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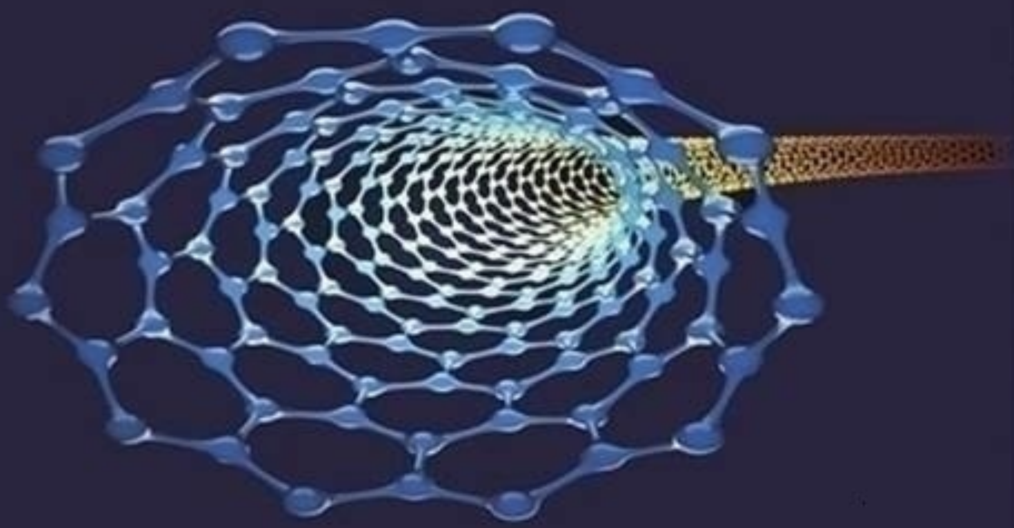

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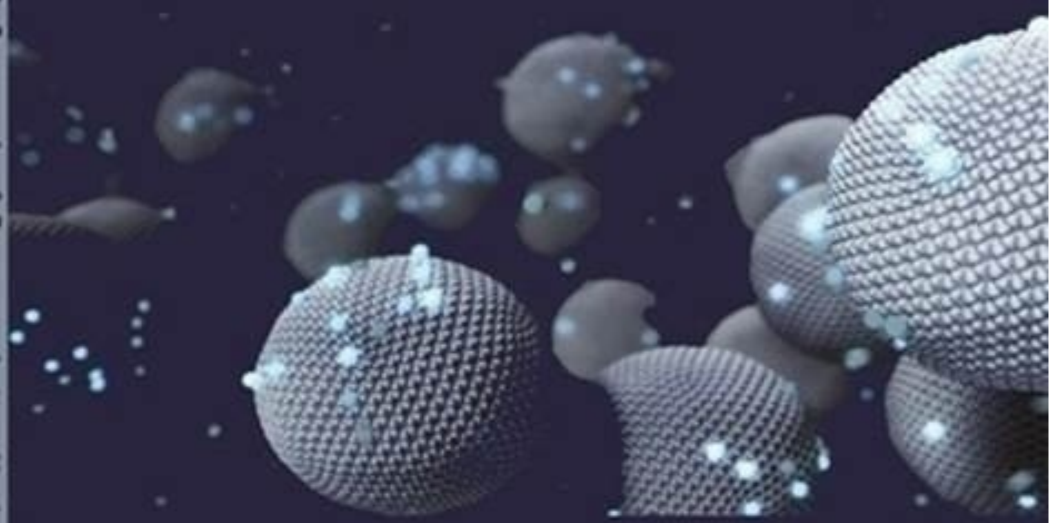

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RESEARCH PAPER

Secure Image Steganography by Utilizing DNA Properties

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A B S T R A C T:

In the last period, Steganography is commonly used as an alternative to encryption to achieve secret communication between parties. Many methods have emerged to achieve steganography, including the use of spatial domain, spread spectrum, transform domain, and etc.

On the other hand, the methods of attackers have also developed in revealing hidden data and trying to retrieve it. To increase the security of the hiding process, some researchers have found hybrid methods that combine encryption and steganography processes.

The research aims to present a new method in steganography by taking advantage of the properties of DNA, which includes the random sequence of nitrogenous bases (A, C, G, T), the process of hybridization, which occurs between two single strands of DNA to form a double strand of DNA so that the bases in the first strand are complementary to the nitrogenous bases in the second strand.

