Hiding Compression Data in an Image Using ANN

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Abstract

In our modern age of technology, Steganography is one of the technologies applied to the transferred information to hide it through embedding secret messages in a certain medium to ensure the safety of this information that is sent and received over the internet without being changed and disclosed. The process of embedding takes place within the electronic multimedia which include (texts, images, audios, videos).

This research suggests a way to add more security to hide the information and data inside a colored image by using the Least Significant Bit algorithm after applying one of the artificial neural network algorithms on it to compress this data before embedding. The algorithm is (back propagation) to reduce the pixels in the image to be transferred other than through the internet. This method depends on the cover image for embedding compressed confidential data. The results showed the difference between the images before and after hiding through the statistical histogram of the images, and the same before and after the compression process in addition to the process of evaluating the quality of the method using the statistical histogram and the scale (PSNR) and (MSE) where the closer to zero, the better the result.

Keywords: Steganography, Least Significant Bit (LSB), Neural Networks, Compression Images, Peak Signal to Noise Ratio (PSNR), Mean Squre Error (MSE).

اخفاء البيانات المكبوسة في صورة
باستخدام الشبكات العصبية الاصطناعية

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المستخلص

في عصرنا الحديث للتكنولوجيا، تعد تقنية الاخفاء إحدى التقنيات المطبقة على المعلومات المنقولة لإخفائها من خلال تضمين رسائل سرية في وسيط معين لضمان سلامة هذه المعلومات التي يتم إرسالها واستلامها عبر الإنترنت دون تغييرها والكشف عنها. تتم عملية التضمين ضمن الوسائط المتعددة الإلكترونية والتي تشمل (نصوص، صور، صوتيات، فيديو).

يقترح هذا البحث طريقة لإضافة المزيد من الأمان لإخفاء المعلومات والبيانات داخل صورة ملونة باستخدام خوارزمية البت الاقل اهمية بعد تطبيق إحدى خوارزميات الشبكة العصبية الاصطناعية عليها لضغط هذه البيانات قبل التضمين. الخوارزمية هي (الانتشار الخلفي) لتقليل وحدات البكسل في الصورة المراد نقلها من خلال شبكة الإنترنت. تعتمد هذه الطريقة على صورة الغلاف لتضمين البيانات السرية المضغوطة. أظهرت النتائج الفرق بين الصور قبل وبعد الإخفاء من خلال الرسم البياني الإحصائي للصور ونفس الشيء قبل وبعد عملية الضغط بالإضافة إلى عملية تقييم جودة الأسلوب باستخدام مقياس (PSNR) و(MSE) حيث كلما اقتربنا من الصفر، كانت النتيجة أفضل.

الكلمات المفتاحية: اخفاء المعلومات، البت الاقل اهمية، الشبكات العصبية الاصطناعية، الصور المكبوسة، نسبة الاشارة الى الضوضاء، متوسط مربع الخطأ.

Introduction

Presently, the use of the Internet has become the most common means of sending and retrieving information. To preserve this data more, it should be protected against all kinds of attacks. Thus, it was necessary to develop information security through the creation of new technologies and means in the field of data security, which included steganography. It is used to hide digital data within an electronic medium without any distortion or change in this medium. It hides data in a way that cannot be easily detected by the human visual system (HSV).

Most of the information steganography systems currently use multimedia files as covering media such as (texts, images, audios, videos), which are widely used in every internet connection. There are five different, modern types of steganography techniques for embedding confidential data. These types are divided according to the type of cover medium:

- Text-Steganography
- Image-Steganography
- Audio-Steganography
- Video-Steganography
- Protocol-Steganography

Generally, steganography is a form of covert technology in which the message between the sender and the recipient is hidden. It also deals with the embedding of confidential information inside files as opposed to encryption, where the message is visible after it is encrypted. Meanwhile, the watermark is concerned with protecting the copyright of digital data.

The most common technique in steganography is LSB, in which the least significant bits of the pixels are replaced with the message contents. This technology is the main method used to ensure the protection of information on the computer, and when it is used in color images it performs the embedding process in three color channels (red, green, and blue), while in gray images the embedding occurs in one color channel 8 bits per (pixel) of the image.

This paper is arranged as follows: Section 2 deals with the literature review. An introduction to the technique of information steganography and compression using neural networks is illustrated in sections 3 and 4. In Section 5, the proposed method is discussed in addition to the results, followed by the conclusions and future work in sections 6 and 7.

LITERATURE REVIEW

Many researchers worked on the security of hiding the information following the traditional method or technology, while others worked with artificial intelligence.

Pragati Manchanda et al [4] proposed a model that combines hiding information with facial recognition where it hides data in the way of (LSB) of pixels in addition to facial recognition as a passkey to log into the steganography application.

U. A. Md. Ehasn Ali et al [5] worked on a new method (LSB) to hide the image information by replacing it with a random location for the bit of pixels. As for Karthikeyan B et al [6], they used the Gray Code technique to hide text in a digital image and then decode it.

As for S. Vijay Ananth et al [7], they used the artificial neural network (levenberg marquaret) to hide the information by converting the entered confidential data into a graphic representation and a number and then embedding it in a thermal image which is the cover image before transmission.

