Payload Minion Stenographic Technique for Color Images

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Incredible evolution of Internet, Digital devices and communication channels lead to an enormous increase in data leading to demand of Data security systems. Image stenography is the technique to hide data inside an image. This paper proposes a message dependent image stenography technique for concealing information into a cover image. Arnold transform is used with 24-bit key insertion before Haar Wavelet Transform based compression of message signal ensuring the security of the message from the untrusted third party. Then based on the statistical features and Payload efficiency decided by the user, the technique finds the adequate coefficients from cover image maintaining the high visual quality for the image. Experimental results show that the technique works better for payload less than 50% as the PSNR for 50 images were found to be 42.75dB. Higher the payload lowers the quality of staego image obtained.

***Key Words* — Image Stenography, Data Security, Arnold Transform, DWT, Haar, payload, Minion.Stenography, Data Security, Arnold Transform, DWT, Haar, payload, Minion.**

I. INTRODUCTION

Data security is of the major issue with extreme increase in the use of Internet in day to day life. The field of data security consists of measures to deter, prevent, detect, and correct security violations that involve the transmission and storage of information. Cryptography and stenography are two major techniques used widely for the purpose. Cryptography is the process of converting ordinary information into unintelligible one called encrypted data. stenography is the art of hiding data. It deals with composing hidden messages known to trusted parties only. In Stenography, only the sender and the receiver know the existence of the message, whereas in cryptography the existence of the encrypted message is visible to the world. Due to this, Stenography removes the unwanted attention coming to the hidden message.

Modern stenography methods are called Digital stegnography. Hiding messages within noisy images, embedding a message within random data, embedding pictures with the message within video files, etc. are some examples. Two basic principles to be considered while performing stenography are the capacity of hidden secret data, and another is the quality of the stego image. Catching both the principles in a technique is difficult because the two principles are antithetic to each other as hiding a lot of secret data in a cover image will lower the quality of stego image while if we hide little secret data in a cover image, the quality of the stego image becomes high [1]. Thus, we should balance the above two principles and try to find an optimum method.

Upon surveying the literature several techniques can be found. Bender et al. [7] proposed the popular Stenographic method based on the least-significant-bits (LSBs) substitution. Discrete wavelet transform (DWT), Discrete Fourier transform (DFT) used by Chen [3], [4] for hiding image in phase achieves an advantages in capacity, but vision effect is unsatisfactory. Yang [5] proposed module substitutions based stenography method for color images embedding a variety of secret bits into, the R, G, and B-plane is encoded by Mod u, Mod u-v and Mod u-v-w substitution, respectively, to alleviate further color distortion and obtain a larger hiding capacity leading improvement in visual quality. To improve embedding capacity Chan and Chang [6] used the concept of modulo operation and side-match-vector-quantization (SMVQ) to conceal secret data into a pallet-based. Taking advantage to the human visual system Chou and Chang [7] applied B plane in RGB color system and U plane in the YUV color system, which to conceal as many secret data. Experimental results showed that they successfully achieved the goals of the high embedding capacity and maintaining the visual quality.
In this paper we based a stereographic technique that achieves a good data hiding capacity by compressing data using the Haar wavelet transform as well as obtains good visual quality.

II. THEORETICAL REVIEW

A. *Arnold Transform*

Arnold Transform also known as Arnold's cat map is a revertible chaotic map from then torus into itself. One of the map's important feature is it returns its initial state within some finite steps if after some being apparently randomized by the transformation. As can be seen in the Figure 1, the original image of the cat is sheared and then wrapped around in the first iteration of the transformation. After some iteration, the resulting image appears rather randomor disordered ultimately eturns to the original image. For an image, the transformation can be implemented by mapping the current element (i, j) of to the $((i+j) \bmod N, (i+2j) \bmod N)$ element of the output matrix.

