Odd-Even Message Bit Sequence Based Image Steganography

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Abstract— **Many individuals and business people use to transfer business documents, important information using internet. These documents are sensitive and if the documents get tempered it may result in serious misuse. Most Steganography techniques have respective strong and weak points. It is the art of hiding messages in the cover material. Hidden message may be in the form of text or image, which is only revealed by the authentic user. In this paper, we have proposed a method of splitting the message into a bit sequence, which then hides into the RGB planes of the image using 2-2-4 Least Significant Bit substitution method. This combination have proved to be a brand new combination in the approach. The above described techniques have different implementations in various spheres of day to day life.**

Keywords— **Steganography, LSB (least significant bit), RGB planes, Data hiding.**

I. Introduction

In today's world of increased security concern in the Internet due to hacking, strong cryptography techniques are required. But, unfortunately, most of the cryptography techniques have become vulnerable to attack by the snoopers[9]. This applies to some of the advanced encryption methods too. So, the need of the hour is to find new methods for keeping the information secret.

One such method commonly proposed nowadays is 'Steganography'. Steganography is the technique of embedding secret messages in such a way that no user other than the known one can view the message[9]. Steganography implements by replacing bits of less used data in data files (such as graphics, sound, text, etc.) with bits of different secret message. This hidden information can be plain text, cipher text, or even images[2][3].

II. Proposed Technique

Inserting a message image into another carrier image, one needs two files. First one is the colour image of any scenery or the image of any object also known as cover image. The second file carries the message itself to be hidden.

In the first step, the cover image in which the message is to be hidden and the message images containing the message are loaded up. The images can be in BITMAP or JPEG format, but more preferable is BITMAP as it is the lossless format available.

Further, the cover image is split into three planes namely Red, Green and Blue using bit slicing [3] and the histogram is plotted for the original cover image.

In the Encoding phase, the cover image is interleaved for the adjustment of the message images in with a Least Significant Bit replacement in the order of 2-2-4 in Red, Green and Blue planes respectively. That is, 2 message images in Red plane, 2 in Green Plane and 4 in Red Plane [4] [5].

The insertion technique used is LSB (Least Significant Bit). LSB insertion is a common, simple approach in embedding information in the cover [1] file. The least significant bits of the cover image are changed as required to insert the data to be hidden. For example, the image of data uses LSB[10] to hide first eight bytes of three pixels.

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Pixels:
      (00100111      10101011      111000001)
      (11101001      00011001      001110100)
      (00101010      11111110      111000111)

Data:            10101010

Result Pixels:
      (00100111      10101010      111000001)
      (11101000      00011001      001110100)
      (00101011      11111110      111000111)
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In proposed technique, message image decomposed into bits and these bits are replaced in the cover image. Selective bit insertion in 3 planes helps to reduce noise signals generated by the use of other methods like Random Pixel Generator[3] and also enhance security from attacks.

The proposed method uses multiple processes like edge tapering [13] to smoothen the image at the end of encoding to reduce the effect of LSB based pixel insertion. Another techniques used are uniform interleaving[7] of the text images, bit slicing, encoding, decoding, de-interleaving, etc. for the successful running of the algorithm [8].

According to the excerpts from "Theory of color" [11], human eye has four types of light receptors: the rods which are sensitive only to black, white and shades of grey, and the three types of cones which are sensitive to different colours.The human eye has four types of light receptors: the rods which are sensitive only to black, white and shades of grey, and the cones of which there are three types, each of which responds to a different range of colour.

The other three types of receptors are called cones [11]. At low light levels, cones cease to function. Cones respond to different wavelengths of light, as follows: 'red', 'green', and 'blue-violet'.

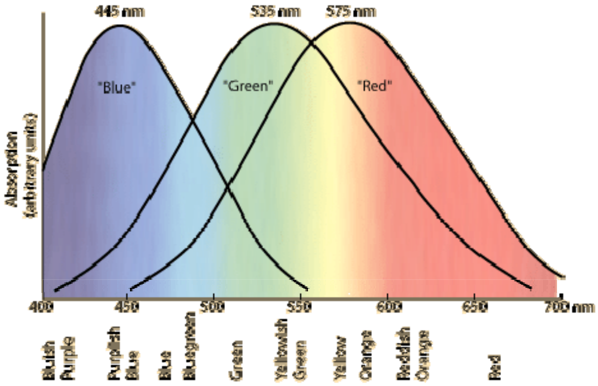

Fig. 1: This diagram shows that there is a degree of overlap between the responses of the types of cones.

Also, you can see from the diagram, the blue-violet cones are less sensitive to light. Approximately twice as much light (quanta) is required to obtain from the blue-violet cones a perceived light level that is similar to that obtained from the red and green cones. Or, in other words, full response of the blue-violet cones requires more light energy than for the red or green cones. As stated in [14], blue-violet cones are less sensitive to light thereby making very difficult for human eyes to observe minor changes in the colour intensity. On the other hand, the range 390 nm ≤ λ ≤ 720 nm, where λ is considered the visible wavelength range [14]. In this range, red and green are equivalently sensitive to human eye [11]. Also Red and Green are more sensitive as compared to the Blue.