K.P. Ravi Kumar et al [8] applied an artificial neural network technique to hide the information used to determine the best image and trying it for a set of images in a database.

Adnan Gutub et al [3] applied multi-bit steganography to multiple images to hide sensitive text on a personal computer and used image steganography to switch the least significant bits with the text to be hidden.

Eric Gyamfi et al [9] used LSB technology and the AES algorithm with a 256-bit key to hide confidential information in addition to proposing a methodology for hiding data in large

quantities by mixing encryption and steganography. The message is first encrypted using the AES (256-bit) algorithm and the encryption result (the encrypted message) is hidden inside an image using LSB insertion.

Zinia Sultana et al [10] proposed a method for combining the LSB algorithm with AES 128 bit encryption and a new method for selecting the image pixel index and an improved hiding tool used in the proposed method.

D. Antony Praveen Kumar et al [11] also used the (LSB) method with another secret method (QR code pattern image) to hide the message, thus increasing the efficiency of the proposed system.

While Sujarani Rajendran et al [12] proposed a new technique for hiding images based on symmetric key as well as generating pseudo-random keys to randomly select the pixel location of the cover image in order to give more secrecy. Further, K.S. Seethalakshmi [13] used neural networks to determine the best locations in the overlay image to embed confidential data and improve image quality.

Deepesh Rawat et al [14], they referred with their research to the use of data hiding technique using enhanced substitution method (LSB) for a color image (24 bit) capable of producing a confidential embedded image.

Whereas Richa Khare et al [16], used an artificial neural network to hide the information contained in the less important bits of the chosen image for the video.

In this paper, both gray and color text and images were used as a secret message. The 24-bit color image was used as a cover image, which includes three channels of colors. Each 8-bit channel is divided into the red, green and blue channels, with many differences in the series used.

Mainly, the work is divided into two major steps. The first step is to compress the secret message (image) into one of the algorithms of neural networks, the most famous of which is (back propagation neural network) because it is one of the most successful algorithms applied to the issue of data compression. Image compression is a representation of an image with fewer bits, thereby reducing the possibility of sending errors. The compressed image or data passes through the network input layer and then through a small number of hidden neurons in the hidden layer. The compressed features of the image are stored. Thus, the fewer hidden neurons, the higher the compression ratio.

The second step is the process of hiding the secret message inside the cover image using the least significant bit algorithm widely used in the techniques of steganography. It was performed in four types of (LSB) in 1bit, 2bit, 3bit and 4bit in order to hide a larger amount of information and obtain a higher storage space. This method succeeded in hiding the secret message without any distortion of the original image or the possibility of noticing the changes occurring in it.

STEGANOGRAPHY

The great development in information technology and internet has increased the demand for a secure communication environment. The protection of data sent via internet has become a major problem in the global internet network given the huge increase in the number of users. Therefore, we need to ensure the security of the secret storage of the transferred information. Steganography is an important branch of information steganography and plays a role in the transfer of confidential data through insecure communication networks, as the process of hiding has recently gained much attention around the world. Steganography is a kind of processing used to hide confidential content in multimedia formats so that the unintended observer does not realize the hidden messages in the carrier file, such as a picture. As a result, the secret message can be hidden. Thus, the main objective of hiding the information is to embed communication content in public coverage media and to hide the message.

Steganography is a safety technique that focuses on hiding confidential messages as they pass through the communication carrier. The formula for the hiding process is:

Cover_medium + hidden data = stego_medium.

Cover_medium is the medium used to hide data. The result medium is stego_medium.

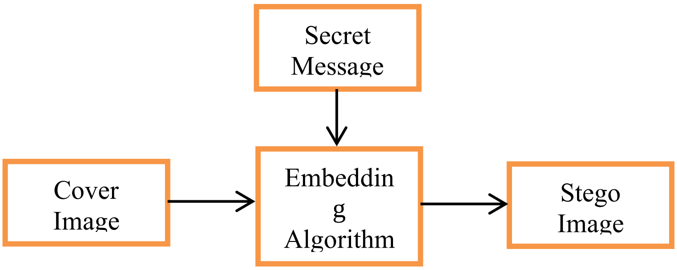


Fig (1): Block Diagram of Image Steganography

The stego image comes from a secret message hidden inside the image.

Steganography is classified into three categories: [5]

- Pure steganography: there is no stego key and the other parts are not informed about the communication.
- Secret key steganography: the stego key is exchanged prior to communication.
- Public key steganography: a public key and a private key are used to secure the communication.

Methods of image steganography can be divided into two groups, considering the data being used during the embedding.

1. Spatial / Image Domain Technique.
2. Frequency / Transform Domain Technique.

In the first group (spatial field technology) the pixels of the image file are changed directly in order to embed confidential data, which is the area followed in this research. An example of the spatial field technology is the LSB method, in which the confidential information within the pixel value of the overlay image is directly hidden. However, the color image is stored at 24-bit depth, and the gray image is stored at 8-bit depth. Meanwhile, the second group (bandwidth technology) the conversion parameters are adjusted instead of the pixel value.

