A Novel Secure Steganography In Contourlet Domain

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Abstract—**Steganography is a technique for secret data communication in an appropriate multimedia medium such as video, audio, image and text files. In this paper, a digital image steganography method provided by the Contourlet domain. In this approach contourlet coefficients within each block separately use a permutation genetic algorithm optimization for hiding the data as a mapping function. The optimal pixel adjustment process (OPAP) is applied after embedding the message to improve the hiding capacity with low distortions. The simulation results show that the quality factor in this method outperform other methods in Contourlet domain, moreover it has high resistance to important steganalysis methods in the Contourlet domain. Thus the proposed approach is also a secure method of steganography.**

Keywords-contourlet domain; genetic algorithm; optimal pixel adjustment process (OPAP); steganography

I. INTRODUCTION

Word Steganography means concealed writing from the Greek word stego (mean cover) and graphy (writing) is used [1]. Steganography is the art of hiding information in a host media such as audio, image, video or text, without noticeable degradation. Until now, many methods have been proposed for hiding data in images. We have two different methods: steganography in spatial or in transfer domain.

The method of spatial domain is very simple and is not detectable by the human eyes. In this method, the pixel value of the image can be manipulated directly. While in transfer domain the coefficient of transfer domain is manipulated. Discrete cosine transform (DCT), Wavelet and Contourlet transform are an example of this.

OutGuess [2], F5 [3], Jsteg [4] and (PQ) [5] are the most important algorithms in DCT. The important feature of DCT, is that after image transform in this domain most of energy is locating at low frequencies (initial conversion coefficients), therefore, exclude or modify the coefficients with greater index, have not important change in the location of the steganography in wavelet domain due to two general properties: being closer to the human visual system and lack of distortions caused by the blocking. Several methods have been presented so far in this domain [6, 7, 8, 9].

II. CONTOURLET DOMAIN

Contourlet transform was proposed in [12]. The contourlet transform provides a multi-scale and multi-directional image expansion. The laplacian pyramid (LP) (10) is first used to capture the point discontinuities, and then followed by a directional filter bank (DFB) (11) to link point discontinuities into linear structures. There is a few studies in this field such as [13, 14 , 15].

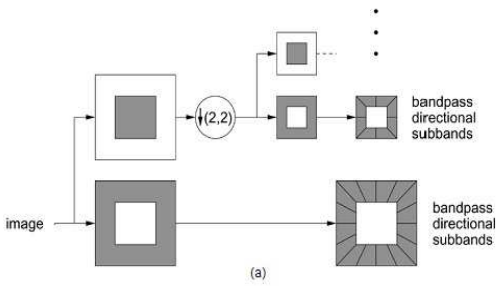

Figure 1. Diagram of a pyramidal directional filter bank (PDFB)

A. *Embedding and Extraction in Contourlet domain*

Contourlet transform is composed of two main parts: the analysis of Laplacian Pyramid (LP) and a Directional Filter Bank (DFB). The original image is transformed by a Laplacian pyramid, image, band pass and low pass image.

III. THE PROPOSED METHOD

In this method, in order to enhance the quality of stego image, three main factors contourlet transform, genetic algorithm and optimal pixel adjustment process (OPAP) was used.

A. *The embedding process is carried out as follows:*

Part 1: The cover image is transformed to contourlet domain, is decomposed with four levels of Laplacian pyramid and sixteen directional filter banks.

Part 2: The regions of the subbands in which the data can be embedded are identified and divided into 8 × 8 blocks.

Part3: the Chromosomes of genetic algorithm, are the number of bits in each block of 1 to 64, we define the default mapping function of 1 to 64 in order.

Part 4: embed the data in 4-LSB of contourlet coefficients.

Part 5: Apply the genetic algorithm based on maximizing the fitness function and determine the optimal mapping function in each block separately. Genetic algorithm, select the best Permutation of pixel blocks in terms of quality (high levels PSNR), to embed the selected data.

Part 6: Apply the OPAP in order to increase the quality of cover image.

Part 7: Calculate the contourlet decomposition of each block.

