Analysis of Data hiding in R, G and B Channels of Color Image using Various Number of LSBs

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***Abstract*—In today's world of fast communication, to insure, the security and integrity of information is a big challenge. Data hiding also known as Steganography is one of the fields that deal in methods related information security and hide secret information and message other information. This paper elucidates the effect of data hiding in different number of least significant bits in the primary colors of RGB color image. These individual color channels are analyzed at different hiding capacity level and its has been observed that high quality Stego images with PNSR 30dB and above can been obtained by hiding secret information in 5 least significant bits of red, green and blue channels, specially the green and blue channels give a very high visual quality. The individual channels can hide 20% data, i.e. one fifth of the overall size of cover image, with undetectable changes in cover image.**

***Index Terms*—Data hiding, color image steganography, hiding capacity, PSNR.**

I. Introduction

The term steganography comes from Greek meaning ''Covered Writing''. Steganography is a field of concealing secret information in other information in innocent way. The hidden doesn't leave any detectable spot and hence the hidden data remain safe from attacks of intruders. In history, thousand year back, the tarces of Steganography were found in various forms. BC Histaiacus used the head of slave as a medium to send a secret message in the 5th century [1–4]. In World War II Naziz developed Steganographic techniques like Microdots, used null ciphers and invisible ink [2, 6, 7]. Later on the Morse code based on secrect information was hidden in a drawing in 1945 [8].

The Steganography became digital with the increase in processors speed and computer power. Especially with progress digital signal processing (DSP), information and coding theory, steganography started touching new skies and it finds new very interesting applications [9]. Kurak and McHugh developed one of the first digital Steganographic method closely related to 4LSB data hiding method [10]. They studied and analyzed the image degradation and corruption. This method is now a day known as image based Steganography.

The hiding of data is possible in image, audio, video, but, a medium having high redundancy level are preferred by Steganographer [11]. Provos and Honeyman [3], scrutinized 3x106 figures to find traces of steganography. Fridrich investigated color and grayscale images for steganography detection [12]. Neeta et. al. utilized LSB for data hiding and evaluated the LSB embedding method for various bits [13]. Namita Tiwari1 and Madhu Shandilya [14] proposed two data embedding methods to hide data in RGB image. The first methods was pixel indicator technique and other was triple-A algorithem. Sahib khan and M. H. Yousaf proposed a new secured steganography technique namely variable least significant bits Steganography. To implement VLSB Steganography different algorithms, decreasing distance decreasing bits algorithm, modular distance technique and varying index varying bits substitution algorithms were proposed [15-17].

This work mainly focuses on RGB color image LSB Steganography. This work divides color image into primary color components and make use of each individual channel for data hiding in its LSBs. It also investigates the effect of data hiding in various LSBs on Stego image quality.

Remaing paper organized as follow. Section 2 presents the data hiding process in R, G and B channels in details. The results are available in the experimental results section as elucidated in Section 3. The Section 3 also gives a detail discussion on data hiding in individual channels i.e. R, G and B. A conclusion is provided in Section 4.

II. Proposed Method and Implementation

In a RGB image each and every pixel composed of three primary color components i.e. red, green and blue and each of the primary color have 256 different shades range 0 to 255 in 8-bit representation.

To hide data in the primary colors using RGB color image as a cover, the color image is divided into its basic color. The R, G and B colors are extracted from a cover image and each of the primary color is subjected to data hiding. All the channels are considered one at a time, and different number of least significant bits is utilized for data hiding. For example, to hide secret message is R channel for data hiding. There is a possibility of hiding 1 bit to 8 bits of message in each element of R channel. In this work, each channel is subjected to

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different number of least significant bits substitution i.e . 1, 2, 3,……8 bits and the resultant Stego image is obtained for each number of least significant bits , in each channel. The implementation of the proposed technique is given here in Fig 1.

