Robust Increased Capacity Image Steganographic Scheme

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***Abstract*—with the rising tempo of unconventional right to use and hit protection of secret information is of extreme value. With the rising tempo of unconventional right to use and hit, protection of secret information is of extreme value. Steganography is the vital matter in information hiding. Steganography refers to the technology of hiding data into digital media without depiction of any misgiving. Lot of techniques has been projected during past years. In this paper, a new steganography approach for hiding data in digital images is presented with a special feature that it increases the capacity of hiding data in digital images with the least change in images perceptual appearance and statistical properties at too much less level which will be very difficult to detect.**

***Keywords*—Image steganography, LSB, Security Analysis, Robustness Analysis**

I. Introduction

The data that are passing on through internet persistently have possibility of third individual nosy. So there should be some criteria to keep information covert today as the current time is of digital contact. Steganography has established significant attention during the previous few years, in particular after anecdotal news suspected that this tool was used by terrorist. Steganography [2] [3] inquire about to make available a clandestine message control between two parties. There are various steganography [4] [5] technique and medium used for this purpose. These methods are gaining value due to the secret communication over the internet.

LSB substitution [1] and LSB matching method are the oldest methods of steganography. Both of these are applied on least significant bit and only one bit per pixel for grayscale and three bits per pixel for color image can be used for hiding message. During past years lot of techniques of steganography have been projected [4] [5] [8].

In this paper the advantages of LSB matching and LSB substitution are used and capacity is increased with least statistical and perceptual change. The paper is arranged as Section 2 describes Method, Section 3 discusses analysis of cases of change in pixel value, Section 4 compares the Substitution with the proposed method in term of change in pixel value, Section 5 is Compare by Analysis tools and Experimental results and discussion, Section 6 is the conclusion and references are in last section.

II. Method

In the proposed method the two operations are performed on one pixel. First the pixel value is adjusted in such a way that the second least significant bit becomes the message bit and after that substitution is performed on the least significant bit. This technique is applied on both the grayscale and color image.

A. Description of the proposed Method

The proposed system performs operations on second and least significant bit separately to improve the performance of simple substitution on least two bits of pixel. These can be described as:

1) Take two consecutive message bits Xi and X_{i+1}

2) For Xi, if second least significant bit is not same as Xi, then increment and decrement in pixel value in such a way that second least bit becomes the message bit Xi.

3) For the X_{i+1}, if least significant bit in not same as X_{i+1}, then simply the least significant bit of pixel will be replaces by the message bit X_{i+1}.

B. Description of the proposed Method

1-Message bits= X_i X_{i+1}=00

Pixel Decimal=4

00000100	00000100	00000100
(a) Pixel Binary	(b) Pixel binary after SLSB operation	(c) Pixel binary after LSB operation

Transformation of pixel value from (a) to (b) require no change because they are before now the same. Same is the case with transformation of (b) to (c). It is concluded from this that it is a case of no change (NC).

2-Message bits= X_i X_{i+1}=11

Pixel Decimal=4

00000100	00000011	00000011
(a) Pixel Binary	(b) Pixel binary after SLSB operation	(c) Pixel binary after LSB operation

Transformation of pixel value from (a) to (b) require decrement of 1 as message bit and pixel second least significant bit are not same. Transformation of (b) to (c) requires no change because they are before now the same. It is concluded from this that it is a case of change of 1 (C-1).

3-Message bits= $X_i\, X_{i+1}$=10
Pixel Decimal=4

00000100	00000011	00000010
(a)Pixel Binary	(b) Pixel binary after SLSB operation	(c) Pixel binary after LSB operation

Transformation of pixel value from (a) to (b) require decrement of 1 as message bit and pixel second least significant bit are not same. Transformation of (b) to (c) also creates decrement of 1. So from (a) to (c) total change is 2. It is concluded from this that it is a case of change of 2 (C-2).

4-Message bits= $X_i\, X_{i+1}$=01
Pixel Decimal=4

00000100	00000100	00000101
(a)Pixel binary	(b)Pixel binary after SLSB operation	(c) Pixel binary after LSB operation

Transformation of pixel value from (a) to (b) require no change. Transformation of (b) to (c) creates a change of 1. So from (a) to (c) total change is 1. It is concluded from this that it is a case of change of 1 (C-1).

