Image Steganography Technique By Using Braille Method of Blind People (LSBraille)

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Abstract

Steganography is the art and science of writing hidden messages in such a way that no one, apart from the sender and intended recipient, suspects the existence of the message, a form of security through obscurity. Steganography is a Greek origin word which means “hidden writing”. Steganography word is classified into two parts: steganos which means “secret or covered” (where you want to hide the secret messages) and the graphic which means “writing” (text). It can be defined as the art of hiding the fact that communication is taking place, by hiding information in other information. Many different carrier file formats can be used, but digital images are the most popular. In this paper, a new image steganography method is proposed. The proposed method hides the secret message inside the cover image by representing the secret message characters using Braille method of reading and writing for blind people that can save more than one-fourth of the required space for embedding. From the experimental results it is seen that the proposed method achieves higher visual quality as indicated by the high peak signal-to-noise ratio (PSNR) in spite of hiding a large number of secret bits in the image.

Keywords: Steganography, Peak Signal-to-Noise Ratio (PSNR), Least Significant Bit (LSB).

1 INTRODUCTION

Data security or data privacy has become increasingly important as more and more systems are connected to the Internet [1]. In general, protecting the secret messages during transmission becomes an important research issue. To protect secret message from being stolen during transmission, there are two ways to solve this problem. One way is encryption, which refers to the process of encoding secret information in such a way that only the right person with a right key can decode and recover the original information successfully. Another way is steganography and this is a technique which hides secret information into a cover media or carrier so that it becomes unnoticed and less attractive [2].

Steganography is a branch of data hiding that allows the people to communicate secretly. As increasingly more material becomes available electronically, the influence of steganography on our lives will continue to grow [3]. In general, steganography is the art of hiding a message signal in a host signal without any perceptual distortion of the host signal. The composite signal is usually referred to as the stego signal. By using steganography, information can be hidden in carriers such as images, audio files, text files and videos [2].

The main terminologies used in the steganography systems are: the cover message, secret message, secret key and embedding algorithm. The cover message is the carrier of the message such as image, video, audio, text, or some other digital media. The secret message is the

information which is needed to be hidden in the suitable digital media. The secret key is usually used to embed the message depending on the hiding algorithms. The embedding algorithm is the way or the idea that usually use to embed the secret information in the cover message [4].

The most frequently used carriers are digital images. The use of digital images for steganography makes use of the weaknesses in the human visual system (HVS), which has a low sensitivity in random pattern changes and luminance. The human eye is incapable of discerning small changes in color or patterns. Because of this weakness the secret Message can be inserted into the cover image without being detected [5].

In this paper a new method that hides the secret message inside the cover image by representing the secret message characters using Braille method of reading and writing for blind people. Braille system uses six raised dots in a systematic arrangement with two columns of three dots, known as a Braille cell [8]; a 6-dot matrix which is the basis of Braille [7].

This paper is organized as follows, section 1 is an introduction. Section 2 briefly introduces the types of image steganography and least significant bit (LSB) technique. Section 3 introduces Braille method in details. Section 4 contains some previous LSB proposed methods. Section 5 presents our proposed LSBraille method. Section 6 contains the experimental results of our proposed method. Finally, section 7 concludes the paper.

2 IMAGE STEGANOGRAPHY

As said before, steganography is the technique that allows people to communicate secretly. Actually, there are two kinds of image steganographic techniques, spatial domain and frequency domain based methods. The schemes of the first kind directly embed the secret data or secret message within the pixels of the cover image. One of the most known examples of spatial domain method is LSB (Least Significant Bit) insertion. The schemes of the second kind embed the secret data within the cover image that has been transformed such as DCT (Discrete Cosine Transformation). The DCT coefficients of the transformed cover image will be quantized, and then modified according to the secret data [2].

2.1 Least Significant Bit (LSB) Insertion Technique

The simplest form of spatial domain image steganography is implemented by inserting the secret data into the least significant bits. Different algorithms would insert the binary form of the secret data in 1, 2, 3 or 4 – LSBs of the cover image. So, it is simple to implement for RGB, Gray Scale or Binary Images and less susceptible to detection by Human Vision System (HVS).[6]

In LSB steganography, the least significant bits of the cover media's digital data are used to conceal the message. The simplest of the LSB steganography techniques is LSB replacement. LSB replacement steganography flips the last bit of each of the data values to reflect the message that needs to be hidden.