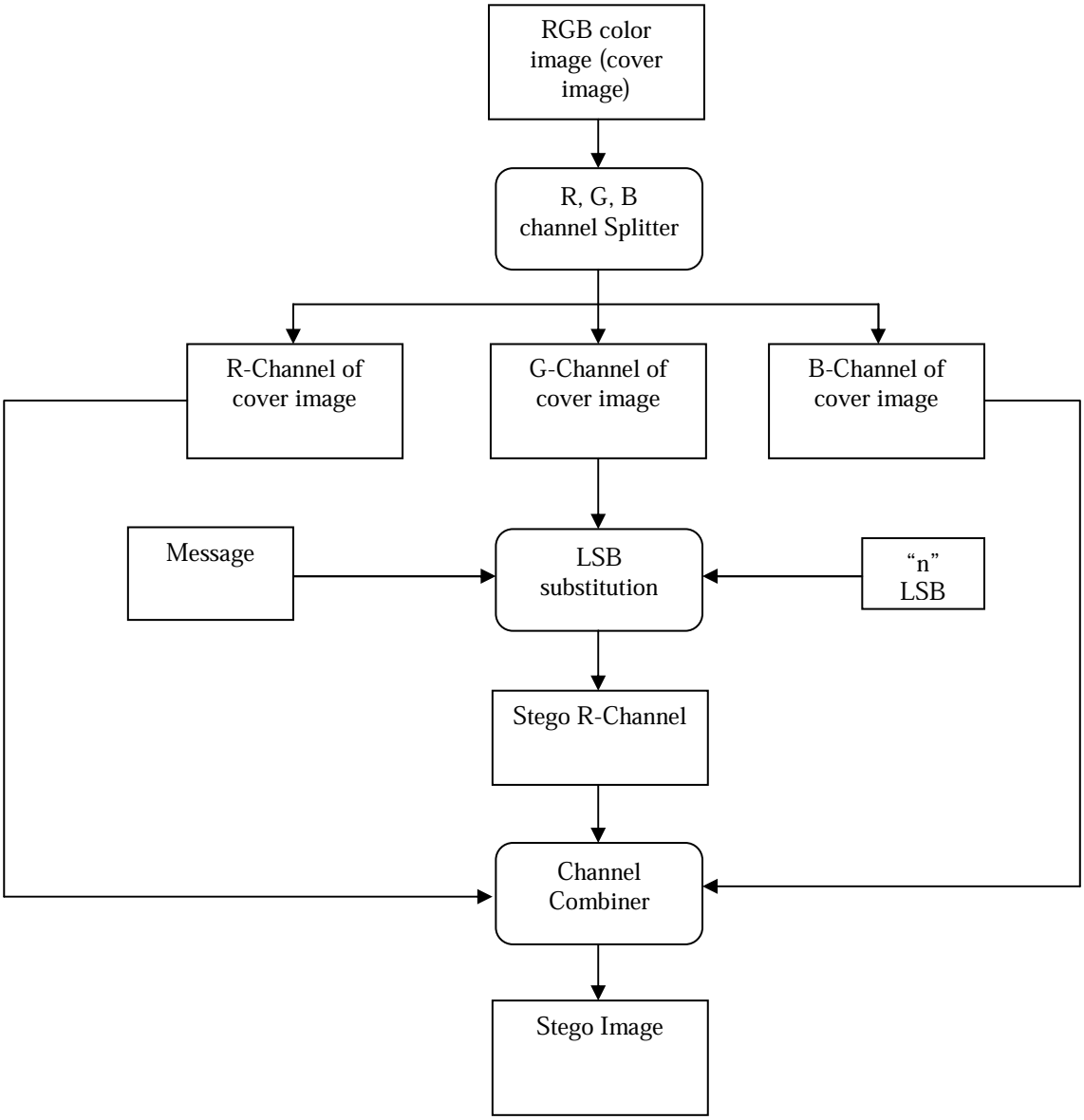


Fig. 1. The "n" bits data hiding in R-Channel of RGB color image

Algorithm:

1. Take a RGB color image
2. Convert the color image into its primary color components i.e. R, G and B
3. Consider one primary color component at a time for data hiding and leave other as it is
4. Embed "n" bits of secret message in the "n" LSB of selected of primary color.
5. Combine the modified primary color and unaffected primary color to get Stego image.
6. Check the quality of Stego image in term of MSE and PSNR
7. Change the"n" number of bits used for data hiding by repeating the whole process

The number of bits "n" used for data hiding may vary from 1 to 8. The same process is repeated for other primary color also and the resultant stego images are obtained for different number "n" of LSB used for data hiding. In this work each color component is analyzed for different number of LSB substitution and the hiding capacity, MSE and PSNR for each case is calculated. The results and there analysis is given experimental results section in details.

The block diagram explains the process of hiding "n" number secret message in the "n" LSB of R-channel of RGB color image. The as shown, the color image is divided into R, G and B individual channels. The red channel is subjected to "n" LSB substitution while, the green and blue channels are left unaffected. After hiding process the modified R-channels with hidden information is combined with the other two unaltered channels to get final Stego image. The process is applied on R-channel for 1, 2, 3,….8 bits data hiding and stego images are obtained and given in experimental results section. The other channels i.e. G and B are also processed, one at time, in the same manner for different number of LSB substitution.