C. Formal steps for insertion process:

Input: Cover Image CI and array of bit stream BS
Output: Stego-Image SI

1. $P \leftarrow m$
2. $i = 0$
3. $l(n) = length(BS)$
4. $for\ j = 0, \ldots, \frac{l(n)}{2}$
   a. $X_i and X_{i+1}\ are\ two\ consective\ bits\ from\ BS$
   b. $SLSBP_j \leftarrow Second\ least\ significant\ bit\ of\ pixel$
   c. $if(X_i \neq SLSBP_j)$
      i. $Adjustment\ of\ pixel\ value\ so\ that\ X_i = SLSB_j$
   d. $end\ if$
   e. $LSBP_j \leftarrow least\ significant\ bit\ of\ pixel\ at\ j\ location;$
   f. $if(X_{i+1} \neq LSBP_j)$
      i. $LSBP_j \leftarrow X_{i+1};$
   g. $end\ if$
   h. $i = i + 2;$
5. $end\ for$

Where *l(n)* is the length of message bits, BS is the array of bit stream that contain the message bits. For the grayscale images the loop of step 4 will run for half of the length of the message bits as one interval of loop will hide two message bits in one pixel. X_i and X_{i+1} are the two consecutive message bits from array of bit stream BS.

For color images the loop interval will be reduced as each interval of loop will hide six message bits in one loop interval in one pixel. In sub-step (a) and (b) of step 4, the second least significant bit and least significant bit will be computed for red, green and blue channel for one pixel. Similarly in sub-step c of step 4, six consecutive message bits will be taken from the bit stream for each interval of loop of step 3 and hide two bits in each red, green and blue channel and therefore sub-step (h) of step 4 will increment 6 instead of 2 in each interval of loop.

Adjustment steps are following:

1. $if(X_i = 0\ \&\&\ SLSBP_j = 1)$
   a. $if(P_j = 255)$
      i. $P_j \leftarrow P_j - 2;$
   b. $else$
      i. $if(P_j \% 2 = 0)$
         1. $P_j \leftarrow P_j - 1;$
      ii. $else$
         1. $P_j \leftarrow P_j + 1;$
      iii. $end\ else$
      iv. $end\ if$
   c. $end\ else$
   d. $end\ if$
2. $else$
   a. $if(P_j = 0)$
      i. $P_j = P_j - 2\ ;$
   b. $else$
      i. $if(P_j \% 2 = 0)$
         1. $P_j \leftarrow P_j - 1\ ;$
      ii. $else$
         1. $P_j \leftarrow P_j + 1\ ;$
      iii. $end\ else$
      iv. $end\ if$
   c. $end\ else$
   d. $end\ if$
3. $end\ else$
4. $end\ if$

These steps just increment or decrement the pixel value in such a way that the second least significant bit becomes the message bit. Observation of all the 256 shades shows that there is 99.22% possibility that this change will be 1 and for only 0.78% it will be 2.

D. Formal steps for extraction process:

While extraction, the loop will not end as long as at least two bits are collected as message bit from all pixels of the image. This is because the insertion is quite different from the retrieval process. We just recover the two LSBs value of each pixel and translate this to ASCII; the message will be understandable and in readable format up to the point that the message was inserted, and will then come into view as claptrap.

Input: Stego-Image
Output: Message

1. $P \leftarrow m$
2. $for\ j = 0, \ldots, m$
   a. $LSBP_j \leftarrow$ $Least\ significant\ bit\ of\ pixel\ at\ j\ location$
   b. $if(SLSBP_j == 0)$
      i. $BS \leftarrow 0$
   c. $else$
      i. $BS \leftarrow 1$
   d. $end\ else$
   e. $end\ if$
   f. $if(LSBP_j == 0)$
      i. $BS \leftarrow 0$
   g. $else$
      i. $BS \leftarrow 1$
   h. $end\ else$
   i. $end\ if$
3. $end\ for$

In step 1 *m* is the total number of pixels in the image. *SLSBP* and *LSBP* are the least two significant bits of pixel P and *BS* is the bit stream of message bits. After collecting all bits in *BS*, its ASCII conversion will give the message in readable format. If we know the length of the message that was inserted, then the loop will be ended when the length of message is completed and only the message will be retrieved i.e., no gibberish will be seen at the end of the message.