The research includes the following steps: First, the secret image to be hidden is encrypted by encoding it into a series of nitrogenous bases, and then the XOR process is performed with a nitrogenous bases sequence for a DNA tape agreed upon between the sender and recipient, the hybridization process applied before and after the XOR process. The results show that encrypted image is much different from the original image and thus they added another level of security to the hidden image.

Secondly, the encrypted image resulting from the first step is hidden in the cover image and using a new method based on the use of the agreed-upon DNA tape as a key.

KEY WORDS: DNA Properties, Secure Image Steganography, OTP key.
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1. INTRODUCTION:

Since it has become possible to store a large amount of information in DNA molecules, then it has become necessary to provide protection and confidentiality for the stored data. DNA Cryptography is a new branch in the field of data encryption that appeared after the discovery of the capabilities of DNA in computing, in which DNA is used as a medium for carrying data and performing calculations with the help of many modern technologies and devices. The DNA consists of two strands wrapped on each other so that they resemble a twisted ladder, and it consists of four types of nitrogenous bases: adenine A, thymine T, cytosine C and guanine G, and these bases are repeated millions or billions of times in all parts of DNA. The process of encoding the DNA tape includes relying on the characteristics or processes that take place on the DNA tape and trying to take advantage of them and combine them with the concepts of alternative and compensatory coding methods to obtain new and efficient coding methods in this field [1] [2].

2. LITERATURE SURVEY

The researchers presented many ideas in DNA cryptography field, as shown in the following researches: Dna cryptography is preferred due to information density and parallelism that are in.herent in any dna molecule, Bevi A. and et al.

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[3] introduce dna-based cryptography algorithm depend on feisteal inspired structure with complex operation added to it. Zhang Y. and et al. [4] propose new encryption method depending on characteristics of the biological puzzle, also the method used DNA chip technology to make the cryptography algorithm feasible secure.

Mansi Rathi and etal. [5] present a complex cryptography method by using DNA sequence in encryption. In this research byte-rotation technique with poly- alphabetic substitution are used. The DNA sequence help in generating a random key. In [6] paul and et al. suggest a new approach using chaiotic logistic maps with dna masking and replacement, the researchers used 8 rules to interprets image binary values to the combination of (A,T,C,G) and then perform operations. Kolte S.and et al. [7] introduced a new index-based symmetric DNA cryptography, each characters in plain text encoded to Ascii and to their equivalent binary format. The resulted binary sequence then transformed into DNA sequence and compared to DNA sequence (key), finds the similar sequence, then store the position as a cipher text. Kolate V. and Joshi R. Al-Mahdi Hasan and et al. [8] introduce asymmetric DNA cryptography based on the concept of data dependency, dynamic encoding and RSA cryptosystem. The basic idea of the proposed algorithm is to create a dynamic DNA table, using data dependency for generating 14 dynamic round keys for multilevel security. V. Kolate and R.B. Joshi [9] produce an effective DNA encryption method using a predetermined terminators in the form of {0I1}e to encoding DNA binary strand, also the terminator domains have sticky ends. The secret massage is encrypted in DNA form and mixed in equimolar amounts with dummy DNA strands. The receiver using the key as primers, and PCR is performed, finally Gel-electrophoresis and the amplified sequences used to extract the encrypted strand to decryption it. The attacker must guess the key sequence to differentiate between the dummy and encrypted strands. Samwal Idris and et al. [10] suggested a new DNA cryptography based on one time pad and Caesar cipher, the plain text is first converted to binary format and after that convert to a DNA sequence, using a previously shared DNA sequence as a OTP key, the encryption then implement. Using chaotic map and DNA encoding Aditya Pai and et al. [11] introduce a novel image encryption algorithm, first transform real picture to 2-D matrix, using DNA scrambling method and Chebyshev mapping for confusing image and encryption. The method indicates the best NPCR and UACI scores. Existing DNA cryptography algorithms indicates that the encrypted text has a low avalanche effect of providing a desirable confusion property, therefore Maria Imdad and et al. [12] reassess the security of the DNA cryptography algorithms by modifying the steps in DNA encryption technique. The researchers enhance the overall security by utilizing an existing DNA encoding / decoding table at a selected step in the algorithm. Varsha Hari and R. B. Joshi [13] using DNA based AES security technique to provide multilayer security system. The use of DNA bases (A, T, C, G) for encoding helps to improve the cryptography performance in terms of parallelism and huge capacity to store the data. The researchers find that compression techniques can also be applied te enhance security.

