardly apparent through the human visual scheme, in addition it uses the red channel to embed the recovery data to recover the data in the red channel if its corrupted by an attack, noticing that the recovery data is naturally less in size than the actual data using any of the error detection/correction techniques known such as hamming distance, an embedding technique is applied in the spatial domain while the compression and conversion of the normally captured video to a 3D stereoscopic video based on cuckoo distribution to distribute the data into the cyan channel to avoid locality of attacks, and of course using different frames to achieve robustness of the embedded data. Figure 2 shows a diagram to explain the steps of the process[16].

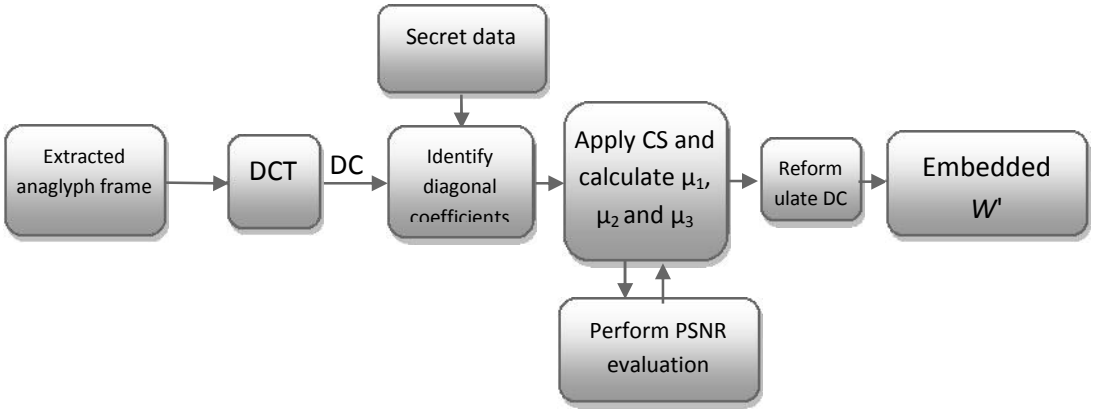
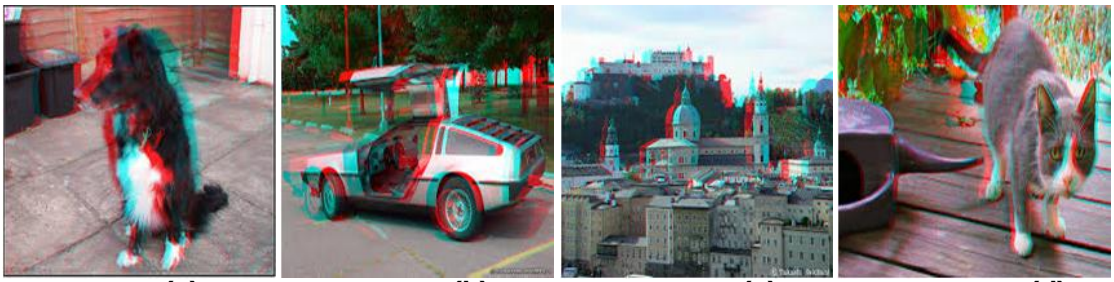


Figure 2: A block diagram of the embedding procedure

Figure 3 shows most of the embedding operation took place inside the conversion operation to obtain the robustness from the spatial domain data hiding, scrambling i.e. the data is scattered throughout all the fame or several frames to obtain the survival of the data from attacking and error correction and detection to implement the immunity of data even if a successful attack has been applied on the file. Noticing that the same process is performed for the recovery data[16].



(a) **(b)** **(c)** **(d)**

(e)

Figure 3. Original anaglyph images examination (a) Dog, (b) Car, (c) City, (d) Cat in addition to (e) The embedded (32×32) image

Embedding

This process is explained as follows[2][16]:

- Rearrange the secret image into a W vector = {w_1, w_2, …, w_m} of binary list.
- Decompose the cover image I then implement DWT of one level to the sub bands LL, LH, HL in addition to HH.
- Choice distinct blocks sized 8×8 elements from LH, HL and HH.
- From the vectorized W elements obtain a single non reoccurrence 8×8 block the obtain its diagonal coefficients D_c, for these coefficients identify MAX and its MIN, if the value of W_i is 1 then the evaluate the first element in D_c by MAX + μ_j , otherwise the replacement is MIN – μ_j, where μ_j are the strength factor parameters (μ_1, μ_2 and μ_3) one for every sub band which are estimated by Cuckoo Search algorithm (CS)
- Perform the I-DWT for all blocks to resulting in embedded image I'.
- Compute the imperceptibility i.e. Measure the quality of the secret image through using tone of the most important performance

criteria which is a peak signal to noise ratio abbreviation as(PSNR). This criterion is defined as follows:

$$PSNR = 10\,log_{10}\left(\frac{255^2}{\frac{1}{M\times M}\sum_{i=1}^{M}\sum_{j=1}^{M}[I(i,j)-I'(i,j)]^2}\right) \quad (3)$$

