Steganography using DES, ABC Optimization and Image Scrambling

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Abstract
With the evolution of Internet Technology, the need for the security of information during its transmission has also increased rapidly. Steganography plays a prominent role in the field of data hiding and providing a means for secret communication. Steganography basically refers to the process of secretly hiding messages into a cover medium in a way that only the receiver can suspect its existence. In this, the data is hidden behind the cover image. The data is hidden character wise behind the pixels of the image. The various algorithms or techniques used for steganography are LSB-Hash, RSA Encryption, and Decryption. In this project, we use DES Encryption to increase the security level, and DWT to preserve the original quality of the cover image, while also keeping the original image intact after extraction. The usage of ABC Optimization increases the embedding capacity and gives improved PSNR and MSE values. Along with this scrambling algorithm to increase the security level of transmission.

Keywords
LSB; steganography; DES; Artificial Bee Colony; Scrambling

I. Introduction

In order to accomplish security and privacy of information, Steganography, Cryptography and Digital Watermarking methods can be applied [1]. The word steganography enticements its name from the Greek word 'Steganos', which means covered or secret, and 'graphy' which means writing or drawing. Steganography is so named as it is the art of transmitting information in such a way that the existence of the data gets concealed [2]. When it comes to secret data sharing,steganography provides another layer of protection, which basically embeds the media [3].
Generally, the file used, in which the data is hidden is refered to as "Cover Object" and "Stego object" is refered to as the file which 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].

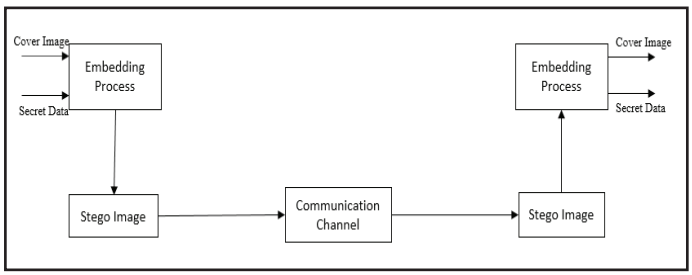

Fig. 1: General Steganography Mechanism

Steganography techniques are classified into two types which are spatial domain and frequency domain techniques. In spatial domain, data is hidden directly on the pixel values of the image and in frequency domain, image is transformed prior to data being 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].

II. Related Work

Amandeep Kaur et al. [9] have introduced amethod in which use the combination of DWT and Artificial Bee Colony which is termed as ABC. In this method, the image is firstread and converted to grayscale if it happens to be an RGB image. 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 optimum pixel values for embedding. Secret data is converted into bits and inserted into 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%.

Christo Ananth et al. [6] proposed a system in which OWT extracts wavelet features, which gives a good separation of different patterns. Moreover, the proposed algorithm uses morphological operators for effective segmentation. From the qualitative and quantitative results, it is concluded that our proposed method has improved segmentation quality and it is reliable, fast and can be used with reduced computational complexity than direct applications of Histogram Clustering. The main advantage of this method is the use of single parameter and is also faster. While comparing with five color spaces, segmentation scheme produces results noticeably better in RGB color space compared to all other color spaces.

N. Vinothkumar et al. [11] have proposed a method which is based on IWT and Optimal pixel Adjustment Process (OPAP). In this method, thecover 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 increases the hiding capacity. The result of the proposed method ensures that difference error is minimized between theoriginal image and modified image. Thus, PSNR level is increased by using themapping 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 gray 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 amethod 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.

III. Proposed Work

The proposed methodology is divided into different subsequent sections like DWT, ABC Optimization to find optimal pixel location for embedding, and DES for encryption. The image is first converted into grayscale if it is a colored image and DWT is applied to divide the image into four subsequent sections which contain one band with low-frequency coefficients and three bands with high-frequency coefficients. Further ABC is applied on the obtained or segmented region to optimize the values for the process of embedding. Themessage to be embedded is first encrypted using DES and then inserted into the appropriate bits of the image, using the LSB insertion method.

