ELEVATE STEGANOGRAPHY IMAGE FOR HIDING SECRET INFORMATION USING ANT COLONY OPTIMIZATION ALGORITHM

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Abstract- **The tremendous development of digital technology, it is mandatory to address the security while transmitting information over network in a way that observer couldn't depict it. Measures to be taken to provide the security by establishing hidden communication using steganography principle which is help to camouflage the secret information in some carrier file such as text, image, audio and video. In this era of hidden data communication, image becoming an effective tool on account of their frequency, capability and accuracy. Image steganography uses an image as a carrier medium to hide the secret data. The main motive of this article is that the uses the combination of frequency domain and optimization method in order to increasing in robustness. In this article, Integer Wavelet transform is performed into the host image and coefficients have been transformed. ACO optimization algorithm is used to find the optimal coefficients where to hide the data. Furthermore, sample images and information having been demonstrated which proved the increased robustness as well as high level of data embedding capacity.**

***Index Terms*- Security, Image, steganography, IWT, ACO (Ant Colony Optimization) algorithm.**

I . INTRODUCTION

Image processing is a skill to perform an algorithmic strategy to signaling an image in multidimensional systematic way. Cryptographic skills afford the confidentiality and security by reducing the prospect of adversaries [1]. There are two processes in cryptography such as: a) Encryption and b) Key management process. Each security system must supply some security process that guarantees the secrecy of the system [2]. Cryptography is collect into Symmetric Key and Asymmetric Key Cryptography [3]. In Symmetric key cryptography, a single key is used for both encryption and decryption [4]. The Asymmetric Key Cryptography uses different keys for both processes [5]. In session key; the symmetric key can be changed every time in communication between two parties. It is randomly generated and valid for only one session [6-8]. If an attacker gets the session key, he/she can decrypt only the messages for a particular session. If both parties always used the same key for all sessions, the attacker would be able to decrypt all messages encrypted with this key [9-12].

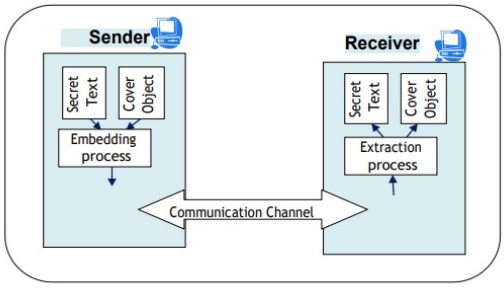


Fig 1. Structural Diagram

The underlying mathematical problem of a public-key cryptosystem determines the efficiency of the cryptosystem in a way. Because these problems dictate the sizes of domain parameters and keys, which in turn affect the performance of the arithmetic operations of the public-key crypto algorithms [13-15]. Optical Cryptography is the art of work made from formal cryptography scheme by dividing any text based information into N subsequent image frames.

Cryptography and steganography are well known and widely used ability that manipulate information (messages) in orderto cipher or hide their existence. These ability have many applications in their Computer science and other related fields: they are used to protect e-mail messages, credit card information and etc. There are various rate on which show of visual cryptography scheme depends, such as pixel expansion, contrast, security, accuracy, computational complexity, share generated is meaningful or meaningless, type of" share generated is meaningful or meaningless, type of secret images(either binary or color) and figure of secret images(either single or multiple) encrypted by the scheme.

Steganography is the art and science of secret communication between two parties over a public medium that is not detectable by an observer. Steganography is obtain from the Greek words “stegos” meaning “cover” and “grafia” meaning “writing” defining it as “covered writing”. In image steganography the data is hidden exclusively in images . Extremely hard to detect, a normal cove message was sent over an insecure channel with one of the periods on the paper containing hidden information. Today steganography is mostly used on computers with digital data being the carriers and networks existence the high speed delivery channels. Steganography is a close cousin of cryptography which is the art and science of secret communication. Cryptography aims to conceal the content of the message whereas steganography hides the very existence of secretive communication as well [17]. For example, figure 1 shows that two users want to sharing information between them. But notice is examining that communication via Internet Service Provider or local server. To protect this communication, steganography provide a model in which sender A wish to send message M to receiver B. Sender embed M over the cover media C and obtained stego object S then sent it over the insecure channel. The terms cover object is defined as various types of multimedia objects are used to hide the data and stego object is known as which object embedded the secret information[18].Effective characteristics of steganography [20];

1. Secrecy : With the allowing of intend users, extracting the hidden information [34-37]
2. Imperceptions: The ability to be completely undetectable [38-40]
3. Capacity: Maximum length of the hidden information which can be embedded in cover object.
4. Accuracy: Extracting of the embedded data should be accurate.