E. Analyses of Cases of Change in Pixel Value

This section makes analysis for all the shades of gray for checking the change in pixel value after the direct substitution and proposed method.

Table 1 shows the cases of change in all the gray shades for substitution method for two bits. Substitution method simply replaces the pixel's least two bits with the two message bits. For example if the two consecutive message bit are 11 and pixel binary is 11111101. Then substitution simply replace 01 with 11, 11111101→11111111.Replacement will be performed if the message bits and pixel's least bits are not same.

In Table I, first column is the gray level; second column is the binary of gray level, third column shows the binary value after substitution of 00, fourth column shows the possibility of C (Change) and NC (No Change) in gray level after substitution of 00. C-1 means the gray level will have change of 1 after substitution, C-2 is a change of 2, C-3 is a change of 3 and NC means that gray level will remain same as before substitution. Similar to substitution of message bits 00, column 5 and 6 shows the possibility of C or NC for the substitution of message bits 11; column 7 and 8 shows the possibility of C or NC for the substitution of message bits 10 and last two columns are for message bit 01.

F. Comprison of Substitution and Proposed Method

From the Table II and IV it is clear that proposed method is better than direct substitution as possibility of C-3 have been decreased from 12.50% to 0.20% by increasing the possibility of C-1 from 37.5% to 49.80%. Change of 3 is a grater change as compare to 1. Change of 1 is invisible to human eye and almost undetectable. So proposed method is better in terms that it decreases the possibility of 3 and increases the possibility of change of 1.

TABLE.I. CHANGE AFTER SIMPLE SUBSTITUTION METHOD

Value	Binary of Value	For Message Bits 00	C/NC 00	For Message Bits 11	C/NC 11	For Message Bits 10	C/NC 10	For Message Bits 01	C/NC 01
0	00000000	00000000	NC	00000011	C-3	00000010	C-2	00000001	C-1
1	00000001	00000000	C-1	00000011	C-2	00000010	C-1	00000001	NC
2	00000010	00000000	C-2	00000011	C-1	00000010	NC	00000001	C-1
3	00000011	00000000	C-3	00000011	NC	00000010	C-1	00000001	C-2
4	00000100	00000100	NC	00000111	C-3	00000110	C-2	00000101	C-1
5	00000101	00000100	C-1	00000111	C-2	00000110	C-1	00000101	NC
6	00000110	00000100	C-2	00000111	C-1	00000110	NC	00000101	C-1
7	00000111	00000100	C-3	00000111	NC	00000110	C-1	00000101	C-2
. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
248	11111000	11111000	NC	11111011	C-3	11111010	C-2	11111001	C-1
249	11111001	11111000	C-1	11111011	C-2	11111010	C-1	11111001	NC
250	11111010	11111000	C-2	11111011	C-1	11111010	NC	11111001	C-1
251	11111011	11111000	C-3	11111011	NC	11111010	C-1	11111001	C-2
252	11111100	11111100	NC	11111111	C-3	11111110	C-2	11111101	C-1
253	11111101	11111100	C-1	11111111	C-2	11111110	C-1	11111101	NC
254	11111110	11111100	C-2	11111111	C-1	11111110	NC	11111101	C-1
255	11111111	11111100	C-3	11111111	NC	11111110	C-1	11111101	C-2

Table II shows the conclusion of Table I.

TABLE.II. CHANGE AFTER SIMPLE SUBSTITUTION METHOD

Total Gray Levels	NC (No Change)	C-1 (Change of 1)	C-2 (Change of 1)	C-3 (Change of 1)
256 for 00	64	64	64	64
256 for 11	64	64	64	64
256 for 10	64	128	64	
256 for 01	64	128	64	
Total:				
1024	256	384	256	128
Average:				
100%	25%	37.5%	25%	12.5%

Table III shows the cases of change for proposed method.