Proposed concept uses DES algorithm for encryption and decryption techniques. An N-level decomposition of the cover image and the secret images are done, and frequency components, DES factor of the same are combined. Secret Messages are extracted from the stego image at the receiver site.

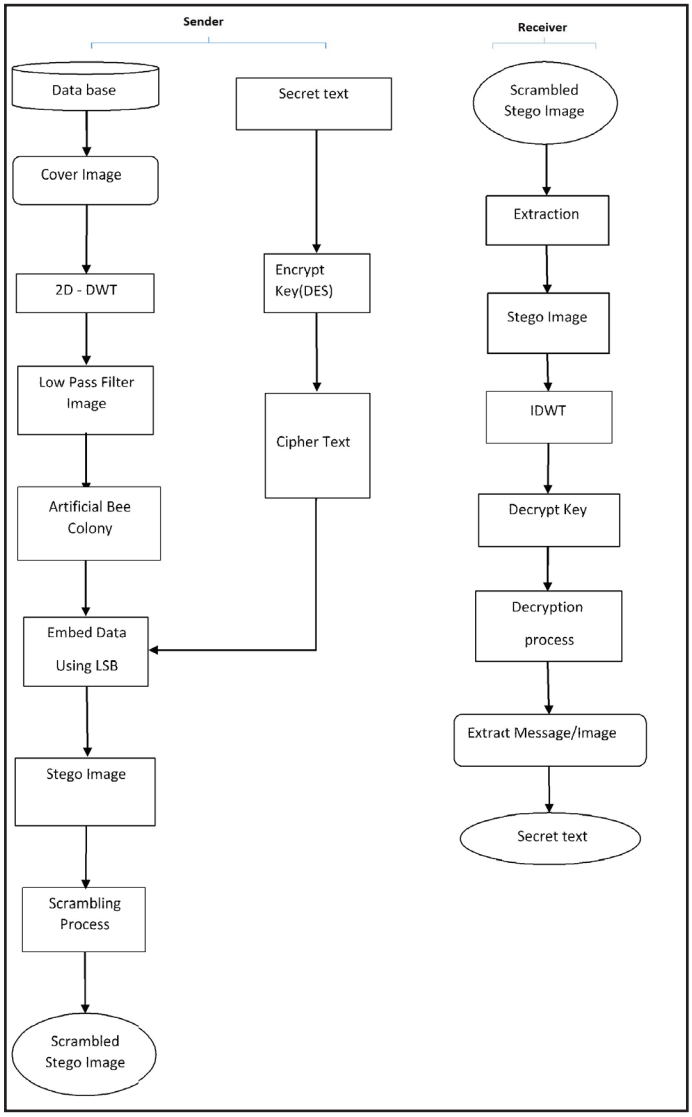

Fig. 2: Proposed Methodology

A. Discrete Wavelet Transformation

The wavelet transform decomposes a typical image data to a few coefficients with large magnitude and many coefficients with small magnitude. In wavelet transform first step decomposes a signal into constituent parts in the time-frequency domain on a basis function localized in both time and frequency domains. The image or signal isdecomposed into four different frequencies: approximation, vertical detail, horizontal detail and diagonal detail.

Up to a level, the decompositions are repeated on the approximation coefficients. As details are not decomposed at the high levels and can be described by the small scale wavelet coefficients, thewavelet transform is not suitable for images having rapid variations.

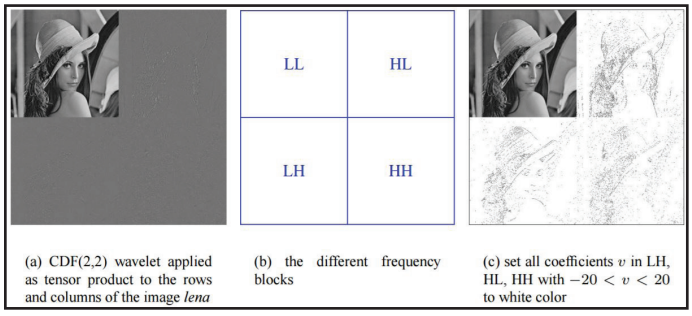

Fig. 3:

