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Offering a New Steganography Metod in DCT Coefficients with Human Criterion Based on Image

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ABSTRACT

One of the most important issues in image steganography using human visual system models. If the weakness of the human visual system is used in making a HVS model and steganography is performed based on this model, the algorithm will have better quality. In this paper, after carefully studying the characteristics of the human visual system, a new method for image steganography in the discrete cosine transform is presented using a human visual system model. In this method, An optimization model is introduced which is able to maintain correlation between the various parts of objects in the neighboring areas in many areas of the picture. The experimental results show which the accuracy of this method is better than competing methods and yet, it has a higher level of comprehensiveness and generalizability. Experiments have been conducted on two thousand sets of images with different variety. Presented method is able to maintain the quality and transparency of the steganography image.

KEYWORDS: Image steganography, discrete cosine transform, model of human visual system, various areas of image.

1. INTRODUCTION

In recent decades, due to the large number of personal computers connected to a public network such as the Internet, explosive in distribution and easy to use of digital multimedia data has occurred. For the protection of digital multimedia products, including text[1], audio[2-3], image[4-5] and video[6-7] are used encryption and steganography techniques. Encryption techniques to protect digital data used during transmission from the sender to the receiver. Data be encrypted at the sender and after receiving in receiver be decoded. From then on, is not done any data protection. While techniques of signal steganography including secret information is placed directly into the data and remains constant, so that it simply is not possible to detect [8]. Image data is the most important media used in the World Wide Web because image has greater capacity than other data and has not time allegiance and most importantly is that human visual perception of images, limited and still the human visual sensitivity to image has not been completely extracted. For this reason, images are an appropriate data in steganography.

Information hiding methods for images[9] are generally classified into two categories including insert in spatial domain[10-11-12], such as the method of changing the least significant bits (LSB) and insert in frequency domain[13-14-15] such as the spread spectrum methods, the wavelet-based embedding methods, and the DCT-based embedding methods. Generally,we can embed larger amounts of information in the spatial domain than in the frequency domain, but hiding data in the frequency domain is more robust than in the spatial domain. Among the methods in the frequency domain, methods based on the discrete cosine transform more than the other two methods have been used in steganography.

Because the DCT transform has desirable features such as a lack of correlation coefficients, so the information is inserted in one of the coefficients and the rest of them does not spread and it simply would not be possible to detect [16]. On the other hand steganography systems that are embedded data in the DCT transform domain are robust against attacks such as lossy compression, including JPEG and some geometric attacks, such as cutting [17].

Image steganography is with error or stego-image transmission through the channel causes the amount of information lost, the resulting image quality is turned down. To evaluate an image system is needed to compare stego-image quality with the original image. Direct method of evaluation will be done by humans, of course there are limits and moreover, it is very costly and time, but it is more suitable than quantitative criteria because quantitative criteria such as sum of squared errors can not be an accurate assessment of image quality because they do not consider the visual parameters [18]. In recent decades, efforts have been made in this field various methods have been proposed, any attempt which their results are close to the quality assessment but only for a specific distortions have been considered [18]. As a result, if we want to quantify compute and compare the two images to the computer, different parameters of human visual system should be considered.

If weaknesses of the human visual system be used in the construction of a HVS model & steganography is performed based on this model, the algorithm will have better quality[17]. But despite the complexity and unknown parts of the human visual system, all the parameters of human visual system are not used in making of HVS model. Example of the human visual system models is watson's model. This model uses perceptual error measure based on DCT transform. Steganography error is measured for each coefficient in each 8x8 block with visual sensitivity corresponding to each basis function DCT. The sensitivity is determined with three factors: frequency sensitivity, luminance masking and contrast masking. However, watson's model is the most complete model to evaluate different methods of steganography and compression, but it has a fundamental flaw. problem is caused division of the cover image into blocks of 8x8. According to

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this flaw, in many areas of the image, Contiguous areas and different objects break. In other words, the correlation between different parts of an object as another feature of the human visual system, the lack of coordination of the objects in the image, definitely undesirable in image watermarking can be seen by the human eye. In this paper, in order to correct the flaw in the model of watson, approach is presented in which the correlations between different parts of an object in the picture preserve and stego-image quality is enhanced.

2. Previous Work

Fariba Takarli (2009)[17] has proposed a model in which the data is embedded into the cover image by changing the coefficients of discrete cosine transform of the image using changes in watson's model. One of the benefits of a good steganography is resistant of stego-image against attacks. The resulting image of steganography using the watson's model have not good resistance against jpeg attacks with low quality. Watson's model has changed using the measurement matrix of jpeg compression to increase strength of stego-image against attack jpeg Up to 30% quality.