Consider an 8-bit bitmap image where each pixel is stored as a byte representing a grayscale value. Suppose the first eight pixels of the original image have the following grayscale values: [3]

(11010010 01001010 10010111 10001100 00010101 01010111 00100110 01000011)

To hide the letter C whose binary value is 10000011, we would replace the LSBs of these pixels to have the following new grayscale values:

(11010011 01001010 10010110 10001100 00010100 01010110 00100111 01000011)

Note that, on average, only half the LSBs need to change. The difference between the cover (i.e. original) image and the stego image will be hardly noticeable to the human eye [3].

3 BRAILLE METHOD

3.1 Braille Definition

Braille is a tactile method of reading and writing for blind people developed by Louis Braille (1809–1852), a blind Frenchman. The Braille system uses six raised dots in a systematic arrangement with two columns of three dots, known as a Braille cell [8], a 6-dot matrix which is the basis of Braille [7]. By convention, the dots in the left column are numbered 1, 2 and 3 from top to bottom and the dots in the right column are numbered 4, 5 and 6 from top to bottom [8].

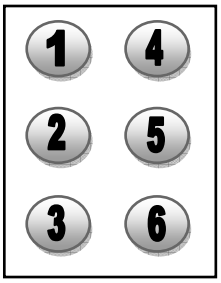

FIGURE 1: 6 – Dots Matrix (Braille Cell).

The six dots of the Braille cell are configured in 64 possible combinations (including the space which has no dots present). The 63 Braille characters with dots are grouped in a table of seven lines. This table is used to establish "Braille order" for listing Braille signs [8].

Line 1:	
Line 2:	
Line 3:	
Line 4:	
Line 5:	
Line 6:	
Line 7:	

TABLE 1: 63 Braille Characters With Dots.

Line 1 is formed with characters in the upper part of the cell, using dots 1, 2, 4 and 5. Line 2 adds dot 3 to each of the characters in Line 1. Line 3 adds dots 3 and 6 to each of the characters in Line 1. Line 4 adds dot 6 to each of the characters in Line 1. Line 5 repeats the dot configurations of Line 1 in the lower part of the cell, using dots 2, 3, 5 and 6. Line 6 is formed with characters using dots 3, 4, 5 and 6. Line 7 is formed with characters in the right column of the cell, using dots 4, 5 and 6 [8].

3.2 Braille Characters and Signs [9]

3.2.1 Letters of the Alphabet

	a		d		g		j		m		p		s		v		Y
	b		e		h		k		n		q		t		w		z
	c		f		i		l		o		r		u		x		

TABLE 2: Braille's Letters of the Alphabet.

3.2.2 Numerals

	1		3		5		7		9
	2		4		6		8		0

TABLE 3: Braille's Numerals.

3.2.3 Punctuations

	,	comma		.	Full stop		'	Single quote
	;	semicolon		?	Question mark		-	Hyphen
	:	colon		!	Exclamation mark		"	Double quote

TABLE 4: Braille's Punctuations.

3.2.4 Other Symbols

	&	Ampersand		+	Plus		>	Greater than
	[	Left bracket		=	Equals		/	Oblique stroke
	@	At		<	Less than		)	Right bracket
	]	Right bracket		*	Asterisk		_	Underline
	(	Left bracket		$	Dollar		%	Percent

TABLE 5: Braille's Other Symbols.

Finally, the total number of characters listed above is (26 Letters + 10 Numbers + 9 Punctuations + 15 Symbols) so, the total will be 60 characters. The rest of characters to reach 64 characters are (space) and the following table:-

	Text continuation		Lower Case Indicator		Upper Case Indicator

TABLE 6: Braille's Rest of Characters.

At this point of the paper we discussed the LSB image steganography technique and the Braille method of reading and writing for blind people. So, how we will use the Braille method for hiding

the secret message in the cover image?, before explaining our new method we will discuss some previous image steganography methods that based on LSB embedding technique.

4 PREVIOUS WORK

In [10], the author proposed a new LSB method that Instead of using the LSB-1 of the cover for embedding the message, LSB-3 which is the 3rd Least significant bit of the pixel has been used and LSB-1,2 may be modified according to the bit of the message, to minimize the difference between the cover and the stego-cover. After the experiments have been done the tables showed that the LSB – 1 has results better than LSB - 3 in which the embedding capacity is the same but the PSNR of LSB – 3 is lower than LSB – 1. After modifications have been done to LSB – 1 and LSB – 2 the PSNR values were enhanced but still lower than the original LSB – 1 method.

