DOI: http://dx.doi.org/10.30684/etj.36.11A.2

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Received on: 03/01/2018
Accepted on: 09/08/2018
Published online: 25/11/2018

# Hiding 9 Gray Images In RGB Image and Using Filters For Noise Removing

***Abstract***- *This paper shows two major techniques, the first is steganography and the second is filters. Gaussian and median filters are used to enhance the quality of image and remove the noise. Two kinds of noise are added to RGB cover image. RGB cover image are divided in to three cover images RGB. The hiding algorithm is Least Significant Bits (LSB) which is used to hide three different images in each part of noisy cover image. The results of proposed system show that the ability of extracting secret message without errors. Normalized Correlation (NC) and Peak Signal to Noise Ratio (PSNR) tests are utilized to find the robustness of the proposed system. The simulation results of this work are performed by Matlab program.*

***Keywords***- *steganography, Filters, LSB algorithm, security.*

**How to cite this article**: H.R. Hatem, "Hiding 9 Gray Images In RGB Image and Using Filters For Noise Removing," *Engineering and Technology Journal*, Vol. 36, Part A, No. 11, pp. 1144-1147, 2018.

## 1. Introduction

Security of data has become increasingly necessary since more and more systems linked to the internet. The secret messages protection during transmission becomes necessary research point. There are two solutions for protection secret message during transmission. One solution is encryption and another solution is steganography technique [1]. Hiding of data (Steganography) is the art and science of communicating in a way that hides the presence of the communication. In contrariety to cryptography, where the attacker is allowed to detect, interrupt and change messages without being able to breach certain security premises guaranteed by a cryptosystem, the intent of steganography is to hide messages inside other messages in a way that does not allow any attacker to even detect the presence of second secret message [2]. Unluckily, images are also sometimes incidentally undermined by undesirable signals, called noise, so that, removal of noise is an important matter in processing of images [3,4]. LSB steganography is the method that used in this paper for hiding nine image in color cover image. The noise is added to cover image before hiding, then, Gaussian and median filter are used to remove the noise from noisy cover image after hiding.

## 2. Related Works

B. Ahuja and M. Kaur proposed a new algorithm in LSB steganography with high data hiding capacity as four LSB's are used to hide data, high confidentiality as distortions, which can cause suspicions for the intruders, are removed through filtering technique [5]. Sontakke and Kulkarni discussed various types of noises and their sources in images and various types of filters used to remove this noise [3]. Singh et al. proposed Fuzzy based, Decision Based and traditional median filters to enhance the stego image and realize LSB based Steganography [6]. Priya et al. proposed Wien filter and Median filter to remove noise without reducing the sharpness of the image [7]. Shehab et al. embedded one to eight gray images or texts in color image without adding noise [8].

## 3. Least Significant Bit Substitution Method

The Least Significant Bit (LSB) steganography is a technique in which least significant bit of the image is substituted by information bit. In this technique, the least significant bits of some or all of the bytes inside an image is substituted by a bits of the secret message. The embedding approach of LSB has become the basis of many techniques that hide messages within multimedia carrier data [9].
A principal algorithm for LSB replacement is to take the first M cover pixels where M is the total length of the secret message for image where M=R×C (where R row and C column numbers in secret image) that is to be embedded in bits. After that every pixel's last bit in cover image will be substituted by one of the message bits [8].

## 4. Procedure of Steganography and Filters

At first, the cover image with the size 512×512 is chosen to provide more space for information as shown in Figure 1. In this work, the procedure of steganography and noise removing parted in two sides:

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**Figure 1: Cover Image jpg (512×512) pixels**

*I. Proposal of Embedded Side*

Steps of embedded side are:

1. Add two types of noise (salt and pepper, Gaussian) into cover image.
2. Transform 2-D noisy color image (R×C) into three(1-D) noisy images (red(M), green(M), blue(M)).
3. Nine secret images with the size 100×100 embedding in three channels, three in noisy R-channel, three images in noisy G-channel and three images in noisy B-channel. As shown in Figures 2 and 3. Figure (2) represents adding Gaussian noise and using Gaussian filter.
4. Each pixel in nine secret image represented by (8-bits/pixel (gray-image)).
5. Replace the value of the LSBs (eighth bit, seventh bit and sixth bit in every pixel (in noisy cover image(R-channel), in noisy cover image (G-channel) and noisy cover image (B-channel))) by the value of bits from first secret image, second secret image, third secret image, fourth, fifth, sixth, seventh, eighth and ninth secret image respectively as shown in Figure 3.
6. Transform back from binary to decimal and then from 1-D to 2-D to get noisy stego-image.