3. Proposed Model

At the end of the introduction, we've seen some of the features and advantages of the proposed method. In this section, the proposed method is introduced in detail and this Strength Points and distinctions are examined more accurately. Fig. 1 shows the block diagram of the proposed method.

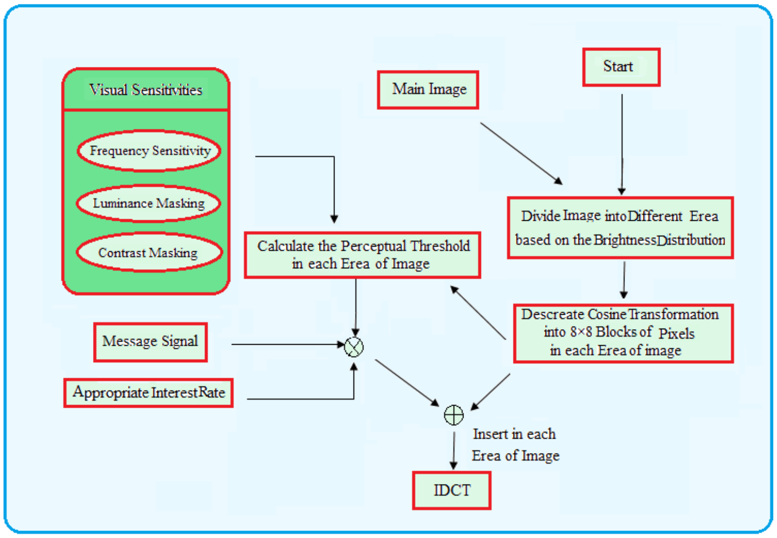

Fig. 1 View process insert of message signals in the image based on the proposed method

3.1. Divide Image into Different Erea on the Brightness Distribution

In many parts of the picture is a correlation between areas of different objects. In many models of the human visual system including models watson and its modified models same method described in part 1, despite due to the sensitivity of human vision, such as frequency sensitivity, luminance masking and contrast masking, correlation between different objects in the image are not considered. Because with divide of images into blocks of 8 × 8, part of an correlated object may place in a block and other part in other block and message signal insert in image makes undesirable in whole object which will be visible by human eye. The proposed method for preventing the adverse effects, first, the images are divided into different areas. Fig. 2 and Fig. 3 block diagram of how to divide the image into different regions based on the brightness distribution shows.

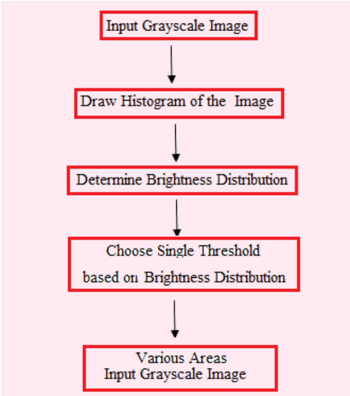

Fig. 2 View process divide images into different regions based on the brightness distribution in grayscale image

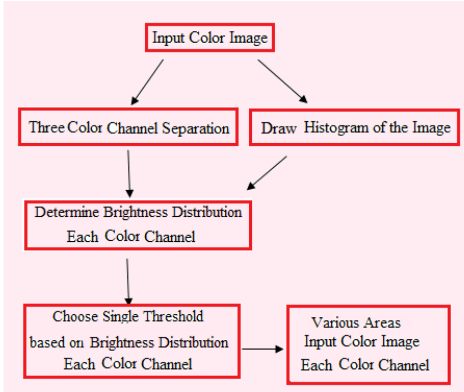

Fig. 3. View process divide images into different regions based on the brightness distribution in color image

3.2. Transform DCT in Blocks of 8x8 Pixels in each Erea of Image

DCT is a general orthogonal transform for digital image processing and signal processing with advantages such as high compression ratio, small bit error rate, good information integration ability[22]. The DCT is a mathematical transformation that takes a signal and transforms it from spatial domain into frequency domain[23]. DCT transform are divided images into high frequency components, intermediate frequency and low frequency. DCT transform and its inverse are defined in the following way**:**

DCT transform**:**

$$b(u,v) = \alpha_u \, \alpha_v \sum_{i=0}^{L-1} \sum_{j=0}^{L-1} a(i,j) \cos\frac{\pi(2i+1)u}{2L} \cos\frac{\pi(2j+1)v}{2L} \qquad 0 \le u,v \le L-1$$

$$\alpha_v = \begin{cases} \frac{1}{\sqrt{L}} & v=0 \\ \sqrt{\frac{2}{L}} & 1 \le v \le L-1 \end{cases} \quad , \quad \alpha_u = \begin{cases} \frac{1}{\sqrt{L}} & u=0 \\ \sqrt{\frac{2}{L}} & 1 \le u \le L-1 \end{cases} \qquad (1)$$

In this equation b (u, v, k) is DCT coefficients for k block.