TABLE.III. CHANGE AFTER PURPOSED METHOD

Value	Binary of Value	For Message Bits 00	C/NC 00	For Message Bits 11	C/NC 11	For Message Bits 10	C/NC 10	For Message Bits 01	C/NC 01
0	00000000	00000000	NC	00000011	C-3	00000010	C-2	00000001	C-1
1	00000001	00000000	C-1	00000011	C-2	00000010	C-1	00000001	NC
2	00000010	00000000	C-2	00000011	C-1	00000010	NC	00000001	C-1
3	00000011	00000000	C-1	00000011	NC	00000010	C-1	00000001	C-2
4	00000100	00000100	NC	00000111	C-1	00000110	C-2	00000101	C-1
5	00000101	00000100	C-1	00000111	C-2	00000110	C-1	00000101	NC
6	00000110	00000100	C-2	00000111	C-1	00000110	NC	00000101	C-1
7	00000111	00000100	C-1	00000111	NC	00000110	C-1	00000101	C-2
. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
248	11111000	11111000	NC	11111011	C-1	11111010	C-2	11111001	C-1
249	11111001	11111000	C-1	11111011	C-2	11111010	C-1	11111001	NC
250	11111010	11111000	C-2	11111011	C-1	11111010	NC	11111001	C-1
251	11111011	11111000	C-1	11111011	NC	11111010	C-1	11111001	C-2
252	11111100	11111100	NC	11111111	C-1	11111110	C-2	11111101	C-1
253	11111101	11111100	C-1	11111111	C-2	11111110	C-1	11111101	NC
254	11111110	11111100	C-2	11111111	C-1	11111110	NC	11111101	C-1
255	11111111	11111100	C-3	11111111	NC	11111110	C-1	11111101	C-2

CONCLUSION FROM TABLE 3:

Table 4 shows the conclusion of Table 3.

TABLE.IV. CHANGE AFTER PROPOSED METHOD

Total Gray Levels	NC (No Change)	C-1 (Change of 1)	C-2 (Change of 1)	C-3 (Change of 1)
256 for 00	64	127	64	1
256 for 11	64	127	64	1
256 for 10	64	128	64	
256 for 01	64	128	64	
Total:				
1024	256	510	256	2
Average:				
100%	25%	49.80%	25%	0.20%

III. COMPARISON BY ANALYSES TOOLS AND EXPERIMENTAL RESULTS

This section discusses the "Comparison and Analysis tools" used to test the proposed method.

A. *Comparison and Analyses Tools*

The comparison section is further subdivided into two sections. First is named as "Security Analysis" and second is named as "Robustness Analysis".

B. *Security Analyses*

Comparing the histograms of cover image and the stego-image gives the clear idea of security. The security examination evaluates the cover image with the stego-image on the basis of histograms of Images. For histogram comparison Correlation, Chi-square, Intersection and Bhattacharya distance [6] are computed between the histogram of cover image and stego-image.

All these comparisons are performed on normalized histogram. The correlation value varies between 1 and -1. Perfect match is 1 and total mismatch is -1. For Chi-square ideal value is 0 and mismatch value is unbound, for intersection 1 is ideal matching value and 0 is mismatched value and Bhattacharya distance gives 0 for the exact match and 1 for mismatch. When these comparison matrices gives ideal values or values that are closer to ideal values then the change in histogram is very least and this is the evidence for Stego-System to be a secure system.

C. Robustness Analyses

Robustness of any method depends on different parameters. In the paper four most important and widely used Image quality measures [7, 9, 10, 11, 12 and 13] namely MSE, PSNR, UIQI and SSIM are computed for comparison.

Fig. 1. Images used for Test

Mean Square Error computes the perceived error. It is pixel value difference based quality measure. Peak Signal to Noise Ratio [10] is inversely proportional to MSE. Less MSE gives High PSNR which is the proof of the fact that image has good quality.

Image Quality Index split the judgment of similarity between Cover Image (CI) and Stego-Image (SI) into three comparisons: Luminance, Contrast and Structural Information.

SSIM estimates "Perceived change in structural information". It computes the similarity between two images of common size. Its mathematical definition is as:

The value of UIQI and SSIM varies between 1 and -1. Closer the highest positive value denotes too much less change in two images and -1 shows totally mismatch. UIQI and SSIM are considered as more consistent and accurate than MSE and PSNR.

