Text Information Hiding in Image by BBPVD Steganography Techniques

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ABSTRACT-We have proposed a BBPVD method to hiding a text data into cover image .This techniques is applicable for both the gray scale & color images. The proposed framework works on pixel value differencing, as the cover image is divided into fixed size blocks and then embeds the text message using the difference values, of two consecutive pixels of each block. In a color image every pixel value is composed of red, green and blue components which are use to embed the text message and each of which ranges from 0 to 255 in case of 8-bit representation. We extend block based PVD from two to four and eight pixel block size for increasing embedding capacity secret text data and increasing security. This enhances the hiding capacity of cover image and quality of stego-image that cannot be perceived by human eyes .PSNR is calculate for image quality after text message embedded in to images and it provides a large embedding capacity in bits .

Keywords: *Cover image, Embedding capacity, Peak signal to noise ratio (PSNR), and Stego-image.*

I. INTRODUCTION

Steganography is an art of sending a secret message under the conceal of a carrier content. The carrier content appears to have totally different but normal meanings. The goal of steganography is to mask the very presence of communication, making the true message not perceptible to the observer [1]. The carrier image in stegnographic is called the “cover image” and the image which has the embedded text is called the “stego image”. On the other hand, steganalysis is the set of techniques that aims to distinguish between cover-objects and stego objects .There are two kinds of image stegnographic techniques: spatial-domain and transform domain based methods. Spatial domain based methods embed messages directly in the intensity of pixels of images [2, 3]. The pixel-value differencing (PVD) method proposed by Wu and Tsai [1] can successfully provide both high embedding capacity and outstanding imperceptibility for the stego-image. They divide the cover image into a number of non-overlapping two pixel blocks. Each block is categorized according to the difference of the gray values of the two pixels in the block. A small difference value indicates that the block is in a smooth area and a large one indicates that it is in an edged area [8].Yang and wang proposed a modified version of PVD which uses random range intervals for data hiding but their algorithm was Susceptible to a natural steganalysis [6]. In this paper, our system performs pixel –value differencing steganography perform by two, four and eight pixel on both gray scale and color image for enhancing embedding capacity and increases security level as well as avoids distorted stego-image.

In this paper we compare and improve information hiding capacity and security by using our new approach block based two, four and eight pixel value differencing. In proposed method color and gray image has been used as cover image, it give better secure information hiding capacity compare to Mandal - das and Wu-Tsai’S PVD method and others [1,3, 6, 8]. In our system, an optimal problem is formulated and solved by embedding and extraction algorithm. The pixel-value differencing is proposed to hide secret text with absolute difference *d* of two serially consecutive pixel of block. The number of secret bits is embed and extracted depends on specified pixels difference values (*d, d’*), which are classified into continuous ranges R and the *d’* difference are used to generate modified pixels i.e. stego-image. This result has shown that our method increases amount of secret text data is hidden and maintain the stego-image at an acceptable and satisfied quality as compare to Mandal and Das,Gulve and Dr.Joshi.

II. PROPOSED SYSTEM

In the proposed system, gray scale & color image is used as cover image, every pixel in a color image composed of three colors (component) i.e. Red, Green and Blue. So, every pixel contains 24 bits (for 8-bit representation) where 8 bits for red component, 8 bits for green and 8 bits for blue component in a pixel, all the three components have been used for data embedding. Firstly, separated each color component from a pixel then we get three separate i*j matrix for each color. Now, apply pixel value differencing method for data hiding in each matrix separately, but in a sequencing manner. Firstly embed bits in 1st pixel block of the red component matrix, then in 1st block of green component matrix and lastly in blue component matrix, then again 2nd block of red matrix and so on. In Extracting step, divide the stego image into three component matrix RED, GREEN and BLUE and execute the following steps for each pixel block, consist of two consecutive adjacent pixels, of RED, GREEN, and BLUE respectively i.e. extract bits from one stego pixel at a time. Then initially same procedure explains for data hiding and data extractions for gray scale and color image.

A. Our contribution:

1. Calculate Difference between every two consecutive pixel of each block continuously.
2. We first-time implement 8-pixel block based value differencing on gray scale and color image
3. We apply same pixel value differencing techniques for 2-pixel, 4-pixel,8-pixel pvd in our proposed system.

