DATA HIDING METHOD DESIGN IN JPEG IMAGE COMPRESSION WITH MODIFIED MODULO AND ELEMENT SELECTION

[1]Priynaka Thakur, [2]Silky Pareyani
[1]Mtech Scholar, [2]Assistant Professor
[1,2]Gyan Ganga College of Technology, Jabalpur

Abstract: This paper presents a new Steganography technique, In this paper, we propose a new high-capacity reversible data hiding method for JPEG-compressed images. This method is based on modifying the quantization table and quantized discrete cosine transformation (DCT) coefficients. Some elements of the quantization table are divided by an integer while the corresponding quantized DCT coefficients are multiplied by the same integer and added by an adjustment value to make space for embedding the data. By analyzing the effect of each single quantized DCT coefficient on the image quality, an embedding sequence is chosen in order to help control the increase of file size after hiding the data meanwhile the PSNR value between the original uncompressed image and stego JPEG image is high. Experimental results show that the proposed method achieves both high capacity and high image quality.

Keywords: DWT: Discrete Wave Transform, SVD: Singular Value Decomposition, PSNR: Peak Signal to Noise Ratio, MSE: Mean Square Error

I-INTRODUCTION

In the proposed scheme, a cover JPEG image is first decoded to get the quantization table and quantized DCT coefficients[5], then some entries of the quantization table are divided by an integer and corresponding quantized DCT coefficients[5] are multiplied by the same integer and added by an adjustment value to make space for embedding the data. After extracting secret bits from the stego image[6], the original JPEG image can be recovered at the same time. The proposed algorithm can be divided into two phases: the data hiding phase and the extracting and restoring phase which are illustrated in the following sections. To reduce the distortion caused by embedding and control the increase of the file size, the selection of embedding positions should be discussed first.

The selection of embedding positions For the purpose of making the influence caused by data hiding as small as possible, the selection of embedding positions should be carefully considered. As Luis F. R. Lucas [4] said, traditional data hiding techniques tended to choose the mid-frequency DCT[5] coefficients in the DCT transform[5] domain. However, when considering the quantization stage, things may be different. Thus, the earlier techniques might affect the researchers' choice on embedding positions in the JPEG compressed domain. Abdelhamid Awad et al.[3] did some simple experimental investigation to decide their optimum parameters. To test the effect of every single quantized DCT[5] coefficient on image quality in much more detail, theoretic analysis and experimental investigation are done in this paper.

A comparative results between Xiaozhu Xie et al [1] work and proposed work has been performed and PSNR obtain in proposed work 37.90 is higher than Xiaozhu Xie[1] PSNR 36.46, also proposed work PSNR 37.7072 (Lena) is higher than Ziqiang Cheng et al [2] work PSNR 35.1. The data embedding rate 6.90 is also higher than Xiaozhu Xie work embedded rate 5.80.

II-METHODOLOGY

Figure 1 below shows the proposed work flow diagram the overall procedure can be understand as by following steps:-

Step 1: input image acquisition can be any taken and image but proposed work use MATLAB standard images of lena, jet, Barbara, baboon and peppers.

Step 2: isolate the Red, Green and Blue frames as the image processing are suitable at 2D matrix only and all the reaming mathematics performed on Red, green, blue individually and at the last all this frame gets concatenate again.

Step 3: separate 8x8 block out of 2D frame as DCT[5] is applicable only on 8x8 block

Step 4: subtract the 8x8 block by 128 as cosine signals varies between -1 to 1, out frame block will vary between -128 to 128.

Step 5: apply DCT on the output block from step 4.

Step 6: perform Quantization by the quantization table provided by JPEG2 standard[10].

Step 7: round the output of quantization at its floor value.

Step 8: output 8x8 block will have few values in its 3x3 frame (9 pixels) rest of the 55 pixels will remains zero, the row zero elements are known as AC components[8] and columns zero will be known as DC components[8].

Step 9: Input the data and convert it into ASCII[7].

Step 10: perform XOR between ASCII data and input KEY.

Step 11: compute modulo 3 operation on the data until each pixels gets convert into set of modulii[3]

Step 12: concatenate the all modulo output

Step 13: hide the modulo components [3] into AC and DC elements[8] of the output frame from step 8.

Step 14: rearrange the 8x8 block and perform all step 4 to step8 operation into new 8x8 block
Step 15: concatenate red, green and blue frame.