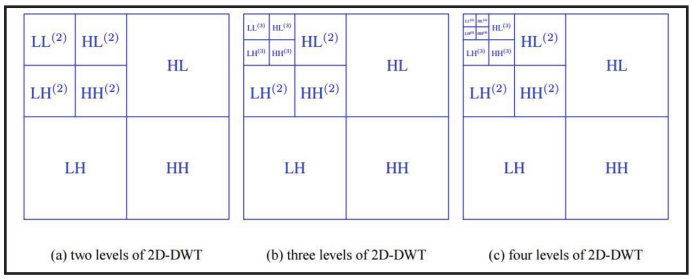

Fig. 4:

B. Artificial Bee Colony Optimization

The ABC algorithm is developed by inspecting the behaviors of the bees on finding afood source, called as nectar, and the information of food sources to the bees in the nest is shared. The different phases of ABC are classified into three types, namely, the employed bee, onlooker bee and the scout bee. In the employed bee phase, the employed bee stays on a food source and provides the neighborhood of the source in its memory. In the onlooker phase, the onlooker receives the information of food sources from the employed bees in the hive and to gather the nectar one of the food source is selected; and for finding new food, the new nectar, sources the scout is responsible. The process of the ABC algorithm is presented as follows:

Step 1. Initialization: In a solution space randomly Spray ne percentage of the populations, and then their fitness values calculated, called as nectar amounts, where the ratio of employed bees to the total population is represented by ne. The populations positioned into the solution space, are called as employed bees.

Step 2. Move the Onlookers: The probability of selecting a food source is calculated, select a food source to move by roulette wheel selection for each onlooker bees and then determine the nectar amounts of them.

Step 3. Move the Scouts: By a continuous predetermined number of iterations, if the fitness values of the employed bees do not improve, which is called" Limit", such food sources are abandoned, and these employed bees become the scouts. The movement of scouts takes place.

Step 4. Update the Best Food Source Found So Far: Memorize the position and the best fitness value, which are found by the bees.

Step 5. Termination Checking: Check whether the termination condition is satisfied by the number of iterations. Terminate the program and output the results if the termination condition is satisfied; otherwise go back to the Step 2.

C. Scrambling Process

The main aim of digital image scrambling, which is used as the preprocessing or post-processing in image information hiding, is to transform a meaningful image into a meaningless or disordered image in order to enhance the power to resist invalid attack and in turn enhance the security. Image watermarking Algorithm based on DWT transform.

This algorithm scrambles the watermarking image and puts the watermarking image and original image in three-layer wavelet transform, eventually embeds the watermarking image in the original image to realize the embedding of watermarking. This algorithm scrambles the watermarking image and puts the watermarking image and original image in three-layer wavelet transform, eventually embeds the watermarking image in the original image to realize the embedding of watermarking.

IV. Results and Analysis

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 difference 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.

$$MSE = \frac{\sum_{M,N}[I_1(m,n) - I_2(m,n)]^2}{M \times N}$$

where,

$$PSNR = 10 \times \log 10\left(\frac{255^2}{MSE}\right)$$

where M and N are the numbers of rows and columns in the input image, respectively. I1 is the embedded image and I2 is the cover image.