B. Data embedding and extracting algorithm:

In our proposed BBPVD system of 2 ,4 and 8 pixels size are used to embed text data in image. In PVD scheme, the cover image is divided into blocks, in which each block consists of two, four and eight consecutive adjacent pixels in row order shown in Table I. Two consecutive adjacent pixels difference |*d*| is classified according to a set of continuous ranges R ,the optimal range R in this system is taken as in "(1)" i.e. the width of each range is taken to be a power of 2. Range specified how many secret bits to be embedded in pixel difference is as given in equation "(2)". The data hiding procedure is independent in each block.

$$R = \{R_k = [l_k, uk]\} \qquad (1)$$

i.e.

$$R = \{[0,7],[8,15],[16\text{-}31],[32,63],[64,127],[128,255]\}$$

$$\{w_k = \log_2 (u_k - l_k)\} = \{3, 3, 4, 5, 6, \text{and } 7\} \qquad (2)$$

Table I: Pixel difference value (*d*)

Block size (pixels)	***Difference d (of consecutive pixel)***
PVD	*d* 1 = abs(f(i,j) -f(i,j+1)) ;

4 Pixels	*d* 1 = abs(f(i,j) -f(i,j+1));
	d 2 = abs(f(i,j+1)-f(i,j+2));
	d 3 = abs(f(i,j+2)-f(i,j+3));

8 Pixels	*d* 1 = abs(f(i,j)-f(i,j+1));
	d 2 = abs(f(i,j+1)-f(i,j+2));
	d 3 = abs(f(i,j+2)-f(i,j+3));
	d 4 = abs(f(i,j+3)-f(i,j+4));
	d 5 = abs(f(i,j+4)-f(i,j+5));
	d 6 = abs(f(i,j+5)-f(i,j+6));
	d 7 = abs(f(i,j+6)-f(i,j+7));

1) Data Embedding algorithm

a) Open cover image. Check image is a gray scale then goes to step 3 else it is a color image.
b) If cover image is color image (24-bit) then separate red, green & blue of every 8-bit component, then apply the following step 3 to step 9 on each block of red, green and blue matrix one after another and so on.
c) Find the difference value $|d_i|$ = abs (f(i , j)-f(i , j+1)) ; for two consecutive adjacent pixels p_0 and p_1, refer Table.I.
d) Find the optimal R_i of d_i ,

$$R_i = \min (u_i - k), \qquad (3)$$

Where, $R \in [l_i, u_i]$ and $k = |d_i|$.

e) The number of secret data bits *t* to hide with each *di*

$$t = \log_2 w_i \qquad (4)$$

Where, w_i = width of the each range R_i

f) Read t bits binary secret data one by one and then converts t into decimal value b.
g) Calculate the new difference value d_i' using

i. $d_i' = l_i + b$ if $d_i \geq 0$,
ii. $d_i' = -(l_i + b)$ if $d_i < 0$

h). Calculate the new pixels values p'_0 and p'_1 of stego-image and repeat procedure from step 3 to step 8 for each Pixel pair block

$$(p'_0, p'_1) = \begin{cases} P_0 - \text{ceil}\,[(d' - d)/2],\ P_1 + \text{floor}\,[(d' - d)/2] & \text{, if d is odd} \\ P_0 - \text{floor}\,[(d' - d)/2],\ P_1 + \text{ceil}\,[(d' - d)/2] & \text{, if d is even} \end{cases}$$

All secret data is embedded then, go to step 10 for gray scale image and step 9 for color image. But , If new pixel pair (p_0' *and* p_1') is out of range [0,255] then the block is label as unusable an restore original pixel value (p_0, p_1).

i). Again after embedding secret data in each block of Red, Green and Blue color, then combine each separate color
Component to form color stego-image.

j). lastly we get stego-image in gray scale or color

2) Data Extraction algorithm

a) Open the stego-image. If it is gray scale image then, it is divided into the same non-overlapping blocks as in the embedding procedure then go to step 3 else it is a color image.
b) Color stego image separate in Red, Green and Blue color matrix for data extraction.
c) The difference value d' for each block of two consecutive pixels p'0 and p'1 in the stego- image Shown in Table II using d' = - (p'0 - p'1) .

Table II: Pixel difference value (*d'*)

Block Size (Pixels)	***Difference d' (of consecutive pixels)***
PVD	*d '1* = f_ex(i,j+1)-f_ex(i,j);
4 Pixels	*d* '1 = f_ex(i,j+1)-f_ex(i,j); *d* '2 = f_ex(i,j+2)-f_ex(i,j+1);

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	d`3 = f_ex(i,j+3)-f_ex(i,j+2);
8 Pixels	d`1 = f_ex(i,j+1)-f_ex(i,j); d`2= f_ex(i,j+2)-f_ex(i,j+1); d`3= f_ex(i,j+3)-f_ex(i,j+2); d`4=f_ex(i,j+4)-f_ex(i,j+3); d`5=f_ex(i,j+5)-f_ex(i,j+4); d`6=f_ex(i,j+6)-f_ex(i,j+5); d`7=f_ex(i,j+7)-f_ex(i,j+6);

d) Find the optimal R i of d i,
R = min (ui -k),

where, Rk Є [lk, uk]. ,k=|d ‘|

e) Obtain the secret data b ’in decimal format by
$b' = d'_i - l_i$.

f) Convert b’ into binary then find the number of bits i.e. t.

g) Binary stream data convert into decimal values.

h) If all data extracted then goto step 9 else goto step 3.

i) Obtain the original embedded secret text by converting decimal value into character.