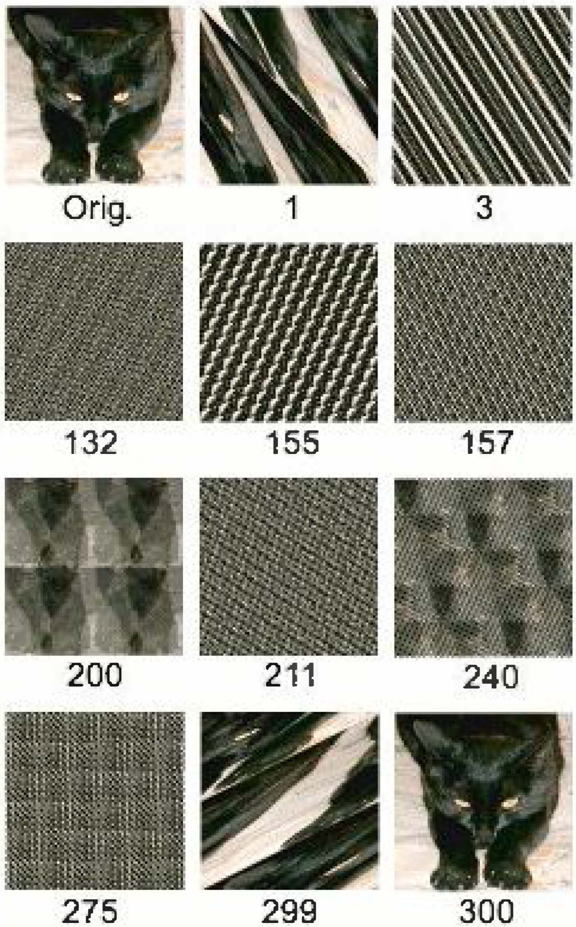

Fig 1. Effect of Arnold Tranform.

B. Haar Wavelet Transform

The Haar wavelet Transform is the simplest wavelet Transform [9]. The technical disadvantage of the Haar wavelet is that it is not continious, and therefore not differentiable. This property can, however, be an advantage for the analysis of signals with sudden transitions, such as monitoring of tool failure in machines. It is composed of a sequence of low-pass and high-pass filters, known as a filter bank. These filter sequences can be applied in the same way as a discrete FIR filter in the DSP, using the MACP command, except as multiple successive FIR filters. The low pass filter performs an averaging/blurring operation, and is expressed as:

$$H = \frac{1}{\sqrt{2}}(1,1) \qquad (1)$$

and the high-pass filter performs a differencing operation and can be expressed as:

$$G = \frac{1}{\sqrt{2}}(1,-1) \qquad (2)$$

on any adjacent pixel pair. The complete wavelet transform can be represented in matrix format by:

Second half: Applying D Transformation to Columns of Image

$$T = W_N A W_N^T$$

First half: Applying 1D Transformation to Rows of Image

The DWT separates an image into a lower resolution approximation image (LL) as well as horizontal (HL), vertical (LH) and diagonal (HH) detail components. The low-pass and high-pass filters of the wavelet transform naturally break a signal into similar (low-pass) and discontinuous / rapidly-changing (high-pass) sub-signals as shown in Figure 2.

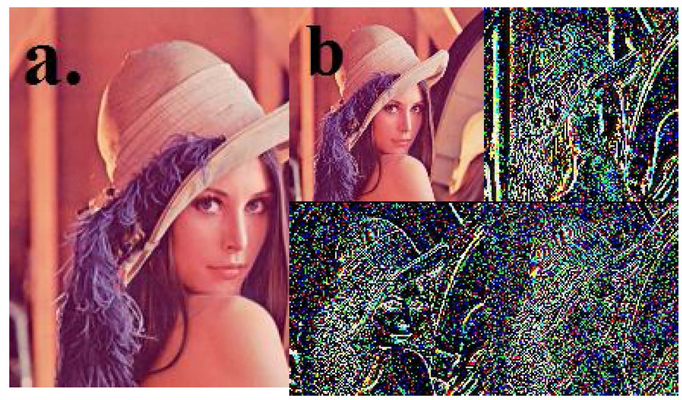

Fig. 2
(a) The original lena image
(b) The effect of haar wavelet transform.

III. METHODOLOGY

The proposed method consists of the mainly three stages, preparation of cover image, preparation of stego image and Embedding process.

Step-1: Preparation of Cover Image

It can be achieved by following steps.