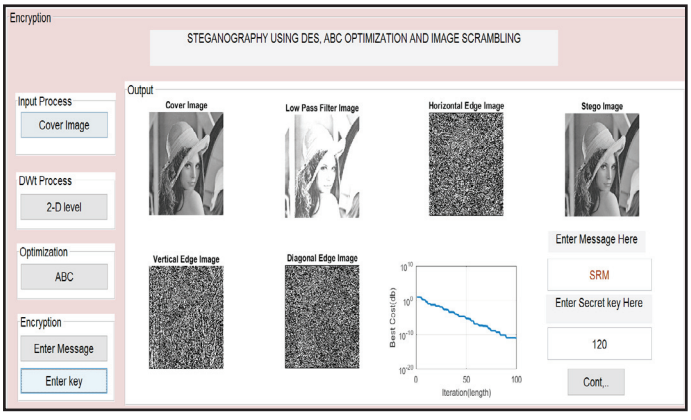

Fig. 5: 2 Level DWT

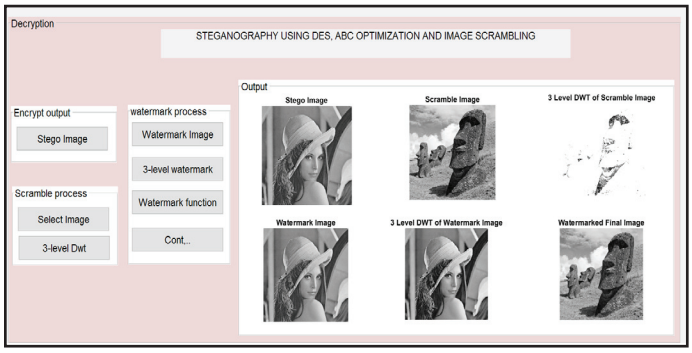

Fig. 6: Image Scrambling

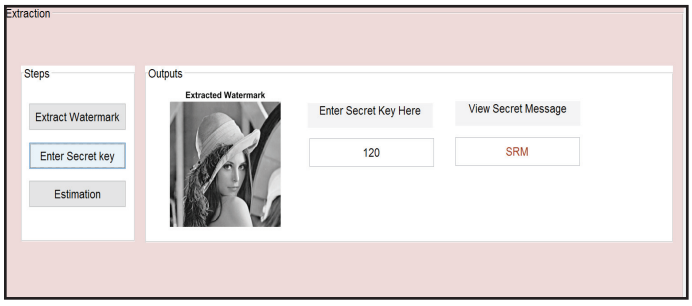

Fig. 7: Extraction Process

Fig. 8: MSE and PSNR Estimation Window

Fig. 9(a) Lena

Fig. 9(b) Baboon

Fig. 9(c) Boat

Fig. 9(d) Honeybee

Fig. 9: Test Images

The experiment has been conducted in MATLAB environment by taking grayscale cover images of dimension512x512. The following jpeg cover images have been taken:1. Lena, 2. Baboon, 3. Boat, 4. Honeybee. The average result evaluated during the experiment is shown in Table 1. The messagethat has been embedding during our

test is "The quick brown fox jumps over the lazy dog."The PSNR and MSE values have been calculated using theequations (1) and (2) respectively. A greatervalue of PSNR represents greater visual quality of the imageand minimum distortion between the original image and theembedded image. Hiding capacity represents the amount ofdata that can be effectively embedded in the image.

Table 1: Comparison results based on Standard DWT steganography and our proposed method

S.No.	Image	MSE		PSNR (dB)	
		Standard Algorithm	Proposed Algorithm	Standard Algorithm	Proposed Algorithm
1.	Lena	0.0321	0.0114	43.6552	48.1392
2.	Baboon	0.0058	0.0021	45.5203	50.0043
3.	Boat	0.0331	0.0118	43.5624	48.0463
4.	Honeybee	0.0195	0.0069	44.3317	48.8157

V. Conclusion

In this research work demonstrated above, it has been observed to be offering a higher level of security. In steganography, the most important factor is the efficiency with which information is concealed in the cover image. From the obtained MSE and PSNR values, it can be inferred that our proposed algorithm has resulted in a significant improvement, over the traditional DWT based steganography.The mean reduction in MSE is 64.3%.The mean increase in PSNR is 10.13%. The usage of DES serves the purpose of encryption, and ABC algorithm helps in improving the hiding capacity. The advantage of using DWT over other transforms, is that it offers atemporal resolution. ThePSNR value is better & MSE value is very less as compared tomany of the existing algorithms.This algorithm is also stronger and robust as well as secure compared to other algorithms. Novisual defects can be observed from the corresponding stegoimages. It can also be referred to devise new algorithms onways tosend different language secret texts or images in audio as well asvideo files with more dynamicity.

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