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Quality Measurements of Lossy Image Steganography Based on H-AMBTC Technique Using Hadamard Transform Domain

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Abstract— Steganography is a type of image information concealing technique which hides a secret message in a different media such as image, video and audio etc, called cover file. The main idea of steganography is to provide security to private or public data. In this paper we combined among Hadamard transformation and Absolute Moment Block Truncation Coding to make a new concept called (H-AMBTC), this concept used for compressing the cover file and conceal the secret data into the cover file. The H-AMBTC compression is not only image compression, but it is more than the AMBTC technique as only half of the number of pixels in the binary converted image are transmitted. In this paper, the comparison process of the H-AMBTC technique is done for 2x2, 4x4, 8x8 and 16x16 block sizes. H-AMBTC is a lossy technique as the cover image and the secret image can be recovered completely.

Keywords— H-AMBTC, AMBTC, PSNR, Hadamard transform, Image information concealing, Steganography.

I. INTRODUCTION

Steganography is an old science, but its applications in the information concealing are new. However, steganography is referred to as a process to conceal secret data of different media (message, image, information, etc.) into another digital media (text, image, audio or video streams), called cover files, steganography can solve the problem of perception of the secret message. The media that conceals the data is called “cover’’ or “host’’ media. Computer based steganography is usually based on randomness. There are many occurrences of randomness in computer based information. Steganography data can be hidden into this random information. The merits of a steganography method are judged on whether the addition of the steganography data changes the randomness. Image steganography as an individual concept has already been discussed. [1] But a few researchers’ works on the images steganography combine with compression tools. In our work, we discuss how to combine the AMBTC technique and Hadamard transform to give a good technique called (H-AMBTC), and combined this work with the image steganography, in this case the image compressed steganography will be high powerful. AMBTC has the same general characteristics as BTC which includes low storage requirements and an extremely simple coding and decoding technique. The main idea of AMBTC is to preserve higher mean and lower mean of each small rectangular block of pixels spatially and non-overlapping divided from the original image. Thus it is necessary to increase the number of quantization levels to improve the image quality. The rest of this paper is organized as following: Sec.2 deals with the Preliminaries which are discussed the AMBTC, Hadamard transformation, compression procedures and image quality measurements. Sec.3, gives the details about the proposed scheme called an H-AMBTC and its algorithms respectively. In Sec.4, the performing and the results are analysed. Finally, Sec.5, gives the concluding remarks.

II. *PRELIMINARIES*

A. *AMBTC*

Block Truncation Coding (BTC) technique is also called a moment preserving quantize. The AMBTC is improved by BTC to be more powerful in image compression to give a good results when the image compressed. The concept of (AMBTC) was introduced by Lema and Mitchell in 1984 [2,6]. The consideration of AMBTC is to maintain the mean and the first absolute moment of image blocks. [4]. in the original form of AMBTC, the image will be segmented into uniform or non-uniform blocks to be controlled. Image compression using AMBTC have very good measurement such as PSNR, MSE and BPP [1,8]. It has more advantages of preserving single pixel and edges having low computational complexity. Other options of the moments result either in lossy MSE or lossy computational complexity. In AMBTC algorithm, similar to BTC, there are four separate steps while coding a single block of size n x n. They are quad tree segmentation, bit plane omission, bit plane coding using 32 visual patterns and interpolative bit plane coding. In this paper, we compress the image using H-AMBTC; the combination of these two techniques it gives a powerful compressed image.

B. *HADAMARD TRANSFORMATION*

A Hadamard matrix H of order n is an n × n matrix of 1s and -1s in which HH´= nIn. (In is the n × n identify matrix.) [2,3]. Equivalently, a Hadamard matrix is an n × n matrix of 1s and -1s in which any two distinct rows agree in exactly n/2 positions (and thus disagree in exactly n/2 positions.). With this definition, the entries of the matrix don't need to be 1s and -1s. They could be chosen from {red, green} or {0, 1} [3]. A Hadamard matrix can exist only if n is 1, 2, or a multiple of 4. It has been conjectured that Hadamard matrices exist for any n that is a multiple of 4. This is probably true but has not been proven [2]. (It has been verified at least through n= 664.). We will be interested primarily in the case where n is a power of 2, in which case Hadamard matrices are known to exist

C. *Compression Procedure*

The image is divided into different blocks dependent on the Hadamard matrices such as 2x2, 4x4, 8x8 and 16x16 pixels. For each block, the Mean and Standard Deviation are calculated, these values change from block to block. These two values define what values the reconstructed or new block will have, in other words the blocks of the BTC compressed image will have the same mean and standard deviation of the original image blocks algorithm [5,7].