In [11] the authors proposed a method depends on LSB and edge detection where edge pixels were selected in order to hide the data by using the "Least Significant Bit Insertion". The algorithm randomly selects the edge-pixels of the image to hide the message because It is not noticeable when a single pixel is modified when its surrounding pixels are least like it. But from our point of view by using LSB in embedding in any region in the image the modifications won't be noticeable because the LSB modifies only the last bit which means the pixel will be increased or decreased by one.

In [12] the authors proposed a method that hide the pixel information of the source image in the destination video frames such that each row of pixel (consisting of 8 bits) is hided in first rows of multiple frames of the target. This makes the hiding so complex and it becomes very difficult to analyze. But what is new in the proposed method? The authors used the original LSB – 1 but by hiding data in multiple frames of the cover video without any modification.

In [1], the authors proposed a method that take the cover image, secret message and secret key, then transfers the secret message into text file, then convert the text file into a zip text file (Compressed File) and convert zip text file to binary codes. Finally the message is embedded by using 2 LSBs. The author here used the zip file for securing the secret message, also it has been compressed. Here they used the original LSB but with last 2 LSBs not LSB – 1 only.

In the next section we will explain the proposed LSBraille method in details and its 6 – bits representation table will be constructed.

5 PROPOSED LSBraille Method

Our proposed method is using the Braille method representations of the characters as each character can be represented by only 6 dots using the 6 – dots matrix which called (Braille Cell). The method will start by representing these characters (dots) as binary digits each of which consists of 6 bits only, not eight bits as in original LSB embedding method which uses the binary representation from the ASCII table. So, by using this representation we can save 2 pixels from each secret byte embedding process or more than one-fourth of the maximum hiding capacity for each cover image, which will increase the maximum hiding capacity (MHC) and enhance the PSNR of the LSB embedding technique.

$$\text{Original LSB MHC (Bytes)} = M \times N / 8 \quad (1)$$

$$\text{LSBraille MHC (Bytes)} = M \times N / 6 \quad (2)$$

As shown in previous equations M is width, N is height of the cover image. As an example if we have 512 x 512 cover image by using the original LSB with 8bit representation of the text, the cover image will hold up to (512 x 512 / 8) = 32,768 byte, but by using our new LSBraille method, the same image can hold (512 x 512 / 6) = 43,690 bytes, which is larger than the original LSB MHC.

Now, we will list Braille method characters and their corresponding 6 – bits representation in a table, in which each black dot will be represented by 1 and each white (empty) dot will be represented by 0.

Char	Black Dots Index in Cell	Binary Representation (6 bits)						Char	Black Dots Index in Cell	Binary Representation (6 bits)					
		1st	2nd	3rd	4th	5th	6th			1st	2nd	3rd	4th	5th	6th
a	1	1	0	0	0	0	0	6	1, 2, 4, 6	1	1	0	1	0	1
b	1, 2	1	1	0	0	0	0	7	1, 2, 4, 5, 6	1	1	0	1	1	1
c	1, 4	1	0	0	1	0	0	8	1, 2, 5, 6	1	1	0	0	1	1
d	1, 4, 5	1	0	0	1	1	0	9	2, 4, 6	0	1	0	1	0	1
e	1, 5	1	0	0	0	1	0	0	1, 2, 3, 4, 5, 6	1	1	1	1	1	1
f	1, 2, 4	1	1	0	1	0	0	,	2	0	1	0	0	0	0
g	1, 2, 4, 5	1	1	0	1	1	0	;	2, 3	0	1	1	0	0	0
h	1, 2, 5	1	1	0	0	1	0	:	2, 5	0	1	0	0	1	0
i	2, 4	0	1	0	1	0	0	.	2, 5, 6	0	1	0	0	1	1
j	2, 4, 5	0	1	0	1	1	0	?	2, 6	0	1	0	0	0	1
k	1, 3	1	0	1	0	0	0	!	3, 4, 5, 6	0	0	1	1	1	1
l	1, 2, 3	1	1	1	0	0	0	'	3	0	0	1	0	0	0
m	1, 3, 4	1	0	1	1	0	0	-	3, 6	0	0	1	0	0	1
n	1, 3, 4, 5	1	0	1	1	1	0	"	4	0	0	0	1	0	0
o	1, 3, 5	1	0	1	0	1	0	&	1, 2, 3, 4, 6	1	1	1	1	0	1
p	1, 2, 3, 4	1	1	1	1	0	0	[	1, 2, 3, 5, 6	1	1	1	0	1	1
q	1, 2, 3, 4, 5	1	1	1	1	1	0	@	2, 3, 4, 6	0	1	1	1	0	1
r	1, 2, 3, 5	1	1	1	0	1	0	]	2, 3, 4, 5, 6	0	1	1	1	1	1
s	2, 3, 4	0	1	1	1	0	0	+	2, 3, 5	0	1	1	0	1	0
t	2, 3, 4, 5	0	1	1	1	1	0	=	2, 3, 5, 6	0	1	1	0	1	1
u	1, 3, 6	1	0	1	0	0	1	<	2, 3, 6	0	1	1	0	0	1
v	1, 2, 3, 6	1	1	1	0	0	1	*	3, 5	0	0	1	0	1	0
w	2, 4, 5, 6	0	1	0	1	1	1	>	3, 5, 6	0	0	1	0	1	1
x	1, 3, 4, 6	1	0	1	1	0	1	/	3, 4	0	0	1	1	0	0
y	1, 3, 4, 5, 6	1	0	1	1	1	1	)	3, 4, 5	0	0	1	1	1	0
z	1, 3, 5, 6	1	0	1	0	1	1	_	3, 4, 6	0	0	1	1	0	1
1	1, 6	1	0	0	0	0	1	(	4, 5	0	0	0	1	1	0
2	1, 2, 6	1	1	0	0	0	1	$	4, 5, 6	0	0	0	1	1	1
3	1, 4, 6	1	0	0	1	0	1	%	4, 6	0	0	0	1	0	1
4	1, 4, 5, 6	1	0	0	1	1	1	Space	Empty Cell	0	0	0	0	0	0
5	1, 5, 6	1	0	0	0	1	1								

