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Full Length Research

Encryptional Hiding Image in Image using Wavelet Transform

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This research implied the algorithm of hiding a gray scale image into another gray scale image. The data elements of the secret image (Which is important image of any application) were place within Discrete Wavelet Transform (DWT) subspaces of the cover image (unimportant image) after simple treatment. The resulting image after the hiding process was called stego_image. The secret image can be encoded by any coding methods before hiding it in the cover image, which will increase the security of the hiding process. Huffman code was efficient coding in this process. Each bit of Huffman code of the secret image was embedded in the high frequency coefficients of the cover image, and the performance of hiding process algorithms was in terms of PSNR and RMSE. For example the PSNR of hiding one secret image in a cover one was 35.914 and RMSE was 16.657.

Keywords: DWT; Hiding system; Huffman codes; Encryption; Image proceesing, steganography.

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INTRODUCTION

Special and reliable security in storage and transmission of digital images are needed in many applications such as military image databases, military images communication and medical image system. Image hiding can fulfill such security tasks to protect the content of digital images (S. Li, X. Zheng, 2002). Information hiding is used to embed data into various forms of media, such as images, audio or text with minimum amount of degradation (S. Katzenbeissers, F.A. Petitcolas, 2000). The proposed hiding scheme uses Discrete Wavelet Transform (DWT) to embed data elements of the secret image in different frequency bands of the cover image. The practice of hiding secret information in a manner such that the existence of secret information is concealed called steganography (S. Boukhonine,2002). It prevents outside observer from recognizing that hidden information is present. Hence, hiding image with steganography reduce the chance of secret image being detected (Kh. Manglem, S. Birendra et al, 2007).

Discrete wavelet transform

Discrete wavelet transform is a technique for analyzing images. It divides a signal into difference frequency components each with different resolution (H. Al _Obaidy,2004) . The input image is divided into 4

(a) (b)

Figure 1. (a) Original image of baby, (b) result after the one-level 2-D Haar-DWT

non-overlapping multi resolution sub-bands by the filters, namely LL1 (Low Low-Approximation coefficients-), LH1 (Low High-vertical details-), HL1 (High Low-horizontal details-) and HH1 (High High diagonal details). The sub-band (LL1) is processed further to obtain the next coarser scale of wavelet coefficients, Generally most of the Image energy is stored in these sub-bands (T. Bhattacharya et al, IJMER]. There are many different wavelet filters: Haar wavelet (db1)and Daubechies Wavelet (db3), ect.

The one-level 2-D Haar-DWT applied on the image “baby” was shown in (Figure 1).

The mathematical approach to the discrete wavelet transform (DWT) is based on the fact that a function f(t) can be linearly represent as:

$$f(t) = \sum a_k \varphi_k (t) \quad ….(1)$$

Where ak are the analysis coefficients and φ_k the analyzing functions, which are called basis functions (M. Jansen, 2001).

the coefficients can be estimated from the following equation:

$$a_k = [\ f(t), \varphi(t)\ ] = \int f(t)\ \varphi(t)\ dt \quad ….(2)$$

Proposed Image Steganography Algorithm

The basic idea to hide information using DWT is to alter the magnitude of the DWT coefficients of three sub-bands, HH, HL, and LH of cover image (Amitava N et al, IJCSS). The human eyes are not sensitive to the small changes in the edges and textures of an image but very sensitive to the small changes in the smooth parts. This allows the secret image to be embedded at high frequency sub-bands without being perceived by the human eye (Amitava N et al, IJCSS).

Hiding one or more important secret image in cover image using DWT would take the following steps:

1-Select a cover image.
2- Decompose a cover image into four sub-bands using DWT : LL, HL, LH , HH.
3-Select one , two or three secret images.
4- Multiply the secret images by constant called coefficient (c) in order to reduce its size.
5-Select the HH sub-band of the cover image for embedding one secret image, its size is equal or less than the size of HH sub-band of the cover image, on other way , select HH , HL sub-bands for embedding one secret image that its sizes is greater than HH sub-band and less than the size of HH,HL sub-bands.
6- Modify the sub-band values of HH (hiding the secret image) by altering the magnitude DWT coefficient of the sub-band (HH) of cover image.
7- If there is more than one secret image (such as two or three secret images) select the HH, HL sub-bands for embedding two secret images ,the size of each one is equal or less than size of one sub-band .In the case of three secret image select the HH , HL, LH sub-bands for embedding three secret images their size is equal or less than size one sub-band.
8- Modify three sub-bands values of HH , HL and LH in each case, (hiding the secret image) by altering the magnitude DWT coefficient of the sub-bands (HH,HL and LH) of cover image.
9-Apply inverse DWT (IDWT) on the DWT transformed image ,including modified sub-bands to produce a new image which contains one ,two or three secret images called " stego image "

Huffman coding

The Huffman coding method is a lossless compression technique. It is a statistical coding method in which the occurrence probability of a pattern has a direct relation