IMAGE COMPRESSION USING ANN

Image compression has become the modern and important trend in information technology and the internet these days, especially after applying it using modern intelligent technologies. In order to maintain privacy and protect the contents of the image, image compression is an essential matter that obligates storing images, transferring or displaying them quickly and efficiently. It also plays a vital role in communications and technology, because it focuses on solving the problem of reducing the amount of data required to represent the digital image. Data compression through several different applications is more effective.

The goal of compression is to reduce the number of bits as much as possible, while maintaining the accuracy and optical quality of the reconstructed image, and this is done by applying compression through one of the neural network techniques. An artificial neural network is the modern tool in compression of images because it processes data in parallel and thus requires less time and is superior to any other technology.

Recently the network used is the multi-layer front feeder network because of its efficiency with choosing the appropriate learning algorithm and using image compression technology to reduce the number of bits required to represent it, which helps to reduce storage space and transmission cost. It is necessary to store, transfer or display images quickly and efficiently.

BACKPROPAGATION NEURAL NETWORK

Backpropagation network is one of the most successful neural network algorithms that compress data or images. Many research studies are being conducted on working on compressing images using the backpropagation training algorithm. Thus, the main role of the compression process is to reduce the number of pixels.

The goal of this network is to train the internet to balance the ability to respond correctly to the input patterns used in training and the ability to provide good responses to similar inputs. The backpropagation neural network algorithm helps to increase system performance and reduce network training time in order to reduce storage space and transportation costs with Maintain quality.

The backpropagation algorithm for training a forward feeding neural network includes several steps to split a large image into smaller windows for image compression operations.

Training through the neural network is one of the methods of image compression to eliminate redundancy because it processes data in parallel and this requires less time.

As shown in Figure (2), the input layer consists of a group of pixels as input from the image specified as a secret message, and by training the weights on it, the hidden layer is made containing the compressed image information. Using the different learning rule to train the multi-layered neural network to obtain the compressed data, and the compressed data (stored in the hidden layer) preserves the complete information and thus the hidden layer output will be the compressed image.

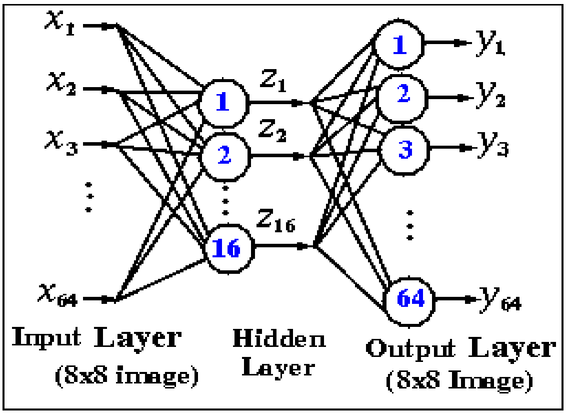


Fig (2): Architecture of Backpropagation Network

THE PROPOSED WORK

It has become easy to intercept information sent over the internet, in order to see the contents of confidential messages or to steal important information or try to change it. The proposed new method for preserving confidential information and preventing it from any attacks may lead to its disclosure. The proposed method uses LSB technology in the hiding process and the artificial neural network in the compression process, because the image transfer process after hiding takes time, especially if the space is large. However, by using the compression process, the storage space and time are also reduced. Further, the neural network will be used for image compression. Two types of multimedia (text and image) were used as secret messages, while color pictures were used as cover mediums.

In the proposed work, the compression of the secret image was used before hiding it in the overlay image, to reduce the number of bits that represent the secret message, and to make the system performance better and time short.

Compression is done by means of a multi-layered back propagation neural network and using a learning algorithm to train this network which consists of an input, hidden and output layer. The image is divided into small sections as an input to the input layer and the network is trained on these sections of the images while generating random weights in the training process where the output of the hidden layer is the compressed image. Then the compressed image is embedded in the cover image.

The suggested method includes two types of hiding confidential messages:

- The first is to hide a text in a color image: the text is converted into a series of bits, and then these bits are hidden in every three bytes of the red, green and blue color channel of the image pixels, thus hiding three orders in one pixel of the image. In this way, we hide the largest number of text characters.
- The second is hiding an image, and it is of two types:

1- Gray image: it is monochromatic as it hides the bits in one bit for each color model (RGB) and one byte of a pixel takes three pixels of the overlay image.
2- Color image: The color model contains three 8-bit channels for each (R, G, and B) values. The secret image bits per pixel are hidden in the four types of LSB (1bit, 2bit, 3bit and 4bit). The proposed work for this purpose is illustrated in Figure (3).