III. EXPERIMENTAL RESULT, COMPARISION AND ANALYSIS

In the PVD technique, blocks size is 2 ,4 and 8 pixels are used to embed data in images. In this paper for the first time, 8-pixel size block based PVD has been implemented for embedding and extracting secret text data in and from color and Gray scale image. For hiding secret text data we take text file size 111 KB for experimentation. For testing four different standard gray and color images namely Lena, Baboon, F-16, Pepper and House each of size 512 × 512 are taken from the USC-SIPI Image Database. Performance analysis and experimental results are given in following Tables III to IV. Table III –IV shows that our proposed system has larger embedding capacity with acceptable PSNR than Mandal and Das [3] and. Gulve and Dr.Joshi [8]shown in Table.V. It shows that the highly textured image has large embedding capacity. Using histogram of cover image and stego-image we measure performance of our system as shown in fig.2 and got acceptable result for our proposed method to hiding secret text data.

Table.III. Experimental Result of Proposed method in terms of Capacity and PSNR for Gray Scale Image

Proposed Method	**Gray Scale Images**							
	Baboon		House		Lena		Pepper	
	Capacity (bits)	PSNR (db)	Capacity (bits)	PSNR (db)	Capacity (bits)	PSNR (db)	Capacity (bits)	PSNR (db)
PVD	425132	39.0302	373705	40.5867	376399	41.1604	379284	41.4428
4-pixel	606217	37.9261	560716	35.3068	507032	39.6475	568418	38.3045
8-pixel	**707229**	**35.5645**	**584429**	**33.2710**	**591509**	**32.3424**	**601812**	**35.6755**

Table.IV. Experimental Result of Proposed method in terms of Capacity and PSNR for Color Image

Proposed Method	**Color Images**							
	Baboon		House		Lena		Pepper	
	Capacity (bits)	PSNR (db)	Capacity (bits)	PSNR (db)	Capacity (bits)	PSNR (db)	Capacity (bits)	PSNR (db)
PVD	1292813	67.0862	1219724	68.6552	1207267	69.1091	1207336	69.3269
4-pixel	2056283	36.9055	1950527	34.3023	1928179	37.2745	1927770	37.1504
8-pixel	**2152104**	**34.6701**	**2027628**	**32.2893**	**2002272**	**34.6590**	**2001914**	**34.6884**

Table. V. Experimental Result of Five pixel Difference method in terms of Capacity and PSNR for Color Image

Five pixel Difference Method	***Gray Image***			
	Baboon		Lena	
	Capacity (bits)	PSNR (db)	Capacity (bits)	PSNR (db)
	75131	43.1635	54917	51.0834

IV. CONCLUSION

In this paper, variants of Pixel Value Differencing (PVD) method for data hiding in gray level and color images are implemented to increase the embedding capacity. A larger block with consecutive pixels will provide a higher capacity at the cost of stego-image quality; as the edge region is used to hide more bits without getting notice. Using this technique, more data can be inserted into areas where differences in the consecutive pixel values is large, as pixels in these areas can tolerate more changes and this leads to good imperceptibility Tri-way Pixel-Value Differencing and and five pixel pair Differencing secret text data file size is 111KB.

As a contribution to the paper we proposed 8-pixel block based PVD techniques is implemented on gray and color images. While using a 24-bit color image red, green and blue color components are used to embed data, stego color image is obtained by combining these stego red, stego green and stego blue components. Color images outperform the gray level images in which the gradual change in color will be harder to detect after the image that has been encoded with the secret message. 24 bit images offer much more flexibility, when used for Steganography. The large numbers of colors will be used to go well beyond the human visual system (HVS), which makes it very hard; to detect a secret message has been encoded. The experimental result shows that a larger amount of hidden data can be encoded into a color image as compared with the other techniques. Our proposed (2,4 and 8 pixels) PVD based methods are secure ,it analyses from embedding capacity histogram and PSNR value.

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