B. OPAP algorithm :

The main goal of this algorithm[17] is minimizing the error between the cover image and the stego image [18]. Embedded error in this case is:

IF $LSB_i - S_i > 2^{k-1}$
$H_i'' = H_i' + 2^k$, if H_i'' in [0,255] (1)
ELSE IF $LSB_i - S_i < -2^{k-1}$
$H_i = H_i' - 2^k$, if H_i in [0,255]
Return H_i

Where H_i' is the pixel with the secret massage S in it. And H_i is a copy of H_i'.

C. Extraction Process

The key used in the embedding process must be shared by the sender and the receiver. Hidden extraction process involves the following steps.

Part 1: The stego image is decomposed with 4 levels LP and 16 directional filter banks of contourlet transform.

Part 2: The selected subbands is recognized.

Part 3: the shared key is used to find the sequence of pixels in each block that contain secret messages.

Part 4: Extract 4-LSBs for each pixel, and discover the secret data.

D. Genetic Algorithms

In this study, we have a permutation genetic algorithm for different permutations embed secret data per each block, based on PSNR of the image. For using genetic algorithm first of all we should define our chromosomes.

E. Design chromosomes

Each block contains 64 contourlet coefficients as one chromosome. The proposed approach uses single-point crossover operator to combine chromosomes. Here, genetic mutation is random and the method is based on tournoment.

F. fitness function design

Here the fitness function try to maximize peak signal to noise ratio (PSNR). Thus, the fitness function according to equation (2) are defined.

$$PSNR = 10 \log \frac{M \times N \times 255^2}{\sum_{ij}(y_{ij} - x_{ij})^2} \quad (2)$$

Where M and N are the size of image, y and x are the intensity of gray level of image in the pixel i, j.

IV. Simulation Result

The proposed approach is simulated by using the software R2009aMATLAB XP operating system with the Intel CPU 2.26GHz and has 1GB RAM. The images used in this study, 4 gray scale images Baboon, Lena, Jet and Boat 8-bit size is 512 * 512[18]. Table 4-1 shows the results of the comparison. The proposed method has been proposed in [18, 19, 16] are compared.

TABLE I. COMPARISON THE PROPOSED METHOD WITH THE METHOD PROPOSED IN [18, 19, 16].

Cover image	Method	PSNR	capacity
Lena	[18]	39.94	50%
	[19]	44.90	27.43%
	[16]	45.20	56.63%
	Proposed method	46.66	56.63%
Baboon	[18]	40.34	50%
	[19]	44.96	27.34%
	[16]	43.69	51%
	Proposed method	44.98	51%
Boat	[18]	40.44	50%
	[19]	44.92	27.33%
	[16]	42.63	58.30%
	Proposed method	43.96	58.30%
Jet	[18]	45.20	50%
	[19]	44.76	27.33%
	[16]	45.55	46.02%
	Proposed method	47.21	46.23%

This approach is also proposed two algorithms of steganalysis in Contourlet domain CBS[1] [20] and [21], moreover it is evaluated by the method proposed in [15] and the method of [16]. In these two steganalysis algorithm a non-linear SVM used to distinguish between the original image and the cover

[1] Contorlet based steganalysis

image. In order to evaluate 300 images (150 cover and 150 stego image) from Washington University image database [22] has been chosen randomly for testing.

TABLE II. COMPARISON THE PROPOSED METHOD WITH THE METHOD PROPOSED IN [15, 16].

Secret data size(bits)	method	Average detection accuracy (%) by [21]	Average detection accuracy (%) by CBS
5000	ContSteg	77	59
	[16]	-	59
	Proposed method	72	58
10000	ContSteg	89	63
	[16]	-	62
	Proposed method	82	61
15000	ContSteg	93	68
	[16]	-	65
	Proposed method	90	67

V. RESULTS

This is a new steganography technique that enhances the quality of the stego image. To enhance the quality of the stego image three important factor such as contourlet domain, genetic algorithm and optimization of pixel adjustment process (OPAP) was used.

The results of the implementation shows that, quality factor in this method is the same method in contourlet domain further. The proposed method has high resistance to steganalysis methods in the contourlet domain. Thus the proposed approach is also a secure method of steganography.

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