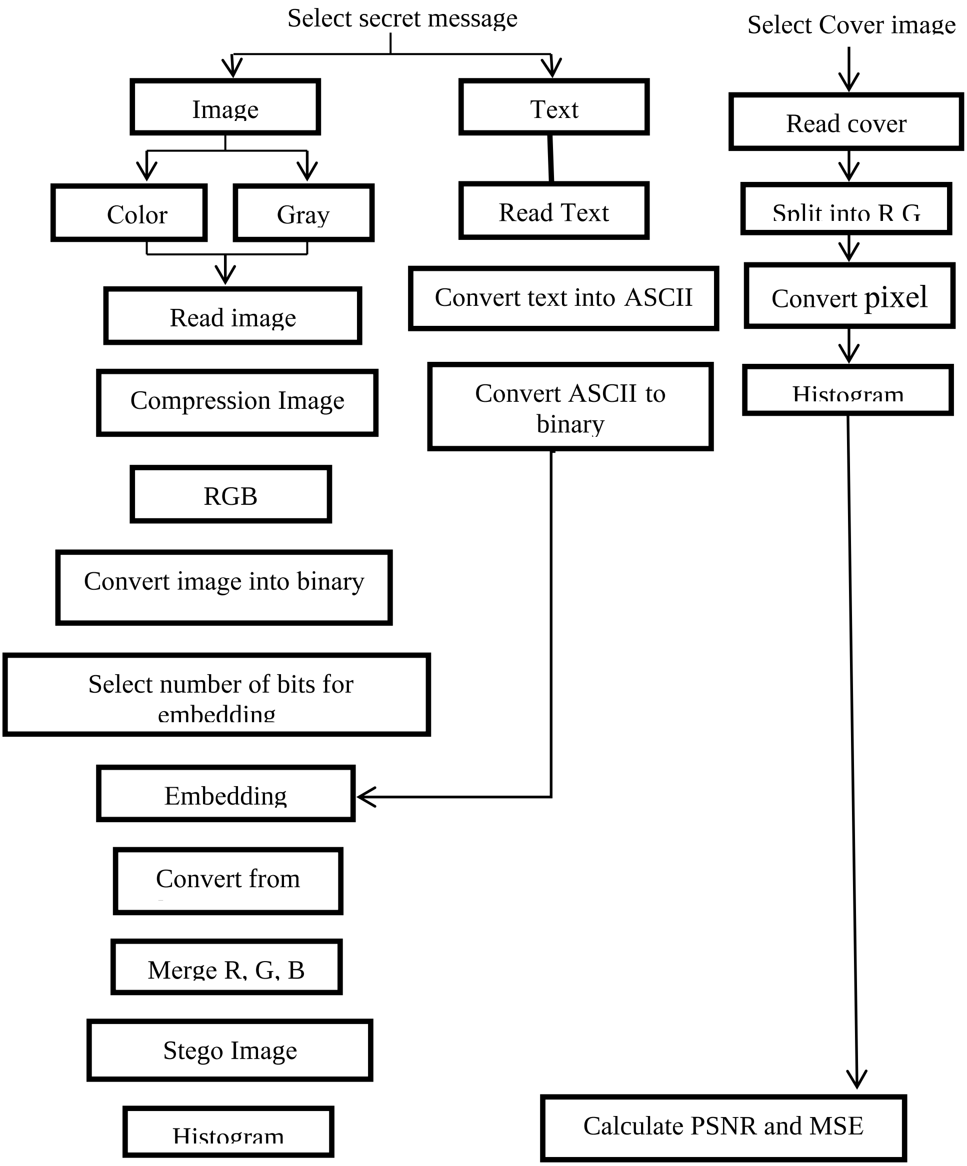


Fig (3): The produced work

Step 1: Choose a cover image: Use color image files as cover medium for embedding confidential messages. We divide the image into three channels of colors (R, G, B).

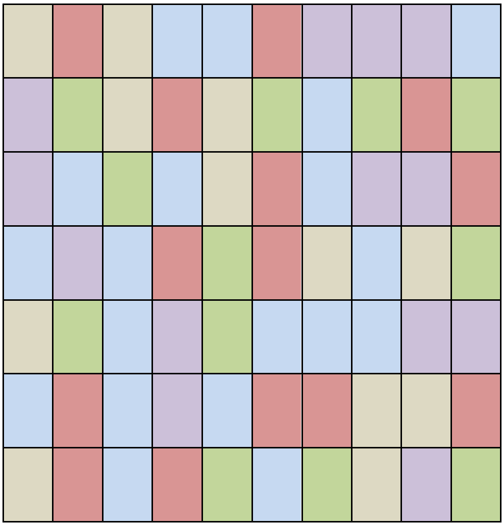
Step 2: Configure the secret message: In this step, the secret message is determined and it can be a text or an image (gray or color). Each person needs several steps to prepare the message and make it ready to hide.

- If the secret message is a text, then the steps of the algorithm are as follows:
  1- Select the text you want to hide
  2- Read the secret text
  3- Convert the text into ASCCII code
  4- Convert the code into binary bits
  5- Choose the number of bits to hide in the overlay image. Go to step 7.
- If the secret message is an image, the following steps must be followed:
  1- Create the desired image for hiding
  2- Choose the image (gray or color)
  3- Read the secret photo

Step 3: Image compression: In this step, the covert image is compressed using the backpropagation neural network algorithm before hiding it in the overlay image. This network is created and trained on the inputs to be the resulting compressed image.

Step 4: RGB plane: The secret message is divided into three color values (Red, Green, Blue) in (RGB) model, to be used in the masking process to represent the points.

Step 5: Convert image to binary bits: After the image is divided into RGB, each pixel of the secret image is converted into a binary value to start the embedding process in the overlay image after specifying the required number of bits in the LSB algorithm as shown in Figure Number (4).



RGB (127,142,150)
R = 11111111
G = 10001110
B = 10010110

Step 6: Choose the number of bits to embed: Determine the number of bits to find out how many pixels you need to hide a byte from the secret image.