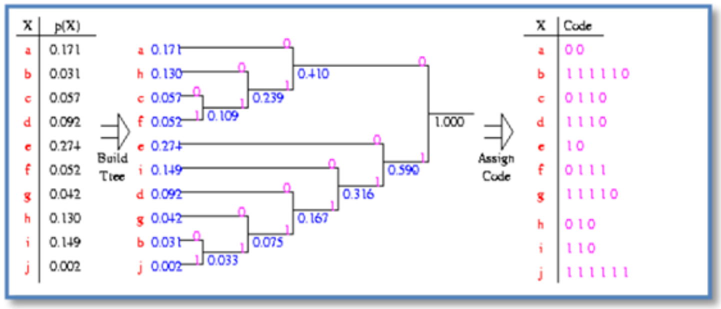


Figure 2. Construction of Huffman code.

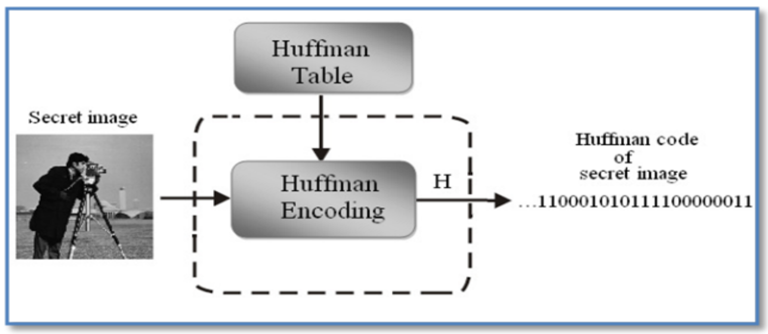


Figure 3.a. Huffman encoding of secret image.

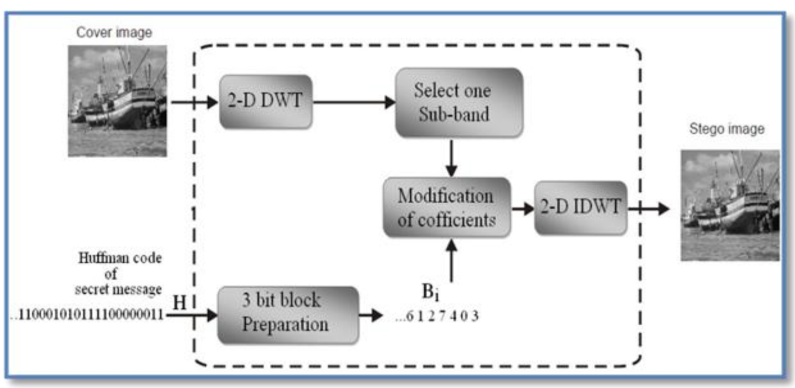


Figure 3.b. Insertion of a Huffman code of secret image into a cover image.

with the length of the code substituting for the patterns. To begin, the Huffman coding method creates a binary tree called a ‘‘Huffman tree”.Next, each path from the root node on the Huffman tree to one leaf node is traversed and a binary code is generated. While visiting each node on the path, if a left child is met, one 0-bit is appended to the binary code. Otherwise, one 1-bit is appended to the binary code. The binary code is the related Huffman code of the pattern in the leaf node on the path. Ultimately, each pattern in the input data is encoded by its related Huffman code. Therefore, to decode the data, the Huffman code table and Huffman codes must be stored. Then the data can be encoded simply by replacing each pattern with its related Huffman code (Saywood, 2002). Figure 2 explain the construction of Huffman codes.

The Hiding process with Huffman coding

Before embedding the secret image into cover image, it is first encoded using Huffman coding (Jayaraman S, 2009). Huffman codes are optimal codes that map one symbol to one code word. For an image, Huffman coding assigns a binary code to each intensity value of the image and a 2-D (M×N) image is converted to a1-D bits stream with length LH < (M×N), Figure 3 explained that Huffman code h is decomposed into 10-bits blocks and thus form a decimal value ranging from 0 to 9. For

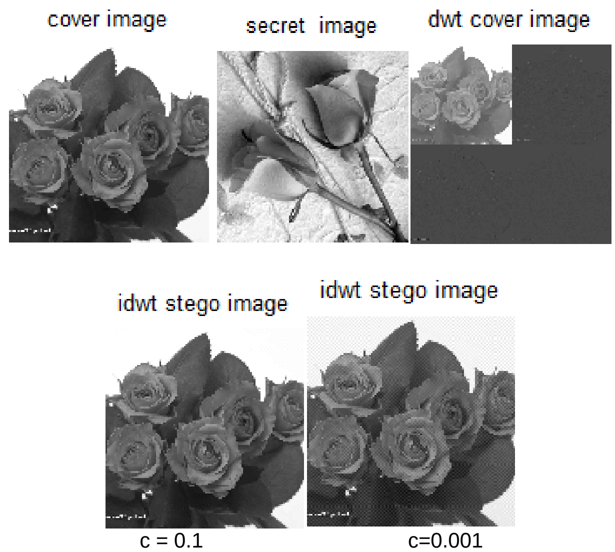


Figure 4. Embedding of one secret image of size (400×400).