3. DEOXYRIBONUCLEIC ACID (DNA)

Is a nucleic acid that contains the genetic instructions of all proteins used in functioning and the development of any living being. The DNA instructions stored as a code made up of four chemical bases: thymine (T), adenine (A), cytosine (C), and guanine (G). In 1953, Watson and Crick presented a model for DNA consisting of two strands or two coiled strands in the form of a helical ladder in which one of the nitrogenous bases in one slit of the helix is linked with the nitrogen base of the other slit by means of hydrogen bonds, the bonding of the nitrogenous bases between the two slits is restricted “not random”, as the adenine in one of the two strands is always bound with thymine in the other strand by two hydrogen bonds, and the cytosine in one of the two strands is linked with the guanine in the other strand with three hydrogen bonds. DNA Hybridization is the process of combining two complementary single DNA strands to form a double strand of DNA, as the nitrogenous bases in the first chain will be linked by hydrogen bonds with the complementary bases in the second chain [1][2].

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5. THE PROPOSED METHOD

The method includes encrypting the image to be hidden by using a DNA tape agreed upon between the two parties as a key and performing the hybridization process as well as performing the hiding process in a different way also depending on the same key. The mechanism of the proposed method can be clarified through the following points:

A. First, the image data to be hidden is encoded into a sequence of nitrogenous bases using Table 1.

TABLE 1. DNA image encoding

Binary image sequence	DNA nitrogen bases
00	A
01	C
10	G
11	T

TABLE 2. DNA BIO-XOR

BIO-XOR	A	C	G	T
A	C	G	T	A
C	G	T	A	C
G	T	A	C	G
T	A	C	G	T

B. Performing the hybridization process for the series of nitrogenous bases resulting from step A, so that the base A is converted to T and the base C to G and vice versa.
C. Implementation of the BIO-XOR process between the DNA strand produced from step B with the DNA strand (the key) as shown in Table 2.
D. Implementation of the process of hybridization on the chain of bases resulting from the encryption process using BIO-XOR, but in a different way this time where the base A to G and the base T to C and vice versa.
E. To get the encrypted secret image, we convert the resulting series of nitrogen bases from step D into a series of binary numbers using Table 1.
F. After encrypting the secret image to be hidden, the key DNA tape is used to take advantage of the tape's randomness property to achieve an efficient hiding process, as shown in Table 3.

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TABLE 3. Proposed Hiding Rules

DNA sequence	Hiding rules
AA	Do nothing
AC	Hide one bit in bit zero
AG	Hide one bit in bit one
AT	Hide two bits in bit zero & one
CA	Hide one bit in bit zero
CC	Do nothing
CG	Hide one bit in bit one
CT	Hide two bits in bit zero & one
GA	Hide one bit in bit zero
GC	Hide one bit in bit one
GG	Do nothing
GT	Hide two bits in bit zero & one
TA	Hide one bit in bit zero
TC	Hide one bit in bit one
TG	Hide two bits in bit zero & one
TT	Do nothing

6. RESULTS AND DISCUSSIONS

There are many important features of deoxyribonucleic acid (DNA) like the ability to store a large amount of data, possibility of parallel processing of nitrogen bases at the same time, and the randomness property of a sequence of nitrogenous bases, all these features gave the DNA tape great importance for its use in the field of data encryption. The proposed method of image encryption is one of the symmetric encryption methods, where both ends of the communication agree on a DNA strand that is selected from one of the genetic libraries, which is equipped with millions of DNA strands of different organisms.

To accomplish the process of symmetric encryption for digital images, the idea of hybridization process that occurs for the single strand of DNA was used by creating hydrogen bonds to link the complementary nitrogen bases to form the helical DNA strand.

The hybridization process was used initially in its standard form and again in a different manner to add a kind of randomness to the encrypted DNA strand, which represents the image data.

The XOR operation was also used, which is usually done on binary numbers, but here it was used on nitrogenous bases (between two series of bases, one of which represents the image data and the other represents the key), figure 1 show examples of encrypted images and table 4 show the proposed encryption method efficiency measurements.

In table 4 the values of Mean Square error (MSE), Peak Signal to Noise Ratio (PSNR), and Normalized Cross Correlation (NCC), were large, few, and very few, respectively. This indicates, as shown in Figure 1, that the resulting image from the proposed encryption process is more different from the original image, hence, adding another level of security to the hidden image.