Where: and I(i, j), I'(i, j) are the pixel values of the host and the embedded images, M×M is the scope of the image, however, the larger value of performance criteria PSNR is the less distortion instigated through implanting data in a host image[16].

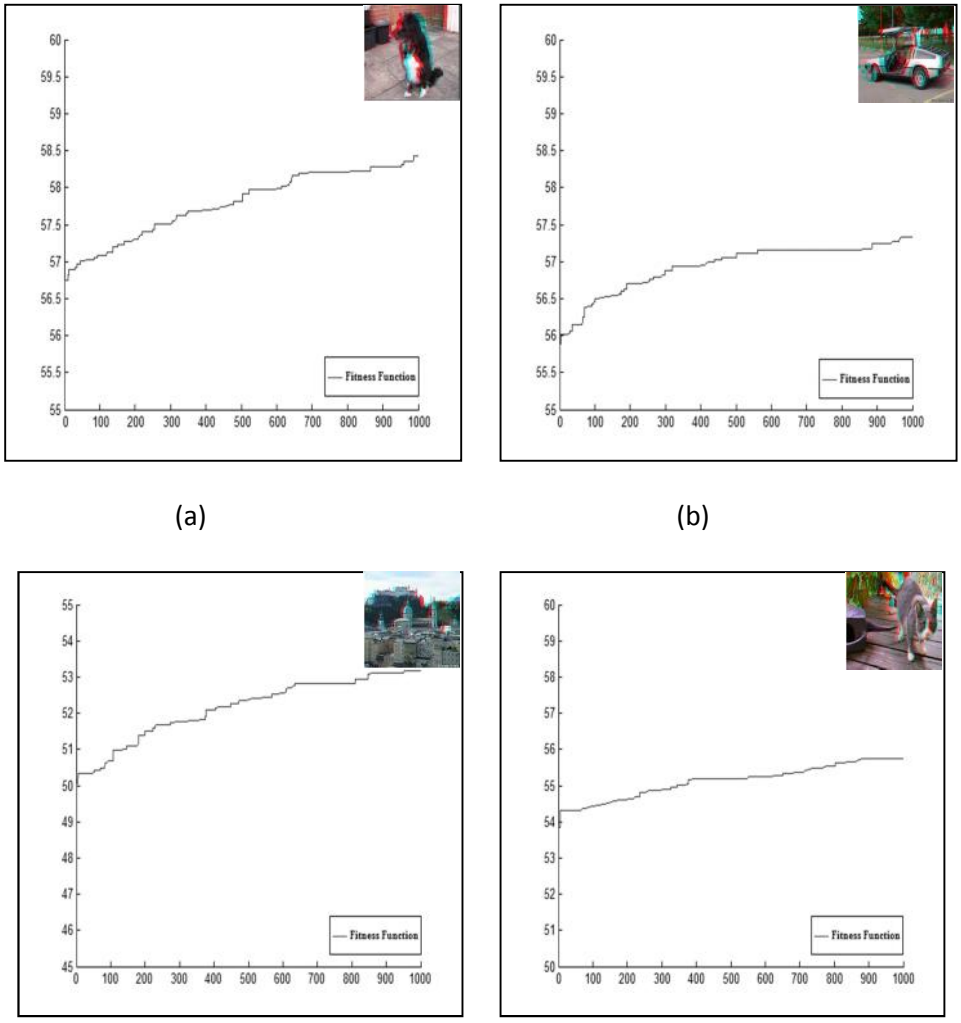
5. Extraction

The original Cover image is not mandatory in this process, and the process is as follows:

- Decomposition the cover image abbreviation as (I ') in to 4 sub bands respectively LL', LH', HL' in addition to HH', by performing DWT of one level.
- For these sub bund, W_i' by calculating average of diagonal coefficients D_c of every embedded block, then if the first factor in D_c is larger than the calculated average then the secret bit is equivalent to one, else the bit is equivalent to zero.
- Obtain the extracted data.

