A Method of LSB substitution based on image blocks and maximum entropy

Mohamed RADOUANE[1], Tarik BOUJIHA[1], Rochdi MESSOUSSI[1], Nadia IDRISSI[2], Ahmed ROUKH[2]

**[1] Department of physics, Faculty of Science, Ibn tofail University,
B.P 242, Kénitra, Morocco**

**[1] Ecole Nationale des Sciences Appliquées, Ibn tofail University,
Kénitra, Morocco**

**[2] Department of physics, Faculty of Science, Moulay ismail University
B.P 11201 zitoune Meknes, Morocco**

Abstract

In this paper we introduce an algorithm of digital watermarking based on embedding watermark into sub images with LSB technique. The watermark is embedded into specifics blocks of the host image, the selection of blocks are based on entropy value.
The simulation results show that the visual quality of the watermarked image and the extracted watermark is good, this result is presented and proved by a high PSNR value.

Keywords: *Information security, digital image watermarking, Entropy, Least Significant Bit (LSB), Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR).*

1. Introduction

In the last years, due to the advancement in technologies and the increase rapidly of data transmission, most people prefers to use the internet as the essential medium to transfer data. The data transmission is made very simple, fast and accurate using the internet.

However, the protection and enforcement of intellectual property copyrights has become an important issue in the digital world.
There are several approaches, methods and techniques have been developed to protect our information during transfer data from source to destination like Cryptography, Steganography and digital image Watermarking.
Fundamentally, watermarking can be described as a method for embedding information into another signal.

In case of digital images, the embedded information can be either visible or hidden from the user. A host image used to hide the secret data is called the host image [5] or the carrier image. After embedding the secret data into the host image, the resultant image is called the watermarked image.

2. Digital watermarking

Digital watermarking technology is an emerging field in computer science, cryptography, signal processing and communications. Digital Watermarking is intended by its developers as the solution to the need to provide value added protection on top of data encryption and scrambling for content protection. Like other technology under development, digital watermarking raises a number of essential questions as follows. [1]
Digital watermarking is defined as a process of embedding data (watermark), into a multimedia object to help to protect the owner's right to that object. The embedding data (watermark) may be either visible or invisible. In case of visible watermarking, the watermark is embedded into the host image such that the watermark is intentionally perceptible to a human observer; whereas in the case of invisible, the embedded image data that is not perceptible, but may be extracted by a computer program. [2]

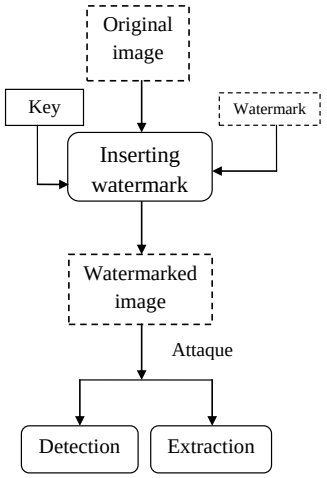


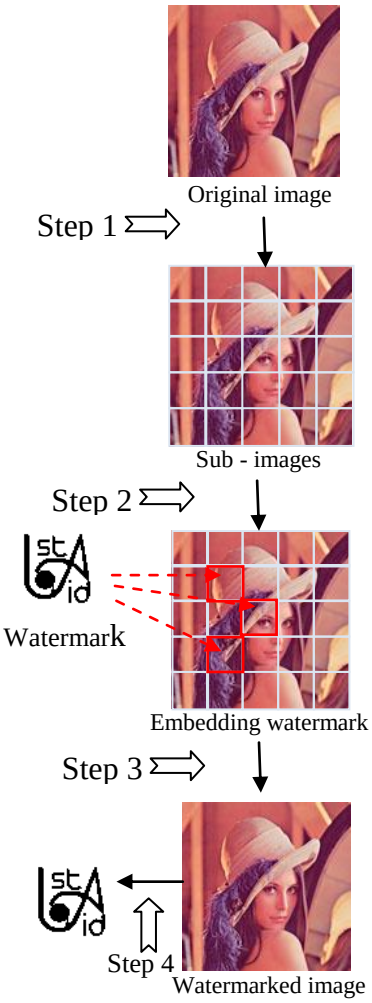
Figure 1 : Scheme of watermarking

3. Least Significant Bit (LSB)

The least significant bit (LSB) technique is used to embed information in a cover image. The LSB technique of a cover image is described by changing pixels by bits of the secret message. These changes cannot be perceived by the human visibility system. This technique was originally designed to work with gray-scale images but is easily extended to color images by treating each color plane as a single plane in which data is inserted in the LSB. [3][4]

The process of embedding data is described with these different steps:

Step 1: devising image into different blocks (sub-images).
Step 2: calculate the entropy of each block
Step 4: inserting watermark image into sub images which have the maximum entropy and calculate the PSNR.
Step 5: recognizing the image devised to have the original image.
Step 6: retrieving watermark with extraction method.