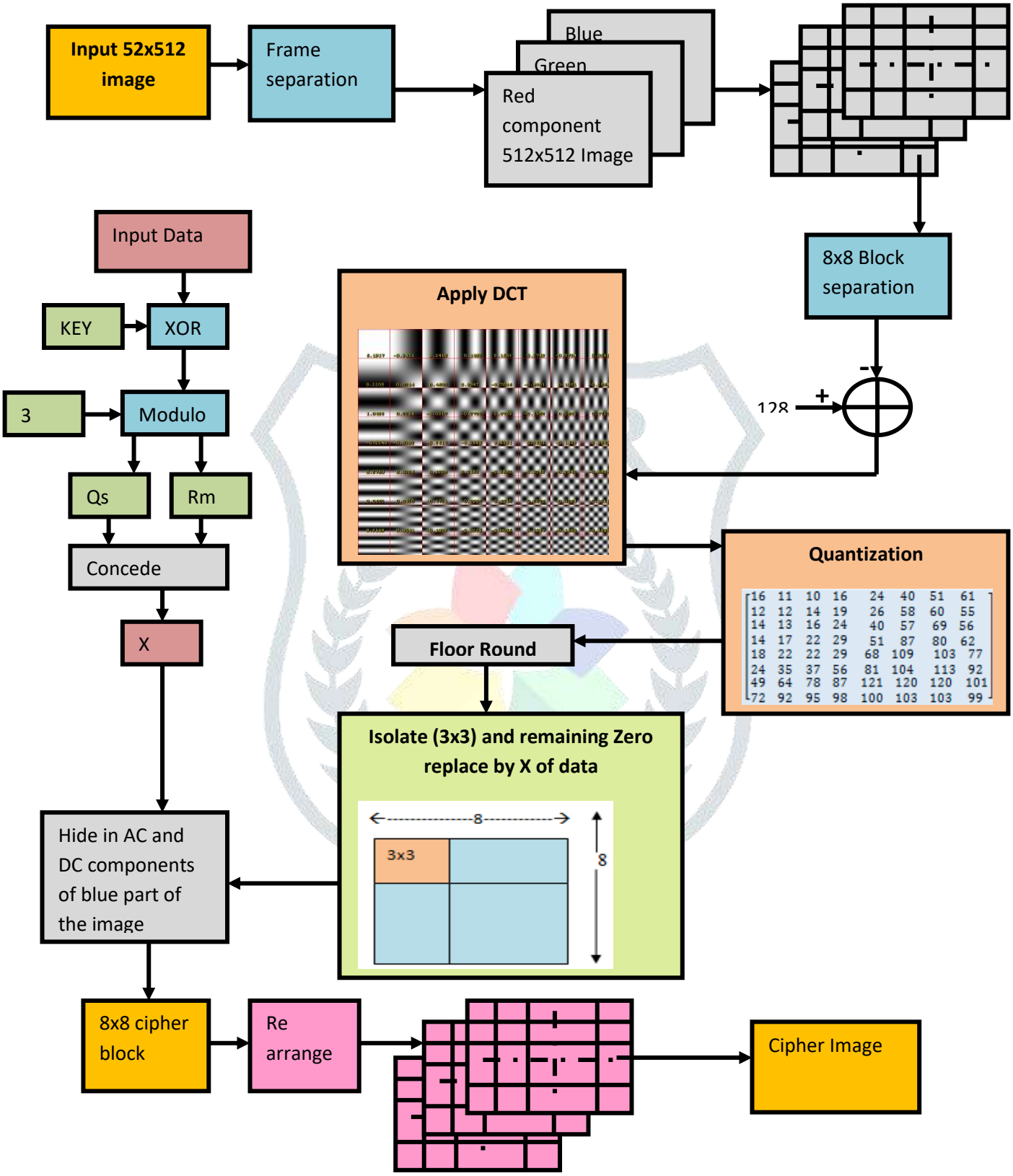

Figure 1 block diagram of proposed work

III- ALGORITHM

Image acquisition: Let an image is x (i, j, k)

Where 'i' is the row number, 'j' is column number, 'k' is frame (k=1 for red, k=2 for green & k=3 for blue) and x is the intensity of pixel at (i, j, k).

i= 1: M

j=1: N

k=1: 3

Hence size of image is MxNx3

Sub-block development:

$c_k(p,q) = x(m:m+7, n:n+7, 1:3)$

Where m= 1 to M with interval of 8 as m=1, 9, 17,…. M

Where n= 1 to N with interval of 8 as n=1, 9, 17, ….N

And k=1, 2, 3,…… (MxN/64)

p=1,2,….8

q=1,2,….8

Subtraction by 128

$$d_k(p,q) = \{128 - c_k(p,q)\}$$

Cosine coefficient matrix and image

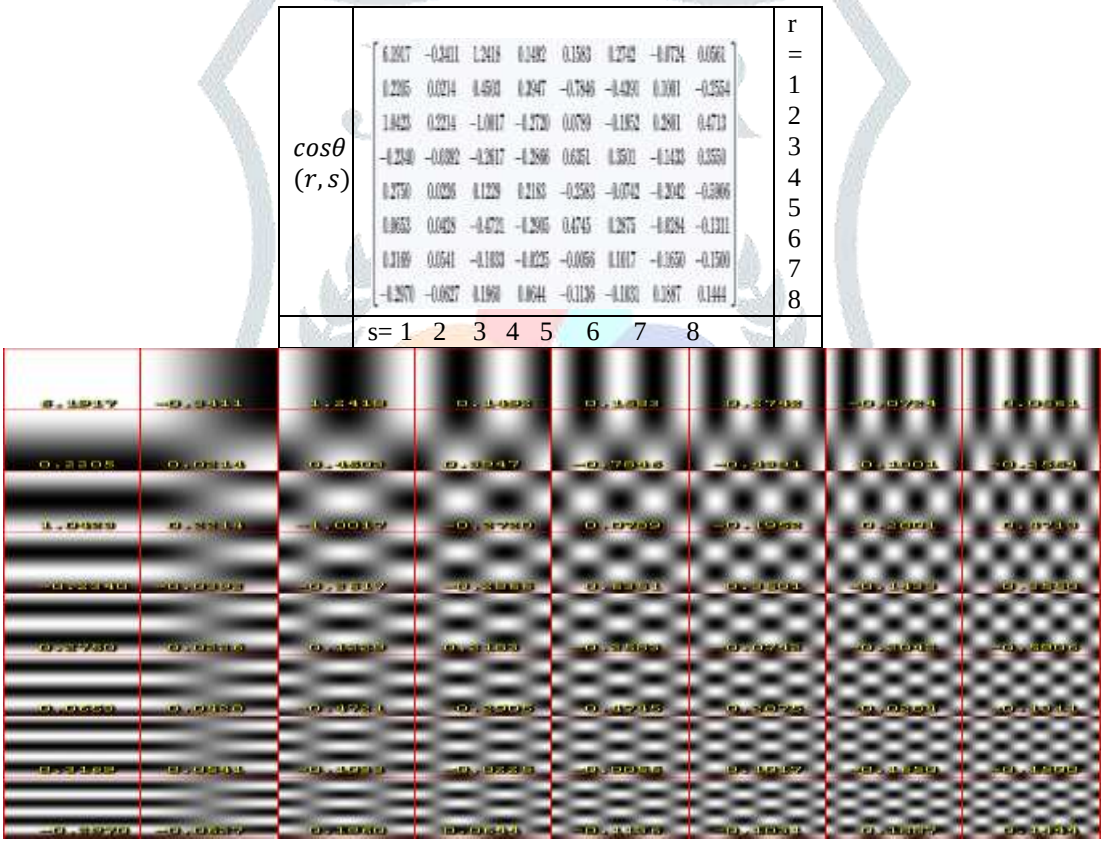

Figure 2 DCT cosine components

r=1, 2,….8 is the row numb er of cosine coefficient image

s=1, 2,….8 is the column number of cosine coefficient image

Combination of each part of cosine coeffecient images to get sub image $\boldsymbol{d_k}$

