

Image encryption based on pixel bit modification

by Fatmawati Fatmawati

Submission date: 07-Feb-2020 08:16PM (UTC+0800)

Submission ID: 1253119769

File name: 6_paper_2018_J._Phys.__Conf._Ser._1008_012016.pdf (402.28K)

Word count: 2101

Character count: 11117

PAPER • OPEN ACCESS

Image encryption based on pixel bit modification

To cite this article: Kiswara Agung *et al* 2018 *J. Phys.: Conf. Ser.* **1008** 012016

View the [article online](#) for updates and enhancements.

Related content

- [Advanced Secure Optical Image Processing for Communications: Compressive optical image security](#)
A Al Falou
- [Multidimensional Z-Matrix with Control Parameters and Its Applications in Image Encryption](#)
Zhao Liang, Liao Xiao-Feng, Xiang Tao et al.
- [A new image encryption algorithm based on the fractional-order hyperchaotic Lorenz system](#)
Wang Zhen, Huang Xia, Li Yu-Xia et al.



IOP | ebooks™

Bringing you innovative digital publishing with leading voices to create your essential collection of books in STEM research.

Start exploring the collection - download the first chapter of every title for free.

Image encryption based on pixel bit modification

Kiswara Agung¹, Fatmawati², Herry Suprajitno²

¹Mathematic Department, University of Jember, Jember, Indonesia

²Mathematic Department, Airlangga University, Surabaya, Indonesia

E-mail: kiswaras@gmail.com

Abstract. There are currently some publications about image encoding without changing pixel values. One of them encodes the image by dividing the image into blocks and then creating permutations and combinations into block positions. The disadvantage of this method is a grayscale histogram of an encoding image similar to a grayscale histogram of a plain image. This happens because the number of grayscale for the light intensity of the plain image is the same as the grayscale for the light intensity of the encoded image. In this article we propose image encoding by manipulating pixel bits. The result of this research is an image coding method where plain images and encoded images have big differences on grayscale histogram and visual.

1. Introduction

Nowadays, researchers about image encoding more focused on several aspects of which: [1] make permutations on some parts of the image, [5] transpose some parts of the image, [2] make combination on some parts of the image, [6] encode the image using affine transformations. [4] Some publications introduce an image encoding method by randomizing the position of pixels. [2] The position of pixels is randomized using permutation and combination processes. [5] divides the image into blocks, then the block position is scrambled to encode the image. [3] Scramble the pixel position on each layer of the colored image.

Image encoding performed by [2, 5, 10] produces a good visual encoding image but the weakness of this method is the grayscale histogram of plain and encoded images having the same shape because the number and pixel values are unchanged for the image before and after encoding. This weakness will be used by hackers as the entrance to destroy or manipulate the existing images. In statistical analysis, the difference between the plain image and the encrypt image can be seen from the mean square error (MSE) value, coefficient correlation, dan peak signal noise relation (PSNR).

In this article we offer an image encoding method by modifying its pixel value. We will manipulate the pixel value by redeeming between least significant bits (MSB) and least significant bits (LSB) in each pixel. The result of this method, the original image and the coded image have a significant difference both visually and from the histogram form. This happens because the number of grayscale of plain image and encrypt image is different, although the pixel position is no different.

2. Research Methods

2.1 Digital Image

Image data and text data is very different because an image contains very large data, and all data are interconnected one and the other. The image data also contains considerable data repetition [7]. The concept of the difference between text data and image data can be shown in the table below.

Table 1. Text and Image Encoding Differences

Type	Secret Data	Encrypted Data	Remarks
Text	"CSEMCKVIE"	"DTFNLDLWJF"	Completely different



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](https://creativecommons.org/licenses/by/3.0/). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

Image (RGB)



Pixel (P₁)=
(24,45, 233)



Pixel (P₂)=
(10, 65, 198)

³
P₁ and P₂ are
completely different,
but visually they look
similar

Image (Gray)



Pixel (P₁)=
(87)



Pixel (P₁)=
(114)

P₁ and P₂ are
completely different,
but visually they look
similar

A digital image consists of a number of elements, each element occupying a certain position and has a value. This element is usually called the picture element or pixel. [8]. An image is defined as a two-dimensional function $f(x, y)$ where x and y are coordinate pairs. The value of $f(x, y)$ is the light intensity of pixels in coordinates (x, y) and usually it's called grayscale. The value of a pixel can be converted to 8 binary digits (bits). 4 digits of the first are called the LSB (Least Significant Bit), where the change of value in this position will not give a significant change to the image. 4 digits of the second are called MSB (Most Significant Bit), where the change of value in this position will have a significant impact on the image [9]. The following figure shows the position of a value of bit.