Step 7: Embedding process: During this step, LSB algorithm is applied and used to hide secret messages in color images. The inclusion in this step depends on the number of bits required to mask the cover image.

There are four cases of including the least significant bit and replacing it with the required bit and the result is a stage after the embedding process. The cases are:

- **Step 7.1: (1LSB):** Hiding is done within 1 bit of the overlay image for each pixel (RGB) value. Each pixel is 8-bits of red, 8-bits of green, and 8 bits of blue. When embedding, each pixel of the confidential message needs three pixels of the overlay image. The formula for hiding the first pixel bit of the secret image was adopted in the first bit of the least significant bit side of the red color model in the overlay image. Then the second bit of pixel for the secret image in the first bit on the side of the least significant bit of the green color model. Then the third bit of pixel for the secret image in the first bit on the side of the least significant bit of the blue color model for the same pixel from the overlay image. The fourth bit of the secret image is hidden in the first bit of the red model of the second pixel, and so on, as shown in Figure Number (5).

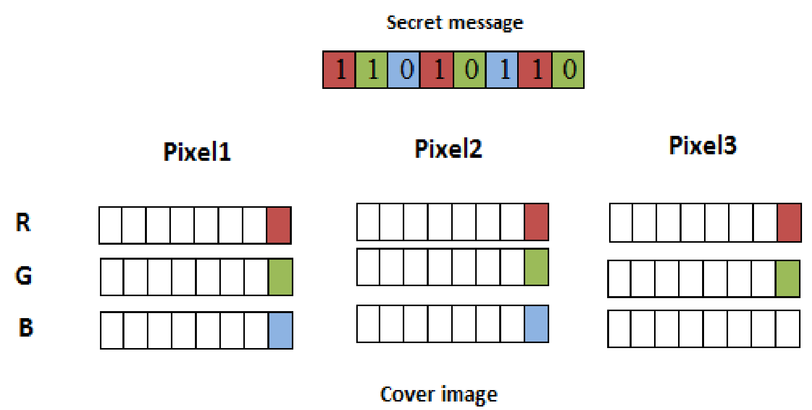


Fig (5): Least Significant Bit Embedding (1-bit)

– **Step 7.2: (2LSB):** In this case, hiding each pixel of the secret image needs two pixels of the overlay image. Whereas the second pixel only needs the red color value for the embedding process.

Replace the first two bits of the pixel of the secret image with the first two bits of the least significant bit of the red model in the chosen pixel in the overlay image. Also, replace the second two bits with the first two bits of the green pattern and continue to hide the third two bits instead of the first two bits of the blue model for the same pixel, as shown in Figure Number (6):

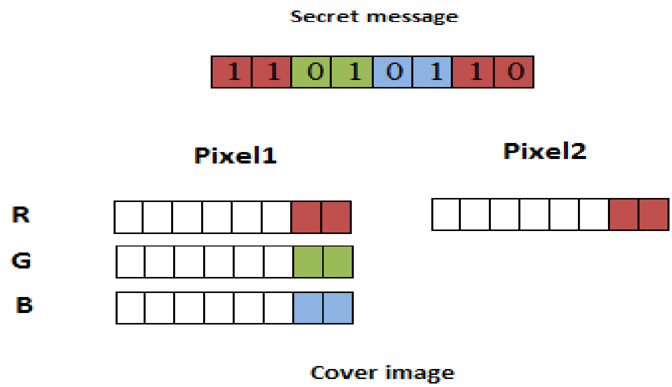


Fig (6): Least Significant Bit Embedding (2-bit)

- **Step 7.3: (3LSB):** Figure (7) illustrates the case of embedding that requires a single pixel to be hidden. The first three bits of the secret image are included instead of the first three bits of the least significant bit side of the red model, and the second three bits instead of the first three bits of the green model. As for the remaining bits, they are embedded in the first bits of the blue color model.

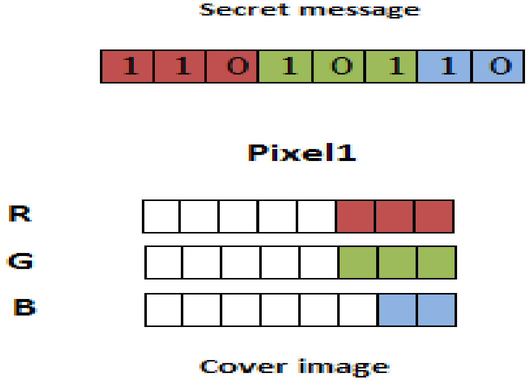


Fig (7): Least Significant Bit Embedding (3-bit)

– **Step 7.4: (4 LSB):** The human visual system can recognize simple message hiding in the 4-bit embedding type image. Certain changes become apparent to the human eye at certain points due to increased bits per pixel.

The last case is to embed the first four bits of the secret image in the first four bits of the red color model from the pixel of the overlay image. It is also embedding the other four bits within the first four bits of the green color model, so this type needs one pixel for every 8 bits of the secret message, as in Figure Number (8).