$A_{pq}(1,1) * cos\theta(1,1) = d_k(p,q)$

$A_{pq}(1,2) * cos\theta(1,2) = d_k(p,q)$

……

……

$A_{pq}(1,8) * cos\theta(1,8) = d_k(p,q)$

$A_{pq}(2,1) * cos\theta(2,1) = d_k(p,q)$

$A_{pq}(2,2) * cos\theta(2,2) = d_k(p,q)$

……

……

$A_{pq}(8,8) * cos\theta(8,8) = d_k(p,q)$

$$e_k(r,s) = \sum_{p=1}^{8}\sum_{q=1}^{8} A_{pq}(r,s)$$

Quantization

$$Q_{rs} = \begin{bmatrix} 16 & 11 & 10 & 16 & 24 & 40 & 51 & 61 \\ 12 & 12 & 14 & 19 & 26 & 58 & 60 & 55 \\ 14 & 13 & 16 & 24 & 40 & 57 & 69 & 56 \\ 14 & 17 & 22 & 29 & 51 & 87 & 80 & 62 \\ 18 & 22 & 22 & 29 & 68 & 109 & 103 & 77 \\ 24 & 35 & 37 & 56 & 81 & 104 & 113 & 92 \\ 49 & 64 & 78 & 87 & 121 & 120 & 120 & 101 \\ 72 & 92 & 95 & 98 & 100 & 103 & 103 & 99 \end{bmatrix}$$

Q_{rs} given above is the JPEG quantization matrix

$$f_k(r,s) = \frac{e_k(r,s)}{Q_{rs}}$$

$$g_k(r,s) = floor|f_k(r,s)|$$

$g_k(r,s)$ is the quantized Image sub-block

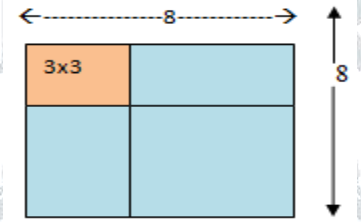

Figure 3: 3x3 separation from zero value AC and DC components

Zig-Zag Arrangement

$$h_k(1,ct) = g_k(a,b) \;\; where\ b = 1,2,\ldots.i\ and\ a = (i+1) - b \;\rceil for\ i = 1,3,5,7$$

ct=ct+1;

$$h_k(1,ct) = g_k(a,b) \;\; where\ a = 1,2,\ldots.i\ and\ b = (i+1) - a \;\rceil for\ i = 2,4,6,8$$

ct=ct+1;

$$h_k(1,ct) = g_k(a,b) \;\; where\ a = 8,7,\ldots.i\ and\ b = i, i+1\ldots.a \;\rceil for\ i = 2,4,6,8$$

ct=ct+1;

$$h_k(1,ct) = g_k(a,b) \;\; where\ b = 8,7,\ldots.i\ and\ a = i, i+1\ldots.b \rceil for\ i = 3,5,7$$

ct=ct+1;

*where ct=r*s*

Apply Run length Coding

Each non zero encoded as triple

[(r, s),c]

Where r number of zeros before current value'

s is the size of number in bits

c is the actual value

$$r_p = r_p + 1\ when\ (h_k(1,i)\ xor\ h_k(1,i+1) == 0)\ else\ p = p+1$$

$$s_p = count\{(s)_2\}$$

$$c_p = h_k(1,i)$$

$$for\ \ i = 1,2\ldots.ct$$

Now can be consider as compressed and coded data stream for the original jpeg image sub-block c_k *(8x8) is* $[r_p, s_p, c_p]$ *and* $g_k(t,u)$ *is the compressed image sub-block where t=1,2,3 and u = 1,2,3*

$c_k(8x8) \rightarrow\ g_k(3x3)$

Let K is the KEY for encryption, then

$$l_k = g_k\ xor\ K$$

Let D is the data which needs to be hide

$$D1 = (D)_2$$

As l_k *is a 3x3 sub-image hence 9 pixels*

$$(y_k(1,1))_2 = (l_k(1,1))_2\ OR\ (0000000\&D1(1,1))$$
$$(y_k(1,2))_2 = (l_k(1,2))_2\ OR\ (0000000\&D1(1,2))$$
$$(y_k(1,3))_2 = (l_k(1,3))_2\ OR\ (0000000\&D1(1,3))$$

$$(y_k(2,1))_2 = (l_k(2,1))_2 \; OR \; (0000000\&D1(1,4)$$
$$(y_k(2,2))_2 = (l_k(2,2))_2 \; OR \; (0000000\&D1(1,5)$$
$$(y_k(2,3))_2 = (l_k(2,3))_2 \; OR \; (0000000\&D1(1,6)$$
$$(y_k(3,1))_2 = (l_k(3,1))_2 \; OR \; (0000000\&D1(1,7)$$
$$(y_k(3,2))_2 = (l_k(3,2))_2 \; OR \; (0000000\&D1(1,8)$$
$$(y_k(3,3))_2 = (l_k(3,3))_2 \; OR \; (0000000\&D1(1,9)$$

y_k will have the data hidden at its LSB and which will be not effected by JPEG compression

IV-RESULT

MATLAB standard image of lena, baboon, Barbara, Jet and papper are taken for the testing of the proposed work and all input images of 512x512 size and the data hidden is of 1 Kb.