II. *Reconstructed Side*

1. The receiver needs noisy stego-image to extract the secret information. The algorithm of extracting is the inverse of the embedding algorithms, as shown in Figure 4.
2. Remove the noise from the noisy stego image by using median filter and Gausssian filters.
3. Divided color stego-image into 3-channel (red, green, blue).
4. Convert each channel of color stego-image from 2-D into 1-D and then convert each pixel to binary number (8-bit/pixel).
5. Take the three last bits from each pixel in (Red, Green and Blue channels) to construct the (1-9) secret image (binary(
6. Transform from binary to decimal value.
7. Transform from 1-D into2-D to construct secret image.

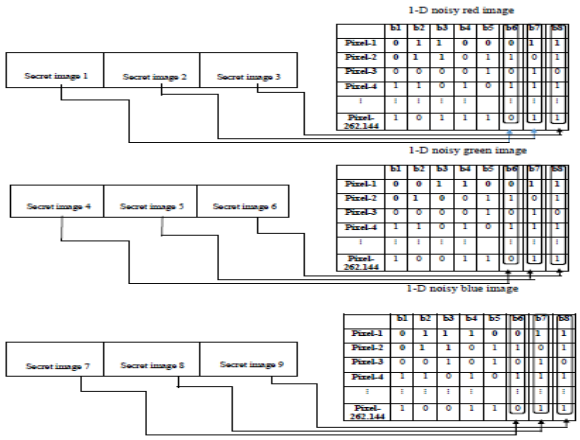


**Figure 2: Embedded System for Gray nine Images**

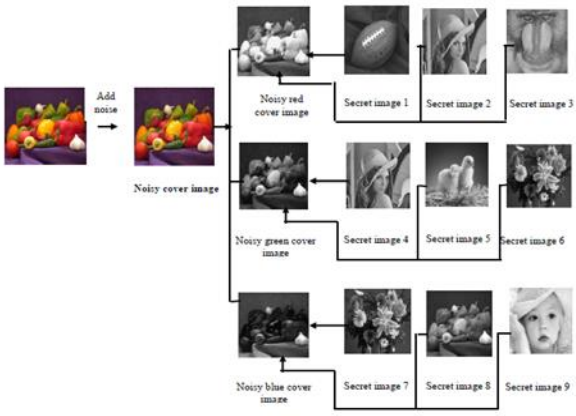


**Figure 3: process of Hiding (9-image) into Cover Image**

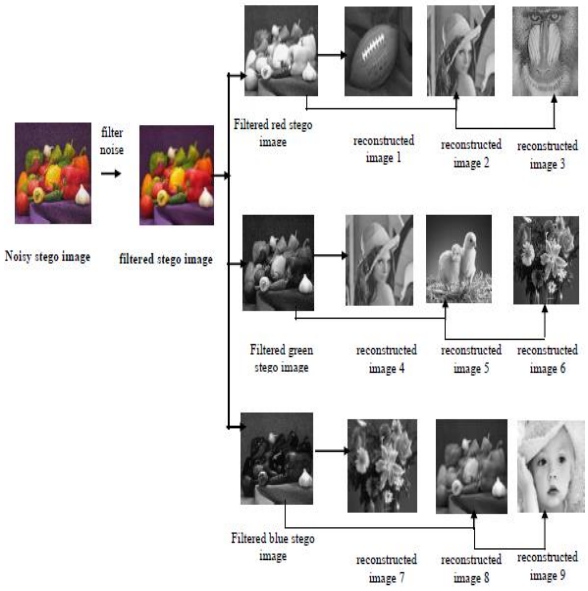


**Figure 4: Reconstructed system for nine Gray Images**

## 5. Computer Simulation Results

The tests that can be used to measure the quality of image are:

*I. Normalized Correlation (NC)*

Normalized correlation between the stego image, noisy stego image, filtered noisy stego image and original-image was evaluated as indicated in tables 1,2,3,4. Therefore, when the stego image, noisy stego image, filtered noisy stego image is perceptually similar to the original -image, then the normalized correlation equals one. From the results of NC, we noted that when the noise is added, NC is decreased but using filters process this case. The correlation can be calculated as shown below [10]:

$$Cor \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(C(i.j)-\bar{C})(St(i.j)-\overline{St})}{\sqrt{\left[\sum_{i=1}^{M}\sum_{j=1}^{N}(C(i.j)-\bar{C})^2\right]\left[\sum_{i=1}^{M}\sum_{j=1}^{N}(St(i.j)-\overline{St})^2\right]}} \quad (1)$$

where: i: row number. j: column number.

M: No. of rows of the cover image N:No. of columns of the cover image.