TABLE 7: Braille's Characters 6 – Bits Representation.

5.1 LSBraille Embedding Algorithm: Message Embedding Using LSBraille Method

Input : Cover Image C ; Secret Message M.

Output : StegoImage S.

Steps:

1) Split C into 3 channels Red (R), Green (G), Blue (B).

2) Split M into characters; M = { m_1, m_2, m_3 …., m_n}.

3) Take m_i from M

4) Convert m_i into Braille 6 – bits representation.

5) Take 6 pixels from B.

6) Apply LSB on m_i's 6 – bits and the 6 pixels of B.

7) Repeat steps from 3 to 6 until the whole M has been embedded in C.

8) Merge the 3 channels R, G, B again to construct the StegoImage S.

In the next section we will discuss in details the results that obtained from the proposed LSBraille method including Maximum Hiding Capacity (MHC) and Peak Signal to Noise Ratio (PSNR).

6 EXPERIMENTAL RESULTS

In this section, we will evaluate the performance of our new proposed method by comparing between the MHC of original LSB and LSBraille methods and comparing the PSNR values by taking the same messages and the same cover images then apply the original LSB method, 2 other LSB methods and our new LSBraille method. The results obtained from these comparisons are recorded and can be summarized in the following tables:-

Cover Image	Maximum Hiding Capacity (Byte)	
	Original LSB	LSBraille
128 x 128	2,048	2,730
256 x 256	8,192	10,922
512 x 512	32,768	43,690
1024 x 1024	131,072	174,762

TABLE 8: Comparison Between MHC of Original LSB and Our LSBraille.

As shown in table 8, the proposed LSBraille method has a higher embedding capacity than the original LSB method. So, our LSBraille method succeeded in obtaining more capacity for the same cover image than original LSB method or our LSBraille method has higher MHC than original LSB method.

Before discussing PSNR comparison tables, as we said before our LSBraille represents each character by 6 bits only not 8 bits. So, the PSNR will be higher than the original LSB because we saved 2 pixels from being modified for each secret message character, but we decided to prove our LSBraille efficiency by applying it and comparing it with some LSB methods.

Cover Image (256 x 256)	Message Capacity (Bytes)	PSNR	
		Original LSB	LSBraille
Boat	8,192	55.91603	57.19327
Bird	8,192	55.92812	57.18989
Flinstone	8,192	55.88576	57.16223

TABLE 9: Comparison Between PSNR of Original LSB and Our LSBraille.

In table 9 we compared our proposed LSBraille method with original LSB method by using 8,192 characters (bytes) secret message and 265 x 265 cover images (boat, bird, flinstone) and we found that our LSBraille method has more PSNR values than Original LSB method which means the stego image quality of our method will be higher than the stego image quality of the original LSB method.

Cover Image (256 x 256)	Message Capacity (Bytes)	PSNR	
		LSB – 3	LSBraille
Boat	8,192	39.1132	57.19327
Bird	8,192	39.0955	57.18989
Flinstone	8,192	39.1188	57.16223

TABLE 10: Comparison Between PSNR of LSB – 3 and Our LSBraille.

