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An Optimized Image Steganographic Method based on Artificial Bee Colony Algorithm

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***Abstract*— With the growth of internet communication, there is need for information to be secured while it transmits from sender to receiver over insecure channel. In data hiding field, steganography is prominent role in which the process of hide secret information with another medium. Among different cover media, image is considered to be an effective and important media due to higher degree of accuracy. In image steganography, secret information is hidden into the cover image and this image may be color or grayscale. Several transform domain techniques are available but IWT is used because of its efficiency. The main objective of the proposed work is that determine the optimal values and data is embedded at that point. In this proposed method, IWT and ABC algorithm is used in which the first step is to read the color image and data which want to conceal. Integer Wavelet transform is performed on color components of image and on these transformed coefficients, use ABC algorithm which is termed as Artificial Bee Colony Algorithm to find the best value for hide the data. The strength of the proposed method is demonstrated by experiment is carried out on secret data and test images which gives good visual quality and high embedding data capacity.**

***Keywords*— Image steganography, IWT, ABC (Artificial Bee Colony) algorithm.**

I. INTRODUCTION

The Steganography is of two Greek words which are steganos and graphia means hiding secret information into cover media. The notion of data hiding or steganography was first introduced with the example of prisoners' secret message by Simmons in 1983[1]. Use any type of media such as text, image, audio and video to conceal the message. In generally, the file is used in which the data is hidden is refer as "Cover Object" and "Stego object" is refers file has secret message. General Steganography mechanism is depicted in Figure 1. Among several cover media, image file are best suited due to their high degree of redundancy [2]. When the data is hidden, two characteristics are must essential which are quality and security. The Image steganography technique is broadly used procedure to protected information used for hidden communication. Such as featured tagging, military agencies copy right protection [3]. 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 [4]. 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 [5]. Integer wavelet transform (IWT) maps an integer data set into another integer data set. In discrete 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 [6]. Optimization algorithms are used to select the best element (with regard to some criteria) from some set of available alternatives [7].

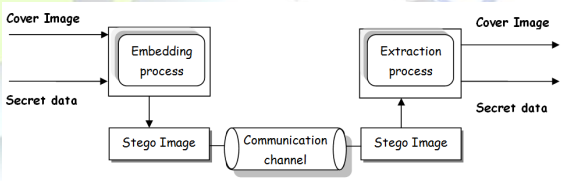

Fig. 1 General steganography mechanism

To find optimal values, many algorithms are introduced depend on nature-inspired concepts which are, GA, PSO, ABC, Bee colony optimization, EA, GWO, etc. ABC (Artificial Bee colony) algorithm is introduced by Karaboga [8] which is depending upon the honey bee swarm behavior. The ABC algorithm consists of three bee groups and food sources. The position of a food source denotes a possible solution to the optimization problem and the nectar amount of a food source represents the quality (fitness) of the associated solution. The three types of bees are onlookers, scouts, and

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employed bees [9]. The bee which carries out random search is known as a scout. The bee which is going to the food source which is visited by it previously is employed bee. The bee which is waiting on the dance area is an onlooker bee. The onlooker bee with scout is also called unemployed bee.

II. Related Work

Amandeep Kaur *et al.* [10] have introduced method in which use the combination of DWT and Artificial Bee Colony which is termed as ABC. In this method, first read image and suppose, read color image then it is converted in to grayscale image and after that, DWT is performed to compute higher coefficients. Masking and Edge Indication has also been used for the initialization of contour that is generated by a signed distance value. Then ABC is applied to get the optimize values. Secret data is converted into bits and inserted in to the appropriate bits of the image. The result shows that PSNR range varying from 60 to 75 effectively and also increasing embedding capacity by 30%.

N. Vinothkumar *et al*. [11] have proposed method which is based on IWT and Optimal pixel Adjustment Process (OPAP). In this method, cover image is divided into 8x8 blocks and IWT is applied to obtain four sub bands. The data is embedded in IWT coefficients and then OPAP is employed which is increase the level of hiding capacity. The result of the proposed method ensure that difference error is minimized between original image and modified image. Thus, PSNR level is increased by using of mapping function.

Miao Ma *et al.* [12] proposed a rapid SAR segmentation method for images that relied on ABC algorithm. The image was segmented using DWT. The low as well as high frequency coefficients were generated. An effective fitness function was produced for ABC after defining the grey number in the Grey Theory. By using this algorithm and the concept of onlookers, employed bees as well as scouts, the optimal threshold value was calculated. The results concluded that this method was much better than Genetic Algorithm as well as Artificial Fish Swarm related segmentation methods.

Ching-Sheng Hsu *et al.* [13] have proposed method in which determine the optimal LSB substitution using Ant Colony Optimization. In this method, secret data is embedded into the last bits of the image. Here optimal matrix is used which helps to hide secret data in optimal points. To determine optimal points, ACO is used here.

Maijid kiamini *et al.* [14] have proposed novel method to embed secret data in to the cover image and thus, imposter couldn't notice what is hidden in it. In this novel method, image is divided in to n blocks of 8*8 pixels and message into n partitions. Here, Particle Swarm Optimization algorithm is used to find the optimal solutions. This method is better when compared to JPEG and Quantitization Table Modification method.

III. Proposed Work

In this section, proposed work is implemented. The proposed method is based on the IWT and ABC which is termed as Artificial Bee Colony algorithm. In this method, firstly read secret data, the input color image as a cover image and from this color image, extract R,G, and B components. Second, Integer wavelet transform is applied separately on these components. Third, on these transformed components, ABC algorithm is used to determine optimal pixel value for embedding data. Forth, the data is converting in to ASCII value and then embed at optimal points. After embedding, finally Inverse IWT is performed to obtained stego image at the sender side. On the receiver side, the data is extract from stego image by using reverse process of embedding process. The flow chart for the proposed method is depicted as in figure 2.