4. Entropy of grayscale image:

Entropy is a statistical measure of randomness that can be used to characterize the texture of the input image. Entropy is defined as:

E=-sum(p.*log2(p))

Where p contains the histogram counts returned from imhist. By default, entropy uses two bins for logical arrays and 256 bins for uint8, uint16, or double arrays.[6]

Results:

We embed watermark in blocks of original image using maximum entropy to select the suitable blocks.

We notice that there is no difference between the original and watermarked images and there is no distortion occurs for these watermarked images.

We got the result after we calculated the Peak signal-to-noise ratio (PSNR).
The PSNR is a better test since it takes the signal strength into consideration. The values were used to evaluate the quality of the watermarked images.

This equation describes how this value is obtained:

$$PSNR = 10 \log_{10} \left[\frac{R^2}{MSE} \right]$$

Where R represents maximum fluctuation or value in the image, its value is 255 for 8 bit unsigned number.

The MSE represents the cumulative squared error between the compressed and the original image.
To compute the PSNR, the mean squared error is first calculated using the following equation:

$$MSE = \frac{\sum_{M,N} [I1(m,n) - I2(m,n)]^2}{M * N}$$

Where M and N are the number of rows and columns in the input images, respectively and I1 (m, n) is the original image, I2 (m, n) is the Watermarked image.

Number Of blocks	Method	PSNR
1 block	1st Bit Substitution (LSB)	65.7059
	2nd Bit Substitution	59.7120
	3rd Bit Substitution	53.7899
	4th Bit Substitution	47.5984
	5th Bit Substitution	41.2750
	6th Bit Substitution	35.4789
	7th Bit Substitution	29.5223
	8th Bit Substitution (MSB)	23.9433
2 blocks	1st Bit Substitution (LSB)	62.7029
	2nd Bit Substitution	56.6401
	3rd Bit Substitution	50.7461
	4th Bit Substitution	44.5714
	5th Bit Substitution	38.3996
	6th Bit Substitution	32.5842
	7th Bit Substitution	26.5419
	8th Bit Substitution (MSB)	20.7166
3 blocks	1st Bit Substitution (LSB)	60.9924
	2nd Bit Substitution	54.8748
	3rd Bit Substitution	48.9145
	4th Bit Substitution	42.8616
	5th Bit Substitution	36.7401
	6th Bit Substitution	30.8495
	7th Bit Substitution	24.7399
	8th Bit Substitution (MSB)	18.8826
4 blocks	1st Bit Substitution (LSB)	59.7102
	2nd Bit Substitution	53.6238
	3rd Bit Substitution	47.6575
	4th Bit Substitution	41.6151
	5th Bit Substitution	35.5435
	6th Bit Substitution	29.6488
	7th Bit Substitution	23.6147
	8th Bit Substitution (MSB)	17.4579

Table1: PSNR values for the blocks method

These figures demonstrate the embed watermark in four blocks of original image.

Figure1: logo to be embedded in image

Figure2:watermarked image with LSB

Figure3:Watermarked Image 2nd bit substitution

Figure3: Watermarked Image 3rd bit substitution

Figure4: Watermarked Image 4th bit substitution

Figure5: Watermarked Image 5th bit substitution

Figure6: Watermarked Image 6th bit substitution

Figure7: Watermarked Image 7th bit substitution

Figure8: Watermarked Image 8th bit substitution

Figure9: extracted watermark

Conclusions

This paper proposed a method of LSB digital watermarking scheme based on combination of LSB and maximum entropy.
The experimental result shows that the proposed method maintains the quality of the watermarked image.
This method is also tested using PSNR and the result of PSNR is compared with different insertion blocks of the host image.
For the future research, we will focus on the studies comparison of different watermarking schemes based on different LBP (Local Binary Pattern).

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