IDCT transform:

$$a(i,j) = \alpha_i \, \alpha j \sum_{v=0}^{L-1} \sum_{u=0}^{L-1} b(u,v) \cos\frac{\pi(2i+1)u}{2L} \cos\frac{\pi(2j+1)v}{2L} \qquad 0 \le i,j \le L-1$$

$$\alpha_v = \begin{cases} \frac{1}{\sqrt{L}} & v=0 \\ \sqrt{\frac{2}{L}} & 1 \le v \le L-1 \end{cases} \quad , \quad \alpha_u = \begin{cases} \frac{1}{\sqrt{L}} & u=0 \\ \sqrt{\frac{2}{L}} & 1 \le u \le L-1 \end{cases} \qquad (2)$$

3.3. Perceptual Threshold Using Visual Sensitivity for each Area[24]

Maximum threshold of visible watermarking error for each DCT coefficient in every block 8 × 8 in every area with corresponding visual sensitivity to each function based discrete cosine transform is scale in corresponding area. The sensitivity is determined by three factors: frequency sensitivity, luminance masking and contrast masking.

3.3.1 Frequency Sensitivity

Initially a frequency sensitivity matrix (T) is defined the amount is fixed and independent of images. The values of 8 × 8 matrix is given in equation 3-1.

$$T = \begin{bmatrix} 1.4 & 1.01 & 1.16 & 1.66 & 2.4 & 3.43 & 4.79 & 6.56 \\ 1.01 & 1.45 & 1.23 & 1.53 & 2.00 & 2.71 & 3.67 & 4.93 \\ 1.16 & 1.32 & 2.24 & 2.59 & 2.98 & 3.64 & 4.60 & 5.88 \\ 1.66 & 1.53 & 2.59 & 3.77 & 4.55 & 5.30 & 6.28 & 7.6 \\ 2.4 & 2.00 & 2.98 & 4.55 & 6.15 & 7.46 & 9.62 & 10.17 \\ 3.43 & 2.71 & 3.64 & 5.30 & 7.46 & 9.62 & 11.58 & 13.51 \\ 4.79 & 3.67 & 4.60 & 6.28 & 8.71 & 11.58 & 14.50 & 17.29 \\ 6.56 & 4.93 & 5.88 & 7.6 & 10.17 & 13.51 & 17.29 & 21.15 \end{bmatrix} \qquad (3)$$

Select values for the matrix is based on perception of eye from change of different frequencies. Sensitivity function of frequency is shown in Fig. 4. This figure shows sensitivity of the eye to change of frequencies.

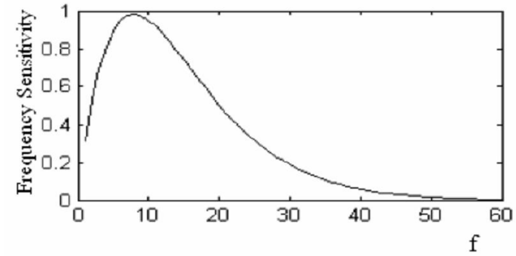

Fig. 4**.** curve of sensitivity of the eye to change of frequencies

As can be seen, eye of human understands change of low frequency so when steganography little change in these coefficients must be created till not cause significant damage to the image quality. On the other hand, high frequencies have no strength against attacks and they can easily be changed by the attacks. The steganography is performed in the middle frequencies.

3.3.2. Luminance Masking Background

Luminance masking is driven by the fact that whatever must average Luminance masking background in block 8 × 8 is, DCT coefficients in the block are more change until their distorted by eye remains still incomprehensible. Then effect of Luminance masking as follows is increased to Frequency sensitivity:

$$T^{L}(u,v,k) = T(u,v)\left(\frac{b(0,0,k)}{\bar{b}00}\right)^{a_T} \qquad (4)$$

b (*o*,*o*,*k*) The dc coefficients for K blocks of image of each area. a_T is a parameter that controls the strength of the mask and the proposed value is 0.649. $\bar{b}00$ DC value corresponding to the average brightness.