Steganography techniques are classified into two types which are spatial domain and frequency domain techniques. In spatial domain, processing is data hidden directly on the pixel values of the image and in frequency domain, image is transformed then data is hidden on the transformed coefficients [21]. Some of the spatial domain techniques are LSB, PVD, EBE, RPE, PMM and Pixel intensity based etc. and some of the frequency domain techniques are DCT, DWT, DFT, IWT and DCVT [22].

Specifically, spatial domain techniques are susceptible to visual attack and pixel alteration [23]. When comparing to spatial domain, transform domain techniques are more robustness because of its hiding scheme in significant areas of cover images [24-28]. Integer wavelet transform (IWT) maps an integer data set into another integer data set . In separate wavelet transform, the used wavelet filters have floating point coefficients so that when we hide data in their coefficients any truncations of the floating point values of the pixels that should be integers may cause the loss of the hidden information which may lead to the failure of the data hiding system [29].

The ant colony optimization algorithm (ACO) is a probabilistic technique for solving many problems which can be reduced to finding good paths through graphs. Ant Colony Optimization (ACO) is a population-based, general search technique for the solution of complex continuous problems which is inspired by the pheromone track laying behavior of real ant colonies. The conduct of ant is intimidated in artificial ant colonies for the search of estimated solutions to discrete optimization problems, to continuous optimization problems, and to important problems in telecommunication, such as routing and load balancing The developed AS strategy attempts to simulate behaviour of real ants with the addition of several artificial characteristics: visibility, memory, and discrete time to resolve many complex problems successfully.

The remaining of the paper is constructed as below: Relevant works have discussed in section 2. In section 3, explain the workflow of proposed method include algorithms. In Section 4, prove the proposed method has increasing in robust and level of capacity by carried out the experiment on sample image and secret data. Finally, Section 5 concludes the article.

II. RELATED WORK

Discrete Wavelet Transforms are used in JPEG2000 image format and several methods embed information using Integer Wavelet Transform Coefficients. Lai and Chang proposed an adaptive data hiding method in the frequency domain [30]. Seyyedi et al. in [22] proposed a high volume payload and secure steganography technique based on integer wavelet transform. Ghasemi et al. combined Genetic Algorithm (GA), OPAP and Integer Wavelet Transforms to reduce distortion while delivering high embedding capacity in[23].

N. Vinothkumar et al [24] have been suggested to embed the data over image on the basis of the combination IWT with Optimal pixel Adjustment Process (OPAP). The method use IWT to transform the coefficients on cover image and OPAP is used to raise the level of hiding capacity. Result shows that minimize difference error betwixt original and encoded image.

Ching-Sheng Hsu et al [25] have been proposed method to determined the optimal LSB substitution using ACO algorithm . This method embeds the data into the last bits of the cover image. Moreover, generate optimal matrix with the help of ACO algorithm to conceal the data at the optimal values.

Rafael Lima de Carvalho et al [26] have been used optimization principle to hide the secret message into the target picture. Optimization done by PSO algorithm and produce better result than classical GA based method.

AmanjotKaur et al [27] have been proposed algorithm which finding an optimal block on image may be the best position to hide the data. The fitness function to be taken where ratio is maximize of sum of contrast and energy and entropy and homogeneity. Results prove that this algorithm showing superiority than PSO algorithm.

III.PROPOSED METHOD

The proposed method is splitted into two subsequent parts such as using IWT for transforming coefficients and ACO to find the best values for embedding. In the first part of proposed method, input the color image as carrier and extracting three RGB color components [31]. Integer wavelet transform is applied on these components and results showing transformed coefficients. Second part concerned the Ant Colony Optimization algorithm which inspired the behavior of ants. These ants deposited pheromone on the path to discover shortest best path from nest to food. More pheromone on path increases, that path followed by every other ants of the colony. Ant Colony Optimization Algorithm work on the basis of the similar mechanism and used in proposed method. The secret raw data has been converted into ASCII values and these can be embedding at the optimal coefficients by applying ACO algorithm. After all secret values were embedded; inverse IWT is processed to gain the stego object and ready to send it to receiver. At the recipient side, received it and extract the secret data from it by performing the reverse procedure of embedding method. With the neat sketch, the entire work of proposed method is described in the following figure.

Algorithm

Proposed embedding algorithm is enumerated below to hide the data over the cover image.

1.Given input as color image and secret data
2. Extract RGB components from color image
3.IWT technique is applied on the bands and makes transformation among the coefficients.
4.ACO algorithm is used to find the optimal points.
5. Data is converting into ASCII values. On each row at every location given by the ACO, embed values at those optimal points.
6. Finally, stego image is obtained by process the inverse IWT method.