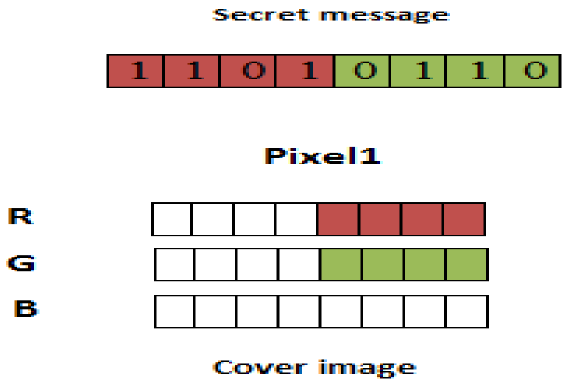


Fig (8): Least Significant Bit Embedding (4-bit)

Step 8: Convert from binary to decimal.
Step 9: Combine RGB values for each pixel: After the hiding process, the values of the three models (R, G, B) are merged together for each pixel to obtain a color image (24-bit) that contains inside the secret message, whether text or image.
Step 10: Calculate histograms for the overlay and stego images: This step gives details on the number of pixels for each value and the distribution of the color value in the image. The histograms for the overlay and stego images are also calculated.
Step 11: Calculating PSNR, MSE: The (PSNR, MSE) value of the overlay image is calculated as compared to the stego image following the equations (1) and (2).

The related performance measures of the proposed system are as followed: The PSNR and MSE between the cover and stego image are calculated using equtaion (1) and (2) [8], [6].

1- **Mean Square Error (MSE):** used to estimate the average of the squared errors. It is the square of error between cover and stego objects and it is measured using MSE as per equation (1).

MSE = 1N 2 (X1ij - X2ij) 2 N j = 1 N i = 1 (1)

Where N: Size of images
cover image pixels intensity values: X1 ij
Stego image pixel intensity values: X 2ij.

2- **PSNR: Peak Signal to Noise Ratio:** used to find the relationship between the maximum power of signal and the noise. It gives quality of stego image compared to the overlay image, i.e., the noise present in the overlay image is measured using equation (2).

PSNR = 10log10 (2552 / MSE) dB (2)

RESULTS AND DISCUSSION

In order to expand the scope of application and adopt different types of images, the LSB steganography algorithm, the compression process for the confidential image, and the possibility of obtaining different sizes and areas of hiding with a variable size of the secret image were applied. The proposed work was implemented using Matlab environment (2016a) and the image used as an overlay is a (512512x) color jpg type image with its statistical histograms, as shown in Figure (9).

The confidential message (text) type was embedded using a variable size algorithm (LSB) into the color overlay image after converting it into binary bits and hiding them in the least significant bit of the byte of the pixel. The results of the image after hiding confirmed the quality of the algorithm. Figure (10) shows an example of an image on which text hiding tests were performed. In addition, images were used as confidential messages, which may be gray or colored, and with different types of images after compression with one of the artificial neural network algorithms (backpropagation NN) to obtain a secret compressed image, as shown in Figure (12).