III. Experimental Results

The proposed method hides secret information into primary color channels of a color image, substituting the LSB of cover channels with information bits. All the three primary colors are analyzed for different number LSB bits substitution to hide different amount of secret information. This method results high visual quality of the stego image. To observe and analyze the effect on the quality of stego image, the proposed work is applied on a cover image shown in Fig 2. The resulted stego image of hiding information into different number of LSB of R-channel is given in Fig 3.

Fig. 2. Cover Image

(a) (b)

(c) (d)

(e) (f)

Fig. 3. Stego image of data hiding in the LSB of R-channel, a) Stego image of 1 bit hiding, b) Stego image of 2 bits hiding, c) Stego image of 3 bits hiding, d) Stego image of 4 bits hiding, e) Stego image of 5 bits hiding, f) Stego image of 6 bits hiding

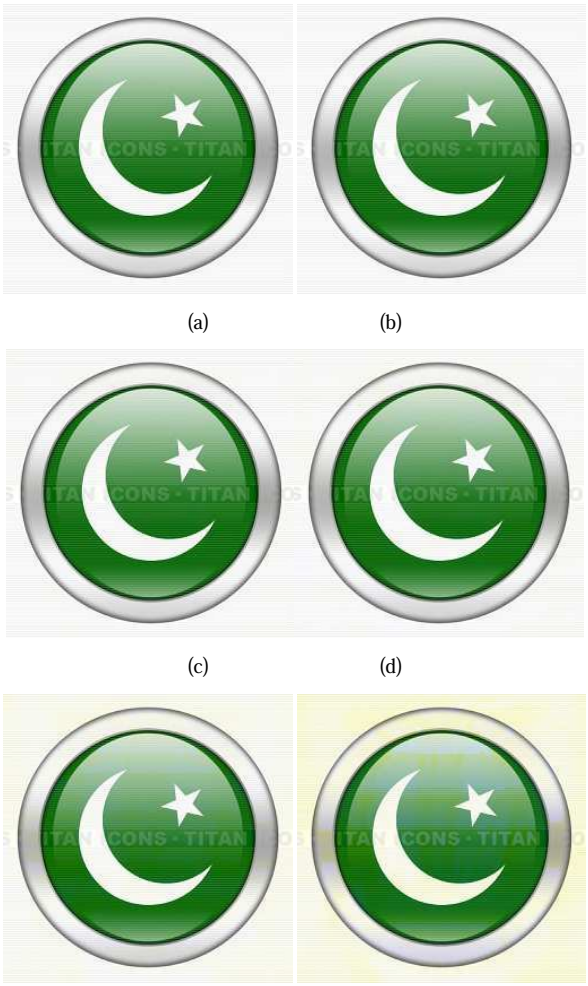
The Fig 3(a), 3(b), 3(c), 3(d), 3(e) and 3(f) shows the stego images of hiding 1 bit, 2 bits, 3bits, 4bits, 5bits and 6bits respectively in the LSB of R-channels of a color image. The stego images show that hiding of information greater than 4bits create visually significant changes in the stego image. So the substitution of 4bits or less creates no visually significant changes and it is better to hide information the 4LSB or less than 4LSB of R-channels.

To judge the quality of stego image Peak-Signal-to-Noise ratio (PSNR) and Mean Square Error (MSE) have been used. The experimental results of data hiding in different number of LSB are listed in Table I, depicting the hiding capacity, MSE and PSNR.

TABLE I. Hiding capacity, PSNR, SNR and MSE of data hiding in R-channel of RGB image

S. No	No of LSBs	Hiding Capacity (%)	PSNR (dB)	MSE
1	1	4.167	53.0106	0.3251
2	2	8.334	47.7809	1.0839
3	3	12.500	41.6345	4.4630
4	4	16.667	35.3542	18.9524
5	5	20.833	30.3079	60.5752
6	6	25.000	25.9652	164.6492
7	7	29.167	25.7531	172.8904