Figure 4 below shows the original and cipher image of Lena develop using proposed work.

Figure 4 input and output image

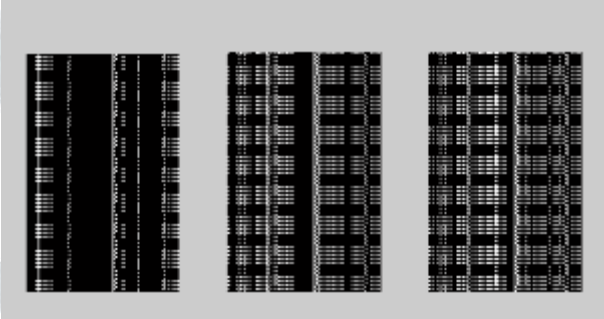

Figure 5 JPEG pixels after run length coding

Figure 5 above shows the binary image of red green and vlue frame after run length coding applied on the lena image.

Figure 6: Proposed work GUI

Figure 6 above shows the proposed work GUI for input and output observation and parameter input and output observation.

The peak signal-to-noise ratio (PSNR)[9] is adopted to evaluate the impact:

$$\text{PSNR} = 10\log10\left(\frac{255^2}{MSE}\right)$$

Where MSE (mean squared error)[9] for an M×N grayscale image is defined as:

$$MSE = \frac{1}{MxN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}(f'(x,y) - f(x,y))^2$$

Where f_(x, y) and f(x, y) are the pixel values of the distorted image and the original image respectively.

Table 1: PSNRs(dB), embedding rate $_e R$ (bpp) and MSE when compressed with QF = 50

QF=50			
	embedding rate *(BPP)*	*PSNR (db)*	*MSE*
Lena	6.68082	36.63	*0.0003526*
barbara	7.053	38.67	*0.000325*
Pepper	6.75878	37.0626	*0.000488*
Jet	7.09368	38.8991	*0.000698*
Baboon	6.97757	38.2624	*0.000671*

Table 1 above shows the obtain results for the MATLAB standard image of lena, baboon, Barbara, Jet and papper, all input images of 512x512 size and the data hidden is of 1 Kb.

Table 2 Comparative results with Xiaozhu Xie

QF=50				
	Proposed work		Xiaozhu Xie et al [1]	
	embedding rate *R*	*PSNR*	embedding rate *R*	*PSNR*
Lena	6.68082	36.63	*6.43*	*38.09*
Barbara	7.053	*38.67*	*5.44*	*35.76*
Pepper	6.75878	*37.0626*	*6.38*	*37.22*
Jet	7.09368	*38.8991*	*6.35*	*38.34*
Baboon	6.97757	38.2624	*4.42*	*32.87*
Average	6.90	*40.90*	*5.80*	*36.46*

Table 2 above shows the comparative results between Xiaozhu Xie et al [1] work and proposed work it can be observe that proposed work PSNR is higher than [1] work, also the data embedding rate is high.

Table 3 Comparative results with Ziqiang Cheng

Input Image QF=50	Proposed work PSNR	Ziqiang Cheng [2] PSNR
Lena	37.7072	*35.1*
Pepper	38.4644	*35.8*

As compare with available work Ziqiang Cheng [2] proposed work found better PSNR for the standard test image of Lena and Pepper.

V-CONCLUSION

In this paper, a high capacity reversible JPEG-to-JPEG data hiding scheme is proposed. Through lowering certain quantization table entries and lifting corresponding quantized DCT coefficients, space is made for embedding data. Using the proposed embedding strategy, our scheme can achieve high embedding capacity and keep the distortion introduced by embedding very low, meanwhile the original cover JPEG image can be restored after the secret data are extracted. Experiment results demonstrate that the proposed method maintain the good image quality of a stego jpeg image when the high capacity data embedded in it. Proposed work Compared with Xiaozhu Xie method and Ziqiang Cheng method and proposed method found superior in terms of the image quality, hiding capacity and PSNR. The proposed scheme is very practical for image files stored and transmitted in the JPEG format.

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