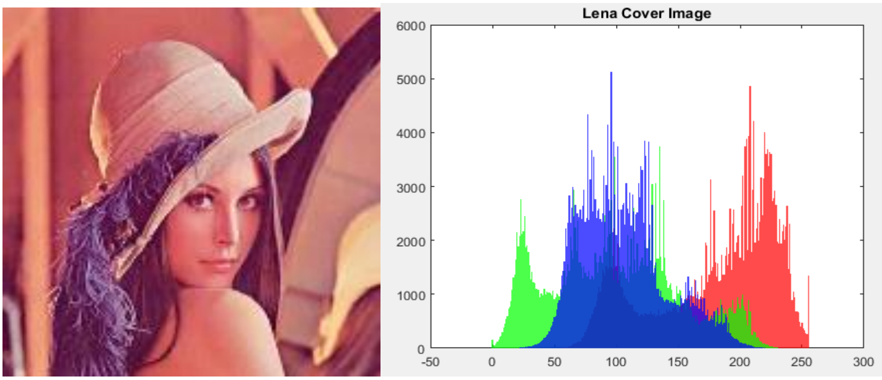


Fig (9): Lena Cover image with histogram

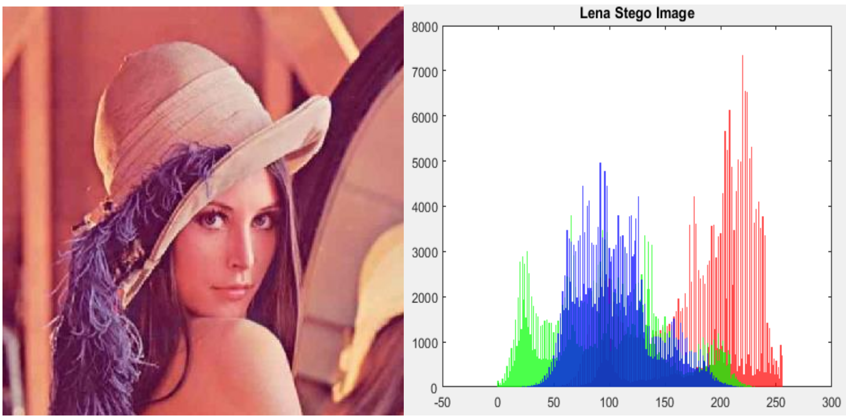
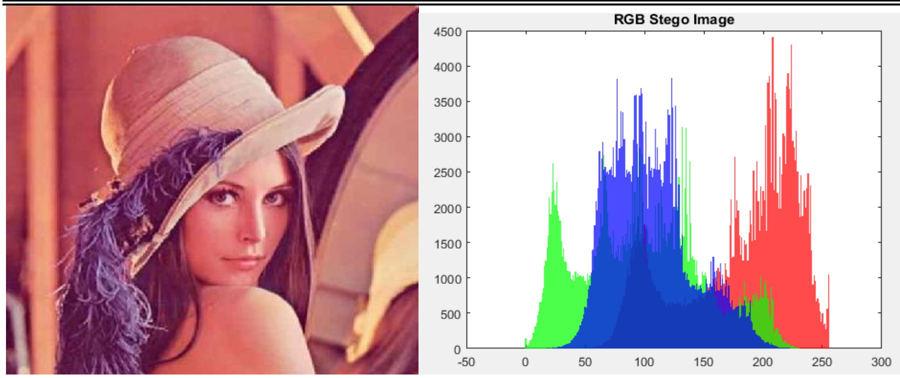


Fig (10): stego image with histogram after hiding text

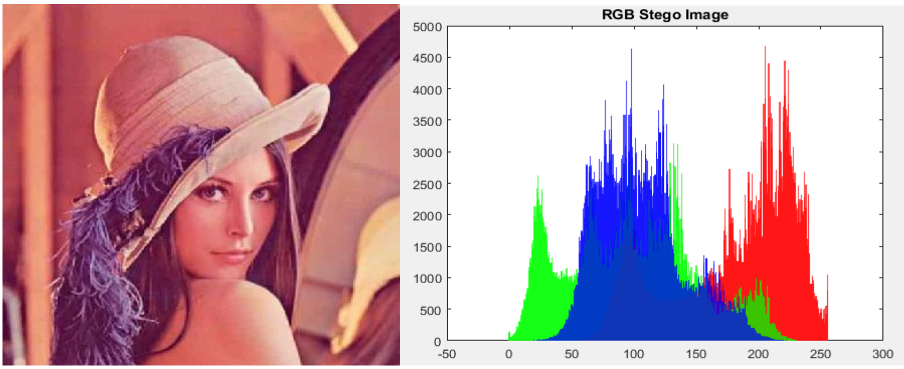
(a) 180x175 **(b) 250x250**

(c) 300x250 **(d) 350x350**

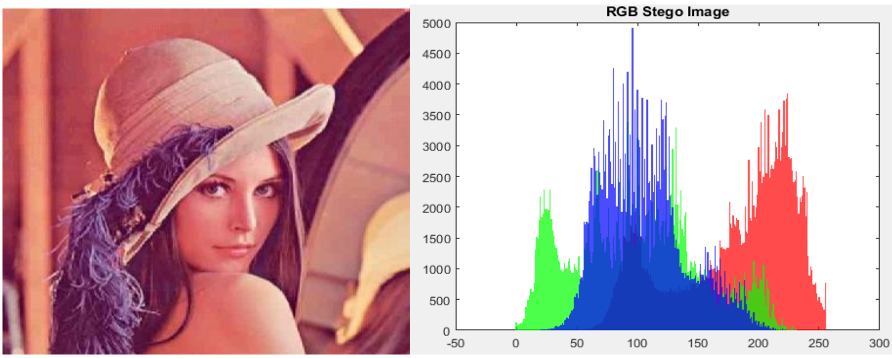
Fig (10): different Secret color image with different sizes



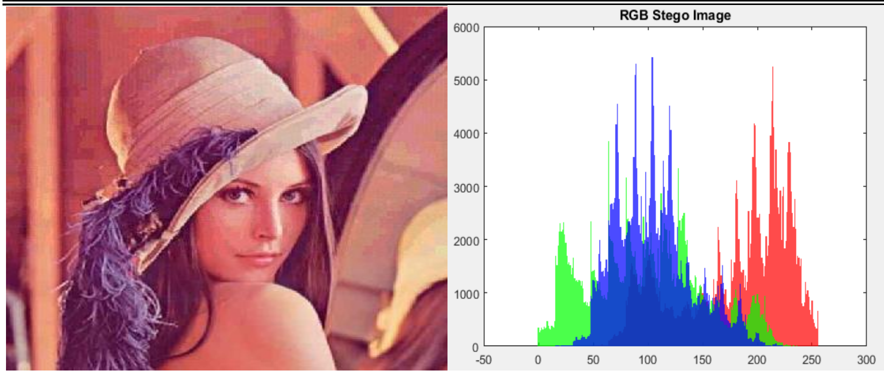
(a) 1-bit LSB with hiding image size 350X350