$$\overline{X} = \frac{1}{n} \sum_{i=1}^{n} x_i \tag{1}$$

$$\sigma = \sqrt{\frac{1}{n} \quad \sum_{i=1}^{n} (\bar{x}_i - x_i)2} \tag{2}$$

Where xi represents the ith pixel value of the image block and n is the total number of pixels in the block. The two values $\overline{X}$ and σ are termed as quantizers of BTC. A two level quantization on the block is where we gain the compression, it is performed as follows:

$$Y\ (i, j) = 1, \quad x\ (i, j) > \overline{X} = 0, \quad x\ (i, j) < x \tag{3}$$

Where x (i, j) are pixel elements of the original block and y (i, j) are elements of the compressed block. In other words it can be explained as: If a pixel value is greater than the mean it is assigned the value "1", otherwise "0". Values equal to the mean can have either a "1" or a "0" depending on the preference of the person implementing the algorithm. By this process each block is reduced to a bit plane. The bit plane along with F and c forms the compressed data. For example a block of 4 x 4 pixels will give a 32 bit compressed data, amounting to 2 BPP. This 16 bit block is stored or transmitted along with the values of Mean and Standard Deviation. Reconstruction at the decoding side is made with two values "H" and "L", which preserve the mean and the standard deviation. For example when we want to represent the 4x4 image blocks we have to applying the following equation:

$$\overline{X} = \frac{1}{n} \sum_{i=1}^{16} x_i \tag{4}$$

The same procedures for representation another image blocks (2x2, 8x8 and 16x16).

D. *Image Quality Measurements*

There are several kinds of parametric measure to measure the quality of an image which plays an important role in various image-processing applications. The parametric measures of image quality are broadly classified into two classes - one is subjective measure and the other is objective measure. In this paper we concentrate in objective measures [1,3] such as Peak Signal to Noise Ratio (PSNR), Weighted Peak Signal to Noise Ratio (WPSNR), Bit Rate (BR), Bit Peer Pixel (BPP) and Structural SIMilarity (SSIM) index. When an image compression algorithm has been implemented and designed to a system, it is important to be able to calculate its performance and this evaluation process should be done in such a manner that various kinds of compression techniques can compare their above mentioned measures [4]. In our proposed scheme, we makes only PSNR to measuring the image quality because the PSNR give an accurate values for the extracted data.

III. *Proposed Scheme*

In this section, a lossy steganography for the H-AMBTC images compressing is produced and the performances of various block sizes are compared. For convenience, we define the notations used in this paper first. The original cover image is denoted as H and is a grayscale image. The H-AMBTC compressed code for H is represented by E, and the reconstructed AMBTC compressed image is denoted by R. Embedding is done by modifying E, and the result is an H-AMBTC compressed host-code E'. The receiver then uses the reconstruction procedure to obtain the H-AMBTC-compressed stego-image R'.

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The following steps exploring our proposed algorithm as:

1. H-AMBTC ENCODING ALGORITHM

Step1: perform the image divide into blocks according to Hadamard matrix.
Step2: Calculate the mean, lower and upper mean.
Step3: If the bit value is less than mean value, it is replaced by zero otherwise it is replaced by one.
Step4: The Conceal bit is obtained by XOR operation of the secret message and key.
Step5: If the concealing bit is zero, the trio generated consists of lower mean, upper mean and the sequence of bits of the image block.
Step6: If the concealing bit is one, the trio generated consists of upper mean, lower mean and the not operation of the sequence of bits of the image block.

2. H-AMBTC DECODING ALGORITHM

Step1: In the trio is obtained if the first element of the trio is less than the second element, then the concealing bit is zero. Else the embedded bit is one.
Step2: If the concealing bit is zero, the sequence of bits of the image block remains same.
Step3: If the concealing bit is one, NOT operation is performed on the sequence of bits of the image block.
Step4: If the binary image consists of one, it is replaced by upper mean else it is replaced by lower mean obtained from the trio.

Now we apply the H-AMBTC with the differences Hadamard as below. But before this, we first give a basic idea about the Hadamard with H1, H2, H3 and H4 as:

$$\text{H1} = [1],\ \text{H2} = \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix},\ \text{H3} = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 \end{bmatrix},\ \text{H4} = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 1 \\ 1 & 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ 1 & 0 & 0 & 1 & 0 & 1 & 1 & 0 \end{bmatrix}$$

Definition1: In the Hadamard we have two matrices H= [1] and H´ = [0], where H is a matrix and H´ is the H invers. Now we convert the Hadamard matrices with the AMBTC technique to gate on the H-AMBTC for the color image. According to the H and H´, the summation of each blocks given in the following equations:

$$\text{H} = \textstyle\sum_{i=1}^{n} block_i \tag{5}$$

$$\text{H´} = \textstyle\sum_{i=1}^{n} block_i\ , \qquad \text{where H´ is a invers of H} \tag{6}$$