IV. Experimental Results

This section presents the experimental results obtained after implementing the proposed method in .NET Framework (C#). A system is designed and implemented in .NET Framework (C#) that shows the functioning of projected Increased Capacity Image Steganography method. The system is named as Robust Increased Capacity Image Steganographic Scheme (RICISS) because of exceptional results of Security Analysis and Robust analysis.

The proposed method is tested on many standard images. Some from the tested database are shown in Figure 1. (a) is the Barbara grayscale image having dimensions 512x512, (b) is the Pepper grayscale image having dimensions 512x512, (c) is the Lena color Image having dimensions 512x512 and (d) is the Pepper color image having dimensions 225x225.

The section also divided into two subsections. First will give the experimental results for grayscale images and second subsection will give for color images.

A. Grayscale Image

In Barbara Gray Image, Figure 1 (a), different numbers of bits are hidden and results are computed between cover and stego image. Table 5 shows the result of security analysis with 30272 bits of hidden data, 41472 bits of hidden data and 63824 bits of hidden data. Table 6 shows the results of robustness analysis for cover and stego Barbara Gray images.

TABLE.V. RESULT OF SECURITY ANALYSIS FOR THE BARBARA GRAY IMAGE

Image	Method	30272 Bits	41472 Bits	63824 Bits
Barbara Gray	Correlation	0.99999	0.99998	0.99997
Barbara Gray	Chi-Square	0.00032	0.00044	0.00068
Barbara Gray	Intersection	0.99979	0.99971	0.99956
Barbara Gray	Bhattacharyya	0.00089	0.00104	0.00139

TABLE.VI. RESULT OF ROBUSTNESS ANALYSIS FOR THE BARBARA GRAY IMAGE

Image	Robustness Analysis IQM	30272 Bits	41472 Bits	63824 Bits
Barbara Gray	MSE	0.07542	0.10348	0.15983
Barbara Gray	PSNR	59.44863	58.07538	56.18712
Barbara Gray	UIQI	0.99998	0.99998	0.99997
Barbara Gray	MSSIM	0.99998	0.99998	0.99997

In Pepper Gray Image, Figure 1 (b), different numbers of bits are hidden and results are computed between cover and stego image. Table 7 shows the result of security analysis with 24880 bits of hidden data, 41472 bits of hidden data and 55952 bits of hidden data. Table 8 shows the results of robustness analysis for cover and stego Pepper Gray images

TABLE.VII. RESULT OF SECURITY ANALYSIS FOR THE PEPPER GRAY IMAGE

Image	Method	24880 Bits	41472 Bits	55952 Bits
Pepper Gray	Correlation	0.99999	0.99998	0.99997
Pepper Gray	Chi-Square	0.00028	0.00046	0.00062
Pepper Gray	Intersection	0.99993	0.99971	0.99961
Pepper Gray	Bhattacharyya	0.00302	0.00336	0.00352

TABLE.VIII. RESULT OF ROBUSTNESS ANALYSIS FOR THE PEPPER GRAY IMAGE

Image	Robustness Analysis IQM	24880 Bits	41472 Bits	63824 Bits
Pepper Gray	MSE	0.07542	0.10348	0.15983
Pepper Gray	PSNR	59.44863	58.07538	56.18712
Pepper Gray	UIQI	0.99998	0.99998	0.99997
Pepper Gray	MSSIM	0.99998	0.99998	0.99997

B. Color Image

This subsection gives the experimental results for the color image. In Lena Color Image, Figure 1 (c), different numbers of bits are hidden and results are computed between cover and stego image. Table 9 shows the result of security analysis and robustness analysis with 66944 bits of hidden data and 81296 bits of hidden data in cover image.