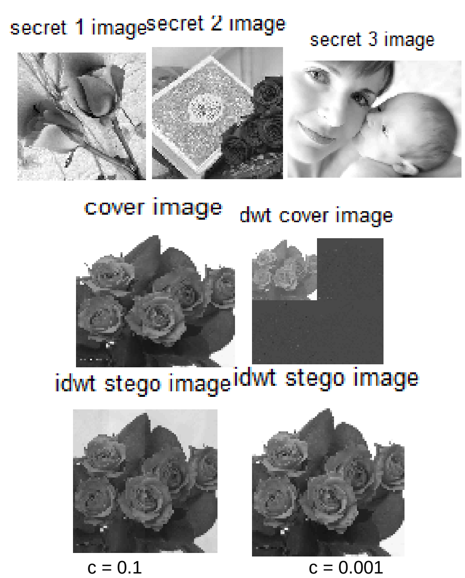
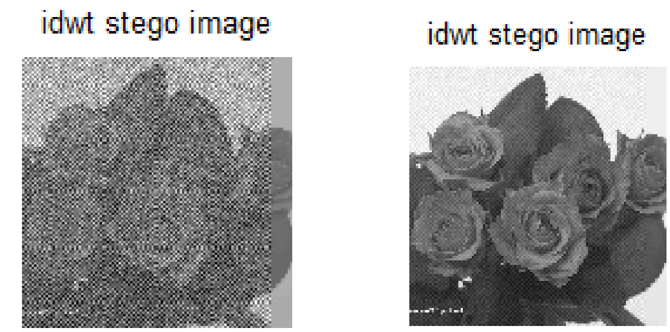


Figure 5. Embedding of three secret images of size (400×400),(200×200)and (400×600).

example, the binary sequence …. 1100010101 100011 0001 011 …. will be changed to the decimal sequence … 789 561 … and so on. It assumes that the size of secret image (in pixel) is one quarter the size of the cover image. For example the size of secret image is (256×256), (M×N) and the size of the cover image (512×512) ,(2M×2N).

SIMULATION RESULTS

The simulation was presented the results of the hiding process. The system has been built with a group of m-files using MATLAB \R2010b. Two or more images will apply to the system. The secret image must multiply by small coefficient (c) with value between 0 and 1 before hiding it in the cover image to minimize its size, in order to reduce its significance on the resulting image (stego-image) and to increase the security of the application. Hiding process has been studied under various values of constant coefficient (c) . The tables and the figures shown below will explain the hiding process of this paper. Figure 4, 5 and 6, Table 1, 2 amd 3



c = 0.1 c = 0.001

Figure 6. Embedding of three encoded secret images of Size (200 x 200), (400x400) and (400x600).

Table 1. Hiding one image in cover image using DWT db1(Harr) and db3 (Daubechies) filters

Cover image	secret image	coeff.(c)	PSNR(dB)		MSE	
			db1	db3	db1	db3
800*800	200*200	0.1	35.914	35.914	16.657	16.54
800*800	200*200	0.001	75.914	75.944	0.0017	0.007
800*800	400*400	0.1	29.390	29.412	74.815	74.44
800*800	400*400	0.001	69.390	69.412	0.0075	0.007
800*800	400*600	0.1	26.550	26.589	143.89	142.6
800*800	400*600	0.001	66.550	66.589	0.0144	0.013

Table 2. Hiding three images in cover image by using DWT db1(Harr) and db3 (Daubechies) filter

Cover image	secret image1	secret image2	secret image3	coeff.(c)	PSNR(dB)	
					dB1	dB2
800*800	400*400	200*200	400*600	0.1	24.41	24.445
800*800	400*400	200*200	400*600	0.001	64.41	64.445

Table 3. Hiding three encoded secret images By using DWT db1(Harr)

Cover image	secret image1	secret image2	secret image3	coeff.(c)	PSNR(dB)
800*800	200*200	400*400	400*600	0.1	7.314
800*800	200*200	400*400	400*600	0.001	47.314

CONCLUSION

In this research, the PSNR by using DWT db3 filter is better than DWT db1 filter by small values. The dimension of cover image must be (2M×2N) and the dimension of secret image must be (M×N) or less

(½M×½N), so that it can be hide in one sub-band of DWT for the cover image . If the dimension of secret image is (M×¾N) ,this image must be reshape and concealed in two sub-band of DWT for the cover image. The PSNR value was improved when the Huffman code had been used on the square images (200×200) or (400×400) ,unless the case of hiding secret image of size (400×600) which must be reshape and hide in sub-band of cover image.

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