6. Experimental results

Figure 4 shows the obtained values of fitness function form the cuckoo algorithm for each frame image.



(a) (b)

(c) (d)

Figure 4. The Cost Function values contrasted with proposed algorithm generations for (a) Girl, (b) Cycle, (c) House in addition (d) Fingerprint examination images.

After obtaining the images with secret embedded data the evaluation of some well-known attacks are applied and the results are evaluated in figure5.

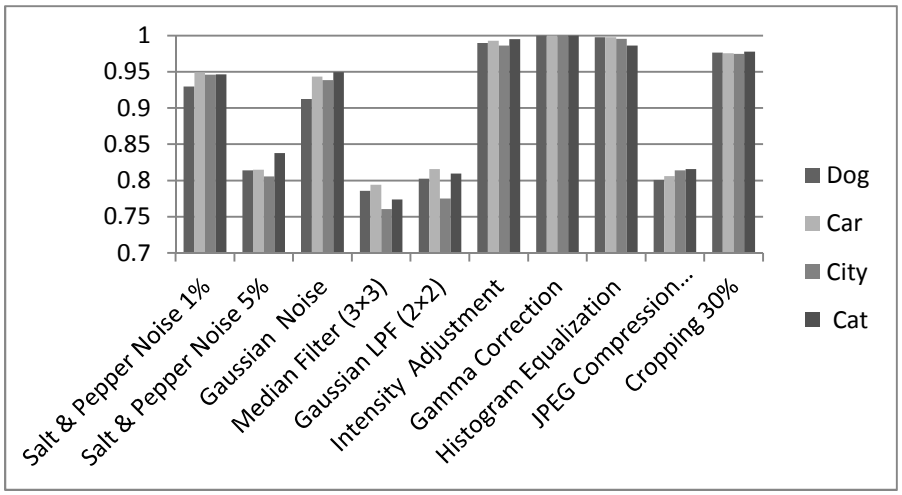


Figure 5: Results of various attacks on frames

Table1 shows how cuckoo search algorithm optimized the PSNR values and how the PSNR values differ dramatically without optimization.

Table 1: PSNR values for test anaglyph images for optimized and non-optimized values

Examination images	Deprived of optimization (Strength factors)	No. of Iterations	Through optimization depend on proposed
Dog	56.3356	200	57.9010
		400	57.9601
		600	58.1087
		800	58.6035
		1000	58.5788
Car	55.1596	200	56.9147
		400	57.7516
		600	57.6977
		800	57.1946
		1000	58.1176
City	48.4536	200	52.2388
		400	52.3926
		600	52.7160
		800	53.4011
		1000	53.6888
Cat	53.3197	200	55.0194
		400	55.6963
		600	55.4459
		800	56.1981
		1000	55.8614

8. Conclusions

Using stereographic files is new in the field of data hiding since there is a little amount of literature that involves this subject and there is no official file type for such video files, the anaglyph 3D effect illuminates the factor that the viewer will notice any visual change in the file due to the magnitude of information to be processed by the human brain at any given moment. Using cuckoo based optimization to identify the best parameters used in the DC secret data injection process for more successful extraction and high degree of imperceptibility and immunity. This method is applicable into the capture software of the stereoscopic filming techniques due to the using of actual two channel cameras.

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طريقه جديده لاخفاء البيانات بالاعتماد على طريقه Levey Flight

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المستخلص

تم دراسه طرق عديده لاخفاء المعلومات ولكن معظم هذه الخوارزميات لم يتم دراسه تاثيرها في المجال العلمي .ولكن هذه الخوارزميات تطبق نفس المعاملات والتوجيهات في كل مرة يتم تطبيقها على بيانات مختلفه.

في بعض الاحيان هذه الخوارزميات تعطي نتائج جيده من حيث قوة عدم الادراك ولكن في هذه الظروف يتم التضحيه بواحده من هذه المعاملات. في الفترة الاخيرة حازت الخوارزميات المستوحاه من الطبيعه على اهتمام العلماء والباحثين لحل بعض انواع المشاكل المعقده التي نهدف منها **الحصول على الحل** الامثل والتي من الصعب فيها الحصول على الحل المضبوط والصحيح بسبب عدد المتغيرات الكثيرة. في هذا البحث تم محاوله تطبيق خوارزميه مستوحاه من الطبيعه تهدف الى زياده معايير اخفاء المعلومات مثل القوة، السعه، وقوة عدم الادراك وتقليل نسبه التشويه التي يتم قياسها باستخدام معايير اكتشاف تشويه **الاشاره**.

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