(b) 2-bit LSB with hiding image size 300X250



(c) 3-bit LSB with hiding image size 250X250



(d) 4-bit LSB with hiding image size 180X175

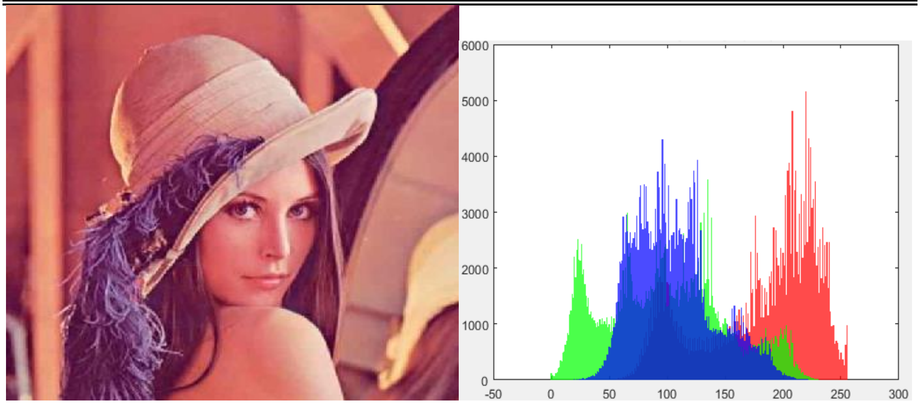
Fig (11): Stego image with histogram in case hiding 1bit, 2bit, 3bit and 4bit (LSB)

(a) 180x175

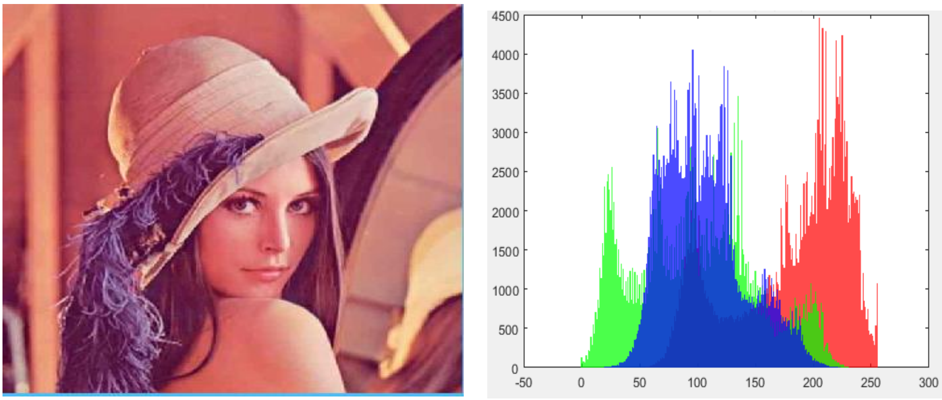
(b) 256x256

(c) 399x400

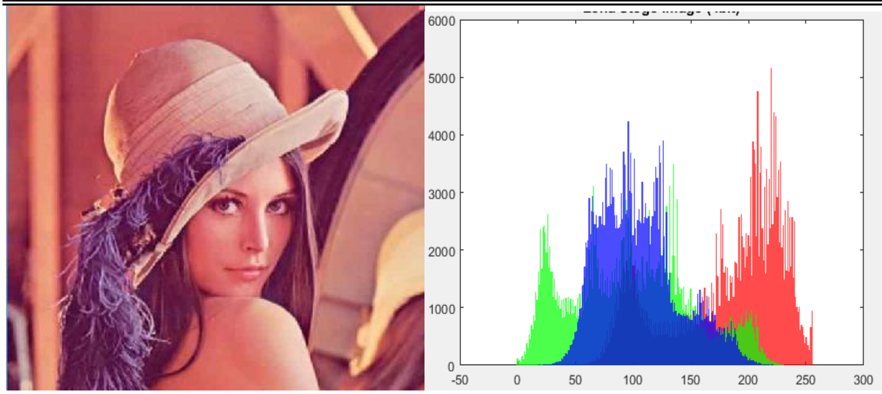
Fig (12): different Secret gray image after compression image with different sizes



(a) Hiding 1 bit.



(b) Hiding 2 bit.



(c) Hiding 3 bit.

Fig (13): Stego image with histogram in case hiding 1bit, 2bit, 3bit compressed gray image

The variations PSNR and MSE value for a different secret gray image with Lena overlay image of size 512x512 with several cases of Least Significant Bits (LSB) are tabulated in Table 1.

Table (1): PSNR and MSE value between Lend overlay and different secret compressed image

LSB	PSNR	MSE
1 bit	53.1160	0.3173
2 bit	53.1066	0.3180
3 bit	53.1024	0.3187

CONCLUSION

In this proposed work, we presented a method to make the data security process stronger and more durable by adopting intelligent techniques in the process of compression of confidential data in addition to the hiding process, which added to the proposed work strength and quality. The proposed method includes the process of hiding the confidential data (text, gray image, color image) in the middle of the overlay in addition to the use of the process of compressing the confidential data using one of the neural network techniques that is used to reduce the number of bits to represent the required image. This way helps reduce data storage space and transmission cost. Further, it is essential to store or transfer images quickly and efficiently. The steganography process involved hiding the confidential data in the overlay image with more than 1bit, 2bit, 3bit, and 4bit) using the LSB algorithm. The comparison between the overlay image and the stego image is illustrated with the help of the PSNR, MSE value. The results proved the quality of the proposed method of hiding in color images after passing through a number of steps, depending on the standard PSNR, MSE.

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