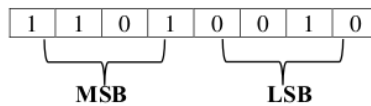


Figure1. MSB,LSB Interpretation

²
The maximum deviation of an image can be searched by creating a grayscale histogram and calculating the area. The smaller the deviation indicates that the coding results the better. To find the area of the histogram image can be searched by the formula: [3]

$$L = \frac{h_0 + h_{255}}{2} + \sum_{i=1}^{254} h_i$$

L = deviation area

h_i = number of pixel that have different i

i = pixel value

The correlation coefficient of an image shows how the relationship between pixels that adjacent each other. The formula for determining the correlation coefficient of an image is [6]:

$$E(x) = \frac{1}{N} \sum_{i=1}^N x_i \quad E(y) = \frac{1}{N} \sum_{i=1}^N y_i$$

$$CC = \frac{cov(x,y)}{\sigma_x \sigma_y}$$

$$= \frac{\sum_{i=1}^N (x_i - E(x))(y_i - E(y))}{\sqrt{\sum_{i=1}^N (x_i - E(x))^2} \sqrt{\sum_{i=1}^N (y_i - E(y))^2}}$$

x_i = the pixel of plain image at i position

y_i = the pixel of encrypt image at i position

N = total of pixel

From the results of correlation coefficient analysis found that if the value of CC smaller then it is said that the results of coding is better. If $CC = 1$ it is said both identical image or encoding fail. If $CC = 0$ it's said the two images are perfectly different. The correlation of image is the relationship between pixel pairs that are adjacent to each other vertically, horizontally or diagonally [1].

2.2 Image Encryption Algorithm by Pixel Modification

In this article we propose an image coding method based on pixel modification. The modification of the pixels that we propose is the exchange between the most significant bits (MSB) and least significant bits (LSB). Because of the type of this image encoding is symmetry, so the encryption procedure as same as the decryption procedure. The following is the proposed image encoding algorithm:

1. Enter the initial image with the known pixel value
2. Convert the pixel value to 8 bits.
3. Exchange between MSB and LSB of each pixel
 - a. Exchange bits 1 and bit 5
 - b. Exchange bits 2 and bit 6
 - c. Exchange bits 3 and bit 7
 - d. Exchange bits 4 and bit 8
4. Apply step 2 to all pixels in the image
5. End

The above algorithm applies to encoding and decoding process. The algorithm of this method can be presented in the following flowchart form:

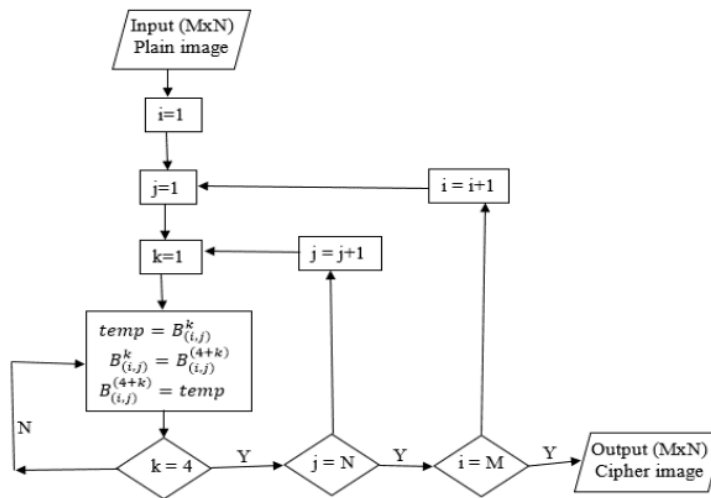


Figure 2. Flowchart Image Encoding

- M = width of image
- N = length of image
- K = bit position
- (i, j) = pixel position

$B_{(i,j)}^k$ = bit to k of pixel on the position (i,j)

For example, if known pixel data as follows:

Table 2. Pixel Data

Layer	Original Image				Encrypt Image			
	Value	Bit	MSB	LSB	MSB	LSB	Bit	Value
Red	69	01000101	0100	0101	0101	0100	01010100	84
Green	186	11011110	1101	1110	1110	1101	11101101	237
Blue	215	11010111	1101	0111	0111	1101	01111101	125

Based on the example above, we know that to encode an image only need to exchange between most significant bits (MSB) and least significant bits (LSB). This method is used for encryption or decryption of an image, so it is symmetry cryptography.