3.3.3 Contrast Masking

In the final step, effect of Contrast masking is increased. Effect Contrast is reduction of perceived changes in frequency due to the energy of the frequency and how its effects the following equation:

$$T^{c}(u,v,k) = \max\left(T^{L}(u,v,k) \cdot (|b(u,v,k)|)^{W_{ij}} \times T^{L}(u,v,k)^{1-W_{ij}}\right) \qquad (5)$$

$T^C(u,v,k)$ is the final equation obtained for Watson's threshold. $b(u,v,k)$ Coefficient of DCT (u,v) in the k blocks of image of each area. w_{ij} a number between zero and one that is often considered to be 0.7.

3.4. Insert Message Signal in Image

As mentioned at the beginning of Section 1-2 In many parts of the picture, there is a correlation between areas of different objects and with insert message signal in image Regardless of the correlation undesirable object is created in the image watermarking which would be detected by the human eye. The proposed method for preventing the adverse effects, after dividing the image into different regions according to figures 4 and 5, message signal insert using an appropriate interest rate and calculated perceptual threshold in each erea of image. In the insert picture of messages based on the proposed model, despite maintaining correlation between different parts of an object in the original image cause stego-image has become more transparent because changes in different areas of the image will be more homogeneous.

4. Implementation & Results

To implement this method, MATLAB software is used. Both color and grayscale image are employed as the original image and a binary image is employed as a picture message. This method has been implemented in such a way that the image of message is embedded in each area of the original image. The results are described in the following.

Fig. 5 include: (a), original image Lena(grayscale) and message image, (b) stego-Image Using Watson's model, (c) stego-Image using proposed model (Both images b and c have identical PSNR is 72.2).

Fig. 5**.** (a) - original image and messaging image
stego-Image (b)- Watson's model, (c)- proposed model

Fig. 6 include: (a), original image wpeppers (grayscale) and message image, (b) stego-Image Using Watson's model, (c) stego-Image Using proposed model (Both images b and c have identical PSNR is 60.2).

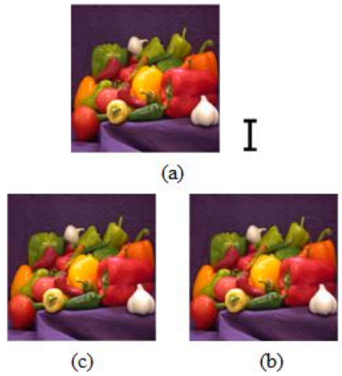

Fig. 6**.** (a) - original image and messaging image
stego-Image (b)- Watson's model, (c)- proposed model

As can be seen, between the original image and stego- image by the proposed method in terms of appearance, there is no difference. With a little careful stego-image by the proposed method than stego-image by Watson's method improved.

Then, to prove his claim, the results of the proposed model with different approaches are examined. For this purpose, the most subjective evaluation process is used in the ITU-R. The used process is most famous example of evaluate process of continuous quality image (DSCQS). DSCQS method gives an objective evaluation of image quality. In this method, a set of pairs of the original image and stego-image against the evaluation person are. Person determines rating of two images through mark a continuous line among 5 value level. Equivalent to the value of 5 level is given in Table 1. The display order original and changed image is random. Finally, the mean score is considered as a result. This process have been doing on two thousand sets of images with different variety For a population of two hundred people. Table 2 shows the results of this process for the proposed model, and Table 3 shows the watson's model.

Table 1. Equivalent to the Value

Quality	Rating
Excellent	1
Good	2
Fair	3
Poor	4
Bad	5

Table 2. Results of DSCQS Method for Proposed Model

Value	Percent
Excellent	96.22%
Good	3.78%
Fair	0%
Poor	0%
Bad	0%

Table 3. Results of DSCQS Method for watson's Model

Value	Percent
Excellent	80.95%
Good	19.05%
Fair	0%
Poor	0%
Bad	0%

As a result of subjective evaluation process also implies, the proposed method is significantly improved compared to the Watson method. because between the original image and watermarking image by the proposed method in terms of appearance, there is less difference than Watson method.

5. Conclusions

In this paper, the characteristics of the human visual system was studied images. According to correlation Between the regions of objects in many parts of the picture as a feature of the human visual system is not often considered. We have introduced the optimal method for image steganography in the discrete cosine transform, which has better performance than other methods of steganogarphy. In this method, an image based on its brightness distribution is divided into different areas and message signal insert using an appropriate interest rate and calculated perceptual threshold in each erea of image. The results show despite maintaining correlation between the parts of objects in the surrounding areas cause more transparent stego-image Because changes in different areas of image will be more homogeneous.

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