Also, in table 10 we compared our proposed LSBraille method with LSB – 3 method by using 8,192 characters (bytes) secret message and 265 x 265 cover images (boat, bird, flinstone) and we found that our LSBraille method has more PSNR values than LSB – 3 method which means that the stego image quality of our proposed method will be higher.

Cover Image (256 x 256)	Message Capacity (Bytes)	PSNR	
		Modified LSB – 3	LSBraille
Boat	8,192	42.4163	57.19327
Bird	8,192	42.4062	57.18989
Flinstone	8,192	42.2932	57.16223

TABLE 11: Comparison Between PSNR of Modified LSB – 3 and Our LSBraille.

Moreover, in table 11 we compared our proposed LSBraille method with Modified LSB – 3 method by using 8,192 characters (bytes) secret message and 265 x 265 cover images (boat, bird, flinstone) and we found that our LSBraille method has more PSNR values than Modified LSB – 3 method which means that the stego image quality of our proposed method will be also higher.

Finally, as shown in tables 9, 10 and 11, after the comparisons have been done among our proposed LSBraille method and original LSB, LSB – 3 [10], Modified LSB – 3 [10] methods by using secret message consists of 8,192 characters and 3 different 256 x 256 cover images (boat, bird, flinstone) we found that our LSBraille method has more PSNR values than other LSB methods which means the stego image quality of our method will be higher than the quality of other LSB methods.

7 CONCLUSION

As shown in comparison tables, after doing the same experiments using the LSBraille, original LSB and 2 other LSB methods, the PSNR values of the proposed LSBraille method were higher than other LSB methods. This means we are succeeded to improve the LSB method's PSNR

(stego image quality). Also we are succeeded to improve the maximum hiding capacity (MHC) as shown in table 8.

Finally, we can say that, our proposed LSBraille method proved its efficiency in image steganography field by enhancing the maximum hiding capacity (MHC) and the stego image quality (PSNR).

8 REFERENCES

[1] R. Ibrahim and T. S. Kuan. "Steganography Imaging System (SIS): Hiding Secret Message Inside An Image". *Proceedings of the World Congress on Engineering and Computer Science, WCECS 2010, San Francisco, USA, Vol. (I), Oct 20-22, 2010.*

[2] A. A. Radwan, A. swilem and A. H. Seddik. "A High Capacity SLDIP (Substitute Last Digit In Pixel". *Fifth International Conference on Intelligent Computing and Information Systems ICICIS 2011,Cairo, Egypt, 30 Jun - 3 Jul 2011.*

[3] V. K. SHARMA and V. SHRIVASTAVA. "A Steganography Algorithm For Hiding Image In Image By Improved LSB Substitution By Minimize Detection". *Journal of Theoretical and Applied Information Technology. 36(1). 15th Feb, 2012.*

[4] A. M. Al – Shatnawi. "A New Method In Image Steganography With Improved Image Quality". *Applied Mathematical Sciences, 6(79), pp. 3907 – 3915, 2012.*

[5] A. H. Seddik. "Enhancing The (MSLDIP) Image Steganographic Method (ESLDIP Method) ". *International Conference on Graphic and Image Processing, Proc. of SPIE 8285(3I). © SPIE 2011.*

[6] S. Chutani and H. Goyal. "LSB Embedding In Spatial Domain - A Review Of Improved Techniques". *International Journal of Computers & Technology, ISSN: 2277-3061, 3(1), Aug. 2012.*

[7] UNESCO. "World Braille Usage". *National library service for the blind and handicapped*, *library of congress*, *Washington*, *D.C, USA, 1990.*

[8] C. Simpson. "The Rules of Unified English Braille". *Round Table on Information Access for People with Print Disabilities Inc, Australia, Version I: June 2010.*

[9] Braille Authority of the United Kingdom. "British Braille". *Royal National Institute of the Blind. Bakewell Road. Orton Southgate, Peterborough, Cambridgeshire, 2004.*

[10] A. I. Abdul-Sada. "Hiding Data Using LSB-3". *J. Basrah Researches (Sciences), 33(4). pp. 81-88, DEC. 2007.*

[11] N. Jain, S. Meshram and S. Dubey. "Image Steganography Using LSB and Edge – Detection Technique". *International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, 2(3), Jul. 2012.*

[12] S. Singh and G. Agarwal. "Hiding Image To Video: A New Approach Of LSB Replacement". *International Journal of Engineering Science and Technology, 2(12), pp 6999-7003, 2010.*