Whereas the proposed extracting algorithm is explained below

1. Receive the stegoimage
2. Data is extracting from the stego image by performing the reverse operation of embedding method.
3. Obtained the secret data.

Ant Colony Optimization Algorithm

The ant colony optimization algorithm (ACO) is a probabilistic ability for solving computational problems which can be minimize to finding good paths between graphs [33]. Ant System's algorithm is main be a resident of mainly in being the prototype of a number of ant algorithms which have found many interesting and successful applications.

Step 1:

Initialize the solution H_i

Step 2:

Find the fitness value (F_i)

$F_i = PSNR + CC$

Step 3:

Based on the fitness find Probability transition matrix

$$P_{ij}^{c} = \frac{(r_{ij})^{\alpha}(n_{ij})^{\beta}}{\sum(r_{ij})^{\alpha}(n_{ij})^{\beta}}$$

Step 4:
Update pheromone and Evaporation pheromone

$$r_{ij} = (1 - \rho) * r_{ij} + \sum_{c=1} \Delta r_{ij}^{c}$$

Step 5:

Find the fitness forH_{new} from pheromone evaporation

$$if(H_{new}) > f(H_i)$$

Step 6: Store the best solution so far attained
Iteration=Iteration+1

Step 7:
Stop until optimal key attained

where, ρ =pheromone evaporation rate S= number of ants

$\Delta\tau ij\ c$ = is the quantity of pheromone laid on edge (i,j) by c-th ant

$\Delta\tau ij\ c$ = { Q/Lc; $if\ ant\ c\ use\ connection(i,j) in\ its\ tour$
0; $otherwise$