3. Results and Discussion

To test this algorithm, we do an experiment . This test is performed using a laptop with the I3 core microprocessor specification and Microsoft Windows 10 operating system .Program written using MATLAB R2016b and good quality image as the data. The results of this algorithm can be shown in the figure below. We use balloon images as data and histogram of grayscale for comparison

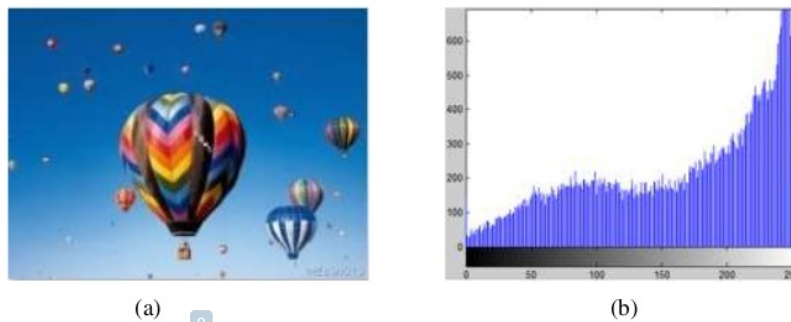


Figure 3. a) Plain Image, b) Histogram Plain Image

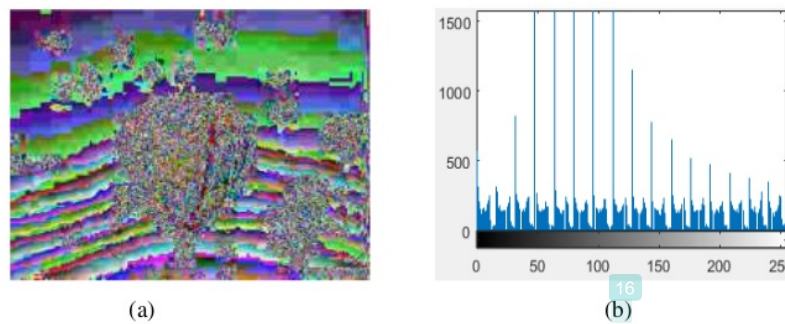


Figure 4. a) Encrypt Image, b) Histogram Encrypt Image

From the visualization results, the image 3a and image 4a above show that the image encoding results are very difficult to interpretation. We can see that density of histogram plain image (figure.3b) is greater than the density of histogram encrypt image (figure.4b). It shows that there is a significant difference between the original image and image of the encoding. In the histogram of figure 3b and 4b above shows that the intensity of the encrypt image as not same as the plain image, it cause the image to be more bad. In addition to analyzing the histogram, we also analyze the correlation between adjacent pixels, by vertically, horizontally and diagonally. Here we choose 2000 pairs of adjacent pixels and we calculate the correlation coefficient.

Table 3. Koefisien korelasi antara plainimage/cipherimage

Proximity Pixel	Plain Image	Encrypt Image
Horizontal	0.82599	0.82589
Vertical	0.99076	0.44643
Diagonal	0.97199	0.31143

There is a difference of correlation coefficient between two adjacent pixels diagonally using our method is 0.97199 (plainimage) and 0.31143 (encrypt image). Similar results also occur in adjacent vertical and horizontal pixels, as shown in Table 3. It is apparent in Table 3. that the difference in coefficient of correlation between two diagonally adjacent pixels is significant enough to cause the two images to differ significant visually.