C(i,j):original image , St(i,j): stego image, $\bar{C}$:the mean of C(i,j)

$$\bar{C} = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N} C(i.j)}{M\times N} \quad (2)$$

$\overline{St}$:the mean of St(i,j)

$$\overline{St} = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N} St(i.j)}{M\times N} \quad (3)$$

*II. Peak-Signal-to-Noise-Ratio (PSNR)*

PNSR is employed for indicating the performance of proposed method. PSNR is usually measured in dB. To compute the peak signal to noise ratio, one starts by defining the error $(e)$ between the cover-image and the stego-image [9].

$$PSNR = 10log_{10}\frac{(L-1)^2}{\frac{1}{M\times N}\sum_{i=1}^{M}\sum_{j=1}^{N}[St(i.j)-C(i.j)]^2} \quad (4)$$

Where, *N*: height of the two images

*M*: the two images width.

*j and i* : column and row numbers.

*L*: is the gray scale level number in the two images

From the results of PSNR in hiding nine images and adding noise in tables 1,2,3,4, we can hide and transmit image in one cover image instead of hide and transmit images in multi-cover images and that lead to reduce time and capacity (means amount of secret information that can be inserted in a cover media) that we need it. Also we noted that the proposed method is successful by using filters to remove the noise from the cover image [10].

**Table 1: Adding Gaussian noise and using Gaussian filter**

| Results | Original image vs.stego image by LSB (without noise) | Original image vs. noisy stego image by LSB | Original image vs.filtered noisy stego image by LSB |
|---|---|---|---|
| 0.01 Gaussian noise | | | |
| PSNR (dB) | 43.0662 | 20.5131 | 24.2239 |
| Correlation | 0.9993 | 0.8969 | 0.8971 |

**Table 2: Adding Gaussian noise and using median filter**

| Results | Original image vs.stego image by LSB (without noise) | Original image vs. noisy stego image by LSB | Original image vs.filtered noisy stego image by LSB |
|---|---|---|---|
| 0.01 Gaussian noise | | | |
| PSNR (dB) | 43.0662 | 20.5131 | 27.5094 |
| Correlation | 0.9993 | 0.8969 | 0.9769 |

**Table 3: Adding salt and pepper noise and using Gaussian filter**

| Results | Original image vs.stego image by LSB (without noise) | Original image vs. noisy stego image by LSB | Original image vs.filtered noisy stego image by LSB |
|---|---|---|---|
| 0.01 salt and pepper noise | | | |
| PSNR (dB) | 43.0662 | 24.7706 | 28.3274 |
| Correlation | 0.9993 | 0.9582 | 0.9817 |

**Table 4: Adding salt and pepper noise and using median filter**

| Results | Original image vs.stego image by LSB (without noise) | Original image vs. noisy stego image by LSB | Original image vs.filtered noisy stego image by LSB |
|---|---|---|---|
| 0.01 salt and pepper noise | | | |
| PSNR (dB) | 43.0662 | 24.7706 | 39.6582 |
| Correlation | 0.9993 | 0.9582 | 0.9985 |

*III. Histogram Analysis*

The cover image and the stego image histograms are obtained to illustrate that the statistical properties of the cover image are not influenced by changing 3-bits in some pixels. Therefore, if the histogram of stego image is equal to the original image histogram, then this means that proposed system was useful [10]. Figure (5) represents the results of histogram comparisons between the original cover image and stego image without adding noise, noisy image, and filtered noisy image. From figure 5, we noted that histogram of image (original) before hiding information is the same that after hiding information and also we noted that the effectiveness of using filters in removing noise to give the same histogram of original image with small different. Figure (5) represents the results of histogram when adding salt and pepper noise and median filter to filtering noise.

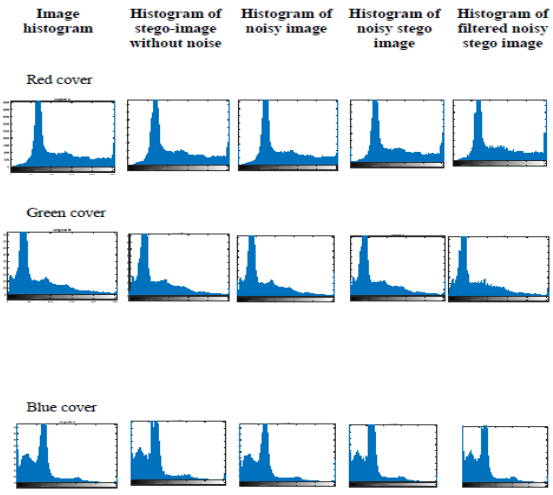


**Figure 5: Results of Histogram**

## 6. Conclusions

The simulation results show that, the proposed algorithm has high PSNR in hiding nine image without adding noise which means that: the stego-image (the image after hiding process) and the original image (the image before hiding process) cannot be remarkable by human eye and hiding images in one cover image instead of hiding images in multi cover images. As a result; reduction in capacity and time. Also; the proposed algorithm has reasonable PSNR in hiding nine image with adding noise and using filters to removing noise. The results of median filter is better than Gaussian filter. The performance evaluation of the proposed algorithm is done depending on parameter: MSE, PSNR, NC and histogram.

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