In order to get maximum efficiency of the algorithm, my proposed technique uses 2-2-4 LSB Insertion. The proposed technique hides data 2-bit in 2 least significant bits of red component (Most significant Byte), 2-bits in 2 least significant bits of green component and 4-bits in 4 least significant bits of blue component (Least significant Byte) [15] of each selected pixel. The ratio 2:2:4 is selected on the basis of context in [14], which denotes the sensitivity of red and green components of the light to be similar. Thereby increasing the security and lowering the rate of distortion in the cover image after the hiding of the secret message image.

2.1 Algorithm used to insert data image into the cover image:

Step 1: Load the cover image.
Step 2: Load the Message Image.
Step 3: Convert text message into binary bit sequence and divide into two groups of even and odd.
Step 4: Calculate and find LSB of each pixel of the cover image.
Step 5: Replace each bit of odd group of the message image in order of 2:2:4 of the LSB in three planes (i.e. Red, Green and Blue component planes) of cover image.
Step 6: Replace each bit of even group of the message image in order of 2:2:4 of the LSB in three planes (i.e. Red, Green and Blue component planes) of cover image.
Step 7: Save the Stegnographed image.

2.2 Algorithm used to retain data image from the cover image:

Step 1: Load the data image.
Step 2: Calculate and find the LSB of each pixel of the cover image with the message image.
Step 3: Recover bits in the order of 2:2:4 from the LSB of the cover image.
Step 4: Determine PSNR.

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III. Results

3.1 Peak Signal to Noise Ratio (PSNR)

Generally, the image Steganography system must embed the content of a hidden message in the image such that the visual quality of the image is not perceptibly changed. Thus to study the embedding perceptual effect, we have used the peak signal to noise ratio (PSNR) which is defined as [6][12]:

$$\mathrm{PSNR} = 10\log_{10}\frac{(\mathrm{L}-1)^2}{\mathrm{RMS}}$$

Where

$$\mathrm{RMS} = \frac{1}{\mathrm{m}\cdot\mathrm{n}}\sum_{\mathrm{i}=1}^{\mathrm{m}}\sum_{\mathrm{j}=1}^{\mathrm{n}}\left(\mathrm{x}_{\mathrm{i,j}} - \mathrm{x}'_{\mathrm{i,j}}\right)^2$$

3.2 Mean Square Error (MSE)

In a sense, any measure of the *centre* of a distribution should be associated with some measure of *error*. If we say that the number *t* is a good measure of centre, then presumably we are saying that *t* represents the entire distribution better, in some way, than other numbers.

In this context, suppose that we measure the quality of *t*, as a measure of the centre of the distribution, in terms of the *mean square error*

$$\mathbf{MSE}(t) = \frac{1}{n}\sum_{i=1}^{k} f_i (x_i - t)^2 = \sum_{i=1}^{k} p_i (x_i - t)^2$$

MSE (*t*) is a weighted average of the squares of the distances between *t* and the class marks with the relative frequencies as the weight factors. Thus, the best measure of the centre, relative to this measure of error, is the value of *t* that minimizes MSE.

In statistics, the mean square error (MSE) is one way to evaluate the difference between an estimator and the true value of the quantity being estimated. MSE measures the average of the square of the "error," with the error being the amount by which the estimator differs from the quantity to be estimated.

3.3 Normalized Absolute Error (NAE)

It’s the numerical difference between the original and reconstructed image.

$$\mathrm{NAE} = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}(|A_{ij} - B_{ij}|)}{\sum_{i=1}^{m}\sum_{j=1}^{n}(A_{ij})}$$

3.4 Average Difference (AD)

It is theaverage of the difference between the pixels of the original and the treconstructed image.

$$AD = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(x(i,j) - y(i,j))$$

TABLE I

Image Name	PSNR	MSE	AD	NAE
Aquarium	56.2544	0.1664	-0.1657	0.0049
Pig	56.2372	0.1671	-0.1663	0.0040
Dawn	56.3589	0.1625	-0.1618	0.0033
Choclates	56.2385	0.1670	-0.1663	0.0057
Sunset	56.1392	0.1709	-0.1701	0.0086
Kitchen	56.2568	0.1663	-0.1655	0.0061
Outdoor	56.2633	0.1661	-0.1653	0.0050
Snow	56.2762	0.1656	-0.1648	0.0031
Machumountains	56.2403	0.1670	-0.1662	0.0054
Ship	56.2455	0.1668	-0.1660	0.0036

IV. CONCLUSIONS

The use of even odd groups of message image bit distribution has led to improvement in the spatial distribution which makes the image less noisy. The previous work implemented the pseudorandom bit generator or the direct bit sequence generator. The use of direct bit sequence created unequal distribution of the message bits in the cover image. This caused the quality degradation of the cover image due to less spatial distribution frequency. In my dissertation, I have implemented improved version of selective 2-2-4 approach of Least Significant bit (LSB) for secret message insertion. The improvement is made in the message image part. Earlier message was directly hidden inside the cover image, whereas now the message is hidden by first creating the binary bit sequence and later dividing it into two groups.

The Least significant Bit approach replaces the least significant bits of the pixel in the cover image. The earlier approach used to hide the secret message which is very susceptible to be detected. The new algorithm reducing noise and increase the Peak signal to noise ratio (PSNR).

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