4. Conclusion

The proposed method produces significant grayscale histogram differences between the original image and the image after encoding so it can correct the weakness of some existing methods before. This method has been tested on many images and the result is very satisfactory because it has a high level of security and quite worthy of being called a good security system. This is demonstrated by the significant differences between plain images and both visual and histogram encoding images, in addition there are also differences in correlation coefficients between two adjacent pixels either vertically, horizontally or diagonally. We hope the next research not only analyze the histogram but also the MSE and PSNR so that the level of security to be better

References

- [1] Dixit A, Drhuv P, Bhakwan D 2012 Image Encryption Using Permutation *Computer Science & Information Technology* **6** 1-9
- [2] Younes M A B and Jantan A 2008 An Image Encryption Approach Using a Combination of Permutation Technique Followed by Encryption *IJCSNS International Journal of Computer Science and Network Security* **8** 28-40
- [3] Chang 2004 Gray-Level Image Encryption Scheme Using Full Phase Encryption and Phase Encoded Exclusive OR Operation *Optical Review* **11** 1 34 - 37
- [4] Fhishawy 2007 Quality of Encryption Measurement of Bitmap Image with RC6, MRC6, and Rijndael Block Cipher Algorithm *International Journal of Network Security* **5** 3 241-251
- [5] Kester Q A 2013 Image Encryption based on the RGB PIXEL Transposition and Shuffling *International Journal of Computer Network and Information Security* 43-50
- [6] Kori P, Dubey P and Richhariya V 2015 Double Phase Image Encryption and Decryption Using Logistic Tent Map and Chaotic Logistic Map *IJSART International Journal and Research Technology* **1** 11 33-39
- [7] Majumdar S 2014 An Analytical Survey on Different Secured Image Encryption Techniques *IJCAT International Journal of Computing and Technology* **1** 8 396-403
- [8] Sakthidasan 2011 A New Algorithm for Image Encryption and Decryption of Digital Color Image *International Journal of Information and Education Technology* **1** 72-86

- [9] Santoso K A, Fatmawati and Suprajitno H 2017 Image Encryption Technique Based on Pixel Exchange and XOR Operation *Proceeding of International Basic Science Conference* 286-288
- [10] Zhou W and Alan B 2009 Mean Squared Error: A New Look At Signal Fidelity Measures *IEEE Signal Processing Magazine* 98-117

Image encryption based on pixel bit modification

ORIGINALITY REPORT

20%

SIMILARITY INDEX

15%

INTERNET SOURCES

14%

PUBLICATIONS

0%

STUDENT PAPERS

PRIMARY SOURCES

1

eprints.uthm.edu.my

Internet Source

5%

2

Kiswara Agung Santoso, Ahmad Kamsyakawuni, Abduh Riski. "Hiding The Text Into An Image By Max-Plus Algebra", 2019 International Conference on Computer Science, Information Technology, and Electrical Engineering (ICOMITEE), 2019

Publication

2%

3

ijcat.org

Internet Source

2%

4

Xing-Yuan Wang, Xue Qin, Yi-Xin Xie. "Pseudo-Random Sequences Generated by a Class of One-Dimensional Smooth Map", Chinese Physics Letters, 2011

Publication

2%

5

epdf.tips

Internet Source

1%

6

V M Chandrasekaran, B Praba, A Manimaran, G Kailash. "Data transfer using complete

1%

bipartite graph", IOP Conference Series:
Materials Science and Engineering, 2017

Publication

7	www.geeksforgeeks.org Internet Source	1%
8	link.springer.com Internet Source	1%
9	Sun Fu-Yan, Liu Shu-Tang, Lü Zong-Wang. "Image encryption using high-dimension chaotic system", Chinese Physics, 2007 Publication	1%
10	Behnia, S.. "A novel algorithm for image encryption based on mixture of chaotic maps", Chaos, Solitons and Fractals, 200801 Publication	1%
11	Communications in Computer and Information Science, 2011. Publication	1%
12	www.irjet.net Internet Source	<1%
13	www.mdpi.com Internet Source	<1%
14	"Proceedings of the Third International Conference on Soft Computing for Problem Solving", Springer Science and Business Media LLC, 2014	<1%

15

Sachin Kailas Bhopi, Nilima M. Dongre, Reshma R. Gulwani. "Binary key based permutation for medical image encryption", 2016 International Conference on Inventive Computation Technologies (ICICT), 2016

<1%

Publication

16

Muhammad Usama, Muhammad Khurram Khan. "Satellite Imagery Security Application (SISA)", 2008 IEEE International Multitopic Conference, 2008

<1%

Publication

17

Li-Min Zhang, Ke-Hui Sun, Wen-Hao Liu, Shao-Bo He. "A novel color image encryption scheme using fractional-order hyperchaotic system and DNA sequence operations", Chinese Physics B, 2017

<1%

Publication

Exclude quotes Off

Exclude matches Off

Exclude bibliography On

Image encryption based on pixel bit modification

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7