- Image test.: In this step we search for cover images containing unrecognizable patterns and whose histogram is equally distributed. Also JPEG format of image is accepted because the systems operate in a transform space and are not affected by visual attacks. (Visual attacks mean that Stenographic messages can be seen on the low bit planes of an image because they overwrite visual structures; this usually happens in BMP images).

- Image preprocessing and correction: The following corrections will be done in each pixel of cover image apply level correction end

1. Contrast Correction
2. Color Balance Correction.

- Haar Wavelet Transformation: Convert the preprocessed cover image to wavelet domain through 2D Haar wavelet transform. After that selection of coefficients that are eligible for replacement is made based on the criteria that it should fall within the range of lower limit (Ll) and Upper Limit (Ul) calculated using the standard deviation and mean of the coefficients defined as:

$$Ul = P(M-S/2) \quad (4)$$

$$Ll = P(M+S/2) \quad (5)$$

Where, P is the constant defined as payload efficiency which lies between 0 to 1, S is the standard deviation of the coefficients and M is the mean of the coefficients.

Step-2: Preparation of Message Image

This step consists of the preparation of the stego images which can be achieved in following steps:

- Scrambling- The message image is transformed into using the Arnold transform. This step would lead to scrambling the image leading to increase in security of the image.
- Key Insertion: Each Pixel of the image is converted to 8-bits and XOR with the 24-bit key using the most Significant bit for the first pixel next 8-bits for the second least significant bits for the third pixel. Again for the fourth pixel the most significant 8-bits are used. The image is to reconstructed from the XORed bits.
- Formation of Vector: Pixels of the image are put in a row and are converted into a vector which is to be transformed as:

$$Pi = Pi\, Ll\, (Ul - Ll) / \max(P) \quad (6)$$

Where, P is the vector calculated.

Step-3: Embedding

Using coefficients location calculated in the above procedure, the message image is embedded in the covered image. Taking the inverse Haar Wavelet transform would return us the stego image required.

IV. SIMULATION RESULTS

The simulations were carried out in MatlabR2009(a) simulation tool. A database of 50 JPEG images was formed from the internet for testing of the proposed method. Fundamentally, payload efficiency (capacity) of a Stenographic system is used as one of the evaluation criteria. Payload efficiency can be defined as the amount of information it can hide within the cover media. It is expressed as a percentage from the full image size.

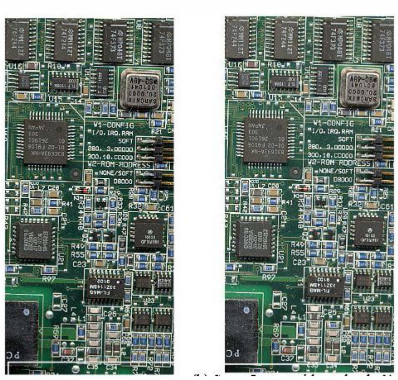

Fig 3. The Original image (Left) and the Stego image obtained (Right).

Fig 4. Sample Images used for simulation.

A visual comparison can be seen in Fig.3. For the evaluation of the algorithm, the PSNR is taken for different Payload efficiency. It consists of PSNR v/s payload for 6 images inFig.4 and also average of all 50 images in the database. All the cover images were of size 512X512. In general we can say that as the payload efficiency is increased the PSNR decreased.

Table I. PSNR V/S PAYLOAD

Image	PSNR(In db)		
	Payload is 30%	*Payload is 50%*	*Payload is 70%*
1.	50.02	41.22	25.32
2	48.32	40.56	24.36
3	49.87	39.72	27.25
4	47.89	42.03	25.63
5	48.61	41.67	24.58
6	52.57	43.25	28.35
Avg (50)	49.28	42.75	23.22

V. CONCLUSION

The proposed algorithm works as a message dependent image Stenographic technique. As the payload efficiency is increased the PSNR of stego image decreases. Using the Arnold transform and secret key insertion ensures the security of the message image. It would be very difficult for the untrusted third to recover the message. The experimental results presented in Section IV show that in the case of low payload image the proposed signal works very efficiently. Further work can be done to make the algorithm locally adaptive or can be done in compressing the message with proper encryption making it more secured as well as more efficient.

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