Block Diagram

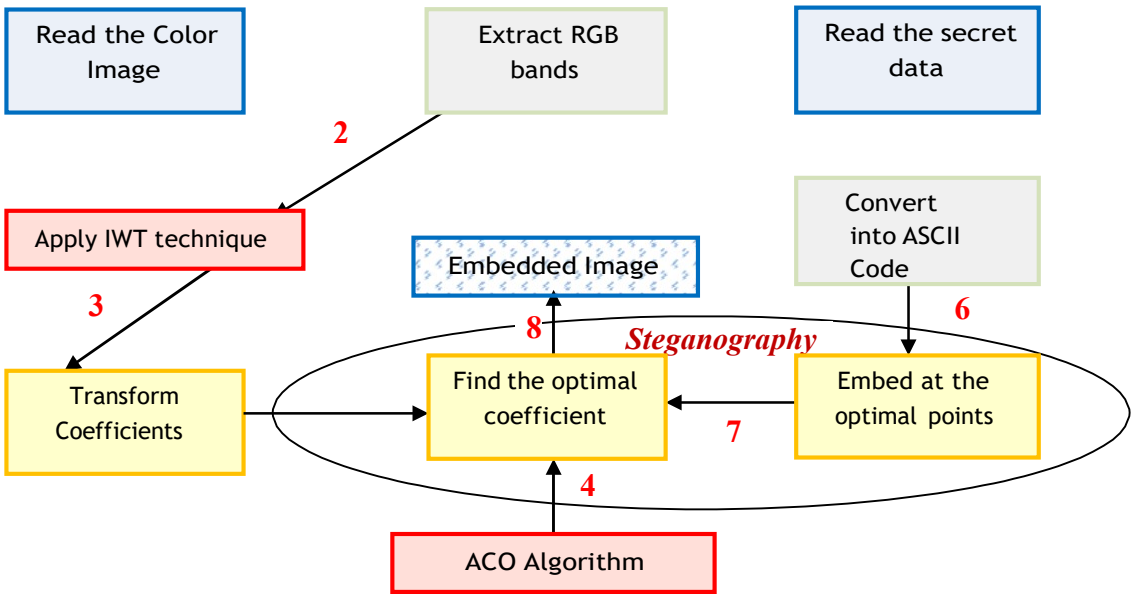


Fig 2. Block Diagram

IV.RESULTS AND DISCUSSION

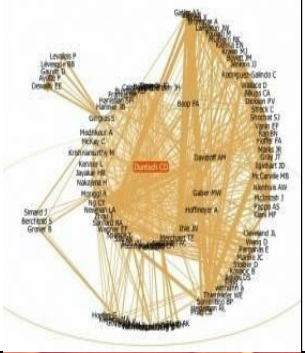
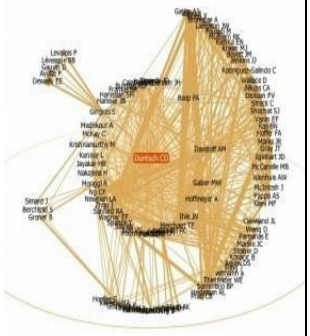
Our proposed approach has been validated by experimenting with variations of the images. The proposed system has been implemented in Visual Studio 2010, with .NET Framework Version 4.0 using the language of C# windows application. The experiment has been conducted several test images by taking RGB cover images of dimension 512x512. Table 1 shows the original images, secret data and stego images. From the above defined experimental results, we can observe that after secret data embedded, there is no visual difference from the original image. Hence, the existence of the embedded message will not be known to the unauthorized users.

Ant system up to date the pheromone track using all the solutions produced by the ant colony [1]. Each edge an affinity for a place to one of the calculated solutions is modified an amount of pheromone proportional to its solution value. At the last of this phase the pheromone of the entire system evaporates and the process of construction and update is iterated. Ant Colony System is more successful since it avoids long convergence time by directly focus the search in a neighborhood of the best tour found up to the current iteration of the algorithm.

In each iteration, colonies of ants are sent to a particular place for solution. Each ant works steadily in their state change rules. Suppose, if an ant completes a work, then the pheromone modernized start to search another antwith similar strength. But it significantly reduces the opportunities and changes the search methodology

Various performance metrics were also verified from the resultant image such as the Peak- Signal – Noise – Ratio, between the original image and this can further be proved from the Peak-Signal-to-Noise- Ratio (PSNR) between closing images and original images.

Table 1. Experimental Results of the Proposed Technique

Original Image	Sample Secret Data	Stego Image
	Information hiding has attracted lots of attention over recent years. It is the art and technique of concealing a message in a cover without leaving any remarkable trace on the cover signal. There are three main compromising attributes for a data hiding system, known as capacity, imperceptibility, and robustness. The data hiding schemes are principally categorized into steganography and watermarking, according to the application based requirements. In the steganography systems, our goal is to provide more capacity, where a better robustness characteristic is of concern in watermarking	
	The term steganography is not new today. In fact several examples from the times of ancient Greece are available in Kahn. In recent years, everything is trending toward digitalization and with the rapid development of the Internet technologies, digital media can be transmitted conveniently over the network. Therefore, messages need to be transmitted secretly through the digital media by using the steganography techniques. Steganography differs from cryptography in the sense that where cryptography focuses on keeping the contents of a message secret, steganography focuses on keeping the existence of a message secret.	
	The word steganography is original from the Greek language words „stegos grafia' the meaning is „covered or concealed writing. In image steganography the information is secreted entirely in images. Steganography is the ability and skill of hidden way of communication. This is fulfilled during hiding secret information in any other information, as a result concealing the presence of the communicated information data.	
	The rapid growth of internet usage over high bandwidth and low cost computer hardware has propelled the explosive growth of steganography. In the present year, secure and hidden communication is the foremost requirement of the people. Therefore steganography is gaining attraction by people due to the security issues over internet. Steganography means covert writing. Steganography has evolved into a digital strategy of hiding a file in some form of multimedia, such as an image, an audio file or even a video file.	

V.PERFORMANCE EVALUATION

For comparing stego image with cover results requires a measure of image quality, commonly used measures Peak Signal-to-Noise Ratio [12]. If SNR and PSNR represent smaller value, then it indicates there is a large between the original (without noise) and distorted image. The main advantage of this calculate is ease of computation, but it does not reflect perceptual quality. An important property of PSNR is that a slight spatial shift of an image can cause a large numerical distortion but, there would be no optical distortion and conversely, a small averagetwist can result in a damaging visual artifact, if all the error is concentrated in a small important region. The performance values the PSNR calculated from the output image is compared with the PSNR values provided in the existing techniques, in the following table 2.

Table 2. Comparison between existing and proposed technique based on PSNR

Cover Image	Size	Proposed Algorithm
Sailboat	256x256	65.6274
Goldhill	300x256	66.0808
Peppers	400x400	69.4901
Lena	512x512	71.6319

VI. CONCLUSION

The proposed method is used to increase high capacity and optimized image steganography technique based on ant colony optimization algorithm. The ACO algorithm can find good solutions efficiently even though the search space is so large. Our experimental results show the proposed method provides acceptable image quality and secret message capacity. In future, some data encryption technique can be applied along with ABC to increase the security level. It may also be possible to optimize the fitness function of the current ABC algorithm. Algorithms like AFS and BFO can also be tried to view their performance with respect to the proposed method.

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