TABLE.IX. RESULT OF SECURITY AND ROBUSTNESS ANALYSIS FOR THE LENA COLOUR IMAGE

Image	Method	66944 Bits	81296 Bits	Method	66944 Bits	81296 Bits
Lena Color	Correlation	0.99999	0.99999	MSE	0.06346	0.07723
Lena Color	Chi-Square	0.00037	0.00044	PSNR	60.09989	59.26520
Lena Color	Intersection	0.99975	0.99969	UIQI	0.99998	0.99997
Lena Color	Bhattacharyya	0.00087	0.00098	MSSIM	0.99998	0.99997

In Pepper Color Image, Figure 1 (d), different numbers of bits are hidden and results are computed between cover and stego image. Table 10 shows the result of security analysis and robustness analysis with 66944 bits of hidden data and 81296 bits of hidden

TABLE.X. RESULT OF SECURITY AND ROBUSTNESS ANALYSIS FOR THE PEPPER COLOUR IMAGE

Image	Method	66944 Bits	81296 Bits	Method	66944 Bits	81896 Bits
Pepper Color	Correlation	0.99992	0.99990	MSE	0.34794	0.41860
Pepper Color	Chi-Square	59.44863	0.00214	PSNR	52.81439	51.99257
Pepper Color	Intersection	0.99889	0.99963	UIQI	0.99993	0.99992
Pepper Color	Bhattacharyya	0.00751	0.00756	MSSIM	0.99993	0.99992

V. CONCLUSIONS

In this paper an increased capacity method of image steganography is presented and implemented for both the grayscale and color images. It makes accessible capacity improvement with least squalor in stego image quality. Experimental outcome be evidence for that the projected technique give good results for security analysis and robustness analysis and thus the projected technique provides the evidence to be strong.

REFERENCES

[1] N.F.Johnson, Sushil Jojadia George Mason University "Exploring Steganography: Seeing the Unseen", (0018-916/98/$10.00©) IEEE, 1998

[2] R.Poornima, R.J.Iswarya, "An Overview of Digital Image Steganography", *International Journal of Computer Science & Engineering Survey* (Vol.4, No 1) 2013

[3] T.Morkel, T.H.P.Eloff, M.S.Olivier, "An Overview of Image Steganography", ICSA Research Group, Department of Computer Science

[4] Jammi Ashok, Y.Raju, S.Munishankaralak, K.Srinivas, Jammi Ashok, "Steganography: An Overview", et.01./*International Journal of Engineering Science and Technology*, (Vol.2 (10)), 2010, 5985-5992

[5] Shikha Sharda, Sumit Budhiraja , "Image Steganography:A Review", *International Journal of Emerging Technology and Advance Engineering* (volume 3, Issue 1), January 2013

[6] ASHA, P. NAGABHUSHAN, N. U. BHAJANTRI, "SIMILARITY MEASURES FOR AUTOMATIC DEFECT DETECTION ON PATTERNED TEXTURES", INTERNATIONAL JOURNAL OF IMAGE PROCESSING AND VISION SCIENCES (IJIPVS) VOLUME-1 ISSUE-1, 2012

[7] Rajkumar Yadav, "Analysis of Various Image Steganography Techniques Based Upon PSNR Metric", *International Journal of P2P Network Trends and Technology*- (Volume1, Issue2), ISSN: 2249-2615, 2011

[8] M. Pavani, S. Naganjaneyulu, C. Nagaraju, "A Survey on LSB Based Steganography Methods", *International Journal of Engineering and Computer Science* ISSN: 2319-7242 (Volume 2 Issue 8) Page No. 2464-2467, August, 2013

[9] Ismail Avcibas, Bulent Sankur, Khalid Sayood, "Statistical Evaluation of Image Quality Measure", *Journal of Electronic Imaging*, 11(2), 206-223(April 2002)

[10] Zhou Wang, *Member*,Hamid R. Sheikh, "Image Quality Assessment: From Error Visibility to Structural Similarity", *IEEE Transactions On Image Processing*, (VOL. 13, NO. 4), APRIL 2004

[11] Yousra A. Y. Al. Najjar, Dr. D. C. Soong, "Comparison of image quality assessment: PSNR, HVS, UIQI, SSIM", IJSER, (Vol. 3, Issue8), ISSN2229-5518, August-2012

[12] Amhamed Saffor, Abdul Rahman Ramli, Kwan-Hoong Ng, "A Comparative Study of Image Compression between Jpeg and Wavelet", *Malaysian Journal of Computer Science*, (Vol. 14 No. 1), pp. 39-45, June 2001

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