After completing the process of encrypting the digital image, in a simple and efficient manner, the DNA tape (the key) was used to hide the encrypted image. The proposed hiding process was characterized by introducing a different method that includes a kind of randomness so that it becomes very difficult for the attacker to retrieve the hidden data.

The hiding process is usually done using the least significant bit, or the two least significant bits, and in a similar format on all the cover data, which gives the attacker the opportunity to retrieve the process, and for this reason, in the proposed method, hiding is done in an arbitrary format.

The randomness of the hiding operation of the proposed method occurs by relying on the DNA bar of the key, which is characterized by being random, depending on the two values of each nitrogen bases of the DNA sequence determines how to perform the hiding operation, which is in four possibilities (1. Hide in bit 0, 2. Hide in bit 1, 3. Hide with bits 0 and 1, 4. Unhide).

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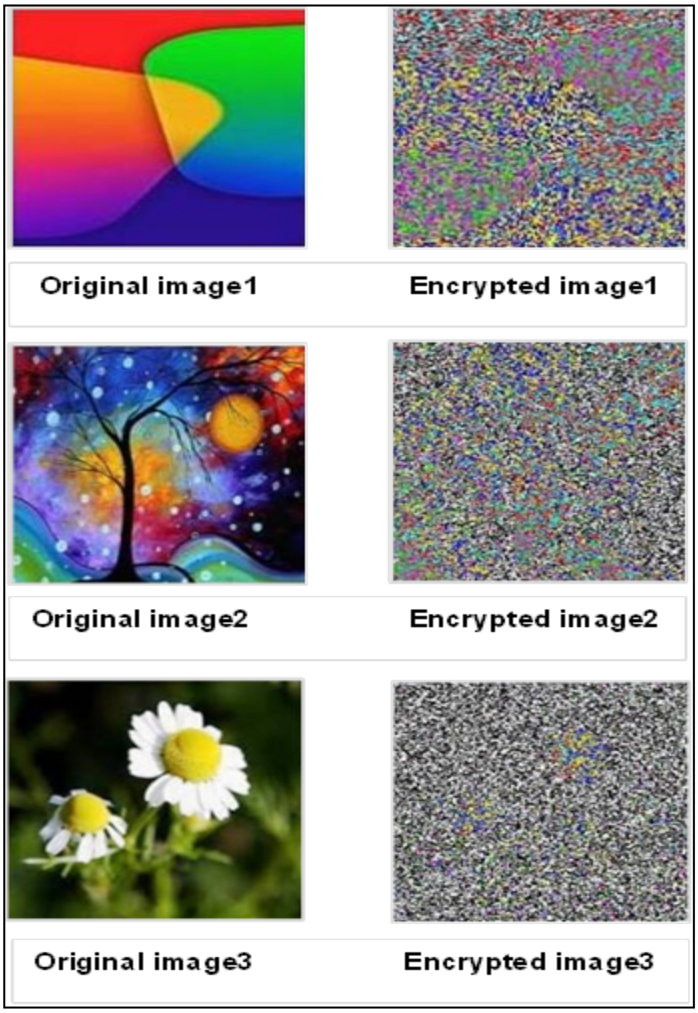

FIGURE 1. Examples of encrypted images

TABLE 4. Efficiency Measurement for Encrypted Images

Original Images	Encrypted Images	MSE	PSNR	NCC
Figure 1 - Original image1	Figure 1 - Encrypted image1	1.5000e+04	6.3698	-0.0059
Figure 1 - Original image2	Figure 1 - Encrypted image2	1.0539e+04	7.9028	0.0153
Figure 1 - Original image3	Figure 1 - Encrypted image3	9.2446e+03	8.4719	-9.6203e-04

7. CONCLUSIONS

1. The methods of encryption and hiding of digital images are based on the secret key, which is the DNA tape that has been agreed upon between the two parties of the connection, and therefore there is no need for the process of key distribution.
2. The tables used in the encryption and hiding operations do not need to be exchanged between the two parties, but only know how to build them.

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3. Taking advantage of the randomness of the DNA strand in constructing the encryption and hiding methods gave a high degree of efficiency to the hiding process.
4. The process of encryption using a DNA strand as a key can be thought of as similar to OTP, which according to Shannon's theory is unbreakable.
5. The DNA tape can be used as a key in many modern encryption methods that use the secret key to give it a high degree of efficiency and eliminate the need for the key distribution.

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