To represent the H-AMBTC with the new form for all Hadamard image blocks of the color image are given in the following form:

$$\text{H} = [\text{block}],\quad \text{H´} = \overline{block} \tag{7}$$

The following hadamard matrixes shows the general forms for the H-AMBTC for H2 , H3, and H4 blocks will be:

$$\text{H2} = \begin{bmatrix} block & block \\ block & \overline{block} \end{bmatrix},\ \text{H3} = \begin{bmatrix} block & block & block & block \\ block & \overline{block} & block & \overline{block} \\ block & block & \overline{block} & \overline{block} \\ block & \overline{block} & \overline{block} & block \end{bmatrix} \text{ and}$$

$$\text{H4} = \begin{bmatrix} block & block & block & block & block & block & block & block \\ block & \overline{block} & block & \overline{block} & block & \overline{block} & block & \overline{block} \\ block & block & \overline{block} & \overline{block} & block & block & \overline{block} & \overline{block} \\ block & \overline{block} & \overline{block} & block & block & \overline{block} & \overline{block} & block \\ block & block & block & block & \overline{block} & \overline{block} & \overline{block} & \overline{block} \\ block & \overline{block} & block & \overline{block} & \overline{block} & block & \overline{block} & block \\ block & block & \overline{block} & \overline{block} & \overline{block} & \overline{block} & block & block \\ block & \overline{block} & \overline{block} & block & \overline{block} & block & block & \overline{block} \end{bmatrix}$$

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To calculate the PSNR vales for the H-AMBTC, we must first calculates MSE, it is shown in the following:

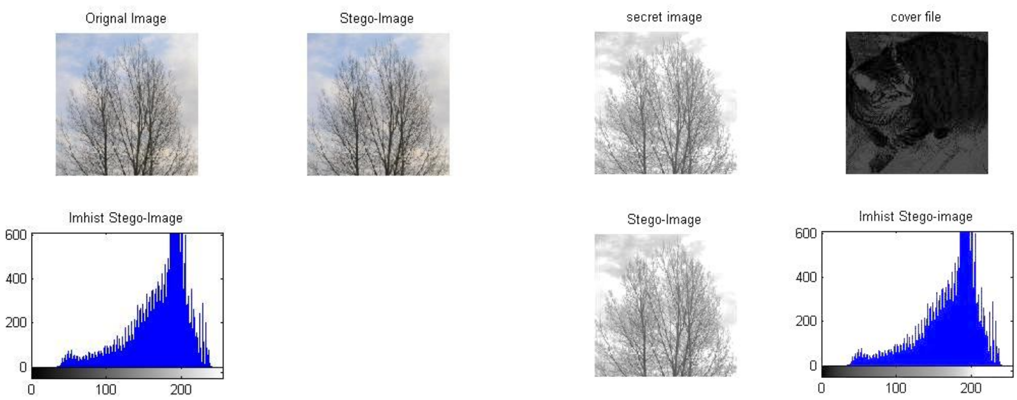
$$MSE = \frac{1}{N^{2-1}} \sum_{i=1}^{N^{2-1}} (y_i - x_i)^2 \quad (8)$$

And the new PSNR values are calculated using the following format:

$$PSNR = 25. \log 25 \ [MSE \ / \ 255^2] \quad (9)$$

IV. PERFORMANCE AND RESULTS

We have selected different blocks size for bit plane omission technique at three different levels of quad tree segmentation for the block size of 16 x 16. As we use a different image blocks size such as 2x2, 4 x 4 and 8x8. We have selected three values. We have applied different combination of threshold values on standard images of size 512 x 512. The PSNR values for the cover image and the reconstructed image is calculated and tabulated for different block sizes.



A. Image compression in H-AMBTC B.Image stego of A image.

Fig.1: The H-AMBTC method for the stego-image.

TABLE1: COMPARISON OF PSNR OF 2x2, 4x4, 8x8 AND 16x16 BLOCK SIZES FOR TREE AND CAT IMAGE.

images	2x2 Blocks	4x4 Blocks	8x8 Blocks	16x16 Blocks
	PSNR	**PSNR**	**PSNR**	**PSNR**
Tree	34.4877	32.0407	31.0162	24.3087
Cat	42.7776	33.8655	32.975	25.1356

This is the first time to combine between AMBTC and Hadamard transformation to give a good quality of image compression to be concealed. From the table.1, the PSNR values are measured to the difference blocks. The PSNR values give a good measurement for the stego-image, because the cover file has been compressed. The best PSNR value is given from 16x16 blocks for Tree and Cat images file. According to Fig.1 first, we has been compressed the cover image file. Secondly, we concealed the the secret image file in the cove image file which is compressed. The experimental our proposed scheme done by MatLab2011a edition.

V. CONCLUSIONS

In this paper, the H-AMBTC algorithm has been presented for the lossy data concealing technique that conceal the secret data in an interpolative AMBTC technique. Even though the AMBTC technique uses compression technique, the compression ratio is further increased using the H-AMBTC technique. This technique is lossy as the secret data can be completely recovered without any loss. The data extraction procedure is simple and the computational cost is less for the proposed method.

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