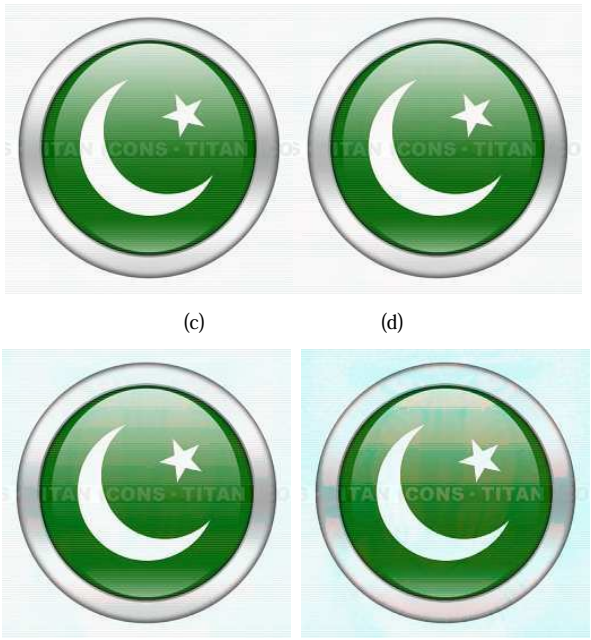
To study the effects of hiding data in the LSB of G-channel the same cover image of Fig 2, has been used. The resulted stego images of G-channel substitution are shown in Fig 4. The Fig 4(a), 4(b), 4(c), 4(d), 4(e) and 4(f) shows the stego images of hiding 1 bit, 2 bits, 3bits, 4bits, 5bits and 6bits respectively in the LSB of G-channels of RGB color image. The results show that the G-channel gives a better quality stego image up to 5bits hiding the G-channel element. However, the quality of stego images get distorted very significantly for larger number bits embedding. G-channel can hide more information than R-channel keeping stego image quality in acceptable range.



(a) (b) (c) (d) (e) (f)

Fig. 4. Stego image of data hiding in the LSB of G-channel, a) Stego image of 1 bit hiding, b) Stego image of 2 bits hiding, c) Stego image of 3 bits hiding, d) Stego image of 4 bits hiding, e) Stego image of 5 bits hiding, f) Stego image of 6 bits hiding

(a) (b)



(c) (d) (e) (f)

Fig. 5. Stego image of data hiding in the LSB of B-channel, a) Stego image of 1 bit hiding, b) Stego image of 2 bits hiding, c) Stego image of 3 bits hiding, d) Stego image of 4 bits hiding, e) Stego image of 5 bits hiding, f) Stego image of 6 bits hiding

The MSE and PSNR are calculated to evaluate the quality of stego image and the experimental results of data hiding in different number of LSB of G-channels are listed in Table II. While, the results of data hiding B-channel are given in Fig 5 and Table III.

TABLE II. HIDING CAPACITY, PSNR, SNR AND MSE OF DATA HIDING IN G-CHANNEL OF RGB IMAGE

S. No	No of LSBs	Hiding Capacity (%)	PSNR (dB)	MSE
1	1	4.167	53.6770	0.2789
2	2	8.334	47.9275	1.0479
3	3	12.500	41.6664	4.4303
4	4	16.667	36.0484	16.1524
5	5	20.833	31.1140	50.3126
6	6	25.000	26.4569	147.0234
7	7	29.167	25.8493	169.1016

TABLE III. HIDING CAPACITY, PSNR, SNR AND MSE OF DATA HIDING IN B-CHANNEL OF RGB IMAGE

S. No	No of LSBs	Hiding Capacity (%)	PSNR (dB)	MSE
1	1	4.167	53.5459	0.2874
2	2	8.334	47.9198	1.0498
3	3	12.500	41.6559	4.4411
4	4	16.667	35.5535	18.1022
5	5	20.833	30.9471	52.2845
6	6	25.000	26.4420	147.5304
7	7	29.167	25.8426	169.3651

From the experimental results, generated by using individual primary color components of RGB image as cover media, an increase in hiding capacity occurs with the use of more LSBs for data hiding. The MSE values are increasing with growing number of LSBs while, the PSNR values are increasing for every stego image obtained from data hiding in primary color components. Using RGB image, the effect of hiding information in the individual colors' components (red, green or blue) create different quality stego images. Green component results in much fine and high quality stego images as compared to other two channels while red create more changes while hiding information in its LSBs. For example green, blue and red channel result in PNSR value of 31.1140dB, 30.9471dB and 30.3079dB respectively. The results show that green channel is more suitable for data hiding using LSB steganography.

IV. Conclusion

This paper has discussed the use of substitution of various numbers of LSBs in the primary color components of RGB color image for hiding covert information. It has been observed from testing results that data embedding in the LSB of R, G and B channels, result in high quality Stego image and doesn't create any visually significant changes in resultant image up to 4LSB substitution in each of the primary channels. But, Green and Blue channels create high quality image even at 5LSB embedding level. The resulted values of PNSR and MSE for various number of LSBs in R, G and B channels also inveterate that green channel create less distortion in image, blue comes 2nd and red create more distortion than green and blue channels. Hence, the green channel and blue channels are more suitable for LSB Steganography than red channels.

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