A. Proposed Algorithm

The following algorithm is used to embed secret data in a cover image.

Input: Cover Image, Text file
Output: Stego image
Step 1: Read input color image and secret data to be hidden.
Step 2: Color image is break into R, G, B color band and then IWT is applied on each color band separately.
Step 3: Artificial Bee Colony optimization (ABC) algorithm is used to find the optimal points where the data to be hide.
Step 4: Secret data is converted in to ASCII values.
Step 5: Data is hide at the optimal points.
Step 6: After that, Inverse IWT is applied to obtain stego image.

The following algorithm is used to extract secret data from a stego image.

Step 6: Input stego image
Step 7: Data is extract by applying reverse procedure of embedding process.
Step 8: Obtain secret message from the cover image.

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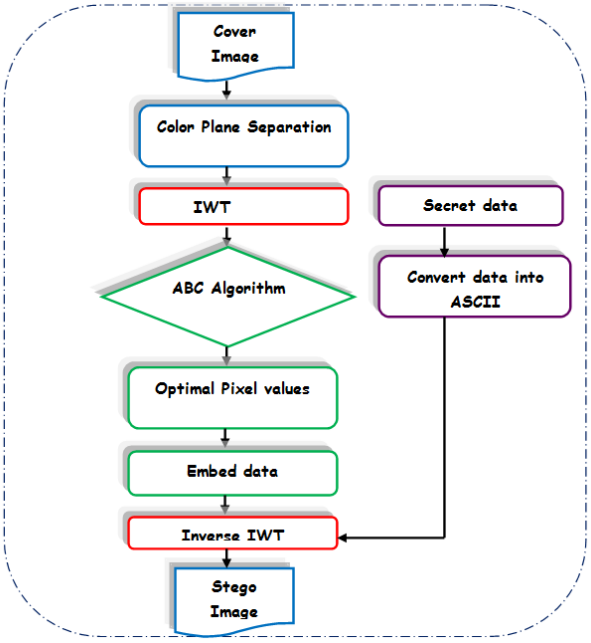


Fig. 2 Flow chart for the proposed algorithm

with .NET Framework Version 4.0 using the language of C# windows application. The experiment has been conducted

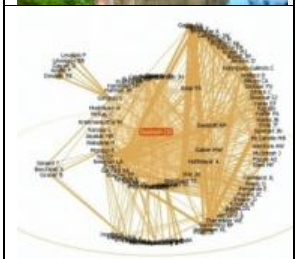
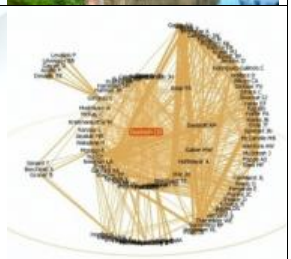
IV. Results and Discussion

A. *Proposed Algorithm*

Our proposed approach has been validated by experimenting with variations of the images. The proposed system has been implemented in Visual Studio 2010, 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.

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

TABLE I
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.	

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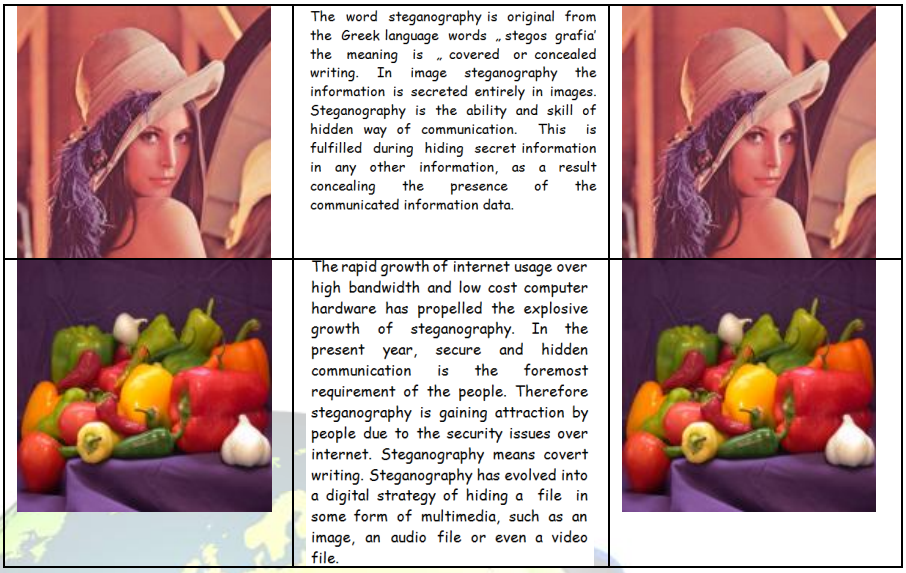

B. *Performance Evaluation*

For comparing stego image with cover results requires a measure of image quality, commonly used measures Peak Signal-to-Noise Ratio. 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 measure 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 visual distortion and conversely, a small average distortion 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 tables 2.

TABLE II
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

V. CONCLUSIONS

The proposed method is used to increase the capacity and the imperceptibility of the image after embedding, and then applied the optimal pixel process to increase the hiding capacity of the algorithm in comparison to other systems. 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. The process has been tried over a set of 60 standard images 15 each of: Sailboat, Goldhill, Peppers and Lena. It has been observed that the proposed method increases the hiding capacity approximately by 33%. It also results into an effective PSNR range varying from 60 to 75 based upon the size of the image and message. 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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